Acland's DVD Atlas of Human Anatomy

Transcript for Volume 1

PART 1

THE SHOULDER

00.00

The best way for us to learn about the upper extremity is to begin at the very beginning, right up here. We'll start by looking at the bones of the shoulder region: the clavicle, the scapula and the humerus. Then we'll look at the joints that let them move, and the muscles, which make them move. Lastly we'll look at the principal blood vessels and nerves in the region. First, the bones.

00.30

BONES, JOINTS AND LIGAMENTS

The bones that connect the upper extremity to the trunk are the clavicle, or collar bone, and the scapula, or shoulder blade. The parts of them that we can feel beneath beneath the skin can be seen in this dissection: here's the spine of the scapula, here's the clavicle. In the dry skeleton, here's the clavicle, here's the scapula.

01.00

The proximal long bone of the upper extremity, the humerus articulates with the scapula at the shoulder joint. The scapula and clavicle articulate with the bones of the thorax at one point only, here, at the sternoclavicular joint.

01.19

The lateral end of the clavicle articulates with this projection on the scapula, the acromion, forming the acromio-clavicular joint. Apart from this one very movable bony linkage, the scapula is held onto the body entirely by muscles. It's thus capable of a wide range of movement, upward and downward, and also forward and backward around the chest wall.

01.50

Looking at the clavicle from above we can see that it's slightly S-shaped, with a forward curve to its medial half. At its medial end this large joint surface articulates with the sternum. At the lateral end this smaller surface articulates with the scapula. On the underside, massive ligaments are attached, here laterally and here medially.

02.21

The scapula is a much more complicated bone. The flat part, or blade, is roughly triangular with an upper border, a lateral border, and a medial border. The blade isn't really flat, it's a little curved to fit the curve of the chest wall.

2.42

This smooth concave surface is the glenoid fossa. It's the articular surface for the shoulder joint. Above and below the glenoid fossa are the supraglenoid tubercle, and the infraglenoid tubercle, where two tendons are attached as we'll see.

03.02

A prominent bony ridge, the spine of the scapula, arises from the dorsal surface, and divides it into the supraspinous fossa, and the infraspinous fossa. At its lateral end the spine gives rise to this flat, angulated projection, the acromion, which stands completely clear of the bone. The clavicle articulates with the scapula here, at the tip of the acromion. This other projection, looking like a bent finger, is the coracoid process.

03.40

Here's how the clavicle and the scapula look in the living body. Round the edge of the shallow glenoid fossa, a rim of fibrocartiilage, the glenoid labrum, makes the socket of the shoulder joint both wider and deeper. This flat ligament, the coraco-acromial ligament, joins the coracoid process to the acromion. Here's the acromio-clavicular joint. Two strong ligaments, the trapezoid in front and the conoid behind, fix the underside of the clavicle to the coracoid process. There's very little movement at the acromio-clavicular joint.

04.16

As we've seen, the medial end of the clavicle articulates with the sternum at the sterno-clavicular joint. Strong ligaments between the clavicle and the sternum and between the clavicle and the underlying first rib, keep the two bones together but permit an impresssive range of motion: up and down, and backward and forward.

04.42

Now let's see how the clavicle and the scapula move, relative to the trunk. Upward movement of the scapula is called elevation; downward movement is called depression. Forward movement around the trunk is called protraction; the opposite movement is retraction. This movement is called upward rotation. The opposite movement is downward rotation. In real life these movements of the scapula are often combined.

05.16

The range of motion of the scapula provides fully one third of the total range of motion of the humerus, relative to the body, sometimes more. Without this movement of the scapula, we'd only be able to abduct our arm to here. That's as far as the shoulder joint goes, before bone hits bone. It's scapular movement that lets us get all the way to here.

05.41

Now let's look at the shoulder joint. To understand the shoulder joint, let's get acquainted with the upper half of the humerus.

This is the head of the humerus. The articular surface is half of a sphere. On the anterior aspect is a well marked groove known as the bicipital groove, because the tendon of the long head of the biceps runs in it. At the proximal end of the groove are the lesser tubercle, and the greater tubercle. Because it's between two tubercles, the bicipital groove is also known as the inter-tubercular groove. Down here on the lateral aspect of the humerus, almost halfway down the bone, is a rough spot, the deltoid tubersosity.

06.21

Here's the shoulder joint, also known as the gleno-humeral joint. This loose sleeve of tissue which encloses the joint is the joint capsule. The capsule doesn't hold the bones together, it's quite a weak structure. What it does is to permit movement. The structures which hold the two bones together are muscles, as we'll see. Here's the tendon of one of those muscles.

06.48

Let's look at the movements that can occur at the shoulder joint. Movement forward and upward is called flexion. Movement downward and backward is called extension. Movement away from the side of the body is ab-duction. The opposite movement is ad-duction. Rotation which moves the front of the arm towards the body, is internal rotation. Rotation the other way is external rotation.

07.23

Now that we've taken a look at the bones, joints and ligaments, let's spend about a minute reviewing what we've seen so far.

07.30

REVIEW

Here's the clavicle, for an easy start. On the scapula here's the blade, the glenoid fossa, the supraglenoid, and infraglenoid tubercles, the spine of the scapula, the supraspinous and infraspinous fossa the acromion, and the coracoid process.

07.57

Here's the proximal humerus, with the head, the greater tubercle and lesser tubercle, the bicipital groove, and the deltoid tuberosity.

08.12

Here's the sterno-clavicular joint, and here's the acromio-clavicular joint, with the conoid ligament and the trapezoid ligament.

08.24

On the scapula, here's the glenoid labrum, and the coraco-acromial ligament. Lastly, here's the capsule of the shoulder joint

08.37

MUSCLES

Now let's move on to look at the muscles. We'll build our understanding pretty much from the inside to the outside. First we'll look at the deepest muscles, the ones that go from the scapula to the humerus. Then we'll look at the ones that go from the trunk to the scapula, and lastly we'll look at the big three muscles on the outside, which cover up almost all the others.

09.05

MUSCLES PASSING FROM SCAPULA TO HUMERUS

Before we look at any shoulder muscles, we need to take note of the tendons of two long elbow muscles, which arise very close to the shoulder joint, and lie deep to everything else.

09.15

They're the tendons of the long head of the biceps, and the long head of the triceps muscles. The long head of triceps arises here, from the infraglenoid tubercle. The long head of biceps arises, surprisingly, here from the supraglenoid tubercle. To get there, it passes inside the joint capsule, and right over the top of the head of the humerus.

09.43

Now let's look at the four short muscles which hold the shoulder joint together. There are three on the back, one on the front. The one on the front is subscapularis. It arises from almost almost all of the anterior, or costal aspect of the scapula. Its tendon inserts here, on the lesser tubercle.

10.05

Subscapularis, acting alone, produces internal rotation of the humerus. Acting with the other three short muscles, it holds the humeral head and the glenoid fossa together, while other, more powerful muscles are at work.

10.20

On the back, there are two muscles below the scapular spine, and one above it. The one above is supraspinatus. It arises from almost all of the supraspinous fossa. It passes under the acromion and inserts here, on the greater tubercle.

10.41

The tendon of supraspinatus runs through a tight spot, between the acromion and the head of the humerus. There's a synovial lined pocket, a bursa, here between it and the acromion. Supraspinatus initiates abduction of the humerus.

11.01

The two muscles below the spine are infraspinatus and teres minor. Between them, they arise from almost all of the infraspinous fossa, infraspinatus here, teres minor here. Infraspinatus inserts here on the back of the greater tubercle, teres minor just below it. Both these muscles produce external rotation of the humerus.

11.28

These four short muscles: subscapularis, supraspinatus, infraspinatus, and teres minor, converge on the humerus to form an almost continuous cuff of flat, supporting tendons, often referred to as the rotator cuff. It's these tendons together with the long head of the triceps down here, which keep the head of the humerus from sliding out of its very shallow socket.

11.58

There are two other muscles to note, that also run from the scapula to the humerus, one on the front, and one on the back. The one on the back is teres major. It arises here, from the lower lateral border of the scapula, and inserts here, on the crest of the lesser tubercle. Teres major is quite a powerful ad-ductor of the humerus.

12.22

On the front here's coraco-brachialis. It arises from the coracoid process. It inserts down here, on the humerus. Coraco-brachialis helps to flex the shoulder joint.

12.40

Altogether there are seven muscles that go from the scapula to the humerus, and so far we've seen six of them. The last one, the deltoid, is so big that it covers up almost everything else, so we'll leave it out of the picture till the very end.

12.54

MUSCLES PASSING FROM TRUNK TO SCAPULA

Now it's time to look at the muscles which hold the scapula in place, and move it in relation to the trunk. There are six of them, four on the back, one in the front, and one underneath.

13.04

The one on the underneath is the large and powerful serratus anterior muscle. This is just part of it. To see it all, we need to move the scapula away from the body. This big expanse of muscle is all serratus anterior. It arises from the side and front of the first eight ribs. In runs back under the scapula, and it's inserted all the way back here, along the medial border of the scapula.

13.36

When the whole serratus anterior muscle contracts, it pulls the scapula forward around the rib cage: that's protrusion. When its upper, or lower fibers contract separately, they help to produce downward, or upward rotation of the scapula.

13.57

Now let's look at those four muscles on the back. One, the trapezius is large and superficial, the other three are small and deep. The three deep ones are levator scapulae, and the two rhomboids, rhomboid minor, and rhomboid major.

14.18

Levator scapulae arises here, on the outermost point of the first three cervical vertebrae. It inserts here, on the upper medial corner of the scapula. Levator scapulae helps to elevate the scapula. The rhomboids arise here, from the fourth cervical to the fifth thoracic vertebrae. They insert here, along the medial border of the scapula.

14.45

The rhomboids elevate and retract the scapula. The large muscle which overlies these three is the trapezius. It's a beautiful but complicated muscle. The trapezius has an upper part, and a lower part, which both converge on the spine of the scapula.

15.09

The upper part of trapezius arises from the occiput, and from the nuchal ligament, and from T1 to T3 in the mid-line. It's inserted along the upper edge of the spine of the scapula, around the acromion, and along the lateral third of the clavicle.

15.28

The lower part of the trapezius muscle is not so massive. It arises from T4 to T12 in the mid-line. It inserts here, on the lower edge of this part of the spine of the scapula. When the whole of trapezius contracts, it powerfully retracts the scapula. When the upper part contracts, it powerully elevates the scapula.

15.58

Last on the list of muscles passing from the trunk to the scapula is the one on the front. It's pectoralis minor. Pectoralis minor arises between the second and the fourth ribs. It's inserted on the coracoid process. Pectoralis minor produces depression of the scapula.

16.21

There are two very small muscles to mention just for completeness. One is subclavius which goes from the first rib to the clavicle. Its function is uncertain. The other is omohyoid, which arises from the hyoid bone way up here, and inserts over here, on the upper edge of the spine of the scapula. Its function is to depress the hyoid bone and the larynx.

16.51

PECTORALIS MAJOR, LATISSIMUS DORSI, DELTOID

Now we'll complete our picture by looking at three big external muscles: pectoralis major, latissimus dorsi, and deltoid.

17.00

Of these, the first two have much in common - pectoralis major on the front, and latissimus dorsi on the back. These two are alike, in that they both pass directly from the trunk to the humerus, bypassing the scapula. Between them they define the posterior and anterior walls of the axilla.

17.27

Pectoralis major arises from the medial third of the clavicle, from the front of the sternum, and from the front of the first six costal cartilages. It's inserted here, on the anterior edge of the bicipital groove.

17.41

Pectoralis major is a powerful adductor of the humerus. When its adducting effect is held in check by other muscles, it also produces internal rotation.

17.53

Latissimus dorsi has a very wide origin. It starts here, under the tail end of trapezius, at T7, and goes all the way down to the sacrum, and out onto the posterior iliac crest. It also has some fibers arising from the lower four ribs, and occasionally from the tip of the scapula.

18.18

It inserts here, on the posterior edge of the bicipital groove. To get to its insertion, the latissimus tendon has to spiral around teres major. Here's teres major. Latissimus spirals from the back, to the front, with the lowest fibers of origin ending up highest.

18.36

Latissimus dorsi, like pectoralis major, is a powerful adductor of the humerus. Acting through the humerus, it's also a powerful depressor of the scapula, powerful enough to overcome the whole weight of the body, as in doing a push-up.

18.52

Last of all, here's the deltoid muscle. It completely surrounds the shoulder joint from the front, to the back. It arises from the spine of the scapula, from the acromion, and from the lateral third of the clavicle. It's inserted here on the deltoid tuberosity of the humerus.

19.16

The deltoid muscle has multiple functions: it's almost like three different muscles. Its anterior part is a powerful flexor, its posterior part is a powerful extensor, and its lateral part is a powerful abductor.

19.36

Now that we've seen all the muscles that act on the scapula, and on the proximal humerus, let's review them. If you want to test yourself, turn off the sound.

19.50

REVIEW OF MUSCLES

Here's subscapularis, supraspinatus, infraspinatus, and teres minor. Here's teres major, and coracobrachialis,

20.14

Now the muscles that arise from the trunk: serratus anterior levator scapulae, the two rhomboids, minor, and major, trapezius, pectoralis minor, subclavius, and omohyoid; and lastly pectoralis major latissimus dorsi, and deltoid.

20.46

We've covered a lot of ground! I suggest you take a break before you watch the rest of the tape. Switch off for a while and start again in a few minutes.

21.05

BLOOD VESSELS

Now let's look at the veins, arteries and nerves of the shoulder region. As you'll see, the main bundle of vessels and nerves lies behind the clavicle, and behind both pectoral muscles, as it passes from the base of the neck to the underside of the upper arm. To understand how things are arranged up here, where the main vessels come up out of the chest, and the main nerves emerge from the vertebral column, there are some key structures that we need to understand: the first ribs, the cervical vertebae, and the scalene muscles. Let's take a look at them.

21.44

Here's the first rib, below and behind the clavicle. This much of it is bone and this much of it is costal cartilage. The two first ribs define the opening at the top of the chest: the superior thoracic aperture. The main artery to the upper extremity, the subclavian artery, crosses the first rib here. The subclavian vein crosses it here, right behind the medial end of the clavicle. Here are the vertebrae: the first thoracic with the first rib; and the seventh, sixth and fifth cervical. Let's take the clavicle away so we can see the vertebrae better.

22.30

The main spinal nerves to the upper extremity emerge here, between the transverse processes. The spinal nerves that we're concerned with are numbered C5, C6, C7, C8, and T1.

22.47

These two landmark muscles, the anterior scalene, and the middle scalene, which are attached to the first rib here, and here, guard the exit of these vital structures. The vein runs in front of the anterior scalene, the artery runs behind it. Between the two scalene muscles, the roots of the brachial plexus also emerge.

23.12

There are two posssibly confusing things that we have to live with. The first is that there's a nerve root named C8, even thought there's no eighth cervical vertebra. The second confusing thing is that the main artery and vein change their names as they go along: here they're called the subclavian vessels, here they're called tha axillary vessels, and from here on down they're called the brachial vessels. The structures themselves don't change, just the names.

23.40

Let's start by looking at the veins. We can be quite brief about this since the veins parallel the arteries in most important respects. It'll be helpful to start on the outside and progress inward, removing some muscles as we go along.

23.55

Here, in the groove between pectoralis major and deltoid, is the cephalic vein, coming up from the arm. It's a vein that doesn't have an accompanying artery. To see where it's going, we'll remove pectoralis major.

24.13

Here's the cephalic vein. Together with other veins from the shoulder region, it joins the main vein of the upper extremity, the subclavian vein. We'll focus our attention on this important vein. The subclavian vein comes up from the arm and passes beneath pectoralis minor. Emerging from beneath pectoralis minor, it passes over the outer surface of the first rib (here's the first rib) and under the subclavius muscle and the clavicle. To follow the subclavian vein further, we'll remove the clavicle, the subclavius muscle, and this muscle, the sternocleidomastoid.

24.58

Here we are, behind the medial end of the clavicle, which went from here (this is the cut end of the clavicle) to here. This was the sterno-clavicular joint. Here's pectoralis minor. Here's the curve of the first rib, and here's scalenus anterior. These structures, the subclavian artery, and the brachial pleus, we'll be seeing in a minute. Let's follow the vein. Just as the subclavian vein reaches the medial border of the first rib, which is here, it's joined from above by the main vein from the head and neck, the internal jugular vein. Together the subclavian and internal jugular veins form the brachiocephalic vein.

25.46

The brachiocephalic vein passes medial to the first rib, and enters the chest. The dome of the pleura lies immediately behind it: here's the pleura. To follow the brachiocephalic vein into the chest, we'll remove these muscles, and we'll also remove this part of the anterior chest wall. We'll also remove the other clavicle.

26.16

Now we're looking inside the chest. Here are the divided ends of the two first ribs; and here's the divided end of the sternum. Here are the two brachiocephalic veins, the right, and the left. A little to the right of the midline they jon together, to form the superior vena cava.

26.39

Apart from what we've just seen, the veins of the region correspond so closely to the arteries that we don't need to consider them separately.
We'll move on now, to look at the arteries. In the dissections that follow, all the accompanying veins have been removed, to simplify the picture.

27.00

To get a good look at the artery as it runs from here, to here, we need to remove pectoralis major. Now only three structures stand between us and it. Here's the artery, passing behind the anterior scalene muscle, behind the clavicle, and behind pectoralis minor. Three names for one artery: subclavian, axillary, brachial. Let's see where it begins.

27.31

Here's a deeper dissection with the chest wall removed. Here are the divided ends of the clavicle, the first rib, the anterior scalene muscle, and the second rib. In the middle we're looking at the trachea, and the common carotid arteries, the right, and the left. On the right side, the subclavan artery arises, along with the common carotid, from the brachiocephalic trunk, which in turn arises from the arch of the aorta. On the left side, the subclavian artery arises directly from the arch of the aorta.

28.13

In the early part of its course, as it passes over the dome of the pleura, the subclavian artery gives off some major branches, which we'll see in other parts of the Atlas. These are the internal thoracic, the thyrocervical trunk, and the vertebral. In addition, the subclavian gives off two branches to the back and shoulder region: these are the transverse cervical and the suprascapular arteries. These two are variable, sometimes they arise here, sometimes here.

28.44

The main artery, now called the axillary, next gives off two branches behind pectoralis minor. They're the thoraco-acromial, and the lateral thoracic arteries. In the axilla, three more branches arise, often close together: the subscapular, and the two circumflex humeral arteries, the anterior and the posterior. The posterior circumflex humeral winds round behind the neck of the humerus. Finally the artery, now known as the brachial artery, passes on down the upper arm.

29.23

NERVES

Now let's look at the nerves. Between about here and here, the five spinal nerves unite, and divide, unite again, and divide again. The tangle which this produces is called the brachial plexus. It's not really too formidable. At the end of the brachial plexus the four main nerves of the arm emerge: the musculo-cutaneous, the median, the ulnar, and the radial. In the course of the brachial plexus, the nerves that supply the shoulder region are given off. We'll look at the main components of the brachial plexus first, then at the local branches.

30.05

Here's the brachial plexus, with several of its small branches removed so we can see the big picture. We'll also remove pectoralis minor. Here are the five roots of the brachial plexus: they are in fact the ventral rami of their respective spinal nerves. They emerge, as we've seen, from between the anterior scalene and middle scalene muscles.

30.31

The top two roots join, and the bottom two join, and the middle one, C7, stays alone. These three big units are called the three trunks: upper, middle and lower. Each trunk divides (here's one of them dividing) into an anterior and a posterior division.

30.52

Of the three anterior divisions, the upper two unite, and the lower one stays alone. The three posterior divisions all unite, as we'll see in a minute.
Once that's all happened, there are again three big units, now called cords: lateral, medial and posterior. They surround the axillary artery.

31.19

The lateral cord divides, to become the musculocutaneous nerve, and one half of the median nerve. The medial cord divides, to become the ulnar nerve, and the other half of the median nerve. This arrangement produces an M-shaped pattern of nerves, musculocutaneous, median, and ulnar.

31.46

Now let's see the posterior cord. We need to remove the medial cord, the lateral cord, and the artery, to get a good look at it. Here's the posterior cord all by itself. Sometimes it starts dividing before all three of the posterior nerves have united. Its principal branches are the axillary nerve, which we'll see again, and the radial nerve.

32.12

Now that we've looked at the main components of the brachial plexus, let's look at the nerves which supply the muscles of the shoulder region. Some of these arise from the cords of the brachial plexus. Some arise in other ways. Let's look at the ones that arise from the cords first. We were looking at a simplified dissection before. Now we'll see the details.

32.33

The medial cord gives rise to one local nerve, the lateral cord to two. The one from the medial cord is the medial pectoral nerve. It's one of a pair. Here's its partner, the lateral pectoral nerve, which arises from the lateral cord. The pectoral nerves supply pectoralis major, and pectoralis minor.

33.00

Also arising from the lateral cord is the musculocutaneous nerve. It supplies three upper arm muscles, one of which we've seen: coracobrachialis. The other two we'll see in the next section.

33.14

The posterior cord (here it is again with all its branches intact) has four branches. The axillary nerve runs round the neck of the humerus, along with the posterior circumflex humeral artery, to supply the deltoid muscle, and also teres minor.

33.35

The subscapular nerves, an upper and a lower, supply subscapularis, and teres major. The thoracodorsal nerve supplies latissimus dorsi.

33.50

Now let's see the shoulder muscle nerves which don't arise from the cords of the brachial plexus. Of these, one is the branch of a trunk, two arise from the roots of the brachial plexus, and two aren't part of the plexus at all.

34.06

Arising from the upper trunk is the suprascapular nerve, which supplies supraspinatus, and infraspinatus. Arising from the C5 root and passing through the middle scalene muscle is the dorsal scapular nerve. It supplies the rhomboid muscles.

34.26

Arising from the C5, 6 and 7 roots, the long thoracic nerve emerges through the medial scalene muscle, runs deep to all three trunks of the brachial plexus, and supplies serratus anterior.

34.41

Trapezius gets its nerve supply from the spinal accessory nerve. Lastly levator scapulae gets a private nerve supply from the nearby roots of C3, 4 and 5.

34.55

We've looked at some prettycomplex and detailed anatomy in the last few minutes. Let's review what we've seen of the veins, arteries and nerves of the shoulder region.

35.06

REVIEW OF VESSELS AND NERVES

First, the few veins that we saw, the cephalic, subclavian, and brachiocephalic veins.

35.16

Next the arteries: the brachiocephalic trunk, the subclavian artery, the axillary, and the brachial artery; the transverse cervical, and suprascapular arteries. The thoracoacromial, lateral thoracic, subscapular, and anterior, and posterior circumflex humeral arteries.

35.52

Lastly nerves, starting with the main components of the brachial plexus. The roots of the brachial plexus, C5, C6, C7, C8 and T1. The three trunks, upper, middle and lower. Each trunk splitting into divisions, anterior, and a posterior. From the divisions, three cords arising, the lateral and medial from the anterior divisions, and the posterior from the posterior divisions.

36.36

Arising from the lateral, and medial cords, the musculocutaneous, medial and ulnar nerves, and the pectoral nerves, medial, and lateral.

36.52

Arising from the posterior cord, the axillary and radial nerves, also the subscapular nerves, and the thoracodorsal nerve. Arising higher up, the suprascapular nerve, the long thoracic nerve, and the spinal accessory nerve.

37.15

Understanding the shoulder region gives us a good foundation for understanding the upper extremity. In part 2 of the upper extremity we'll take a long trip, from here to here, and in part 3 we'll look at the hand.

37.37

END OF PART 1

PART 2

THE ARM AND FOREARM

00.00

In this section we'll go from the shoulder to the wrist. We'll look at the bones, joints and muscles that are involved in three different functions: elbow movement, forearm rotation, and wrist movement. We'll also look at the vessels and nerves, from the shoulder to just below the elbow.

00.26

A good many of the muscles that are in the forearm are finger and thumb muscles. We'll leave those muscles out of the picture in this section, and see them when we do the hand.

00.36

ANATOMICAL TERMS DEFINED

We need to give a clear meaning to our usual anatomic terms, medial and lateral, anterior and posterior. When we use those terms in the upper extremity, we imagine the extremity to be fixed in this so-called anatomic position. That's useful, but calling something medial or lateral can become pretty confusing below the elbow, because everything can rotate so much.

01.01

To get our bearings in the forearm and hand we often use the more convenient terms that are derived from the two functions, flexion and extension, and from the two bones of the forearm, the ulna and the radius. This is the flexor aspect of the forearm, and this is the extensor aspect. This is the ulnar side, and this side, with the thumb on it, is the radial side.

01.31

Let's also understand the terms we use for movements. At the elbow, bending is flexion, straightening is extension. Rotation of the forearm is referred to as pronation and supination. Pronation puts the palm of the hand down, and supination brings it up. To remember which is which, remember supination has "up" in it.

1.58

At the wrist, this is flexion, this is extension. The two sideways movements of the wrist are ulnar abduction, and radial abduction. There's one last term to define - the arm. In everyday conversation this whole thing is the arm, but in anatomy this is the arm, just this bit here, and this is the forearm.

02.27

BONES, JOINTS AND LIGAMENTS

HUMERUS AND PROXIMAL FOREARM

Now lets look at the bones, starting with the humerus. We've looked at its proximal end already, now lets see the distal end.

02.37

It's flattened from front to back, with a complicated articular surface, and two prominent lumps, the medial epicondyle and the lateral epicondyle.
These are major muscle origins, as we'll see. Above each epicondyle is a ridge, the epicondylar ridge. Here's the lateral one. The articular surface is in two parts. The pulley-like trochlea articulates with the ulna. The rounded capitulum articulates with the radius.

03.10

Now we'll add the radius and the ulna to the picture. The big hollow on the back of the humerus, the olecranon fossa, accommodates the end of the ulna, the olecranon, in full extension.

03.26

Now let's look at the two forearm bones, the radius and the ulna. They're different, in that the ulna is bigger proximally, the radius is bigger distally. They're also different in that the radius rotates, the ulna doesn't. The two bones are held togeher by two radio-ulnar joints, the proximal and the distal. Forearm rotation happens simultaneously at both these joints.

04.01

The two bones are also held together along most of their length by the strong but flexible interosseous membrane, which prevents the two bones moving lengthwise relative to each other. Let's look at the proximal ends of the redius and thee ulna.

04.18

We'll look at the ulna first. The main feature of the proximal end of the ulna is this large curved articular surface. The curve that it forms is called the trochlear notch. It articulates with the trochlea of the humerus.

04.37

The very proximal end of the ulna is the olecranon. The triceps tendon is attached to it. This projection is the coronoid process. Distal to it this rough area, the ulnar tuberosity, marks the insertion of the brachialis tendon. This small curved surface, the radial notch, is where the head of the radius articulates.

05.03

This is the head of the radius, This is the neck. The end of the head articulates with the capitulum of the humerus. Its curved side aticulates partly with the radial notch of the ulna, and partly with the ligament that surrounds it, as we'll see. Just radial to the neck is the radial tuberosity, which is the insertion for the biceps tendon.

05.28

Now let's look at this unique joint, where two quite different things happen. The humerus articulates with the forearm bones to form the elbow joint, and the forearm bones articulate with each other to form the proximal radio-ulnar joint.

05.45

Here's the joint with its loose capsule removed and its ligaments intact. Here's the front of the joint in extension, and here's the back of the joint in flexion.

06.00

The key structure to understand is this remarkable ligament, which not only holds the radial side of the elbow together, but also holds the rotating head of the radius in place against the ulna. It has two parts. This part is the radial collateral ligament, this part is the annular ligament. We'll take the humerus out of the picture for a minute, to get a look at the proximal radio-ulnar joint.

06.27

Here's the trochlear notch of the ulna, here's the head of the radius seen end on. The annular ligament, together with the radial notch of the ulna, provides a perfectly fitting socket for the head of the radius to rotate in.

06.45

Here's the anular ligament with the radial head removed. It's attached to the edges of the radial notch of the ulna. It's shaped like a shallow cup, wider here than here, to fit the radial head not just round here, but also under here. So the radial head, while it's free to rotate, is otherwise totally trapped.

07.12

Now let's go back to the intact elbow joint, and see how it's held together by its two collateral ligaments. The radial one arises from the lateral epicondyle. It fans out, and becomes continuous with the anular ligament.

07.27

The two parts of this complex ligament hold the humerus and the radial head securely together. What we see here isn't the edge of the ligament, it's the cut edge of the tendon of origin of a muscle, the supinator, which arises from the ligament. We'll see this shortly.

07.45

Here's the ulnar collateral ligament. It arises from the medial epicondyle, and fans out in a triangle. It's attached to the ulna all along the medial side of the trochlear notch.

07.59

To complete our picture of the elbow joint, here it is with its its capsule intact. It's thin and baggy in front, and also behind, to allow a full range of movement. There's also a very flexible sleeve of joint capsule here, between the anular ligament and the neck of the radius.

08.21

The elbow joint is stable, that means it stays together, for two reasons - partly because of the strength of the ligaments, which we've seen, and partly because of the shape of the bones. The humerus and the ulna interlock closely and deeply. Their surfaces are curved in two planes, from front to back, and from side to side.

08.46

The elbow and the proximal radio-ulnar joint are considered to be all one joint, because they're enclosed in one continuous space. By contrast, the two joints that we'll look at next, the distal radio-ulnar joint and the wrist joint are physically separate, even though they're close together, so we'll look at them separately.

09.07

DISTAL FOREARM AND WRIST

To understand the distal radio-ulnar joint, let's look at the distal ends of the radius and ulna. The head of the ulna has a rounded articular surface. This part articulates with the radius, this part articulates with a key structure that we'll see shortly, the triangular fibrocartilage. The pointed tip of the ulna is called the ulnar styloid.

09.33

The broad distal end of the radius has two articular surfaces. This large one articulates with the proximal row of carpal bones, to form the wrist joint. This small surface articulates with the ulna. This point is the radial styloid. Here's the distal radio-ulnar joint with its capsule intact, and with the capsule removed.

10.05

Here's the structure that holds it together, the triangular fibrocartilage. It's also known as the articular disk. It's attached to the radius here, and to the ulnar styloid here. As the distal end of the radius rides around the head of the ulna, the ulnar styloid provides the pivot point.

10.26

Now let's look at the wrist joint. Though we often speak of it as one joint, there are really two joints here, very close together. They're called the radiocarpal joint, and the mid-carpal joint. To understand them let's look at the bones. We'll look at them this way up.

10.44

Eight small carpal bones form the carpus. Distal to the carpus are the metacarpals, numbered one, two, three, four and five.

11.00

The carpal bones are in two rows, a proximal and a distal. The bones in each row are attached closely to one another. The four bones of the proximal row are the scaphoid, the lunate, the triquetral, and the pisiform, which sits by itself on the triquetral. The scaphoid, the lunate and part of the triquetral articulate with the distal end of the radius, to form the radio-carpal joint.

11.32

The distal surface of the proximal row forms a deeply concave notch, which the bones of the distal row fit into. The bones of the distal row are the trapezium, the trapezoid, the capitate, and the hamate. The capitate and part of the hamate project proximally.

11.50

The basesof the five metacarpals articulate with the distal row of carpal bones. The first one, for the thumb, articulates by itself with the trapezium. The other four articulate in a row, here. The distal row of carpal bones articulates with the proximal row here, to form the midcarpal joint. The projecting capitate and hamate fit into the notch in the proximal row.

12.17

When flexion and extension occur at the wrist, the movement happens partly at the radiocarpal joint ,and partly at the midcarpal joint. When radial deviation and ulnar deviation occur, the action happens mainly at the radio-carpal joint.

12.37

Here’s the wrist joint, or rather joints, with much of the capsule removed, and the two collateral ligaments, here, and here, intact. Here’s the radiocarpal joint, here’s the midcarpal joint.

12.55

The radial collateral ligament goes from thje radial styloid to the scaphoid and its neighbor, the trapezium. The ulnar collateral ligament goes from the ulnar styloid, to the triquetral and pisiform bones.

13.15

14Here’s the wrist joint with the joint capsule intact. The joint capsule is thick and strong all the way round the joint. On the extensor aspect, the capsule forms the broad dorsal radiocarpal ligament. On the flexor aspect it forms the palmar radiocarpal ligament.

13.35

Unlike the elbow, which is held together partly by the interlocking shape of the bones, the wrist is held together entirely by the strength of its ligaments. The two collateral ligaments hold the bones together in radial abduction and ulnar abduction, and the radio-carpal ligaments hold them together in flexion and extension. The strength of the radio-carpal ligaments also ensures that, when the radius rotates, the hand goes with it.

14.04

Before we move on to look at the muscles, let’s review what we’ve seen of the bones and joints.

14.10

REVIEW OF BONES, JOINTS AND LIGAMENTS

On the humerus, here’s the medial epicondyle, and epicondylar ridge, and the lateral epicondyle, and epicondylar ridge. Here’s the capitulum, and the trochlea.

14.29

On the proximal ulna, here’s the trochlear notch, th olecranon, the coronoid process, the ulnar tuberosity, and the radial notch. On the proximal radius, here’s the head, the neck, and the radial tuberosity.

14.51

Here’s the radial collateral ligament, the anular ligament, the ulnar collateral ligament, and the joint capsule. On the distal ulna here’s the head, and the ulnar styloid.

15.12

On the distal radius, here’s the surface for the ulna, the surface for the wrist joint, and the radial styloid. Here’s the scaphoid, the lunate, the triquetral and pisiform, the trapezium, the trapezoid, the capitate and the hamate; and here are the metacarpals.

15.38

At the wrist,here’s the triangular fibrocartilage, the radial collateral ligament, the ulnar collateral ligament, the palmar radiocarpal, and dorsal radiocarpal ligaments

15.56

End of time sequence

MUSCLES

Start of new time sequence

00.00

Now let’s look at the muscles. There are three sets of muscles to look at: the ones that flex and extend the elbow, the ones that pronate and supinate the forearm, and the ones that flex and extend the wrist. We’ll look at each set of muscles separately. Later on in this section we’ll see them all together.

00.24

ELBOW FLEXORS AND EXTENSORS

First the muscles that flex and extend the elbow. There are three flexors, and one extensor. The three flexors are brachialis, biceps, and brachioradialis.

00.35

Here’s the brachialis muscle. It arises from this broad area on the anterior humerus. It’s inserted here, on the ulnar tuberosity. The action of brachialis is to flex the elbow, which it does equally well whether the forearm is pronated or supinated.

00.56

The biceps muscle, its full name is biceps brachii, lies in front of the brachialis. It’s a more complicated muscle. For a start, it has two heads a long and a short. To get a good look at them, let’s take away the anterior half of the deltoid muscle, and also pectoralis major

01.20

Here’s the long head of biceps, here’s the short head. The tendon of origin of the short head merges with that of another muscle, coracobrachialis. Their common tendon of origin arises from the coracoid process.

01.38

The tendon of the long head makes a strange journey. It runs up the bicipital groove, and passes inside the shoulder joint, to reach its origin from the supraglenoid tubercle of the scapula.

01.52

The two heads unite to form a single belly, which narrows to form this unusual tendon. The main part dives down between he radius and the ulna, and inserts on the radial tuberosity. On its lateral edge the tendon fans out, here it is in the intact forearm, into a thin sheet of fascia, the bicipital aponeurosis, which becomes continuous with the deep fascia surrounding the forearm. The aponeurosis gives the biceps an indirect attachment to the ulna.

02.26

The biceps flexes the elbow. It does this more efficiently when the forearm is pronated , because then it's fully stretched when it starts its action. The biceps can also be a powerful supinator of the forearm, as we'll see later.

02.42

The last of the three elbow flexors is brachioradialis. It arises halfway up the humerus, just below the radial tuberosity. It's inserted all the way down here, on the distal radius. Brachioradialis is an efficient flexor of the elbow, whether the forearm is pronated or supinated.

03.05

The action of the flexors is opposed by just one extensor muscle, the triceps. The triceps muscle has three heads, a long head, a lateral head, and a medial, or deep head.

03.24

The long head arises, as we saw in the last section, from the infraglenoid tubercle of the scapula. The lateral head arises high up on the lateral side of the posterior humerus. The medial head arises from a broad area lower down and more medially. As we'll see, the radial nerve runs next to the bone, between the lateral and medial heads

03.46

The three heads of triceps converge, to form this massive tendon, which inserts here, on the olecranon. Contraction of the triceps extends the elbow.

04.00

Just for completeness, we need to mention this tiny muscle, the anconeus. It runs from the lateral epicondyle to the lateral aspect of the proximal ulna. Anconeus is a very minor elbow extensor.

04.16

WRIST FLEXORS AND EXTENSORS

Now let's look at the muscles that produce pronation and supination. There are two of each.

04.22

Of the two pronator muscles, the larger and more proximal one is pronator teres. Along with several other muscles, it arises from the medial epicondyle. In addition it has a small deep head of origin which arises from this part of the ulna.

04.39

Here's the deep head of pronator teres. The median nerve passes between the two heads of pronator teres as it enters the forearm. Pronator teres inserts here, halfway down the lateral surface of the radius. Here's its action: pronation.

05.00

The second pronator muscle is pronator quadratus, which arises from the anteromedial aspect of the ulna, and inserts here, on the anterior surface of the radius. Here's the action of pronator quadratus.

05.16

Now let's look at the two muscles which produce supination. The one that we haven't seen yet is simply called supinator. Here it is. It arises from the lateral epicondyle, from the anular ligament, and from this ridge on the ulna, the supinator crest. It's inserted on the radius, along a line ending just above the insertion of pronator teres. The deep branch of the radial nerve runs through the supinator. It enters here, and emerges under here. Here's the action of supinator it's a nice match for pronator teres.

06.11

The other supinator muscle we know about already. It's the biceps. The insertion of the biceps on the radial tuberosity gives it plenty of power to rotate the radius, especially when the elbow is flexed. When the biceps is working as a supinator, its flexing action is held in check by the simultaneous action of the triceps.

06.38

Because of the great strength which biceps contributes, supination is a more powerful action than pronation. Now let's look at the muscles which produce wrist movement. There are three flexors and three extensors.

06.54

We'll look at the flexors first. The two important ones are flexor carpi radialis, and flexor carpi ulnaris. They both arise from the medial epicondyle, where they share a massive tendon of origin, the common flexor tendon, with two other flexor muscles. In addition, flexor carpi ulnaris has an extensive ulnar head, which arises from this border of the ulna

07.26

The ulnar nerve, as we'll see, passes between the two heads of flexor carpi ulnaris as it enters the forearm. The two wrist flexors diverge, to arrive at the radial and ulnar sides of the wrist. Flexor carpi radialis passes through a deep ligamentous tunnel, and ends up inserting on the base of the second metacarpal.

07.53

Flexor carpi ulnaris inserts on the pisiform bone. From the pisiform, the pull of flexor carpi ulnaris is transmitted to the hamate bone, and to the base of the fifth metacarpal, by these strong ligaments, the piso-hamate and piso-metacarpal ligaments.

08.11

The two wrist flexors, acting together, produce flexion of the wrist. Acting separately, the ulnar and radial flexors contribute to ulnar abduction, and radial abduction respectively.

08.27

Lying between these two main wrist flexors is a third small one, palmaris longus. It arises from the medial epicondyle, like the other two. Its tendon, seen here in the intact forearm, lies superficial to all its neighbors, and inserts not into bone, but into this dense layer of fascia, the palmar aponeurosis, which covers the palm of the hand. Through this soft tissue insertion, palmaris longus helps to flex the wrist. It's frequently absent.

09.00

Now let's go round to the other side of the forearm and see the wrist extensors. Here they are: extensor carpi radialis longus, and brevis, and extensor carpi ulnaris. Brachioradialis, which you'll remember goes from here to here, has been removed in this dissection.

09.23

Extensor carpi radialis longus arises from the lateral epicondylar ridge, just below brachioradialis. Extensor radialis brevis arises from the lateral epicondyle, an origin which it shares with several other extensor muscles. They all arise together from the epicondyle and from this common extensor tendon.

09.43

Extensor carpi ulnaris arises from the lateral epicondyle, and it also has an ulnar head, just like flexor carpi ulnaris, which arises from this border of the ulna.

09.53

As the extensor tendons cross the back of the wrist they pass under this structure, the extensor retinaculum, which acts as a pulley. Extensor radialis longus and brevis are inserted on the bases of the second and third metacarpals, extensor ulnaris on the base of the fifth metacarpal.

10.14

When the wrist extensors act together, they extend the wrist. That's an important part of the action we make when we go to grip something. The powerful gripping muscles, whose tendons run over the front of the wrist, are slack and feeble when the wrist is flexed, but become tight and powerful when it's extended.

1034

When the radial extensors, or the ulnar extensor contract separately, they help to produce radial or ulnar abduction of the wrist. They do this in conjunction with the corresponding wrist flexor muscle, either radial or ulnar.

10.50

It's good to study muscles function by function, as we've done so far in this section, but it's also important to see how they all overlap and fit together. If you'd like to use this next overview as a review section, turn off the sound.

11.16

REVIEW OF MUSCLES

Let's look at a dissection that includes all the muscles that we've looked at so far, in the arm and forearm, and in the adjoining shoulder region.

11.30

Here's the biceps, with its two heads hidden both by the deltoid, and by pectoralis minor. Here's the short head of biceps, running close to coracobrachialis.

11.45

Running up behind biceps and coracobrachialis is latissimus dorsi. Here's brachialis, going to its insertion on the ulna, and here's biceps, on its way to the radius. Here's pronator teres, crossing over from the medial epicondyle to the radius.

12.07

Also arising from the medial epicondyle here's flexor carpi radialis, palmaris longus, and flexor carpi ulnaris. Here's pronator quadratus, deep to everything. Let's go round to the other side. Here's the triceps, with its long head going up beneath the deltoid.

12.33

Here's teres major, and here's latissimus dorsi again, both lying in front of the triceps. Here's triceps going to its insertion on the olecranon. Here's brachioradialis, going to the radius here.

12.55

Here's extensor carpi radialis longus, and brevis, and extensor carpi ulnaris. Lying deep to all the muscles which share the common extensor tendon is supinator, all on its own.

13.08

BLOOD VESSELS

At this point our picture of the forearm is complete as to some functions, incomplete as to others. That's the way we're going to leave it for now. We'll be returning to the forearm in the next section to look at the important muscles there that we've not seen yet: the long muscles of the fingers, and of the thumb.

13.34

Now let's move on to look at the vessels and nerves of the region. We'll go from the shoulder to just below the elbow. First we'll look at the veins.

13.46

Many superficial veins from the forearm converge just below tghe elbow to form two large veins - the basilic and the cephalic. The cephalic vein stays at a superficial level as it runs up the arm over the biceps. At the top of the arm it lies between deltoid and pectoralis major.

14.09

The large vein crossing the front of the elbow is the antecubital vein. It crosses from the cephalic, to the basilic vein. The basilic vein then runs up the medial aspect of the arm to join this brachial vein, which is one of a pair.

12.25

The two brachial veins join together as they pass up the arm, here they are joining, to become one brachial vein, The name of this vein then changes: up here it becomes the axillary vein.

14.40

To get a good look at it proximally we'll remove pectoralis major. Here's the axillary vein, running alongside the median nerve and the axillary artery, and disappearing with them behind pectoralis minor.

14.56

Now lets look at the artery, and the principal nerves of the arm. From here on the veins, which run parallel to the arteries, have been removed to simplify the picture.

15.07

Here's the main artery, the axillary artery. It emerges from beneath pectoralis minor surrounded by major nerves. As it passes into the arm its name changes. From here on down, its the brachial artery. Here , right next to the latissimus tendon, it gives off a large branch,the deep brachial, or profunda brachii , which passes backwards deep to the triceps. Along with it goes the radial nerve, which we'll see in a minute.

15.37

The brachial artery runs down the medial side of the arm, alongside the brachialis muscle. The median nerve crosses over the artery. The brachial artery passes beneath the bicipital aponeurosis, which we'll remove.

15.56

Alongside the biceps tendon it divides into the two major arteries of the forearm, the radial, and the ulnar. The radial artery stays quite superficial. It runs down the forearm between pronator teres and brachioradialis. The ulnar artery has a much deeper course. It dives down alongside the brachialis tendon, and passes deep to pronator teres.

16.23

We'll leave the arteries there. We"ll see their further course in the next section.

16.31

NERVES

Now we'll go back up to the top, and look at the nerves. Four nerves surround the axillary artery as it emerges from beneath pectoralis minor. They're the musculocutaneous, the median, the ulnar, and the radial. We'll look at them in that order.

16.51

The musculocutaneous nerve supplies three flexor muscles in the arm. The first of these is a flexor of the shoulder, coracobrachialis. The musculocutaneous nerve runs right through coracobrachialis, and emerges here, deep to the biceps. It runs down the arm between biceps and brachialis, supplying both muscles. It emerges here, to become the lateral cutaneous nerve of the forearm.

17.19

The median nerve and the ulnar both run all the way down to the elbow without supplying anything.

17.28

They start out close together. Halfway down the arm they diverge. The median nerve stays close to the brachial artery, crossing in front of it . At the elbow it lies medial to the artery. It dives down between the brachialis tendon and pronator teres, and passes between the two heads of pronator teres to enter the forearm.
17.50

The ulnar nerve slants backwards. It runs down just medial to the triceps tendon, and behind the medial epicondyle. It turns a sharp corner round the underside of the medial epicondyle, where there's a fibrous tunnel for it. It passes between the two heads of flexor carpi ulnaris to enter the forearm.
18.14

Once they get below the elbow, the median and ulnar nerves get busy. Between them they supply all the flexor and pronator muscles of the forearm. Of the muscles that we've seen already, the median nerve supplies four, pronator teres, flexor carpi radialis, palmaris longus, and pronator quadratus. The ulnar nerve supplies one muscle that we've seen so far, flexor carpi ulnaris.
18.45

Lastly, let's look at the radial nerve. It has a long spiral course, from here, round to here. Up here, the radial nerve lies behind all the other nerves and vessels. Just below the latissimus tendon it runs back between the long head and the medial head of triceps.
19.10

To follow its course, we need to go right round to the back, and find the same spot again from behind. Here's the long head of triceps, here's the medial head, and here's the radial nerve. To see where it goes, we'll remove the long head of triceps.
19.30

As the radial nerve passes round the humerus, it lies right on the bone. It runs between the medial and lateral heads of triceps, then runs beneath the lateral head, to emerge here, still right on the bone, just above brachioradialis.
19.51

Under cover of brachioradialis it reaches the ateral epicondyle, where it divides into a deep, or motor branch and a superficial, or sensory branch. That's as far as we'll follow the radial nerve for now. Of the muscles that we've seen, the radial nerve supplies the triceps, anconeus, brachioradialis, all three wrist extensors and supinator.
20.233

To end this section, let's briefly review first the vessels and then the nerves, from the shoulder to the elbow.
20.42

REVIEW OF BLOOD VESSELS AND NERVES

Here's the cephalic vein, and the basilic vein, the antecubital vein, the brachial vein, and the axillary vein. Here's the axillary artery the brachial artery the profunda brachii artery. At the elbow, the radial artery and the ulnar artery.
21.22

Now the nerves: here's the musculocutaneous nerve, the median nerve, the ulnar nerve, and the radial nerve, with its superficial branch and its deep branch.
21.47

That brings us to the end of this section. In the next section, we'll move on, to look at what the upper extremity is all about: the hand.
22.00

END OF PART 2

PART 3

THE HAND

00.00

To understand the hand we'll begin by looking at the bones and joints. Then we'll look at some important pulleys, and then we'll see the muscles. After that we'll add the vessels and nerves, and lastly we'll look at the skin.

00.19

The terms that we'll use for orientation are ulnar and radial for the sides of the hand, radial being the side with the thumb, and palmar and dorsal, for the front and the back.

00.34

BONES, JOINTS AND LIGAMENTS

To begin looking at the bones and joints of the hand, lets see what they're called. Here are the eight carpal bones, and here are the five metacarpals. Each finger has a proximal phalanx, a middle phalanx, and a distal phalanx. The thumb just has two phalanges, a proximal phalanx and a distal phalanx.

00.55

The joints of the hand have long names. The joints between the carpus and the metacarpals are the carpometacarpal joints. The joints between the metacarpals and the proximal phalanges are the metacarpo-phalangeal joints.

01.12

The joints between the phalanges are the interphalangeal joints - proximal and distal. We'll often refer to these joints as CMC joints, MP joints, and IP joints, for short.

01.28

To look in some detail at the bones and joints of the hand, we'll look first at the carpus, then at the four fingers with their metacarpals, then at the thumb with its metacarpal.

01.39

We saw he individual names of the carpal bones in theprevious section. Let's look at their overall shape. There are two bony projections on each side. On the ulnar side , the pisiform bone and this part of the hamate called the hook. On the radial side, the tubercle of the scaphoid and the crest of the trapezium. With these projections the bones of the carpus form the base and side walls of a space called the carpal tunnel.

02.07

Here's how the carpus looks in the living body. The radiocarpal, and mid-carpal joints are hidden by their heavy capsular ligaments. Here are those four projections again, the tubercle of the scaphoid, the crest of the trapezium, the pisiform, and the hook of the hamate. And here's the carpal tunnel, still without its roof.

02.34

Now let's move on to look at the metacarpals of the four fingers, and at their CMC joints. Here are the carpometacarpal joints. The bases of the four finger metacarpals, tightly packed together, articulate here, with the distal row of carpal bones. The base of the first metacarpal, the one for the thumb, articulates separately here, with the trapezium.

03.06

These four carpometacarpal joints allow only a small amount of movement. The fifth metacarpal is the most mobile, the fourth is less so, the third hardly moves at all, and neither does the second. When the CMC joints are flexed, the metacarpal heads lie in a curve.

03.02

This strong ligament is the deep transverse metacarpal ligament. It keeps the metacarpal heads of the four fingers from spreading apart. As it crosses each MP joint,the ligament is continuous with a structure that we'll meet shortly, the palmar plate. Since it doesn't connect to the first metacarpal, the ligament doesn't prevent movement of the thumb away from the hand.

03.57

Next we'll move on to look at the bones and joints of the fingers themselves. The proximal and middle phalanges are flattened on their flexor aspects. The flexor tendons run along here. The sheath that surrounds the flexor tendons is attached to these ridges. The tip of the distal phalanx is flattened. The fibrous pulp of the fingertip is attached here. The bed of the fingernail is attached here.

04.26

Now let's look at the metacarpophalangeal joint, the MP joint. It's the joint at which the finger becomes separate from the hand. We'll take the other fingers away, so that we can see it from all sides.

04.40

The articular surface of the metacarpal head is curved in two planes, from side to side, and from front to back. The base of the proximal phalanx has a concave articular surface that's also curved in two planes.

04.59

The shape of the bones allows a wide range of flexion and extension at the MP joints. It also allows a range of side to side movement that's greater when the joints are extended, less when they're flexed. We'll see why that is in a minute. Let's see how the joint looks in the living body.

05.21

The MP joint has a capsule that's loose on the back to allow the joint to flex. On the front , the capsule thickens remarkably, into a tough piece of fibrocartilage, the palmar plate, also called the palmar ligament. The palmar plate moves along with the proximal phalanx when the joint flexes.

05.43

Here's the palmar plate incised, to show how thick it is. As we'll see, some important structures are attached to the palmar plate, or merge with it. One of them we've seen already, the deep transverse metacarpal ligament. It goes here.

06.01

Here we've removed most of the joint capsule, so that we can see the two massive collateral ligaments which hold the MP joint together. The collateral ligaments run obliquely from the back of the metacarpal head, to the front of the base of the proximal phalanx. The collateral ligaments are loose when the joint is extended, but when it's flexed, they become tight. So when the joint is extended, side to side movement can occur readily, but when the joint is flexed, the tightness of the ligaments prevents side to side movement.

06.40

We need to understand the names that are given to those side to side movementsat the MP joints. Spreading all the fingers apart is called abduction. Bringing them all together is adduction. Those are useful terms for describing those collective movements of the fingers, but when we're speaking of an individual finger, it's often simpler to speak instead of ulnar deviation and radial deviation.

07.06

Now let's move on to the interphlangeal joints. The proximal and distal IP joints are very much alike. They're different from the MP joints in that they only allow flexion, and extension

07.21

The head of the phalanx is curved mainly from front to back, with a slight depression in the middle. The base of the adjoining phalanx has a corresponding curve to it.

07.35

The capsule of an IP joint is much like that of an MP joint, but the collateral ligaments are different, in that they're equally tight in flexion and in extension.

07.53

Now let's move on from the fingers, to look at the bones and joints of the thumb The first carpo-metacarpal joint is the joint which gives the thumb its special position, and a great deal of its special mobility.

08.08

Let's take off the metacarpal heads, to see the joint surfaces. Here's the first CMC joint. It sits in front of the other CMC joints, and at an angle to them. Because of this, the thumb and its metacarpal lie in front of the fingers and their metacarpals. Because of the angle of the carpometacarpal joint, the thumb faces not forward, as the fingers do, but sideways, across the hand.

08.40

The articular surface on the trapezium is curved in two planes, from side to side, and from back to front. The base of the first metacarpal is curved in the same way. The shape of the joint surfaces enables the first metacarpal to move in this plane, and in this plane. We'll name those movements in a minute, but first let's look briefly at the other two joints of the thumb.

09.09

The MP joint of the thumb is unlike the finger MP joints. It's much more like an interphalangeal joint. It permits only flexion and extension. On its flexor aspect there are two tiny sesamoid bones, which are embedded in the joint capsule. The one interphalangeal joint of the thumb is just like the IP joints of the fingers.

09.32

Now let's go back to the CMC joint, and see how the first metacarpal moves, and what the movements are called. Movement away from the second metacarpal is called abduction. Movement toward it is adduction. Movements at right angles to this axis are called flexion and extension.

09.56

These two sets of movements often happen in combination. As it makes these movements, the first metacarpal also rotates around its own long axis, as the pen is doing. When it's abducted and flexed, it rotates medially. When it's adducted and extended it rotates laterally.

10.16

This rotation can't happen in isolation, but only as part of those other movements. It happens because of the curious and complex shape of the CMC joint surfaces. This important and complex movement of the thumb is called opposition. It's a combination of abduction, flexion, and medial rotation, all occurring here at the CMC joint. Because of the rotation that occurs, the tip of the thumb ends up pointing toward the fingers. Once the thumb is in opposition, flexion at the MP and IP joints brings the tip of the thumb into contact with the fingers

10.58

PULLEYS AND SLIDING STRUCTURES AND FASCIA

We've looked at the bones and joints of the hand, and at the movements they're capable of. Before we move on to look at the muscles which move the fingers and thumb, and the tendons by which they act, there are a number of important pulleys and sliding strutures that we need to understand. These structures guide the

direction of pull of the tendons as they cross the wrist joint, and pass along the fingers.
11.23

We'll look first at the two big pulleys at the wrist, the flexor retinaculum, and the extensor retinaculum.
11.30

Here's the flexor retinaculum. It's a tough , unyielding strap of fibrous tissue. The flexor retinaculum is the structure that forms the roof of the carpal tunnel. It's attached on the radial side to the scaphoid and the trapezium, and on the ulnar side to the pisiform bone, and the hook of the hamate. As we'll see, the median nerve , and all the flexor tendons to the fingers and thumb go through the carpal tunnel.
11.59

The flexor retinaculum branches off in two places, here and here, to enclose two small, separate tunnels. This one, on the radial side, encloses the tendon of flexor carpi radialis. This one, superficial and on the ulnar side, encloses the ulnar artery and nerve.
12.23

We'll be returning to the flexor retinaculum later, to look at some important structures that arise from it: the palmar aponeurosis, and some of the thenar and hypothenar muscles.
12.35

Let's go round now to the dorsal aspect of the wrist, to see the other big pulley, the extensor retinaculum. It runs obliquely, from this ridge on the radius, to the ulnar styloid, the triquetrum, and the hamate.
12.52

The extensor retinaculum has a number of deep extensions which are attached to the underlying radius. These divide the space under the retinaculum into several small, separate tunnels. All three wrist extensors, and all the extensor tendons to the fingers and thumb, pass under the extensor retinaculum.
13.17

Now let's look at the structures in the fingers, and in the thumb, which hold the flexor and extensor tendons in place, allow them to move, and guide their direction of pull.
11.28

In each finger this structure, the flexor tendon sheath, provides the two flexor tendons with a smoothly lined, tightly enclosing tunnel to run in. The sheath starts just proximal to the MP joint, and extends all the way to the distal phalanx. To see the sheath better, we'll divide it.
13.52

Parts of the sheath are thick and fibrous, and parts of it are thin and collapsible. On this finger we'll remove the thin parts of the sheath and just leave the thick parts. These act as pulleys for the flexor tendons, as we'll see. At each joint the sheath is attached to the edge of the palmar plate. Between the joints the sheath is attached along each phalanx.
14.20

The floor of the tunnel for the flexor tendons is formed by the palmar plates, and by the smooth flattened surfaces of the phalanges. The thumb has a similar flexor tendon sheath for its one long flexor tendon.
14.37

The arrangement for the extensor tendon is entirely different, and quite complex. On each finger the extensor tendon, and the tendons of three intrinsic muscles, come together to form a structure called the extensor mechanism. Let's take a look at it. We'll look at the muscles themselves a little later. So that we can see the extensor mechanism from all sides, well look at one finger in isolation.
15.08

Here's the extensor tendon, approaching the back of the MP joint. Here, both on the radial side, and on the ulnar side, is the tendon of one of the interosseous muscles. In addition here, on the radial side only, is the tendon of a lumbrical muscle. On each side a triangular sheet of tendinous tissue fans out, and connects the extensor tendon to the interosseous tendon. This triangular sheet is called the extensor hood.

15.41

The extensor tendon divides into three slips over the proximal phalanx. The central slip crosses the proximal IP joint and inserts here, on the base of the middle phalanx.

15.54

The slips on each side fuse with the interosseous tendon to form the two lateral bands. The lateral bands join together over the middle phalanx and insert here, on the base of the distal phalanx.

16.09

The thumb doesn't have such a complex extensor mechanism. The insertion of its two extensor tendons is relatively simple, as we'll see.

16.20

One last structure to look at before we move on to muscles is the palmar fascia, or palmar aponeurosis.

16.28

It's a dense triangular sheet of fibrous tissue which covers the middle part of the palm of the hand. Proximally it's continuous with the flexor retinaculum and with the tendon of palmaris longus. Distally it separates into slips, which insert into the edges of the palmar plates of the MP joints. The palmar fascia protects the underlying nerves, tendons and vessels from harm. The skin of the palm of the hand is firmly attached to it.

16.58

Now that we've looked at the bones, joints and pulleys of the hand, we're about ready to see the muscles. Before we do that, lets review what we've seen so far.

17.11

REVIEW OF BONES, LIGAMENTS, JOINTS, PULLEYS

Here are the carpal bones, the metacarpals, the proximal phalanges, middle phalanges, and distal phalanges; the carpometacarpal joints, the MP joints of the fingers, added words the proximal IP joints, the distal IP joints. On the thumb, the MP joint, and the IP joint.

17.48

The flexor retinaculum, and the side tunnel for the ulnar nerve, the extensor retinaculum, the flexor tendon sheath, the palmar plate, the collateral ligaments of the MP joint, the extensor mechanism, and the palmar aponeurosis.

18.17
End of time sequence

MUSCLES

Start of new time sequence
00.00

Now we'll move on to look at the muscles of the hand. We'll begin by looking at the extrinsic muscles, the long muscles of the hand which lie in the forearm. Then we'll move on to look at the intrinsic muscles, the short muscles that lie in the hand. Starting with the extrinsic muscles, then, we'll look first at the flexors of the fingers, then at the extensors of the fingers, and lastly we'll look at the four long muscles of the thumb.

00.28

EXTRINSIC MUSCLES - FLEXORS OF THE FINGERS

Flexion of the fingers is produced by two long muscles, flexor digitorum profundus, and flexor digitorum superficialis

00.36

Here's the deep finger flexor, flexor digitorum profundus. It arises from the anterior and medial surface of the ulna, and from the interosseous membrane. Here are its four tendons, entering the carpal tunnel. We'll follow them in a minute. This adjoining muscle we'll see later on. It's flexor pollicis longus, the long thumb flexor.

01.10

Now let's add the superficial finger flexor, flexor digitorum superficialis to the picture. Here it is. It lies right on top of the profundus. It has two heads of origin, a radial head and a humero-ulnar head. The humero-ulnar head arises, as part of the common flexor tendon, from the medial epicondyle of the humerus, and also from the adjoining ulna. Its radial head arises from this long oblique line on the radius. Between the two heads there's a gap, which the median nerve and the ulnar artery both pass through.

01.50

The four separate tendons of flexor digitorum superficialis are bundled together as they enter the carpal tunnel. Before we follow the superficialis and profundus tendons into the hand, we'll bring the forearm to the upright position.

02.05

As the flexor tendons pass through the carpal tunnel, they're all enfolded within this common synovial sheath which extends into the palm of the hand. Just as the flexor tendons emerge from the carpal tunnel, the four profundus tendons give rise to these four intrinsic muscles, the lumbricals. We'll be looking at these later. For now we'll remove them to simplify the picture.

02.31

Just before reaching the MP joint, the superficialis and profundus tendons of each finger enter the flexor tendon sheath together. To follow them we'll remove the sheath. Over the proximal phalanx, the superficialis tendon splits into two halves, which pass around the profundus tendon. We'll remove. the profundus tendon for a moment. The two halves of the superficialis tendon re-unite, and as they do so they insert here, on the middle phalanx.

03.05

The profundus tendon (here it is back in place) emerges between the two halves of superficialisand continues distally to insert here, on the base of the distal phalanx.

03.20

The action of flexor digitorum superficialis is to flex the proximal IP joint, and the MP joint. The action of flexor digitorum profundus is to flex both the IP joints, and the MP joint.

03.41

EXTRINSIC MUSCLES - FLEXORS OF THE FINGERS

Now let's look at the muscles that extend the fingers. There are three, a large one, that extends all four fingers, and two small ones, for the index and little fingers.

03.51

The large one is extensor digitorum, sometimes called extensor digitorum communis. It arises from the common extensor tendon, and thereby from the lateral epicondyle. As it passes distally it divides into four slips, which pass together under the extensor retinaculum. We'll follow them beyond there in a minute.

04.13

The extensor muscle to the little finger, extensor digiti minimi, arises from the ulnar side of extensor digitorum, and passes under the retinaculum by itself. The extensor muscle to the index finger, extensor indicis, lies deep to extensor digitorum. It arises from the ulna and the interosseous membrane. Its tendon passes under the retinaculum along with extensor digitorum.

04.44

Emerging from beneath the extensor retinaculum, the extensor tendons fan out. As they approach the MP joints they branch and rejoin in an irregular fashion. Extensor indicis and extensor digiti minimi join the respective extensor digtorum tendons as they reach the MP joint. Here at the MP joint each extensor tendon gives rise to the extensor hood, then divides into three parts, as we saw when we looked at the extensor mechanism a little while back. The extensor muscles produce extension at all three joints of the finger. Their main effect is at the MP joint.

05.25

As we'll see later, the interosseous muscles and the lumbricals also have major roles in extending the interphalangeal joints.

05.33

EXTRINSIC MUSCLES - LONG MUSCLES OF THE THUMB

Now let's move on, to look at the long muscles of the thumb. The thumb has a long flexor, a long abductor, and two extensors, a long one and a short one.

05.43

The long flexor, flexor pollicis longus, lies deep in the forearm. We'll remove flexor digitorum superficialis to see it. Here's flexor pollicis longus, lying alongside flexor digitorum profundus. It arises from the anterior surface of the radius, and from the interosseous membrane.

06.08

Its tendon passes through the carpal tunnel with the finger flexors. Here's the tendon of flexor pollicis longus emerging. It enters the fibrous flexor sheath of the thumb, and inserts on the base of the distal phalanx. Flexor pollicis longus flexes both the MP joints and the IP joints of the thumb.

06.32

The other three long thumb muscles lie on the extensor aspect of the forearm. They lie deep to extensor digitorum, which we'll remove.

06.44

This is the long abductor, abductor pollicis longus, and these are the extensors, extensor pollicis brevis, and longus. The abductor arises from the radius here, and also from the interosseous membrane. The two extensors arise a little more distally, the short one here, the long one here.

07.09

Here's extensor digitorum back in the picture. The three thumb muscles emerge obliquely from beneath the extensor digitorum. Their tendons pass beneath the extensor retinaculum, extensor longus by itself, the other two together.

07.28

The tendon of abductor pollicis longus inserts round here, on the base of the first metacarpal. Extensor pollicis brevis inserts on the base of the proximal phalanx, and extensor pollicis longus inserts on the base of the distal phalanx.

07.46

The movement produced by abductor pollicis longus is a combined abduction and extension occurring at the CMC joint. It's the reverse of opposition.

07.59

Extensor pollicis longus extends the IP joint and the MP joint of the thumb. Extensor pollicis brevis extends only the MP joint.

08.10

We've now seen all the extrinsic muscles of the hand. Before we move on to look at the intrinsics, let's back up, and see how the extrinsics fit in with the elbow muscles, the rotator muscles, and the wrist muscles that we saw in the last section. If you'd like to use this next overview as a review section, turn off the sound.

08.32

REVIEW OF ALL FOREARM MUSCLES

Here are all the muscles intact. Here's biceps, brachialis, and brachioradialis. We'll remove brachioradialis. Here, arising from the medial epicondyle and sharing the common extensor tendon, are pronator teres, partly hidden, and the three wrist flexors, flexor carpi radialis, palmaris longus, and flexor carpi ulnaris.

09.07

We'll remove the wrist flexors, but leave pronator teres still in place. Here's flexor digitorum superficialis. Its long oblique origin runs right next to pronator teres.

09.23

We'll remove pronator teres, and flexor digitorum superficialis. Here are the three deepest muscles, flexor digitorum profundus, flexor pollicis longus, and beneath them all, pronator quadratus.

09.42

Now let's look at all the muscles on the extensor aspect of the forearm. We've already removed brachioradialis, it went from here to here. Here are extensor carpi radialis longus, and brevis, and extensor carpi ulnaris. Here between the wrist extensors, sharing the common extensor tendon, is extensor digitorum.

10.09

We'll remove the wrist extensors to see extensor digitorum by itself. Here's extensor digitorum. Supinator lies deep to it here, and distally the three long thumb muscles emerge from beneath it.

10.28

Removing extensor digitorum, we see supinator, abductor pollicis longus, extensor pollicis brevis and longus, and extensor indicis.

10.46

INTRINSIC MUSCLES - INTEROSSEI AND LUMBRICALS

Now we'll move on to look at the intrinsic muscles of the hand. They're in four groups: the interosseous muscles, the lumbricals, the short muscles of the thumb, and the short muscles of the little finger.

11.05

There are seven interosseous muscles, or interossei. Here they all are together. There's one for each side of the index, middle, and ring fingers, and one for the radial side of the little finger. By tradition they're divided into these four dorsal interossei, and these three palmar ones, but to understand what they do, it’s simpler to consider them in twos, like this.

11.34

The two interossei for the middle finger are a typical pair. They arise from the shaft of their own metacarpal, and from its neighbors. They pass behind the deep transverse metacarpal ligament. We’ll remove the ligament, and we’ll also remove the other fingers and metacarpals to simplify the picture. On each side of the MP joint, the interosseous muscle narrows down to a double tendon, which has a long part, and a short part.

12.03

The short part inserts here on the base of the proximal phalanx. The long part of the interosseous tendon joins the extensor mechanism to become its most outlying part. Merging with the lateral slip of the extensor tendon, it forms the collateral band of the extensor mechanism. The two collateral bands come together distally, as we’ve seen, to insert here on the distal phalanx.

12.30

The line of action of the interosseous tendon passes in front of the axis of rotation of the MP joint, marked by this pin, and behind the axes of the two IP joints. When the two interosseous muscles of a finger contract together, their action is to flex the MP joint, and extend both the IP joints. When one of the interossei contracts separately, it produces either ulnar deviation, or radial deviation at the MP joint.

13.06

The many fine gradations of finger movement are produced by complex interactions between the interossei, the lumbricals, and the long flexors and extensors.

13.18

The interosseous muscle on the radial side of the index finger is unusually large. It’s the first dorsal interosseous muscle. It has two heads, which arise from the first, and from the second metacarpals. The radial artery, coming round the side of the carpus, passes between its 2 heads, as we’ll see.

13.43

The first dorsal interosseous produces powerful radial deviation of the index finger. It’s one of a pair of intrinsic muscles that are strongly involved in this action, called key pinch, as in holding a key.

13.58

We’ll see the other one of the pair, adductor pollicis, when we look at the thumb muscles. Let’s move on now to look at the four lumbrical muscles.

14.08

Here are the lumbricals, one for each finger. Each lumbrical muscle arises from the side of one or both of the adjoining flexor digitorum profundus tendons.
The lumbricals pass in front of the deep transverse metacarpal ligament. Each lumbrical inserts on the radial side of the extensor mechanism, just distal to the long part of the interosseous tendon. The action of the lumbricals reinforces the action of the interossei in extending the IP joints. They also assist in radial deviation of the MP joint.

14.46

INTRINSIC MUSCLES - SHORT MUSCLES OF THE THUMB AND LITTLE FINGER

Now we’ll move on to look at the four short muscles of the thumb. One of them lies by itself, and three lie close together. The one that’s by itself is adductor pollicis, the other key pinch muscle.

15.01

Adductor pollicis has two heads, a transverse head and an oblique head. The transverse head arises from the third metacarpal. The oblique head arises from the ligaments in the base of the carpal tunnel. Adductor pollicis inserts on the ulnar sesamoid bone, and on the base of the proximal phalanx of the thumb. Adductor pollicis produces adduction at the carpometacarpal joint.

15.30

The other three thumb muscles make up this bulge, that's called the thenar eminence. Collectively these three are called the thenar muscles. On the outside are flexor pollicis brevis, and abductor pollicis brevis. Deep to them both is opponens pollicis.

15.53

Abductor brevis arises from the trapezium, and from the flexor retinaculum. Flexor brevis arises from the flexor retinaculum and from the trapezoid. These two muscles insert here, on the base of the proximal phalanx of the thumb, on the radial side.

16.11

Opponens pollicis, here it is by itself, arises from the trapezium, and from the flexor retinaculum, and inserts along the radial side of the first metacarpal.

16.23

The three thenar muscles overlap, and their actions overlap too. Between them they produce abduction and flexion at the carpometacarpal joint, bringing the thumb away from the second metacarpal and across the palm, and thereby also rotating it medially. As we've seen, these movements add up to opposition of the thumb.

16.50

Lastly, let's look at the three short muscles of the little finger. They make up this smaller bulge, the hypothenar eminence, and collectively they're called the hypothenar muscles.

17.03

They're arranged in much the same way as the thenar muscles, and their names are similar. On the outside are abductor digiti minimi, and flexor digiti minimi. Deep to them lies opponens digiti minimi

17.19

The abductor arises from the pisiform bone, and inserts just like an interosseous muscle, partly into the base of the proximal phalanx, and partly into the extensor mechanism.

17.33

The flexor arises from the hamate bone, and the flexor retinaculum, and inserts near the abductor on the proximal phalanx. The opponens arises from the hook of the hamate, and inserts along the ulnar side of the fifth metacarpal. The ulnar nerve and artery pass underneath the flexor and opponens as they enter the hand.

17.56

The abductor has the same actions as an interosseous muscle. The flexor helps to flex the MP joint, and the opponens produces flexion of the fifth metacarpal at the carpometacarpal joint. These three muscles help to make the little finger specially mobile.

18.18

Now that we've looked at the extrinsic muscles and the intrinsic muscles of the hand, let's see how they all fit together. This can be a review session, if you'd like to turn off the sound.

18.30

REVIEW OF ALL HAND MUSCLES

Here’s the hand with all the muscles and long tendons present. On the back, here are the tendons of extensor digitorum, extensor indicis, and extensor digiti minimi.

18.47

Deep to the extensor tendons are the interossei. Here’s the tendon of extensor pollicis longus, and brevis, and abductor pollicis longus.

18.59

On the front, here’s the palmar aponeurosis, which we’ll remove. Here are the tendons of flexor digitorum superficialis, and profundus, and here’s one of the lumbrical muscles.

19.17

Here’s flexor pollicis longus, surrounded by flexor pollicis brevis. Here are abductor pollicis brevis, and deep to it, opponens pollicis. Here are abductor digiti minimi, together with flexor digiti minimi, and deep to them opponens digiti minimi.

19.38

We’ll remove the flexor tendons, to see adductor pollicis, and the interossei. The three most radial interossei lie here, behind adductor pollicis.

19.51

BLOOD VESSELS

Now we’ll move on to look at the principal veins, arteries and nerves of the hand. First, the veins.

20.06

We’ve filled the veins by injecting blood here. That’s why the veins of this finger stand out so much more clearly. The small veins of the thumb, fingers and hand pass mainly to the the dorsal aspect of the hand, to join these large superficial dorsal veins. Crossing the wrist, these are joined by the superficial veins draining the dorsal aspect of the forearm. These unite to form the cephalic vein, seen here at the elbow.

20.36

The veins draining the flexor aspect of the forearm unite to form the basilic vein. The antecubital vein passes from the cephalic to the basilic just below the elbow.

20.50

We’ll remove the superficial veins, and the superficial fascia, to see some of the deep veins of the forearm. These run alongside the arteries. Here are the accompanying, or concommitant veins of the radial artery, coming together with those of the ulnar artery, just below the elbow.

21.09

Next, let’s look at the two main arteries of the hand, the radial, and the ulnar. In the dissection we’ll see, the arteries have been injected with red latex to make them more visible.

21.20

The radial artery runs down the forearm deep to brachioradialis. It lies on pronator teres, flexor digitorum superficialis, and flexor pollicis longus. In the distal foream the radial artery emerges from beneath brachioradialis, and lies superficially, between the border of the radius, which is here, and the tendon of flexor carpi radialis.

21.46

At the wrist, the radial artery gives off this superficial branch, then spirals around the lateral aspect of the wrist, running beneath the tendons of abductor pollicis longus, extensor pollicis brevis, and extensor pollicis longus. It passes between the two heads of the first dorsal interosseous muscle, one of which we’ll remove, and gives off branches to the thumb and sometimes the index. Finally it passes between the two heads of adductor pollicis, to enter the palm. We'll see where the radial artery goes in a minute.

22.26

Now, let's go back up to the elbow, and look at the ulnar artery. It has a much deeper course. The ulnar artery passes beneath pronator teres. To see where it goes, we'll remove pronator teres, and flexor carpi radialis.

22.45

After passing beneath pronator teres, the ulnar artery gives off the common interosseous artery. It then passes between the two heads of flexor digitorum superficialis. To follow it we'll go round to the ulnar side of flexor digitorum superficialis and raise it up. Here's the ulnar artery. It runs down the forearm between flexor digitorum superficialis, and profundus.

23.16

In the distal forearm it emerges, along with the ulnar nerve, between flexor digitorum superficialis and flexor carpi ulnaris. At the wrist it passes through the tunnel in the side of the flexor retinaculum, to reach the hand.

23.35

Let's get re-oriented. Here's the radial artery, with its superficial branch; here's the ulnar artery. Emerging from its fibrous tunnel, the ulnar artery divides, into a large superficial branch, and a smaller deep branch. The deep branch dives between the hypothenar muscles.

24.00

The superficial branch runs behind the palmar aponeurosis, which we'll remove, and runs across the palm in front of the flexor tendons. It usually ends by anastomosing with the superficial branch of the radial artery, forming a loop called the superficial palmar arch. The superficial palmar arch gives off these common digital arteries.

24.25

Each common digital artery divides into two digital arteries. Each digital artery runs along one side of the finger, beside the flexor sheath, in company with the digital nerve. At the tip of the finger the two digital arteries re-join, to form this terminal anastomosis.

24.46

Now let's see what happens to the radial artery in the hand. We last saw the radial artery running around the wrist, and disappearing here between the heads of adductor pollicis. To see where it comes out, we'll go round to the front of the hand and remove the superficial palmar arch, and the flexor tendons.

25.05

Here's the radial artery emerging. It crosses in front of the interossei, usually anastomosing with branches of the ulnar artery to form the deep palmar arch.

25.18

NERVES

Now we'll look at the three main nerves of the forearm and hand, the radial, the median and the ulnar. We'll go back to where we last saw the radial nerve.

25.30

Here we are at the elbow, with braschioradialis retracted. Here's the radial nerve. It diivides, as we saw, into a superficial and a deep branch. The superficial branch runs down the forearm deep to brachioradialis. In the distal forearm it passes backwards and emerges from beneath the brachioradialis tendon Approaching the wrist it crosses over extensor pollicis brevis, and longus, to reach the back of the hand.

26.03

The superficial branch of the radial is entirely a sensory nerve. It supplies, usually, the radial half of the back of the hand, the back of the thumb, and part of the back of the index.

26.17

The deep branch of the radial nerve, also known as the posterior interosseous nerve, is a motor nerve. As we saw in the last section, it passes through the supinator , and emerges here, deep to extensor digitorum. It breaks up into several branches. Between them these supply extensor carpi ulnaris, extensor digitorum and the other two finger extensors, and these three long thumb muscles, abductor pollicis longus, and extensor pollicis brevis, and longus.

26.54

Now let’s look at the median nerve. Let’s go back to the elbow, where we saw it in the last section.

27.02

Here’s the median nerve, next to the brachial artery. To see where it’s going we’ll retract flexor carpi radialis. The median nerve first dives between the two heads of pronator teres. It then immediately passes between the two heads of flexor digitorum superficialis.

27.24

The median nerve passes down the forearm between flexor digitorum superficialis and profundus. It emerges at the wrist to the radial side of the superficialis tendons. It's crossed by the tendons of palmaris longus and flexor carpi radialis.

27.43

The median nerve passes through the carpal tunnel to reach the hand. It lies just beneath the palmar aponeurosis, which has been removed here. The median nerve gives off this small motor branch to the thenar muscles, and then gives off these three common digital nerves. The common digital nerves break up into palmar digital nerves, two each for the thumb. index, and middle fingers, and usually one for the radial side of the ring finger.

28.15

The median nerve typically provides sensation to the medial half of the palm, the flexor aspect of the thumb, the index and middle fingers, and the radial side of the ring finger.

28.27

Of the extrinsic hand muscles, the median nerve supplies flexor digitorum superficialis, flexor pollicis longus, and the radial half of flexor digitorum profundus. Of the intrinsic hand muscles, it supplies only the three thenar muscles, and the radial two lumbricals.

28.50

Lastly, let’s look at the ulnar nerve. As you’ll recall from the last section, the ulnar nerve enters the forearm by passing round the medial epicondyle, and between the two heads of flexor carpi ulnaris.

29.04

Here’s the ulnar nerve. It runs down the forearm between flexor carpi ulnaris, and flexor digitorum superficialis, with profundus deep to it. Here, it gives off a dorsal sensory branch, which goes to the back of the hand. At the wrist, it runs along the radial side of flexor carpi ulnaris. Along with the ulnar artery it passes through the side tunnel in the edge of the flexor retinaculum.

29.33

Here it is emerging from the tunnel. Again the palmar aponeurosis has been removed. The ulnar nerve divides into a superficial branch and a deep branch. The superficial branch divides into palmar digital nerves for the little finger, and typically the ulnar side of the ring finger. The deep branch passes between the hypothenar muscles. To follow it we’ll remove the flexor tendons. The deep branch of the ulnar nerve runs across the palm in front of the interossei. It passes in between the two heads of adductor pollicis, we'll remove the transverse head, to reach the most radial of the interossei.

30.19

The ulnar nerve typically provides sensation to the ulnar half of the back and the front of the hand, and to the little finger and the ulnar half of the ring finger.

30.34

Of the extrinsic hand muscles, the ulnar nerve supplies only the ulnar half of flexor digitorum profundus. Of the intrinsic hand muscles it supplies the hypopthenar muscles, all the interossei, adductor pollicis and the ulnar two lumbricals.

30.59

Before we move on to look at the skin of the hand, let's briefly review what we've seen of the vessels and nerves.

31.09

REVIEW OF VESSELS AND NERVES

Here's the cephalic vein, the basilic vein, and the antecubital vein. Here's the radial artery, in the forearm, and at the wrist; the ulnar artery in the forearm, and at the wris; the superficial palmar arch, common digital arteries, and digital arteries, and the deep palmar arch.

32.05

Here's the radial nerve, with its deep branch, and its superficial branch. Here's the median nerve in the forearm, and at the wrist, with its motor branch, the common digital nerves, and digital nerves.

32.38

Here's the ulnar nerve in the forearm, here's its dorsal sensory branch. Here's the ulnar nerve at the wrist, with its superficial branch, and its deep branch. Here's the distribution of the radial nerve, the median nerve, and the ulnar nerve.

33.14

SKIN, FINGERNAILS

Last of all, we'll take a look at the skin of the hand, and at the fingernails. On the back of the hand the skin is thin, and freely movable. This underlying layer of loose areolar tissue enables the skin to move. When the wrist and the MP joints are extended, the skin is loose and redundant. When they're flexed, it becomes tight.

33.52

By contrast, the skin on the front of the hand is quite thick, and much less movable. It's fixed to the underlying palmar aponeurosis by many strands of tough fibrous tissue. The creases on the palmar skin are lines along which the skin is thinner. The creases act as joints in the skin when the MP joints flex.

34.20

It's easy to see where the MP joints are when we look at the back of the hand. But because of the way the skin slopes forward in between the bases of the fingers, the position of the MP joints can be a surprise, when we're looking from the front of the hand. The MP joints aren't here, they're right back here, in line with the distal palmar skin crease.

34.46

So fully half the length of the proximal phalanx of each finger lies beneath the skin of the palm. On the fingers, as in the hand, the skin is thin and extensible on the back, thick and deeply creased on the front. Let's take a close look at the specialized skin of the fingertip.

35.07

The skin of the fingertip contains huge numbers of sensory nerve endings. The pulp of the fingertip is composed of fat, interlaced with many fibrous strands which anchor the skin to the distal phalanx.

35.24

The fingernail is a hard plate of keratin that's produced by the specialized epithelial cells which lie beneath its base, here. A fold of skin overlaps the edge of the nail, and adheres to it closely. We'll remove the skin on one side, to see the full extent of the nail, here's its edge; and we'll take away one half of the nail, to see the underlying nailbed, or nail matrix.

35.56

Finally we'll remove part of the nailbed, here's the cut edge of the nailbed. It's closely adherent to the underlying distal phalanx. The actual nail forming tissue is just here. It's the nail forming tissue that produces this pale area, the lunula, at the base of many peoples' nails.

36.19

That brings us to the end of this tape on the upper extremity. The remaining tapes of the Video Atlas will be the lower extremity, the trunk, the organs of the thorax and abdomen, and the head and neck.

36.33

END OF VOLUME 1

Acland's DVD Atlas of Human Anatomy

Transcript for Volume 2

PART 1: THE HIP

BONES, LIGAMENTS AND JOINTS

00.00

We'll look at the lower extremity in four sections. In this first section, we'll look at the hip. After that we'll look at the knee; then we'll go down to the ankle, and lastly we'll look at the foot.

00.13

Before we get started, there's a simple term we need to define: the leg. In everyday speech, "the leg" means everything from the hip downwards. In anatomy, only this part, from the knee to the ankle, is the leg, and this part , from the hip to the knee, is the thigh.

00.30

In looking at the hip region, we'll start with the bones, then we'll look at the hip joint and how it moves, then we'll look at the muscles which produce movement at the hip joint, and lastly we'll look at the vessels and nerves. First, let's see the bones.

00.47

Here are the lumbar vertebrae, the pelvis, and the two femurs. We'll look at the pelvis by itself.

00.56

The pelvis is made up of the two hip bones, or innominate bones, and the sacrum. The fibrous joints which unite them, the two sacro-ilicac joints behind and the pubic symphysis in front, permit almost no movement. We'll look at the right hip bone by itself.

01.20

The hip bone is formed by the fusion of three bones, the ilium, the ischium, and the pubis. The names of these bones give rise to the names of the various features of the hip bone. Let's look at these features.

01.37

This broad bony plate is the wing, or ala of the ilium. Its broad, roughened edge is the iliac crest, an area where many important muscles attach. The iliac crest ends in front at the anterior superior iliac spine, and behind at the posterior superior iliac spine.

02.00

This is the ischial spine, with the greater sciatic notch above it, and the lesser sciatic notch below it. This is the ischial tuberosity. The ischial tuberosity is another area where many muscles attach. It's also the part of the hip bone that we sit on.

02.17

The socket for the hip joint is called the acetabulum. This broad smooth area is the articular surface. We'll see it again in a minute with the articular cartilage intact.

02.30

The big hole in the lower part of the hip bone is the obturator foramen. This is the body of the pubis, this is the superior ramus of the pubis, and this is the ischio-pubic ramus. This prominence is the pubic tubercle, to which the inguinal ligament is attached

02.53

It's helpful to keep in mind that the upper part, and the lower part of the hip bone face in different directions, like my hands. If we look at the hip bone from in front, like this, we're looking at the inner aspect of the ilium, and the outer aspect of the pubis and ischium. Now that we've looked at the hip bone, let's bring the sacrum back into the picture. We're looking at the bones as they'd be in the upright, standing position, and it's perhaps surprising to see the angle at which the sacrum lies. Its pelvic surface is more nearly horizontal than vertical.

03.29

The sacrum is attached to the hip bone not only by the sacro-iliac joint, seen here from behind, but also by two big ligaments, one going to the ischial spine, and one going to the ischial tuberosity, as we'll see in a minute.

03.44

Now let's add the femur to the picture. The femur is the longest bone in the body. We'll be looking at its distal end in the next section. For now, let's look at the features of the proximal end.

03.57

This is the head of the femur, this is the neck. Since the head is wide and the neck is narrow, the head of the femur can go a long way in this axis, and in this axis, before bone hits bone.

04.16

This prominent lump is the greater trochanter, and this one is the lesser trochanter. The greater and lesser trochanters are important muscle insertions. This line, the inter-trochanteric line, marks the insertion of a major ligament of the hip joint, which we'll see in a minute. On the back of the femur this prominent ridge, the inter-trochanteric crest, runs from the greater to the lesser trochanter. This broad rough area is the gluteal tuberosity. This rough line running down the shaft of the femur is the linea aspera. Many muscles have their origins or their insertions on the linea aspera, on the gluteal tuberosity, and in this hollow in front of the intertrochanteric crest.

05.10

Now that we've looked at the dry bones, let's see how they look in the living body. The big gap between the sacrum and the ischium is bridged by two massive ligaments. The sacro-spinous ligament goes to the ischial spine, the sacro-tuberous ligament goes to the ischial tuberosity. Let's go round to the front and see those two ligaments from the inside. Here's the sacro-spinous ligament, here's the sacro-tuberous ligament. These two openings are the lesser sciatic foramen, and the greater sciatic foramen. The sciatic nerve passes through the greater sciatic foramen. The obturator foramen is largely closed by the obturator membrane. The obturator nerve and vessels pass through a small tunnel here.

06.09

Now let's take a look at the hip joint. We'll remove the femur for a moment., and look at the acetabulum. Here's the broad, c-shaped articular surface, sometimes called the lunate surface. This non-articular part of the acetabulum is the acetabular fossa. Around the edge of the bony acetabulum this rim of fibrocartilage, the acetabular labrum, adds to the depth of the acetabulum.

06.40

This is the cut end of the ligament of the head of the femur. Its other end is attached here, on the center of the femoral head. Now let's go back to the intact hip joint.

06.52

The capsule of the hip joint is a sleeve of ligaments. The capsule is thin on the underside. Everywhere else it's thick and strong. This part of the capsule behind is called the ischio-femoral ligament. This anterior part of the capsule, which is the thickest, is known as the ilio-femoral ligament. The fibers of these capsular ligaments become tight when the joint is extended.

07.23

The capsule is attached to the hip bone all the way round the acetabular labrum. On the back of the femur the capsule is attached about halfway along the femoral neck. On the front of the femur the capsule is attached out here, on the inter-trochanteric line.

07.43

Now let's take a look at the various different movements that occur at the hip joint. Movement can occur in three different axes. Forward movement is flexion, backward movement is extension. Movement out to the side is abduction, movement in toward the midline is adduction. Rotation outward is lateral rotation, rotation inward is medial rotation.

08.22

Rotation at the hip joint is accompanied by marked backward and forward movement of the greater and lesser trochanter.

08.31

Now we're almost ready to move on, to look at the muscles of the hip region. Before we do that, let's take a minute to review what we've seen of the bones, and of the hip joint. If you'd like to use this review section to test yourself, turn off the sound, and see how many of the structures you can name. There's another blue sign like this one, at the end of the review section.

08.53

BONE AND JOINT REVIEW

Here's the wing of the ilium, the iliac crest , the anterior superior iliac spine, the posterior superior iliac spine, the ischial spine, the ischial tuberosity, the acetabulum, the obturator foramen, the body of the pubis, the superior pubic ramus, the ischio-pubic ramus, and the pubic tubercle.

09.28

On the femur here's the head, the neck, the greater trochanter, the lesser trochanter, the inter-trochanteric line, the inter-trochanteric crest, the gluteal tuberosity, and the linea aspera.

09.54

Here are the sacro-spinous ligament, the sacro-tuberous ligament, the ischio-femoral ligament, the ilio-femoral ligament, and the obturator membrane.

10.10

MUSCLES

Now let's move on to look at the muscles that produce movement at the hip joint. There are five muscle groups to look at: the short rotators, the flexors, the adductors, and the extensors. We'll look at the six short rotator muscles first, because they lie deep to all the others.

10.33

The short rotator muscles arise from four different bony surfaces, the inner surface of the sacrum, both the inner surface and the outer surface of the area around the obturator foramen,and from the outer surface of the ischium. They all converge on this small area on the back of the femur, just medial to the greater trochanter.

10.58

The one that arises from the sacrum is piriformis. Here it is. Piriformis arises from here on the sacrum. It leaves the pelvis by passing through the greater sciatic foramen, along with the sciatic nerve. We'll go right round to the back to see where it comes out. Here's piriformis emerging. It inserts here, high up on the medial aspect of the greater trochanter.

11.32

Piriformis is an important muscle to understand, because it's closely related a very important structure, the sciatic nerve. Next we'll look at the two obturator muscles, obturator internus and externus. They lie on each side of the obturator membrane.

11.50

Here's obturator externus. It arises from the obturator membrane, and from the adjoining edge of the ischio-pubic ramus

12.00

Obturator externus passes backwards just beneath the neck of the femur. Here's its tendon, passing laterally , to reach its insertion here, below piriformis.

12.16

Next we'll see obturator internus, which comes around the back of the ischium here, from inside the pelvis. We'll go around this way to see where it arises. Here's obturator internus. It arises from this wide area on the ilium and ischium, and from the obturator membrane. It leaves the pelvis through the lesser sciatic foramen. As it passes round the back of the ischium, obturator internus does a 90° turn.

12.54

As it makes the turn , it's joined above and below by these two little muscles, gemellus superior, and gemellus inferior. They arise from the ischium here, and here. Along with obturator internus, they're inserted here.

13.15

The last of the short rotators is quadratus femoris. Quadratus femoris arises from the ischial tuberosity here, and inserts on the femur here, on the intertrochanteric crest.

13.31

All these short rotator muscles have the same action: by pulling the back of the femur medially, they produce lateral rotation at the hip joint. When the foot is on the ground, the same muscle action produces what appears to be a different movement: rotation of the trunk to the opposite side. So contraction of these muscles has two possible effects, depending on whether the limb is free to move, or whether it's fixed. As we'll see, that's holds true for every muscle that produces movement at the hip joint.

14.10

Now we'll move on to look at the groups of muscles which produce adduction, and abduction at the hip. We'll look at the five adductors first. There are three named adductors, adductors magnus, brevis, and longus; and there are two other muscles which adduct, pectineus and gracilis.

14.29

The adducting muscles all arise from this region on the pubis and ischium, and they're all inserted along this line, the lowest, gracilis, right down here on the tibia. Let's start with the named adductors,

14.51

Here's the largest of the them, adductor magnus. Adductor magnus arises from the outer border of the ischio-pubic ramus. Its insertion is in two parts, with a gap in between. The upper part of adductor magnus inserts here, on the linea aspera. The lower part inserts here, on the adductor tubercle of the femur

15.19

This gap is the adductor hiatus. The main blood vessels to the leg pass through here, from the front of the thigh, to the back.

15.33

The other two named adductors, brevis and longus, sit in front of adductor magnus. Here's adductor brevis. Here's adductor longus.

15.47

Brevis arises here on the body of the pubis, longus arises here. They're inserted on the femur right next to adductor magnus, brevis above, longus below. The insertion of adductor longus stops just short of the adductor hiatus.

16.08

The other two adducting muscles are a short muscle, pectineus, and a very long muscle, gracilis

16.18

Pectineus is the shortest of the adductors. It arises from this line on the superior pubic ramus. It inserts here, just in front of adductor brevis.

16.32

Gracilis is the most medial of all the thigh muscles. It arises here on the pubis, and it's inserted all the way down here, on the tibia.

16.44

The main effect of all these muscles, is to produce adduction at the hip joint.

16,52

The gracilis is the first muscle we've met which crosses both the hip joint, and the knee joint. We'll be meeting more muscles like it quite soon. A muscle that crosses both the hip, and the knee can either act at the hip, at the knee, or at both joints at once. The movement that it does produce is determined by what other muscle groups are acting at the same time.

17.19

For now, when we look at a muscle that goes from above the hip to below the knee, we'll just look at the way it acts at the hip. In the next section we'll take a second look at each of these muscles, and see how it acts at the knee.

17.32

Now let's move on, and look at the three muscles which produce abduction at the hip joint. The two important abductors are gluteus minimus, and gluteus medius. We'll go round to the back to look at them.

17.44

Here are the short rotator muscles that we've seen already, quadratus femoris, obturator internus and the gemelli, and piriformis. Now we'll add gluteus minimus to the picture. Gluteus minimus arises from this part of the wing of the ilium. It's inserted here, on the front of the greater trochanter.

18.12

Overlying gluteus minimus, is gluteus medius. Gluteus medius arises from this part of the ilium. It's inserted here, on the outer aspect of the greater trochanter.

18.30

Though gluteus medius is mainly an abductor as we'll see, its anterior part also produces medial rotation at the hip

18.41

The last of the abductors is called the tensor fascia lata. Before we look at it, we need to digress for a minute, and get acquainted with the structure that gives it its name, the fascia lata.

18.51

The fascia lata is a continuous sheet of dense fibrous tissue that surrounds all the muscles of the thigh. Along the outer aspect of the thigh there's a very marked thickening of the fascia lata called the ilio-tibial tract. It extends all the way from here on the ilium, down to here, on the tibia.

19.17

Here's the ilio-tibial tract by itself, with the rest of the fascia lata removed. These muscles, in front of it and behind it, we'll be looking at in a minute. Between the muscles is a strong fibrous septum, which attaches the ilio-tibial tract to the femur. At its lower end, the ilio-tibial tract is attached down here on the tibia.

19.43

The ilio-tibial tract acts as the tendon of insertion of two muscles, a big one back here, gluteus maximus, which we'll see later, and this one, which we were just getting ready to look at, tensor fascia lata.

20.00

Tensor fascia lata arises from the iliac crest here. It inserts here on the ilio-tibial tract.

20.10

The three hip abductors move the limb to the side. When the foot is on the ground the hip abductors, pulling down on the ilium, raise the opposite side of the pelvis up. This tilting of the pelvis happens in a small way each time we take a step, making it easy for the opposite foot to move forward without touching the ground.

20.38

Now let's move on to look at the muscles which produce flexion at the hip. There are four, two that act only at the hip, and two that act at the hip and also at the knee. The first two are the most important hip flexors - they're called iliacus, and psoas major.

20.57

Iliacus arises here from the iliac crest, psoas major from all the way up here, on the lumbar spine.

21.06

Here's psoas major. Psoas major arises from the transverse processes of all five lumbar vertebrae, and from the sides of the intervertebral discs and the adjoining vertebral bodies. We'll see its insertion in a moment.

21.24

Here's iliacus. It arises from almost all of the inner aspect of the wing of the ilium.

21.34

As they pass downward together, iliacus and psoas major pass over the superior pubic ramus and under a structure here that we haven't been introduced to yet, the inguinal ligament.

21.52

The two muscles pass downward and backward, and insert together down here, on the lesser trochanter. Contraction of the iliacus and psoas major produces flexion of the hip joint.

22.10

When the limb is free to move, flexion brings the thigh forward. When the limb is fixed, as it is here, flexion of both hips brings the body upright.

22.24

The other two muscles which help in hip flexion are rectus femoris, and sartorius. They're more important for their actions at the knee, than for their actions at the hip. We'll look at them briefly here, and in more detail in the next section. Rectus femoris is part of a huge muscle with four heads called quadriceps which we'll see in a moment.

22.46

Here are the muscles that we've seen already: psoas major and iliacus, pectineus, adductor brevis, longus, and magnus, and gracilis. Now let's add quadriceps to the picture.

23.06

All this is quadriceps. It's the main muscle that extends the knee. The only part of quadriceps which acts as a hip flexor is this part, rectus femoris. Its the only part that arises from above the hip joint, which is here.

23.23

Rectus femoris arises by two heads here and here, just above the acetabulum. Its final insertion, along with the other three heads of quadriceps, is right down here on the tibia. Rectus femoris is quite a weak hip flexor.

23.43

Now we'll add the last hip flexor, sartorius. Sartorius is a very long narrow muscle that lies outside all the others. It runs in a spiral, starting here on the anterior superior iliac spine, and ending up all the way down here, on the tibia. Sartorius helps to flex the hip. It can also produce lateral rotation at the hip.

23.12

Now let's move on to look at the four muscles that extend the hip. The first three, which are known collectively as the hamstring muscles, act at the hip and at the knee. The fourth one, gluteus maximus, acts only at the hip. We'll come to it last because it lies outside the others and covers them up

24.30

Here's the back of the thigh as we saw it last. Here's gluteus medius, here are all the short rotators, here's adductor magnus, and here's the back of quadriceps.

24.43

The three hamstring muscles all arise from the ischial tuberosity. Here they are. Two of them run down to the medial aspect of the leg, one runs to the lateral aspect. The lateral one is biceps femoris. The two medial ones are semimembranosus, and semitendinosus.

25.05

Here's semimembranosus by itself. It has a long flat membrane-like tendon of origin, which arises from here on the ischial tuberosity. It's inserted here on the back of the tibia.

25.22

Here's semitendinosus, lying behind semimembranosus. It has a long cord-like tendon of insertion. It arises from here, next to semimembranosus. It inserts down here on the medial aspect of the tibia, close to two other muscles that we've seen already, sartorius and gracilis.

25.50

Now that we've seen these two, we'll add biceps femoris to the the picture. Biceps femoris has two heads of origin, a long head, and a short head.

26.04

The long head arises from here on the ischial tuberosity, along with semitendinosus. The short head arises from almost the whole length of the linea aspera, and from this supracondylar line

26.22

The two heads of biceps femoris join together, forming a tendon that runs down behind the lateral aspect of the knee, then runs forward to insert here, on the head of the fibula.

26.33

We'll be taking another look at the hamstring muscles, their insertions, and their actions at the the knee, in the next section. We'll look at their action at the hip in a minute, but before we do that we'll add the last and largest of the hip extensors, gluteus maximus, to the picture.

26.49

Here's the upper end of the hamstring muscles, here, overlying them, is gluteus maximus. It's a thick, flat sheet of muscle. Gluteus maximus arises from here on the back of the ilium, and from the side of the sacrum, and from the sacrotuberous ligament.

27.09

The upper three quarters of gluteus maximus inserts into the ilio-tibial tract. The lower one quarter of gluteus maximus passes more deeply, and inserts here on the back of the femur, on the gluteal tuberosity.

27.25

Now let's look at the actions of the hip extensor muscles, starting with the hamstring muscles. Contraction of the hamstring muscles can produce both knee flexion, and hip extension. When knee flexion is held in check by the action of quadriceps, the hamstrings just produce extension at the hip, which is the action that propels us forward in normal walking.

27.54

Gluteus maximus isn't used in the gentle action of normal walking. It comes into play when a powerful action is needed, especially an action that opposes the force of gravity. The action of gluteus maximus extends the hip from a position of full flexion, as in climbing stairs, or rising from a squatting or sitting position. The same action, balanced against the force of gravity, controls the rate of hip flexion, as we sit down.

28.24

Gluteus maximus is one of the two big anti-gravity muscles of the lower extremity. The other one, acting at the knee, is quadriceps as we'll see in the next section.

28.33

Gluteus maximus has yet another set of actions when the lower extremity is fixed and upright. Then the action of gluteus maximus pulls the back of the pelvis downward, raising the body from a forward bend at the hips, or, when balanced against gravity, controlling the rate of bending forward.

28.54

Now we've looked at all the muscles that produce hip movement. As we've seen, several of them also have important actions at the knee, and we'll be looking at these a second time in the next section. We're now almost ready to move on, to look at the vessels and nerves of the hip region, but before we do that, let's review what we've just seen of the muscles.

29.14

REVIEW

Here's gluteus maximus, biceps femoris, semitendinosus, and semimembranosus.

29.26

Here's gluteus medius, and gluteus minimus.

29.33

Here's piriformis, obturator internus, and quadratus femoris; and here's adductor magnus, seen from behind.

29.43

On the front, here's tensor fascia lata, sartorius, and rectus femoris, psoas major, and iliacus, pectineus, adductor brevis, adductor longus, and magnus, and gracilis, and here again are piriformis, obturator internus, and obturator externus.

30.18

BLOOD VESSELS

Now we'll move on, and look at the blood vessels and nerves of the hip region. We'll follow the course of the vessels and nerves from the inside of the body, to the proximal part of the thigh. In the next section we'll follow them on down to below the knee. To understand the course of the main blood vessels, the femoral vessels, there's a structure we need to look at, that we saw before, the inguinal ligament; and there's a space between muscles that we need to understand, called the femoral triangle.

30.51

Here's the inguinal ligament. It's a strong, tight band that forms the lowest part of the anterior abdominal wall. The inguinal ligament passes from the anterior superior iliac spine, to the pubic tubercle. The inguinal ligament isn't an isolated structure, it's the lower edge of this large sheet of tendon-like material, the external oblique aponeurosis. Here's the inguinal ligament. The fascia lata, which we've seen already, is attached to it along here.

31.22

Tha gap between the inguinal ligament and the superior pubic ramus is occupied partly by the iliacus and psoas muscles, and partly, as we'll see, by the femoral nerve, artery and vein, and the inguinal lymph nodes. The other muscle in the picture here is obturator externus.

31.45

Now let's add all the other thigh muscle to the picture, and see the femoral triangle. Here, the fascia lata has been left intact; here, it's been removed. The femoral triangle is the name given to this deep hollow. It's bounded by sartorius laterally, adductor longus medially, and the inguinal ligament above. Int the depths of the triangle pectineus, psoas major and iliacus pass backward toward their insertions.

32.19

Now that we understand the inguinal ligament and the femoral triangle, we can move on and look at the blood vessels in the hip region, starting with a brief look at the principal veins. Almost all the veins in the region run parallel to arteries of the same name, so we won't need to look at them all separately. There's just one important vein we do need to look at, that has no corresponding artery - the long saphenous vein, also called the greater saphenous vein. With t he main vein there's a change of name that we need to understand. Below the inguinal ligament it's called the femoral vein. Above the inguinal ligament it's called the external iliac vein. It's the same with the artery. The vessels themselves don't change, just their names.

33.00

Here's the thigh with just the skin removed. The anterior superior iliac spine is here. Here's the long saphenous vein, which starts at the ankle, and passes up the medial side of the knee, and up to the top of the thigh. We'll remove all the subcutaneous fat to see it better. The inguinal ligament runs from here to here. Here's the fascia lata. Superficial veins from other parts of the region join the upper end of the long saphenous vein which passes through an opening in the fascia lata, the saphenous hiatus. Here, near the top of the saphenous vein are two of the inguinal lymph nodes. The main lymphatic vessels draining the lower extremity pass under the inguinal ligament here.

33.55

To see where the saphenous vein goes, we'll remove the fascia lata, and the underlying fat. Here are the main blood vessels to the leg - the femoral vein, and artery, and this is the femoral nerve. The long saphenous vein ends by joining the femoral vein here.

34.16

The femoral vein passes beneath the inguinal ligament. To see where it goes, we'll remove the abdominal wall, leaving just the inguinal ligament. This is the inguinal ligament, this is the top of the pubis. Here the vein is called the femoral vein, here above the inguinal ligament it's the external iliac vein; it's all the same vessel. To see where it goes, we'll remove the artery.

34.45

This muscle is the psoas major muscle. The external iliac vein is joined by the internal iliac vein to form the common iliac vein The right and left common iliac veins join in the midline to form the inferior vena cava.

35.03

Now we'll remove all the veins from the picture so that we can look at the arteries. We'll look first at the internal and external iliac arteries. Then we'll look at the femoral and deep femoral arteries which supply almost all of the lower extremity; then we'll look at the gluteal arteries which supply the gluteal or buttock area.

35.23

Here's the abdominal aorta, dividing to give off the left and right common iliac arteries. The common iliac divides, into the internal iliac and external iliac arteries. The external iliac passes under the inguinal ligament, emerging as the femoral artery.

35 44

The femoral artery gives off two small branches and one large branch. The small branches are the superficial circumflex iliac, which runs laterally, and the external pudendal, which runs medially. The large branch is the deep femoral artery, which we'll look at in a minute. The femoral artery itself runs downward, and passes beneath the sartorius muscle. We'll follow its further course in the next section of this tape.

36.10

Below the point where it gives off the deep femoral, the femoral artery is often referred to as the superficial femoral. It supplies everything from about here downward, but the main artery that supplies the thigh is the deep femoral.

36.24

To follow the deep femoral artery, we'll remove the femoral artery. We'll also remove the sartorius muscle and the femoral nerve.

36.34

Early in its course, the deep femoral gives off two large branches, the medial circumflex femoral, and the lateral circumflex femoral. It then passes behind adductor longus, which we'll remove.

36.48

Here's pectineus, adductor brevis, adductor magnus, rectus femoris. The deep femoral artery runs down in front of adductor brevis and adductor magnus, giving off numerous muscle branches, including several which run backward through adductor magnus to supply the posterior thigh muscles.

37.11

Now we'll go up to the internal iliac artery again, to look at the gluteal vessels, which provide the blood supply for the buttock.

37.20

The left side of the pelvis has been removed to give us a better view. Here's the internal iliac artery. Its branches which go to the pelvic viscera have been divided. Here, arising from the internal iliac, are the superior gluteal and inferior gluteal arteries. They both pass backward through the greater sciatic foramen, one above and one below the piriformis muscle, which is here. To see where they emerge, we'll go right round to the back, and remove gluteus maximus.

37,56

Here's piriformis, here's gluteus medius. Again, all the veins have been removed to simplify the picture. Here's the superior gluteal artery, and here's the inferior gluteal artery, branching to supply the muscles of the buttock region.

38.17

NERVES

Now that we've looked at the blood vessels of the hip region, we can move on to look at the nerves. We'll look first at the femoral nerve and the obturator nerve, which supply the front and the medial aspect of the thigh, then we'll look at the gluteal nerves and the sciatic nerves, which supply the buttock and the back of the thigh. All the nerves of the lower extremity come from the anterior rami of the second to the fifth lumbar nerves, and the first, second and third sacral nerves. To see where these arise, let's take a look at the lumbar spine and the sacrum.

38.52

Below each vertebra there’s an intervertebral foramen. An anterior ramus emerges through each foramen. The anterior rami of the sacral nerves emerge from the anterior sacral foramina. Each anterior ramus is numbered according to the vertebra, or the sacral segment, that’s above it. Here's the third lumbar vertebra, here's where the L3 ramus emerges.

39.19

We'll start by looking at the femoral nerve, and the obturator nerve. This is the femoral nerve, this is the obturator nerve. The white structure between them is the psoas major tendon. Both these nerves arise from the lumbar plexus, which lies up here within the thickness of the psoas major muscle.

39.40

The femoral nerve emerges lateral to psoas major, the obturator nerve medial to it. We'll follow the femoral nerve. It runs across the iliacus muscle, and passes under the inguinal ligament just lateral to the femoral artery. Below the inguinal ligament the femoral nerve breaks up into several branches.

40.01

The femoral nerve supplies iliacus, all four heads of quadriceps, and also pectineus, and sartorius.

40.14

Now lets look at the obturator nerve. Emerging below the medial border of psoas major, it crosses the wing of the sacrum, then runs along the back of the ischio-pubic ramus. It leaves the pelvis by passing forward through the obturator canal, just above obturator internus. To see where it emerges, we'll remove pectineus.

40.41

Here's the obturator nerve, emerging over the top of obturator externus. Its branches run down between the adductor muscles. The obturator nerve supplies obturator externus, adductor brevis, and longus, and the anterior part of adductor magnus.

41.04

Now we'll look at the two gluteal nerves, the superior and the inferior, and at the largest nerve of the lower extremity, the sciatic nerve, which supplies the posterior thigh muscles, and also almost everything below the knee. The gluteal and sciatic nerves arise from the sacral plexus.

41.24

Here's the sacral plexus. It's formed by the anterior rami of L4 and 5, and S1.2 and 3. The sacral plexus overlies the piriformis muscle.

41.39

This is the sciatic nerve. It arises from L4 through S3. This is the superior gluteal nerve. The inferior gluteal nerve arises out of sight behind the sciatic nerve. All three nerves leave the pelvis through the greater sciatic foramen. To see where they come out, we'll go round to the back, and remove gluteus maximus

42.02

Here, the vessels have been removed to simplify the picture. Here's piriformis. Here's the sciatic nerve, here's the inferior gluteal nerve, and here's the superior gluteal nerve, disappearing beneath gluteus medius. The superior gluteal nerve supplies gluteus medius, gluteus minimus, and tensor fascia lata. The inferior gluteal nerve supplies gluteus maximus.

42.33

The sciatic nerve runs down the middle of the thigh. Deep to it are quadratus femoris, and lower down, adductor magnus. This is the long head of biceps femoris which crosses over the nerve obliquely, and covers it up. We'll follow the sciatic nerve further, in the next section of this tape.

42.55

In the thigh, the sciatic nerve supplies semitendinosus, semimembranosus, and also biceps femoris, and the posterior part of adductor magnus.

43.09

Lastly, there are a few hip muscles which have their own individual nerve supply. Psoas major is supplied by several small branches of the lumbar plexus. Small separate branches of the sacral plexus supply piriformis, obturator internus, and quadratus femoris

43.32

Now let's review the vessels and nerves of the hip region.

43.37

REVIEW

Here's the long saphenous vein, and the femoral vein, becoming the external iliac vein.

43.50

Here's the common iliac artery, the internal iliac, giving off the superior gluteal and inferior gluteal arteries. Here's the external iliac, becoming the femoral artery.

44.06

Here's the superficial circumflex iliac, and the external pudendal. Here's the deep femoral, giving off the lateral circumflex femoral, and the medial circumflex femoral arteries.

44.20

Now the nerves: the femoral nerve, the obturator nerve, the sciatic nerve, the inferior gluteal nerve, and the superior gluteal nerve.

44.37

That brings us to the end of this section on the hip region.
In the next section we'll look at the knee.

END OF SECTION 1

PART 2: THE KNEE

BONES, LIGAMENTS AND JOINTS

00.00

In this section, we'll look at the knee. First we'll look at the bones, then the knee joint and how it moves, then the muscles that move it, and lastly the vessels and nerves. Let's see the bones, starting with the femur.

00.21

We saw the proximal end of the femur in the last section. Now let's look at the distal end.

00.28

The two smoothly curved surfaces are the lateral condyle and the medial condyle. The deep notch which separates them is the intercondylar notch. Above the two condyles are the epicondyles, lateral and medial. The sharp corner on the medial epicondyle is the adductor tubercle. This prominent ridge is the medial supracondylar line, this one is the lateral supracondylar line. Now we'll add the tibia and the fibula to the picture.

01.12

The tibia and the fibula are fixed to each other firmly by two joints, the proximal, and distal tibio-fibular joints. There's almost no movement at either of these joints. Let's take a look at the proximal end of the tibia.

01.33

This is the medial condyle, this is the lateral condyle. On top of the two condyles are two quite separate articular surfaces. They're much flatter than those on the femur. The rugged expanse between the articular surfaces is the inter-articular area. This prominent lump on the front, the tibial tubercle, is the final insertion of the quadriceps tendon. The small facet under here is for the fibula, which we'll add.

02.06

This is the head of the fibula, this is the neck. The head of the fibula is the point of attachment of a major ligament of the knee joint, as we'll see.

02.15

The space on each side of the knee between the femoral condyle and the tibial condyle is occupied by a crescent shaped piece of cartilage, a meniscus, which we'll see shortly. The space in the middle, the intercondylar notch is occupied by the two cruciate ligaments. The intercondylar notch and its contents divide the knee joint into two almost separate halves.

02.42

There's one more bone to add to the picture, the patella, or kneecap. The patella, as we'll see, is embedded within the quadriceps tendon, which comes from up here, and inserts on the tibia down here on the tibial tubercle. On the back of the patella the articular surface is divided into facets. These articulate either with the femoral condyles when the knee is flexed, or with this central articular area when it's extended.

03.16

Now that we've seen the bones of the knee joint, let's see how the joint looks in the living body.

03.22

In building up our picture of this quite complicated joint, there are several structures that we need to understand: first the two joint cartilages or menisci, then the ligaments, the two cruciate ligaments and the two collateral ligaments, then the patella and the quadriceps tendon on the front, and lastly the capsule which encloses the joint.

03.44

Here are the two articular surfaces of the tibia. The two menisci sit on top of them. Here are the menisci. They're made of flexible fibrocartilage. They're shaped a little differently, the lateral one is almost a circle, the medial one is more C-shaped. In cross section, each meniscus is thick at the outer edge and thin at the inner edge. The two ends of each meniscus are attached to the inter-articular area of the tibia, the medial ones far apart, the lateral ones close together.

04.26

In addition each meniscus is attached all the way round its edge, both above and below, to the joint capsule. Here's part of the joint capsule. We'll see more of it later.

04.41

The lateral meniscus is much more mobile than the medial one, partly because its two ends are attached close together, partly because of a big difference in the mobility of the joint capsule around the edge.

04.56

By filling in the spaces between the femoral and tibial condyles, the menisci produce an even distibution of synovial fluid, to nourish and lubricate the articular cartilage of the femur and tibia. Now lets look at the two pairs of ligaments which hold the bones together at the knee joint - the two cruciate ligaments on the inside, and the two collateral ligaments on the outside.

05.21

We'll look at the cruciate ligaments first. They're the important structures which prevent forward and backward movement of the femur on the tibia. Their name comes from the fact that they form a cross like this.

05.36

Here's the anterior cruciate ligament, seen from in front. Here's the posterior cruciate ligament, seen from behind. To get a better look at them, we'll remove the lateral condyle of the femur.

05.53

Now we can see the whole of the anterior cruciate ligament. Te anterior cruciate ligament goes from here on the tibia, to here on the femur, on the inner aspect of the lateral condyle. The anterior cruciate ligament prevents the femur from moving backward in relation to the tibia.

06.21

Now we'll look at the posterior cruciate ligament. We'll remove the anterior cruciate ligament to see it better. The posterior cruciate ligament goes from here on the femur, to here on the back of the tibia. The posterior cruciate ligament stops the femur from moving forward on the tibia.

06.42

By preventing backward and forward movement, the cruciate ligaments ensure that the condyles of the femur stay in one place, as they roll on the condyles of the tibia. Without them, the femur would roll off the back of the tibia in flexion, and would roll off the front of it in extension.

07.04

Now let's look at the two collateral ligaments, the fibular collateral ligament on the lateral side, and the tibial collateral ligament on the medial side. The tibial collateral ligament goes from the medial epicondyle of the femur, to the anteromedial aspect of the proximal tibia.

07.26

The tibial collateral ligament blends with the capsule of the knee joint behind, and also in front. On its inner aspect, it's firmly attached to the edge of the medial meniscus, which is here. Now let's look at the rather different fibular collateral ligament. It goes from the lateral epicondyle of the tibia, to the head of the fibula.

07.54

The fibular collateral ligament stands out from the side of the knee joint. Unlike its tibial counterpart, it doesn't blend with the joint capsule. It's not attached to the meniscus.

08.07

When the knee joint is extended, both the collateral ligaments are tight. When it's flexed, they become less tight. The function of the collateral ligaments is to keep the femoral and tibial condyles together,and thus to prevent the knee joint from bending from side to side like this, or like this.

08.34

In addition to the obvious knee movements - flexion and extension - it's also possible for the tibia to rotate a little on the femur, like this. This rotation can happen only when the knee is flexed - when it's extended the tightness of the collateral ligaments makes rotation impossible. The next structure we need to add in building up our picture of the knee joint is the quadriceps tendon, and along with it, the patella.

09.02

Here's the distal end of the quadriceps muscle, which we'll see in more detail later in this section. Here's the quadriceps tendon. The patella, which is here, is enfolded within the tendon. The part of the tendon below the patella is known as the patellar ligament. On the medial side, and on the lateral side, the tendon is continuous with the capsule of the knee joint.

09.32

Between the quadriceps tendon and the femur is an extension of the knee joint cavity, the quadriceps bursa. It's lined with synovial membrane. This lubricated pocket enables the quadriceps tendon to slide easily on the femur.

09.49

Now we'll complete our picture of the knee joint by adding the fibrous capsule which encloses it.

09.56

Here's the knee joint with the joint capsule intact. On the medial side the thin capsule is continuous with the tibial collateral ligament, but on the lateral side the capsule is separated from the fibular collateral ligament. On the back of the joint the capsule is thick and strong. The thickened posterior capsule prevents hyperextension of the knee joint.

10.26

Here we've divided the fibrous capsule to see its inner surface. It's lined on the inside with synovial membrane all the way round the joint, except at the back. At the back, as we'll see if we remove the capsule, the thin synovial membrane (here it is) passes forwards around the cruciate ligaments, covering them on the front.

10.54

Besides being the largest joint in the body, the knee joint is also much the most complicated! Before we move on to look at the muscles which produce knee movement, let's review what we've seen of the bones, and of the knee joint.

11.06

REVIEW

On the femur, here's the lateral condyle, and epicondyle; the medial condyle, and epicondyle; the adductor tubercle, and the intercondylar notch.

11.28

On the tibia, here's the lateral condyle, the medial condyle, the tibial tubercle, and the facet for the fibula.

11.40

Here's the head of the fibula, the neck of the fibula, the proximal tibio-fibular joint, and the patella.

11.54

Here's the medial meniscus, the lateral meniscus, the anterior cruciate, and posterior cruciate ligaments. The fibular collateral ligament, the tibial collateral ligament, the quadriceps tendon, the patellar ligament, and the joint capsule.

12.24

MUSCLES

Now we'll move on to look at the muscles which produce movement at the knee joint. We've met most of them already. The one muscle that extends the knee is the massive quadriceps. We saw it briefly in the last section. We'll take a better look at it now. The main flexors of the knee are the so-called hamstring muscles, semi-membranosus, semitendinosus, and biceps femoris. Besides flexing the knee, the hamstring muscles also extend the hip. We took a good look at them in the last section. Here, we'll just re-visit their insertions. In addition we'll look at three muscles at the back of the knee that we haven't yet seen - popliteus, gastrocnemius, and plantaris.

13.12

We'll start with quadriceps. Its name comes from the fact that it has four heads. Oddly, these are named as though they were separate muscles. Three of the heads arise from the femur. They're all called vastus intermedius, vastus medialis, and vastus lateralis. The fourth head, rectus femoris, arises from the hip bone. All four heads converge on the quadriceps tendon, which we've seen. We'll start with the deepest of the heads, vastus intermedius.

13.43

Here it is. It forms a bulge on the front of the femur. Vastus intermedius arises from this broad area around the lateral aspect and front of the femur.

13.56

Wrapped around the outside of vastus intermedius are vastus medialis, and vastus lateralis. These two cover vastus intermedius almost completely. Their fibers run obliqely, all the way round to the back. Here's lateralis, here's medialis, almost meeting it.

14.23

Vastus lateralis arises from the lateral edge of the linea aspera, and from the side and front of the greater trochanter. Vastus medialis arises from the medial edge of the linea aspera, and from just below the lesser trochanter. The thin strip of bone between these two lines of origin provides the insertion of all the adductor muscles, and also the origin of the short head of biceps.

14.53

Now let's add rectus femoris to the picture. Here it is. Rectus femoris arises from the ilium just above the hip joint. Its tendon of origin has two parts, a posterior or reflected part and an anterior or straight part. The anterior part arises from this prominence, the anterior inferior iliac spine. The posterior part arises from just above the acetabulum.

15.28

All four heads of quadriceps converge on the quadriceps tendon. The lowest fibers of vastus lateralis and medialis insert into the sides of the patella.

15.40

The principal action of the quadriceps muscle is to extend the knee. When the foot is off the ground, that action simply straightens the leg, and holds it straight. When the foot is on the ground, the action of quadriceps has several important effects.

15.58

In normal walking, quadriceps straightens the leg as the foot reaches the ground, then keeps the leg straight while the hamstring muscles extend the hip.

16.09

Quadriceps is also one of the two big anti-gravity muscles of the lower extremity. Its partner, which we've seen already, is gluteus maximus. Acting together, quadriceps at the knee and gluteus maximus at the hip, lift the body upward, when we climb uphill, when we rise from a sitting position, and when we jump. The same muscle actions propel us forward when we're pushing a heavy load.

16.47

In addition to these actions, when quadriceps and its partner gluteus maximus act in balance with the force of gravity, they control our rate of descent as we sit down. and also when we walk downhill.

17.04

We need to digress for a moment to look at a structure called the adductor canal, which lies between vastus medialis, and the adjoining adductor longus muscle. The adductor canal is important because the femoral vessels run through it, in their course from the front of the thigh to the back.

17.23

Here's vastus medialis, here are the adductor muscles, magnus behind, longus in front, with brevis up here. The adductor canal is formed by the groove between adductor longus and vastus medialis, and by this sheet of fascia, called the roof of the adductor canal, which bridges over between the muscles. The adductor canal is covered over by the sartorius muscle.

17.53

We'll see the adductor canal again when we look at the blood vessels. Now let's move on to look at the muscles which produce flexion at the knee joint. We'll revisit the main flexors, the three hamstring muscles, and two minor flexors, sartorius and gracilis.

18.11

Here are the hamstring muscles again. On the medial side, here are semi-membranosus and semi-tendinosus. As we've seen, they both arise from the ischial tuberosity and insert on the medial side of the knee, semimembranosus here, semitendinosus here.

18.31

On the lateral side, here's biceps femoris. It arises both from the ischial tuberosity, and from the femur, and inserts down here, on the head of the fibula.

18.44

We've already seen that these three muscles, which usually act together, can produce either extension of the hip, or flexion of the knee. Whether they do one, the other, or both, is determined by what other muscles are acting in opposition to them at the time. When flexion of the knee is resisted by quadriceps, the hamstring muscles produce extension at the hip. When extension of the hip is resisted by the hip flexors, the hamstring muscles produce flexion of the knee.

19.18

In addition, the hamstring muscles, acting separately, produce medial rotation and lateral rotation at the knee joint. As we've seen, these movements can only happen when the knee is flexed. The two semi- muscles produce medial rotation, biceps femoris produce lateral rotation.

19.41

The other two minor knee flexors that we've seen already are sartorius, and gracilis. Here's sartorius, which arises up here. Here's gracilis, arising here. These two insert close to semitendinosus. sartorius here, gracilis here.

20.07

We've already seen the actions of these two muscles at the hip. At the knee, they help to produce flexion. Now we'll complete our picture of the muscles around the knee by looking at three muscles at the back that we haven't met yet, popliteus, gastrocnemius and plantaris.

20.25

Here's the popliteus muscle. It arises from this area on the back of the tibia, and inserts up here on the lateral epicondyle of the femur. The tendon of popliteus passes through the capsule of the knee joint to reach its insertion. Popliteus is a minor flexor of the knee, and it can also produce medial rotation of the tibia.

20.52

Lying on top of popliteus is the small plantaris muscle. It's a vestigial structure. It arises from the lateral epicondyle of the femur. The tiny tendon of plantaris runs down on the back of this big muscle, soleus. We'll see where it ends up in the next section.

21.16

Lying on top of the two small muscles that we've just seen, is the much larger gastrocnemius muscle. Gastrocnemius arises by two heads, from the back of the medial and lateral condyles of the femur.

21.31

Gastrocnemius runs downward, and joins with the underlying soleus muscle, which we'll see in the next section, to form the calcaneal tendon, or heel cord. Gastrocnemius has a slight flexing action at the knee, but its main action, by far, is at the ankle joint: we'll see it again in the next section.

21.51

Now that we've seen all the muscles that arise or insert at the knee joint, let's see how they all fit together.

21.58

REVIEW

You can use this overview as a brief review section.

Here on the front are quadriceps. sartorius, and gracilis. On the back, here are semitendinosus, and semimembranosus. Here's biceps femoris. and here's gastrocnemius, Here's plantaris, and popliteus.

22.29

VESSELS

Now we'll move on, to look at the principal veins, arteries and nerves in the region of the knee. We'll begin where we saw them last, just below the hip. We'll follow them to just below the knee.

22.49

With the main artery and vein, there's a change of name that we need to understand. In the upper and middle thigh, they're known as the femoral vessels, but below the adductor hiatus they're called the popliteal vessels. The same vessels, just a different name.

23.03

Here's the thigh, with the skin removed, and a strip of subcutaneous fat taken out so that we can see the long saphenous vein. Here it's in the middle of its course from the ankle to the top of the thigh. To see the femoral vessels we'll remove the superficial fat, and deep fascia.

23.22

Here are the femoral artery and vein at the point where we saw them last, disappearing beneath the sartorius muscle. To follow their course, we'll remove sartorius, and also gracilis.

23..36

Here's vastus medialis, here's adductor longus, with adductor magnus behind it. The femoral vessels pass beneath the roof of the adductor canal, and through the adductor hiatus. To see where they emerge, we'll remove semi-membranosus and semi-tendinosus, and go round to the back. Here are the vessels emerging behind adductor magnus. They're now known as the popliteal artery and vein.

24.04

A little above the knee the popliteal vessels are joined by the sciatic nerve. At the back of the knee, the popliteal artery lies deep to the nerve, and to the popliteal vein. To see the artery better, we'll go to a different dissection in which the muscles are intact, and the nerve and the vein have been removed.

24.22

Above the knee, which is just here, the popliteal artery gives off these two superior genicular arteries, lateral, and medial. At the knee it gives off these branches, to the two heads of gastrocnemius; and below the knee it gives off these two inferior genicular arteries, medial, and lateral. The popliteal artery then disappears deep to the two heads of gastrocnemius. We'll see where the vessels go from there, in the next section.

25.00

NERVES

Now let's look at the nerves. In the last section we looked at three major nerves - the obturator, the femoral, and the sciatic. We'll follow the sciatic nerve in a minute. The obturator nerve and the femoral nerve we don't need to follow any further, except to remind ourselves of the muscles that they supply.

25.17

As we've seen before, the obturator nerve supplies obturator externus, adductor brevis, and longus, and the anterior part of adductor magnus. The femoral nerve supplies iliacus, pectineus, all four heads of quadriceps, and sartorius.

25.47

The obturator and femoral nerves also have sensory branches, some of whch go below the knee. We'll leave these out. We'll go on now to look at the sciatic nerve. We saw the sciatic nerve a minute ago, with the hamstring muscles absent. To see the whole picture, we'll add the hamstring muscles.

26.06

Here are semimembranosus and semitendinosus, here's biceps femoris. Here are the two heads of gastrocnemius. The space that's bounded by these muscles is called the popliteal fossa. As we saw in the previous section, the sciatic nerve passes deep to biceps femoris. Here it is emerging. Here are the popliteal vessels, coming in beneath the "semi " muscles, and passing deep to the nerve. Above the knee the sciatic nerve divides into two major nerves - the tibial nerve, and the common peroneal nerve.

26.45

The tibial nerve runs downward in the midline, and passes between the two heads of gastrocnemius, along with the popliteal vessels. The common peroneal nerve, diverges laterally, running just behind the tendon of biceps femoris.

26.69

It passes around the neck of the fibula, here's the fibula, and passes into this muscle, peroneus longus. We'll follow the further course of both these nerves in the next section.

27.11

Of the muscles that we’ve seen in this section, the tibial nerve supplies popliteus, gastrocnemius, and plantaris.

27.22

We’ll conclude this section by briefly reviewing what we’ve seen of the vessels and nerves of this region.

27.29

REVIEW

Here's the femoral vein, and artery; the superior genicular arteries, lateral, and medial and the inferior genicular arteries, medial and lateral. Here's the popliteal artery, and vein.

Here’s the sciatic nerve, the tibial nerve, and the common peroneal nerve.

28.13

That brings us to the end of this section on the knee. In the next section we’ll look at the leg, the ankle, and the joints of inversion and eversion of the foot.

END OF PART 2

PART 3: THE LEG AND ANKLE

BONES, LIGAMENTS AND JOINTS

00.00

In this section we'll go from the knee, to a little below the ankle. We'll start by looking at the bones, and the joints of the the ankle region. Then we'll look at the muscles which produce movements at those joints. Lastly we'll look at the blood vessels and nerves of the region.

00.21

Before we start, we need to understand the meaning of some anatomic terms regarding the foot and its movements. The upper and lower surfaces of the foot are called the dorsal surface, and plantar surface. This part of the foot is called the tarsus, these bones are the tarsal bones. The long bones in front of them are the metatarsals.

00.48

We'll be looking at two sets of movements, which happen in two different places. The upward and downward movements, that occur at the ankle joint itself, are called dorsi-flexion, and plantar flexion.

01.03

The side to side rocking movements that occur at the joints just below the ankle are called eversion, for turning outward, and inversion, for turning inward. Lastly, speaking of definitions, recall that "the leg" in anatomy means just the part of the lower extremity that's between the knee and the ankle.

01.23

Now lets look at the bones. We'll start by taking a further look at the two long bones of the leg, the tibia and the fibula. The tibia is much the larger of the two bones.

01.35

The shafts of the two bones are covered by muscles, except for the anteromedial aspect of the tibia, which lies directly beneath the skin all the way from the knee to the ankle.. The proximal end of the fibula doesn't form part of the knee joint, but its distal end forms an important part of the ankle joint, as we'll see.

02.01

The tibia and fibula are held together throughout their length by the strong interosseous membrane. Above and below the're attached at the two tibio-fibular joints. The proximal tibio-fibular joint is a synovial joint, the distal one is a fibrous joint. There's very little movement at either of these joints. Distally the two bones are strongly held together by the anterior tibio-fibular ligament, and the posterior tibio-fibular ligament..

02.37

The projecting ends of the tibia and fibula, which stick out on either side of the ankle, are called the medial malleolus, and the lateral malleolus.

02.53

The articular surface for the ankle joint is a broad notch, formed by the curved undersurface of the tibia, and the inner surfaces of the medial malleolus, and the lateral malleolus.

03.08

Now let's look at the bone that articulates with the tibia and fibula to form the ankle joint - the talus. This is the talus. The bone below and behind it is the calcaneus, or heel bone. The bone in front of the talus is the navicular bone. We'll meet the remaining tarsal bones shortly. Now we'll go round to te lateral view to see the talus by itself.

03.31

This is the head of the talus, this is the neck. The talus has three articular surfaces, one on the head, and one on the underside for the two joints of inversion and eversion, and one on top for the ankle joint.

03.52

Here’s the ankle joint. Let’s see how it looks in the living body. Here the loose parts of the joint capsule have been removed, leaving these thickened parts, which are the ligaments of the joint. Here’s the front of the joint in plantar flexion, here’s the back of the joint in dorsiflexion.

04.28

On the lateral side, the joint is held together by the posterior talo-fibular and anterior talo-fibular ligaments. On the medial side it’s held together by this massive ligament, the deltoid ligament, which attaches not only to a broad area on the talus but also to the adjoining bones below and in front, as we’ll see shortly. The ligaments of the ankle joint ensure that the talus can’t rock from side to side like this, or move backward or forward like this, relative to the tibia and fibula.

05.12

Here’s the ankle joint with its joint capsule intact, and with the rest of the bones in place. The capsule of the ankle joint is loose on the front, and it’s also loose on the back. This looseness allows for a full range of dorsiflexion and plantar flexion.

05.37

Now we’ll move on, to look at the two joints of inversion and eversion. There’s one directly beneath the main part of the talus, called the subtalar joint; and there’s one below and in front of the head of the talus that has an unwieldy name, the talo-calcaneo-navicular joint. We’ll call it the T.C.N. joint for short.

05.56

To understand these joints we need to get acquainted with the remaining tarsal bones. We already know the talus, the calcaneus, and the navicular. In front of the navicular are the three cuneiform bones, first, second, and third. Lastly, the bone in front of the calcaneus is the cuboid bone.

06.18

Now let's look at the calcaneus by itself. The posterior part of the calcanueus forms the heel. The massive calcaneal tendon, also called the Achilles tendon, is attached here. Here on the medial side there’s a projecting shelf which the medial part of the talus sits on, called the sustentaculum tali.

06.42

On the front of the calcaneus there’s an articular surface for the cuboid bone. On the upper aspect of the calcaneus there are two articular surfaces for the talus, a small one in front, a larger one behind.

07.01

The larger of these two surfaces, together with the corresponding surface on the underside of the talus, forms the subtalar joint. The head of the talus fits into a socket, which we’ll see by taking the talus away. The socket is formed by this surface of the calcaneus, this surface of the navicular bone, and by a strong ligament here which we’ll see in a minute. These surfaces, together with the head of the talus, form the talo-calcaneo-navicular joint.

07.41

Here’s what these joint surfaces look like in the living body: the surface for the subtalar joint, and the two surfaces for the T.C.N. joint. This structure in between, which forms part of the TCN joint, is the upper surface of the strong calcaneo-navicular ligament, also misleadingly called the spring ligament, which helps to hold up the head of the talus. It goes from here on the calcaneus to here on the navicular.

08.11

The movement that happens at the subtalar and T.C.N joints is a rocking motion, that takes place around an obliquely placed axis.

08.20

This rod shows the position of the axis: it's oblique to the long axis of the foot both in this plane, and in this plane. Here's eversion...here's inversion. Again, eversion...and inversion

08.43

Several strong ligaments hold the malleoli, the talus, the calcaneus and the navicular bone together. On the medial side, which we'll see first, there's one extensive ligament to look at, the deltoid ligament. We've seen part of it already,

009.01

Now here's the whole of the deltoid ligament. This is the part we saw before, going from from the medial malleolus to the talus. In addition, parts of the deltoid ligament fan out below onto the sustentaculum tali of the calcaneus, and in front onto the navicular bone, so that the deltoid ligament holds all four of these bones together.

09.25

On the lateral side there are two important ligaments, the calcaneo-fibular ligament which goes from the lateral malleolus to the side of the calcaneus, and this strong ligament, the interosseous talo-calcaneal ligament, which goes from here on the calcaneus, to here on the talus.

09.49

To see that ligament better, we'll remove the talus. The interosseous talo-calcaneal ligament lies between the subtalar joint and the T.C.N. joint..

10.02

Now that we've seen the ankle joint and the joints of inversion and eversion, we'll look very briefly at the remaining joints of the tarsus. Between the navicular and its neighbors, the cuneiform bones and the cuboid bone, there's hardly any movement. But there is a small amount of rotation here between the cuboid and the calcaneus, which lets the front part of the foot invert and evert a little, independently of the calcaneus.

10.29

We'll see more of the bones and ligaments of the foot in the next section. For now, we've seen enough to understand how the joints of the ankle region move. Before we move on to look at the muscles that produce those movements, we need to take a look at some important pulley-like structures that are attached to the bones of the ankle region. These are called retinacula, the singular of which is retinaculum. Each retinaculum guides and keeps in place a set of tendons that pass from the leg to the foot. There's a retinaculum on the front of the ankle, and one on each side of the ankle, behind and below each malleolus.

11.06

Here on the front are the upper part and the lower part of the extensor retinaculum. These aren't isolated structures, they're localized thickenings of this layer of investing deep fascia, which we'll meet later. Four tendons, a nerve and an artery pass under the extensor retinaculum.

11.31

On the lateral aspect, behind the malleolus, here's the peroneal retinaculum. It accommodates the tendons of two peroneal muscles as they pass around the lateral malleolus.

11.46

On the medial side the flexor retinaculum fans out from the back of the medial malleolus. The space beneath the flexor retinaculum is divided into four separate tunnels. Three tendons, and the posterior tibial vessels and nerve, pass through these tunnels as they pass around the ankle and into the foot.

12.09

Now let's review what we've seen of the bones, joints and pulleys of the ankle region. Then we'll move on to look at the muscles of the leg.

12.17

REVIEW

Here's the tibia, the fibula, the medial malleolus, the lateral malleolus, the talus, and the ankle joint.

12.34

Here's the interosseous membrane, the proximal tibio-fibular joint, the distal tibio-fibular joint, the posterior tibio-fibular, and talo-fibular ligaments, the anterior tibio-fibular, and talofibular ligaments, and the deltoid ligament. Here's the calcaneus, the cuboid, the three cuneiform bones, and the navicular,

13.13

Here are the surfaces for the subtalar joint, and for the T.C.N. joint. Here's the calcaneo-navicular ligament, the calcaneo-fibular ligament, and the interosseous talo-calcaneal ligament. Here's the extensor retinaculum, the peroneal retinaculum, and the flexor retinaculum.

13.49

MUSCLES

Now we'll move on to look at the muscles that produce movement at the joints of the ankle region. In doing this, we'll meet most but not all of the muscles that are in the leg.

14.05

There are four muscles that in the leg, the long flexors and extensors of the toes, that we'll leave out of the picture till the next section. These are the long flexors and the long extensors of the toes. Along with the muscles, we'll meet the various layers and partitions of deep fascia which divide the muscles of the leg into rather distinct compartments.

14.23

We'll start with the muscles that produce dorsiflexion and plantar flexion at the ankle joint; next we'll look at the fascial layers and compartments, lastly we'll look at the muscles of inversion and eversion.

14.35

First, then, the dorsiflexors and plantar flexors. Dorsiflexion involves just lifting the foot. Plantar flexion involves lifting the whole body. So it's not surprising that the muscles for plantar flexion are much larger than the ones for dorsiflexion.

14.52

There's one muscle on the front of the leg for dorsiflexion, tibialis anterior. There are three on the back of the leg for plantar flexion, gastrocnemius, soleus, and plantaris. Here's tibialis anterior. Tibialis anterior arises from the lateral surface of the upper tibia, and from the interosseous membrane.

15.17

The tendon of tibialis anterior passes under the extensor retinacula, and winds around the medial side of the tarsus, to insert right down here, on the first cuneiform bone, and on the base of the first metatarsal. The main action of tibialis anterior is to produce dorsiflexion at the ankle.

15.49

Dorsiflexion is not the only action of tibialis anterior. It also has a role in producing inversion, as we'll see shortly. What's more, tibialis anterior is not the only muscle that produces dorsiflexion. It's assisted in that, by the long extensor muscles for the toes, which we'll see in the next section.

16.11

We'll move on now to look at the muscles that produce plantar flexion. Two large muscles, gastrocnemius and soleus, and one small muscle, plantaris, join together to form the massive calcaneal tendon.

16.26

Here's gastrocnemius; here deep to it is soleus. Gastrocnemius has two heads, a medial and a lateral. These arise, as we've seen, from the medial and lateral condyles of the femur. The two heads of gastrocnemius unite, forming a flat tendon. The gastrocnemius tendon in turn unites with the tendon of soleus to form the calcaneal tendon. To look at soleus we'll remove gastrocnemius.

17.04

Here's the whole of soleus. Here's its medial border, here's its lateral border. Here's the cut edge of the gastrocnemius tendon. Soleus arises from the medial edge of the tibia, from this oblique line on the back of the tibia, and from this area on the back of the fibula.

17.34

Between the fibular, and the tibial origins of soleus there's an arch of fibrous tissue. The popliteal vessels, and the tibial nerve, pass beneath this arch. Here are their divided ends.

17.50

For completeness, we'll add plantaris to the picture. Here it is. Plantaris arises here on the lateral epicondyle of the femur. The long tendon of plantaris runs almost to the ankle before uniting with the calcaneal tendon. The calcaneal tendon is also known as the Achilles tendon or simply the heel cord. It inserts into a broad area here, on the back of the calcaneus. In front of the calcaneal tendon there's a pad of fat, which fills the gap between the tendon and the back of the ankle joint

18.35

The action of soleus, gastrocnemius, and plantaris is to produce plantar flexion at the ankle joint. Their action lifts us off the ground when we stand on tip-toe. When balanced against gravity, the same action controls our rate of descent. In addition, these muscles provide an important part of the propulsive force in normal walking, in going uphill, in running, and in jumping.

19.16

Before we move on to see the muscles that produce inversion and eversion, we need to digress for two minutes, to look at the layer of deep fascia that surrounds all the muscles of the leg, and the three fibrous partitions, or septa that divide the leg muscles into somewhat distinct compartments.

19.32

This outer layer is the investing deep fasica. It surrounds all the muscles of the leg. The investing deep fascia is attached to the tibia here, and here . It's attached to the fibula not directly, but indirectly by two fibrous septa here, and here, that we'll see in a minute.

20.07

The investing deep fascia wraps around the back of the calcaneal tendon, like a sling. Distally the investing deep fascia is continuous with the superficial part of the flexor retinaculum, with the peroneal retinaculum, and with the two parts of the extensor retinaculum.

20.27

Now we'll look at the fibrous septa, the singular of which is septum. There are three of them. Together with the interosseous membrane, they divide the muscles of the leg into four compartments, two on the front of the leg, and two on the back. We'll look at the back first. We'll remove gastrocnemius and soleus, down to here.

20.50

Here's soleus, divided, here's the investing deep fascia, divided at a lower level. In front of soleus, this transverse intermuscular septum crosses the back of the leg. It runs from here on the tibia, to here on the fibula.

21.18

Three muscles that we haven't seen yet lie between the transverse septum and the bones. To see the transverse septum better, we'll remove the rest of soleus. The transverse septum is thin up here, but toward the ankle it becomes thicker. At the ankle, the transverse septum is continuous with the flexor retinaculum.

21.48

The other two septa have cumbersome names: they're the anterior and the posterior crural intermuscular septa. To see them, we'll remove the investing deep fascia down to here, exposing several muscles that we haven't met yet. We'll be meeting them soon. This is the posterior crural septum, lying just in front of the soleus muscle. This is the anterior crural septum. These two septa are attached to the fibula here, and here.

22.33

The anterior crural septum divides the muscles in front of and lateral to the two bones into an anterior compartment, which contains four muscles including tibialis anterior, and a more laterally placed peroneal compartment, which contains two of the three peroneal muscles.

22.55

Now that we've seen these fascial structures, let's get back to the muscles, the ones that produce inversion and eversion. There are two muscles that produce inversion, tibialis anterior, which we've seen already, and tibialis posterior.

23.10

Here's tibialis posterior. Tibialis posterior arises from the back of the tibia, the back of the fibula, and from the interosseous membrane in between. Its tendon passes immediately behind the medial malleolus, through a fibrous tunnel that's covered by the flexor retinaculum. Beyond the malleolus the tendon of tibialis posterior fans out. It has a wide insertion, here, on the navicular and first cuneiform bones and also under here, on the bases of the second, third and fourth metatarsals. Here's the action of tibialis posterior: it inverts the foot

24.07

The other muscle that can act as a foot invertor is tibialis anterior, which inserts so close to tibialis posterior that it has almost the same line of action. We looked at tibialis anterior, in its role as an ankle dorsiflexor, earlier in this section.

24.28

Now we'll look at the three muscles that evert the ankle: peroneus longus, brevis, and tertius. Here's peroneus brevis. Peroneus brevis arises from here on the distal fibula.

24.48

Lying on top of peroneus brevis, is peroneus longus. Peroneus longus arises from here on the proximal fibula. Its origin extends up onto the head of the fibula, with a gap here.

25.10

The deep peroneal nerve passes under the upper end of peroneus longus here, as we'll see. The other muscle in the picture here is tibialis anterior.

25,23

At the ankle, the tendons of peroneus longus and brevis pass behind the lateral malleolus and beneath the peroneal retinaculum, longus behind, brevis in front. Peroneus brevis runs forward to insert here, on the base of the fifth metatarsal. To see the remarkable course of the peroneus longus tendon, we have to remove the entire sole of the foot. Peroneus longus runs around the cuboid bone, and along a deeply placed fibrous tunnel , to insert right over here, on the base of the first metatarsal.

26.05

Lastly, in front of peroneus brevis and longus, here's peroneus tertius. Peroneus tertius arises from here on the fibula. The tendon of peroneus tertius passes under the extensor retinaculum, and in front of the lateral malleolus to insert here, on the base of the fifth metatarsal, next to peroneus brevis. The action of all three of the peroneal muscles is to evert the foot.

26.44

In addition, peroneus tertius, acting along with its anterior neighbors, can help to dorsiflex the ankle. The muscles of inversion and eversion are important, because they enable us to stay balanced and upright on a surface that tilts to one side, or to the other.

27.03

Now that we've looked at the muscles that produce movement of the foot, we're nearly ready to move on to the vessels and nerves of this region. Before we do that, let's review what we've seen of the muscles, and the associated fascial structures.

27.19

REVIEW

Here's the investing deep fascia, here's the posterior crural septum, the anterior crural septum, and the transverse intermuscular septum. Here's tibialis anterior, here's gastrocnemius, soleus, and plantaris, and the calcaneal tendon. Here's tibialis posterior, peroneus longus, peroneus brevis, and peroneus tertius.

28.15

VESSELS

Now we'll move on, to look at the vessels and nerves of the region. We'll go from the knee, where we saw them last, to just below the ankle. We'll start with the veins.

28.32

Here's the leg with the skin removed. To expose the two major superficial veins, two strips of subcutaneous fat have also been removed. Here's the short saphenous vein on the back, and the long saphenous vein on the front.

28.55

The long saphenous vein passes over the medial malleolus, which is here and runs up the medial side of the leg. We've seen its more proximal course in the previous sections of this tape.

29.13

The short saphenous vein runs up between the calcaneal tendon and the lateral malleolus. It goes up the back of the leg, and passes through the deep fascia near the knee to join the popliteal vein.

29.30

To see some of the superficial veins in more detail, we'll remove the subcutaneous fat from the back of the leg. The short saphenous vein, like the long saphenous vein, is joined by a number of superficial branches The saphenous veins are also joined by several perforating veins like this one, which bring blood from the muscle compartments that lie deep to the investing deep fascia.

29.54

In the last section we saw the principal deep vein of the leg, the popliteal vein. here it is again. With the tibial nerve behind it and the popliteal artery in front of it, it disappears between the two heads of gastrocnemius. In this section we won't follow the deep veins any further, since their course is just the same as that of the corresponding arteries.

30.19

We'll look at the arteries next. The three main arteries which supply the leg and ankle region are all branches of the popliteal artery. They're the anterior tibial, the posterior tibial, and the peroneal. In the dissection that we'll see, all the veins have been removed, to simplify the picture.

30.39

Here's the popliteal artery, passing between the two heads of gastrocnemius. Its branches to gastrocnemius have been removed. To follow the popliteal artery, we'll remove gastrocnemius. The popliteal artery runs down the back of the popliteus muscle, then passes through the fibrous arch in the origin of soleus. We'll remove soleus.

31.03

At the lower border of the popliteus muscle, the popliteal atery gives off this major branch, the anterior tibial artery, which runs forwards. We'll follow it in a minute. The popliteal artery then ends by dividing into the peroneal artery, and the posterior tibial artery. We'll follow the posterior tibial artery first. It runs down the back of the leg, just behind the deep posterior muscles. It's covered by the increasingly thick transverse intermuscular septum, which we'll remove.

31.37

As it passes toward the medial side of the ankle, the posterior tibial artery lies just behind tibialis posterior. At the ankle, the artery passes through a tunnel beneath the flexor retinaculum, part of which has been removed here. Within its tunnel, the posterior tibial artery divides into the medial plantar, and lateral plantar arteries, which we'll follow in the next section.

32.03

Next we'll look at the peroneal artery. The peroneal artery passes laterally, and runs beneath a muscle that we'll be looking at at in the next section, flexor hallucis longus. We'll remove it. The peroneal artery runs down between the deep posterior muscles, close to the fibula, which is here. It gives off numerous branches to the surrounding muscles, and ends behind the lateral malleolus.

32.32

Lastly, we'll look at the anterior tibial artery. Here's where we saw the anterior tibial artery last, arising from the popliteal artery. It immediately passes forward through a gap in the interosseous membrane. We'll go round to the front to follow it. Here it is emerging. The anterior tibial artery runs down the leg on the interosseous membrane, just lateral to tibialis anterior. The long toe extensors, which have been removed in this dissection, lie lateral to the artery. At the ankle, the anterior tibial artery passes beneath the extensor retinaculum. Here's the artery emerging on the dorsum of the foot . Beyond this point it's called the dorsalis pedis artery. We'll follow it further in the next section.

33.23

NERVES

Now we'll look at the nerves of this region, the tibial nerve, and the common peroneal nerve. We saw them last at the knee, the tibial nerve disappearing, along with the popliteal vessels, between the heads of gastrocnemius; the common peroneal nerve disappearing underneath peroneus longus. We'll look at the tibial nerve first. To follow it, we'll remove two muscles which it supplies: gastrocnemius, and soleus

The tibial nerve follows the same course as the posterior tibial artery. The nerve passes beneath the flexor retinaculum just behind the artery. Beneath the flexor retinaculum, the tibial nerve divides, into the medial plantar nerve, and the lateral plantar nerve. We'll see where these go in the next section.

34.19

In the leg, the tibial nerve supplies gastrocnemius, plantaris, soleus, and all three of the deep flexor muscles, including tibialis posterior.

34.33

Now we'll follow the common peroneal nerve. As it passes under the peroneus longus muscle, the common peroneal nerve divides, into the superficial peroneal nerve, and the deep peroneal nerve. The superficial peroneal nerve runs down beneath peroneus longus. It emerges here, and continues down to the foot as a sensory nerve, as we'll see in the next section. The superficial peroneal nerve supplies peroneus longus, and peroneus brevis.

35.08

The deep peroneal nerve runs under peroneus longus, here it is again, and then under this adjoining muscle, which is extensor digitorum longus. Here's the deep peroneal nerve emerging, just medial to the anterior tibial vessels, and medial to tibialis anterior. The deep peroneal nerve follows the same course as the anterior tibial vessels, as it runs down the leg, and under the extensor retinaculum.

35.41

Of the muscles that we've already seen in the leg, the deep peroneal nerve supplies: tibialis anterior, and peroneus tertius.

35.53

Now let's review what we've seen of the vessels and nerves of the leg and ankle region.

35.59

REVIEW

Here's the long sapheous vein, the short saphenous vein, and the popliteal vein. Here's the popliteal artery, the peroneal artery, and the posterior tibial artery, the medial plantar, and lateral plantar arteries, and the anterior tibial artery

36.37

Now the nerves: the tibial nerve, the medial plantar nerve, and the lateral plantar nerve, the common peroneal, superficial peroneal, and deep peroneal nerves.

36.59

That brings us to the end of this section on the leg and ankle. In the next section, we'll look at the foot.

END OF PART 3

PART 4: THE FOOT

BONES, LIGAMENTS AND JOINTS

00.00

In this section we'll look at the foot. As usual, we'll start with the bones. After that we'll look at the joints and ligaments, the muscles, the blood vessels and nerves, and lastly the skin.

00.20

We saw most of the bones of the foot in the last section. Here, we'll briefly review the tarsal bones, then we'll look at the metatarsals and the bones of the toes.

00.30

Here's the calcaneus, the talus, the navicular, the cuneiforms - first, second, and third - , and the cuboid. Let's see the same bones again from beneath: the calcaneus, the cuboid, the cuneiforms, the navicular, and the talus again.

01.01

Now we'll look at the metatarsals. Like the toes, the metatarsals are numbered one, through five. The first metatarsal is more massive than the others. The second metatarsal is the longest. On the base of the fifth metatarsal there's a prominent tubercle.

01.26

The metatarsals are slightly curved from end to end. The heads of the metatarsals lie in one flat plane, but their bases form an arch from side to side, as do the tarsal bones that they articulate with. These are the three cuneiform bones, and the cuboid. These are the tarsometatarsal joints. There's very little movement at any of them.

02.02

The bones of the foot are arched in two planes, from side to side as we've just seen, and also from end to end. We'll be looking at the structures that support the arches of the foot in a minute. To finish with the dry bones, let's look at the toes.

02.22

The big toe has only two phalanges, a proximal, and a distal. The other four toes have three phalanges, proximal, middle, and distal. These are the metatarso-phalangeal joints, or MP joints for short. The joints between the phalanges are the interphalangeal joints.

2.44

The bones of the toes are quite similar to the corresponding bones of the fingers, which are shown in Volume 1 of this atlas. Now that we've seen the dry bones of the foot, let's see what they're like in the living body. We're already familiar with the ligaments around the ankle. What we'll look at now are the ligamentous structures that hold this apparently delicate arch of bones together, and enable it to support the whole weight of the body.

03.12

Here's the foot with all the soft tissues removed, and all the joints and ligaments intact. On the dorsum of the foot there's an almost continuous layer of ligaments, connecting the tarsal bones both to each another and to the metatarsals, and connecting the heads of the metatarsals together. The ligaments on the dorsum of the foot are strong ligaments, but the truly impressive ligaments, the ones which support the longitudinal arch, are on the underside of the foot.

03.42

First, here's the short plantar ligament. It goes from here on the calcaneus, to here on the cuboid bone. Just in front of the short plantar ligament is the groove for the peroneus longus tendon. Lying directly beneath the short plantar ligament is the long plantar ligament. The long plantar ligament also starts here on the calcaneus, and goes all the way to the bases of the third, fourth and fifth metatarsals.

04.20

The long plantar ligament bridges over, or rather under, the peroneus longus tendon - here's the tendon, going to its insertion on the base of the first metatarsal.

04.33

There's another, even more impressive structure that supports the arch of the foot - the plantar aponeurosis. The plantar aponeurosis is a massive sheet of tendon-like tissue that runs the whole length of the foot. It starts here on the calcaneus. It fans out as it runs forward. As it approaches the MP joints, the plantar aponeurosis splits into five divisions. Most of the fibers of each division pass into two slips, which pass forward and upward toward the M.P. joint. We'll see where they go in a minute.

05.19

To understand where the slips of the plantar aponeurosis insert, we first need to look at the MP joints, and at some structures nearby: the flexor tendon sheaths, the plantar ligaments of the MP joints, and the ligament that connects the metatarsal heads, the deep transverse metatarsal ligament.

05.42

Here's the deep transverse metatarsal ligament. It goes all the way from the first MP joint, to the fifth. The flexor tendon sheaths, which we'll see in a minute, are attached along these lines.

05.58

To take a look at a typical MP joint, and the structures around it, we'll look at a toe and its metatarsal in isolation. Here's the MP joint with its capsule intact. Here it is with the loose parts of the capsule removed. There's a broad collateral ligament on each side. The MP joint can't flex much beyond a straight position, but it can extend all the way to here.

06.33

Here's an MP joint divided longitudinally. The joint capsule is thin on the dorsal aspect, and massively thickened on the plantar aspect. This thick part of the capsule is the plantar ligament of the MP joint, it's fixed to the proximal phalanx here, so when the joint is extended, the plantar ligament is pulled forward.

06.57

Here's the plantar ligament in the intact joint. The tendon sheath is attached to the plantar ligament here, and here. Here's a short piece of the tendon sheath intact. It runs the whole length of the toe, as we'll see later. Also attached to the plantar ligament of the MP joint is the deep transverse metatarsal ligament: here's its attachment on one side, here it is on the other side.

7.36

Here's the MP joint of the big toe, the first MP joint. It's much larger than the other MP joints, and it has two additional structures, a pair of sesamoid bones, which are enclosed within the plantar ligament. One of them's here, the other one's here.

08.02

Now that we've looked at the MP joints and the structures around them, let's go back to the plantar aponeurosis, and see how it's inserted. As we've seen, each division of the aponeurosis gives rise to two slips. These lie on each side of the flexor tendons. The two slips are inserted here, and here, on each side of the plantar ligament of the MP joint.

08.33

Since the plantar aponeurosis is inserted into a set of movable structures, the plantar ligaments of the MP joints, its tightness varies depending on the position of these joints. When the MP joints are straight, the plantar aponeurosis is slack, but when the’re extended, it becomes much tighter.

08.57

The plantar aponeurosis acts as a continuation of the achilles tendon. When it’s tight, as it is when the MP joints are extended, it enables the pull of the calcaneal tendon be transmitted directly to the metatarsal heads. That’s why the arch of the foot remains an arch, even at the moments when we place the heaviest loads on it.

09.18

The plantar aponeurosis is the central part, and much the strongest part, of a layer of fascia, the plantar fascia, which covers the entire sole of the foot. We’ll see the whole of the plantar fascia when we've looked at at the muscles of the foot, which we’re going to do shortly. Let’s now review what we’ve seen, of the bones, joints, and ligaments of the foot.

09.42

REVIEW

Here are the metacarpals, the proximal phalanges, the middle phalanges, and distal phalanges, the tarso-metatarsal joints, the metatarso-phalangeal joints, and the interphalangeal joints.

10.05

Here are the short plantar ligament, the long plantar ligament, and the plantar aponeurosis. Here’s the deep transverse metatarsal ligament, the flexor tendon sheaths, and the plantar ligament of the MP joint.

10.33

MUSCLES

Now we’ll look at the muscles which produce movement of the toes. We’ll look at the extensor muscles first. There are two long extensors to the toes, and two short ones. The long extensors are two of the four muscles that we left out of the picture in the last section.

10.56

Here’s extensor hallucis longus. Extensor hallucis longus arises from the interosseous membrane, and from the adjoining fibula. Lying on top of extensor hallucis longus is extensor digitorum longus. Extensor digitorum longus has a long line of origin here on the fibula. This gap is for the common peroneal nerve.

11.35

To see all the muscles of the anterior compartment together, we’ll add tibialis anterior to the picture, here it is. We saw tibialis anterior in the last section. It almost covers up extensor hallucis longus. We’ll also add peroneus tertius, which arises in continuity with extensor digitorum longus.

12.01

Here are the tendons of all these musces passing under the extensor retinaculum: peroneus tertius, extensor digitorum longus, extensor hallucis longus, and tibialis anterior.

12.19

The tendon of extensor hallucis longus inserts partly into the extensor expansion of the first MP joint, and partly here, into the base of the distal phalanx of the big toe.

12.32

The tendons of extensor digitorum longus insert, by way of the extensor expansion of each toe, into the bases of the middle and distal phalanges. The extensor expansion of the toe is quite similar to the extensor expansion of the finger, which is described in some detail in Volume 1 of this atlas. Here's the action of extensor hallucis longus: it extends both joints of the the big toe. Here's the action of extensor digitorum longus: its action is mainly at the MP joint.

13.09

The two long toe extensor muscles have another important action besides extending the toes. They're also quite powerful dorsiflexors of the ankle.

13.22

Now let's add the short extensors to the picture. Here they are. They lie beneath the tendons of the long extensors. Extensor hallucis brevis goes to the big toe, the four slips of extensor digitorum brevis go to the four short toes. The short toe extensors arise here, on the front of the calcaneus.

13.49

The tendons of the short extensors join the corresponding long extensor tendons. The action of the short extensors is the same as that of the long extensors, except that they don't dorsiflex the ankle.

14.02

Now we'll look at the muscles which flex the toes. First we'll look at the two long flexors, flexor hallucis longus, and flexor digitorum longus. They're the other two muscles that we left out of the picture in the last section.

14.19

Here's flexor hallucis longus. Flexor hallucis longus arises from here on the back of the fibula. Medial to flexor hallucis longus is flexor digitorum longus. Flexor digitorum longus arises from here on the back of the tibia. This gap is for the tendon of tibialis posterior.

14.48

The relative position of these two muscles, this one for the big toe, this one for the four small toes, is the reverse of what you'd expect when you look at where they're going. As we'll see, their two tendons cross over just below the ankle.

15.05

To complete our picture of the deep posterior leg muscles, we'll add the third one, tibialis posterior to the picture. We saw it in the last section. It's the most deeply placed of the three muscles. Tibialis posterior, crosses beneath flexor digitorum longus, and emerges in front of it, just above the ankle.

15.26

At the ankle, here are flexor hallucis longus, flexor digitorum longus, and tibialis posterior, each passing beneath the flexor retinaculum in its own fibrous tunnel. Emerging below the retinaculum, the two long toe flexors cross over, flexor hallucis longus lying deeper.

15.47

The tendon of flexor hallucis longus passes forwards, and enters the fibrous flexor tendon sheath of the big toe. The two sesamoid bones lie on each side of it, here and here, as it passes beneath the MP joint. Flexor hallucis longus is inserted here, on the base of the distal phalanx of the big toe. Flexor digitorum longus divides into four tendons, one for each of the small toes. These pass along the flexor tendon sheaths, and insert here on the distal phalanges. Here's the action of flexor hallucis longus, here's the action of flexor digitorum longus.

16.40

Now we'll move on, to look at the numerous small muscles on the plantar aspect of the foot. The intricacy of these muscles reminds us that our human foot has evolved from feet that had many other functions besides that of being walked on. Since some of the smaller muscles are now almost vestigial structures, we'll be looking at them quite briefly.

17.03

We'll look at the small plantar muscles in four groups, first the interosseous muscles; then the short muscles that occupy the middle of the foot; then the short muscles for the big toe; and lastly the ones for the fifth toe.

17.19

Here are the interosseous muscles. There are seven of them, two for each of the three middle toes, and one for the fifth toe. The interosseous muscles arise from the shafts of the metatarsals, and insert into the bases of the proximal phalanges. The action of the interosseous muscles is to flex the toes at the MP joints.

17.52

Now we'll look at the middle group of muscles. These are all closely associated with the tendon of flexor digitorum longus. The middle group consists of the tiny lumbrical muscles, flexor accessorius, and, superficial to them, flexor digitorum brevis, which we'll see again in a moment. The four lumbricals are just like the lumbricals in the hand. We won't look at them in detail.

18.25

Flexor accessorius, also called quadratus plantae, arises by two heads from from here and here on the calcaneus. Flexor accessorius inserts here, into the deep aspect of the tendon of flexor digitorum longus. Flexor accessorius aids in flexing the toes.

18.52

Now we'll add flexor digitorum brevis to the picture - here it is again. Flexor digitorum brevis arises from here on the calcaneus. Flexor digitorum brevis divides to form four tendons. Each of these enters one of the tendon sheaths, along with a tendon of flexor digitorum longus. Inside the tendon sheath, which we'll remove, the brevis tendon splits into two halves, which encircle the longus tendon. Flexor digitorum brevis inserts here, on the bases of the middle phalanges. Flexor digitorum brevis assists in producing flexion at the PIP and MP joints. Lying superficial to flexor digitorum brevis is the plantar aponeurosis, which we've looked at already.

19.52

Now we'll look at the muscles for the big toe. To build up a picture of them, we'll first take the middle group of muscles out of the picture so that we're again looking at just the interossei. The muscles for the big toe are flexor hallucis brevis, adductor hallucis, and abductor hallucis. We'll look at them in that order.

20.21

Flexor hallucis brevis has two almost distinct parts, which arise here from the cuboid and third cuneiform bones. Flexor hallucis brevis gives rise to two tendons of insertion, which attach first to the medial and lateral sesamoid bones, then to the base of the proximal phalanx of the big toe. The tendon of flexor hallucis longus - which we'll add to the picture for a moment - runs between the two halves of flexor hallucis brevis.

20.58

Here's adductor hallucis. It arises by two heads, an oblique head, and a transverse head. The oblique head arises from the bases of the middle three metatarsals, the transverse head arises from the deep transverse metatarsal ligament.

21.20

These two heads converge, and merge with the medial head of flexor hallucis brevis, sharing its insertion on the medial sesamoid bone, and on the base of the proximal phalanx.

21.32

Medial to flexor hallucis brevis is abductor hallucis. Abductor hallucis is the most medial of all the foot muscles. It arises here, on the medial side of the calcaneus. The tendon of abductor hallucis merges with the medial part of flexor hallucis brevis, and inserts with it here, on the medial sesamoid bone, and on the base of the proximal phalanx.

22.03

The main action of all three of the short muscles of the big toe is to produce flexion at the MP joint. In addition, adductor and abductor hallucis brevis can produce adduction and abduction of the big toe.

22.23

Lastly, there are two short muscles for the fifth toe, a short flexor and an abductor. Here's the flexor, flexor digiti minimi brevis. It's an outlying interosseous muscle that's been given a long name. Here's the abductor, abductor digiti minimi. It arises all the way back here, on the calcaneus. It's inserted here, on the proximal phalanx of the fifth toe.

22.52

Now that we've seen the muscles for the big toe and the fifth toe, we need to see how all these short muscles fit together. To do that, we'll put the long flexor tendons, and then the central group of muscles back into the picture.

23.07

First we'll add flexor hallucis longus to the picture. Flexor hallucis longus lies deep to abductor hallucis as it enters the foot. Here's flexor digitorum longus, entering the foot along with flexor hallucis longus. The tendons of flexor digitorum longus cover up adductor hallucis. Here are the lumbricals, flexor accessorius, and last of all flexor digitorum brevis.

23.46

Now that we've seen all the muscles of the foot, let's get a complete picture of the layer of deep fascia that encloses them all, the plantar fascia.

24.00

The central, thickened part of the plantar fascia is the plantar aponeurosis, which we've seen already. The medial and lateral parts of the plantar fascia extend on each side of the plantar aponeurosis. On the medial side the plantar fascia covers abductor hallucis.

24.20

On the lateral side it covers abductor digiti minimi. Here on the lateral side there's a marked thickening of the plantar fascia, called the lateral cord of the plantar aponeurosis, which goes from here on the calcaneus, to here on the base of the fifth metatarsal. The lateral cord of the plantar aponeurosis helps to support the longitudinal arch of the foot, on the lateral side.

24.49

We've seen all the muscles of the foot! Let's review them, before we move on to look at the blood vessels and nerves of the foot.

24.59

REVIEW

Here's extensor digitorum longus, extensor hallucis longus, extensor digtorum brevis, and hallucis brevis. On the back, here's flexor digitorum longus, flexor hallucis longus,

25.31

Here are the interosseous muscles, the lumbricals, flexor accessorius, and flexor digitorum brevis. Here's abductor hallucis, flexor hallucis brevis, and adductor hallucis; and lastly here are abductor digiti minimi and flexor digiti minimi brevis

26.09

VESSELS

Now we'll look at the blood vessels and nerves of the foot, starting with the veins. The superficial veins of the lateral aspect of the foot join together to form the short saphenous vein. The ones on the medial aspect of the foot join together to form the long saphenous vein.

26.35

In addition, at a deeper level, the arteries, which we'll be looking at next, are closely accompanied by concomitant veins, like these. From here on we'll remove all the concommitant veins to simplify the picture.

26.51

We last saw the anterior, and posterior tibial arteries entering the foot, beneath the extensor retinaculum and flexor retinaculum respectively. Here's the anterior tibial artery at the ankle, passing beneath the extensor retinaculum. We'll remove the retinaculum.

27.13

As it passes in front of the ankle, the anterior tibial artery crosses beneath extensor hallucis longus, emerging lateral to it. It gives off branches to the tarsal region, then continues on to the dorsum of the foot. Beyond this point it's known as the dorsalis pedis artery.

27.32

The dorsalis pedis artery passes beneath the extensor hallucis brevis muscle, gives off this first dorsal metatarsal artery, and ends by diving through the first interosseous muscle to join up with the lateral plantar artery which we'll see in a minute.

27.50

Now we'll look at the posterior tibial artery, or rather, at its two terminal branches, the medial plantar, and lateral plantar arteries. Here's where we saw them last, emerging from under the flexor retinaculum, the lower part of which has been removed in this dissection. Also removed, are the abductor hallucis muscle, here, and the plantar aponeurosis, here. This is the distal end of the posterior tibial artery. This is the the lateral plantar artery, this is the medial plantar artery.

28.26

The medial plantar artery is usually the smaller of the two. It crosses over the tendons of the two long toe flexors, and runs along the medial side of the foot. Its branches supply the adjoining muscles, and the underside of the big toe.

28.41

Now we'll look at the lateral plantar artery. It passes deep to flexor digitorum brevis, which we'll remove. After giving off this calcaneal branch, the lateral plantar artery passes downwards and then laterally, across flexor accessorius. When it reaches the base of the fifth metatarsal, which is here, it curves around and passes deep to flexor digitorum longus and the interosseous muscles, to join up with the dorsalis pedis artery.

29.15

NERVES

Now we'll look at the nerves of the foot. We'll follow the nerves that we saw in the last section: the superficial and deep peroneal nerves, and the medial and lateral plantar nerves. There are two more nerves that we'll also look at for completeness - the sural nerve, and the saphenous nerve. We'll start with the two peroneal nerves.

29.38

The superficial peroneal nerve runs down in front of the lateral side of the ankle, and breaks up into several branches. These fan out to provide sensation to this large area on the dorsum of the foot.

29.53

The deep peroneal nerve enters the foot along with the dorsalis pedis artery. It gives off a motor branch, which supplies the short toe extensor muscles. It continues distally as a sensory nerve, which supplies this small area between the big and second toes.

30.13

Next we'll look at the medial and lateral plantar nerves. They follow the same course as the medial and lateral plantar arteries. Here's the medial plantar nerve. It gives off a motor branch which supplies flexor digitorum brevis, abductor hallucis, and flexor hallucis brevis.

30.44

To follow the medial plantar nerve, we'll go round to the underside of the foot. Distally, the medial plantar nerve breaks up into common plantar digital nerves. These pass between the metatarsal heads, where each in turn divides into two plantar digital nerves.

31.04

The median plantar nerve supplies the underside of the big toe, the second, third and half of the fourth toes. It also supplies this medial area on the sole of the foot

31.20

Now we'll look at the lateral plantar nerve. It runs just in front of the lateral plantar artery. To follow it, we'll again go round to the underside of the foot. Flexor digitorum brevis has been removed. The lateral plantar nerve gives motor branches to flexor accessorius and abductor digiti minimi.

31.47

It then divides into a deep branch, which suppies all the interossei and adductor hallucis, and a superficial branch, which supplies flexor digiti minimi brevis, and provides sensation to the lateral part of the sole, the fifth toe and half of the fourth toe

32.06

To complete our picture of the nerves that provide sensation to the foot, we'll add two nerves that were passed over in the last section - the sural nerve, and the saphenous nerve.

32.18

The sural nerve, which runs down the back of the leg, is formed by two nerves which join together. One is the medial sural cutaneous branch of the tibial nerve, the other is the sural communicating branch of the common peroneal nerve.

32.34

The sural nerve runs down the lateral side of the ankle, behind the lateral malleolus. The sural nerve supplies sensation to a variable area along the lateral side of the foot.

32.46

The saphenous nerve, a branch of the femoral nerve, emerges at the knee, from beneath the insertion of the sartorius muscle. It runs down the medial side of the leg, and supplies a variable area on the medial side of the foot and ankle.

33.06

Last of all, the heel area is supplied by calcaneal branches of the tibial nerve, which are given off beneath the flexor retinaculum. Now let's review what we've seen of the blood vessels and nerves of the foot.

33.22

REVIEW

Here's the start of the long saphenous vein, and the short saphenous vein. Here's the dorsalis pedis artery, the lateral plantar artery, and the medial plantar artery,

33.46

Here's the sural nerve, the superficial peroneal nerve, and the saphenous nerve, the deep peroneal nerve, the medial plantar nerve, and the lateral plantar nerve,

34.06

SKIN OF FOOT

Last of all, we'll look at the skin of the foot. On the dorsum of the foot, the skin in thin and mobile. On the plantar aspect the skin is markedly thickened, especially in the weight bearing areas. There's a generous padding of fat on the sole of the foot, especially on the heel.

34,42

The skin on the sole of the foot is tethered to the deeper tissues by numerous firm strands of fibrous tissue. These strands arise from the underlying bone, and plantar aponeurosis, and pass through the fat, into the subdermis, keeping the weight bearing skin firmly in place.

35.01

That brings us to the end of Voume 2. In Volume 3, we'll look at the musculo-skeletal system of the trunk, from the neck, to the pelvis.

END OF VOLUME 2

Acland's DVD Atlas of Human Anatomy

Transcript for Volume 3

PART 1

THE SPINE

00.00

This tape describes the musculo-skeletal system of the trunk. We'll look at the trunk in four sections. In this first section we'll look at the spine, and the spinal cord. In the following sections we'll look at the thorax, the abdomen, and the pelvis.

BONES, LIGAMENTS AND JOINTS

00.20

The spine is known in anatomy as the vertebral column, or spinal column. In looking at it, we'll look first at the bones, then at the structures that hold the bones together, then at the main muscles which move it. After that, we'll add the spinal cord, and the spinal nerves to the picture.

00.39

Here's the vertebral column It consists of twenty-four separate vertebrae, the sacrum, and the coccyx. There are seven cervical vertebrae, twelve thoracic vertebrae, and five lumbar vertebrae. The sacrum consists of five vertebral segments fused together. The coccyx - our vestigial tail - consists of three or four tiny segments.

01.20

The highest cervical vertebra articulates with the skull; the thoracic vertebrae articulate with the ribs; and the sacrum articulates with the two innominate bones to form the pelvis.

01.38

When seen from in front, the spine appears straight, but when we look at it from the side, we see that it's markedly curved. The lower cervical vertebrae form a forward curve, the thoracic vertebrae form a backward curve, the lumbar vertebrae curve forward again, and the sacrum curves sharply backward.

02.00

These peices of material represent the intervertebral disks, which we'll be looking at shortly.

02.07

The vertebrae of each region are numbered from above down. Instead of using the words cervical, thoracic, lumbar, and sacral, we often just use the letters C,T, L, and S. For example, we'd call the fourth lumbar vertebra the L4 vertebra.

02.06

There are marked differences between vertebrae of different regions, but they all have some basic features in common. We'll look at a typical thoracic vertebra to see what these features are.

02.39

In front, this cylindrical mass of bone, the body of the vertebra, supports the weight of everything that's above it. Behind, there's a set of bony plates and projections which serve three functions: to protect the spinal cord; to give attachment to muscles and ligaments; and to articulate with the adjoining vertebrae.

03.01

This arch of bone, the neural arch, encloses the spinal cord. The space that's surrounded by the arch and the back of the body is called the vertebral foramen.

03.19

The series of vertebral foramina create the tubular space that contains the spinal cord. The space is called the vertebral canal .

03.31

This part of the neural arch is called the lamina, this part is the pedicle. There's a small notch in the upper edge of the pedicle, and a larger notch in the lower edge. Together, the notches above and below form this opening on each side, the intervertebral foramen. A spinal nerve emerges through each intervertebral foramen.

04.04

Arising from the neural arch are three large bony projections called processes - a spinous process in the midline, a transverse process on each side. Also arising from the neural arch are four articular processes, two above, and two below.

04.27

The lower ones face forward, the upper ones face backward. The articular processes of adjoining vertebrae interlock, forming a pair of synovial joints which permit movement between adjoining vertebrae.

04.44

Now that we've looked at one vertebra, let's look at the specialized and different features of vertebrae from the cervical, thoracic, and lumbar parts of the spine.

04.56

Here's a typical cervical vertebra, the fourth one. The body is small. The upper surface of the body is curved, somewhat in the shape of a saddle. The lower surface has the same curvature in reverse.

05.13

The vertebral foramen is large and triangular. The neural arch is formed mainly by the two straight laminae. The pedicles are very short. The spinous process is short, and ends in a double point.

05.34

The upper articular facets face upward and inward, the lower ones face downward and forward. The mass of bone between the articular facets is called the articular pillar.

05.51

The transverse processes arise from the side of the body, and also from here on the articular pillar. The transverse process of a cervical vertebra has a hole in it, the transverse foramen, through which the vertebral artery passes.

06.12

The transverse process is shaped like a gutter, pointing downwards. It ends in two tubercles, an anterior, and a posterior, where the scalene muscles attach.

06.23

Of the seven cervical vertebrae, the first two, which are called the atlas and the axis, differ from the others in several ways. We'll see them in detail in Volume 4 of this Atlas. The seventh cervical vertebra also differs from the others, in that it has a long spinous process ending in a single point, which forms this small prominence on the back of the neck.

06.50

The cervical vertebrae form the most mobile part of the spine, partly because of the curved shape of their bodies, which makes flexion and extension easy and partly because of the shallow slope of their articular processes, which makes lateral flexion easy. The movements that can occur in the cervical spine are forward flexion, extension and lateral flexion, to one side or the other.

07.32

Rotation also occurs in the neck. Almost all of it happens at the specialized joints between the atlas and the axis vertebrae, which we'll look at in the tape on the head and neck,Volume 4 of this atlas. In that tape we'll also look at the way the atlas vertebra articulates with the bone which forms the underside of the skull, the occipital bone. The joints between the atlas and the occipital bone are called the atlanto-occipital joints.

08.06

Next we'll look at the special features of the thoracic vertebrae. The bodies of the thoracic vetebrae become progessively more massive from above down, as they do from the top to the bottom of the vertebral column.

08..22

Each of the thoracic vertebrae articulates with a pair of ribs. On each side, the vertebra articulates with the rib at two points: here at the end of the transverse process, and here, where the pedicle meets the body. We'll be looking at the ribs in the second section of this tape.

08.58

The transverse processes of the thoracic vertebrae point sideways, the spinous processes points downwards, each one overlapping the one below. The articular processes are almost vertical: the upper ones face almost straight backwards, the lower ones face forwards.

09.20

There's only a little movement between thoracic vertebrae, partly because of the presence of the ribs, and partly because of the way the spinous processes are arranged.

09.29

The movements that are possible are small amounts of forward flexion, lateral flexion, and perhaps surprisingly, rotation.

09.48

Now we'll take a look at a lumbar vertebra. The body is massive. The transverse processes are small, the spinous process is broad, and points almost straight backwards.

10.06

The upper articular processes of lumbar vertebra face inward, the lower ones face outward. Because of this arrangement, there's almost no rotation between lumbar vertebrae. The movements that can occur in the lumbar spine are flexion, and extension, and lateral flexion to either side.

10.04

Lastly, we'll look at the sacrum. Besides being the lowest part of the spine, the sacrum is also an important part of the pelvis.

10.54

Here's the sacrum, together with the coccyx. The sacrum is formed by five vertebrae fused together. From top to bottom it has a marked backward curve. When we're standing upright, the sacrum is oriented just as we see it here. The upper part of this backward-facing dorsal surface is angled at about 45º to the vertical. The upper part of this forward-facing pelvic surface is more nearly horizontal than vertical. On the dorsal surface there are two articular processes, for the fifth lumbar vertebra.

11.37

The lowest intervertebral disk is quite wedge-shaped. Its shape accounts in part for the very marked curvature of the spine between the fourth lumbar vertebra and the sacrum. The most anterior point on the sacrum is called the sacral promontory. The vertebral canal continues down the back of the sacrum.

12.06

From within the vertebral canal, the anterior rami of the spinal nerves S1 to S4 emerge form these pelvic sacral foramina. The posterior rami emerge from these dorsal sacral foramina. The vertebral canal ends at this opening, the sacral hiatus, that's shaped like an upside down V.

12.30

This curved auricular surface articulates on each side with the upper part of the innominate bone, or hip bone, to form the pelvis. The joints between the sacrum and the hip bones are the sacro-iliac joints. These joints permit almost no movement.

12.59

The broad ridge on each hip bone adjoining the sacrum is the iliac crest. It's an important muscle attachment, as we'll see shortly.

13.13

We'll be looking at the hip bone in more detail in the last section of this tape. For now, we'll return to the spine.

13.23

Now that we've looked at the dry bones of the vertebral column, let's look at the structures that hold the bones together, and that enable them to move. We'll look first at the intervertebral disks, then at the ligaments of the vertebral column, then at the posterior joints.

13.39

These structures are arranged in a similar way from the top of the spine to the bottom. We'll be looking at all of them in the lumbar region.

13.48

Here's an intervertebral disk. The disk is a massive pad of fibrocartilage, that's firmly attached to the vertebral body above and below, all the way round the circumference.

14.01

If we cut through a disk and look at it from above, we see that it's made of concentric layers of material. The disk consists of an outer ring of tough fibrocartilage, called the anulus fibrosus, and a soft center of almost liquid material, called the nucleus pulposus.

14.22

The disk is solid enough to transmit the weight of the body, and it's flexible enough to permit movement between the vertebrae. T he side of the intervertebral disk forms the anterior margin of the inter-vertebral foramen, through which the spinal nerve emerges.

14.43

The vertebrae are also held together by ligaments. Some of these go from vertebra to vertebra; some run the length of the spine. Starting at the back, we'll look at the ligaments which hold the spinous processes together, the interspinous and supraspinous ligaments; then the ligament that holds the laminae together, the ligamentum flavum. Then we'll look at the two ligaments that help to hold the bodies together: the anterior and posterior longitudinal ligaments.

15.14

First, the interspinous ligaments - here they are. They run from the lower edge of one spinous process to the upper edge of the next one. Now we'll add the supra-spinous ligament to the picture.

15.30

The supra-spinous ligament merges with the interspinous ligaments. It runs the whole length of the vertebral column, connecting the tips of the spinous processes. The supraspinous ligament serves as a midline attachment for some important muscles, as we'll see later. These ligaments help to limit flexion of the spine.

15.52

The structure, or structures, that chiefly limits flexion of the vertebral column is the series of short ligaments that hold the laminae together, which are known collectively as the ligamentum flavum.

16.06

The ligamentum flavum lies on the front of the laminae. To see it, we'll cut though the pedicles of all the vertebrae, along this line, and look at the laminae from the inside.

16.18

Here’s the ligamentum flavum. It goes from one lamina to the next all the way down the spine. Here, where it’s been cut through we can see how thick it is. The ligamentum flavum made of yellowish fibro-elastic tissue, hence its name, which means yellow ligament.

16.41

Next we’ll look at the two ligaments which hold the vertebral bodies together - the anterior and posterior longitudinal ligaments. The anterior is the stronger of the two - here it is. The anterior longitudinal ligament covers the front and sides of the vertebral bodies. It runs the whole length of the vertebral column. We’ll cut through it along this line to see it better.

17.06

The anterior longitudinal ligament is thick and strong. It’s attached to the upper and lower edges of each vertebral body. It limits extension of the spine. In extension, the tightness of the anterior longitudinal ligament helps to prevent backward and forward movement of the vertebral bodies relative to each other.

17.30

The posterior longitudinal ligament runs along the back of the vertebral bodies. To see it we’ll divide the pedicles along this line again, and look at the bodies by themselves.

17.45

Here’s the posterior longitudinal ligament. It’s narrow where it overlies each vertebral body, and it widens out to cover the back of each intervertebral disk. The posterior longitudinal ligament helps in a small way to limit flexion of the vertebral column.

18.03

Each vertebra is attached to its neighbors not only by the intervertebral disks and the ligaments that we’ve seen, but also by the joints between the articular processes - the posterior joints. Each posterior joint is surrounded by a capsular ligament, which is loose enough to permit the small amount of movement that occurs between any two vertebrae.

18.30

The capsular ligament has no great strength, but the articular processes themselves are strong. Because the upper ones face forward and the lower ones backward, the articular processes prevent the vertebra above from slipping forward, relative to the vertebra below.

18.51

Now that we’ve looked at the vertebrae, and at the stuctures that hold them together, we’re almost ready to move on, to look at the principal muscles of the vertebral column. Before we do that, let’s briefly review what we’ve seen so far. If you’d like to use the following review to test youirself, turn off the sound, and name the structures as they’re shown.

19.15

REVIEW OF BONES, LIGAMENTS AND JOINTS

Here’s a cervical vertebra, a thoracic vertebra, and a lumbar vertebra.

19.27

Here are the body, the vertebral canal, the pedicle, the lamina, the transverse processes, the spinous processes, the articular processes, and the intervertebral foramen.

19.54

In the cervical vertebra, here’s the anterior tubercle, and the posterior tubercle of the transverse process, and here’s the transverse foramen.

20.05

Here’s the sacrum, the coccyx, the pelvic sacral foramina, the dorsal sacral foramina, and the sacral hiatus.

20.17

Here’s an intervertebral disk; the anulus fobrosus, and the nucleus pulposus. Here are the interspinous, and supraspinous ligaments, the ligamentum flavum, the posterior longitudinal ligament, and the anterior longitudinal ligament.

20.40

MUSCLES

Now we'll look at the muscles. Most movements of the vertebral column are produced by an extensive set of muscles, that run all the way along the back of the spine. The’re known collectively as the paravertebral muscles.

21.00

The highest of them are attached to the base of the skull, the lowest ones arise from the sacrum and iliac crest, some in between are attached to the backs of the ribs, and many are attached to the transverse and spinous processes of the vertebrae. We’ll build up our picture of these muscles from the inside to the outside.

21.25

This is a dissection of the mid-thoracic region. On the left side, all the paravertebral muscles are in place, partly hidden beneath a covering layer of fascia. On the right side, all the paravertebral muscles have been removed. We’re not concerned at present with these outlying muscles, the levators, and the intercostals.

21.47

Now we’ll add the paravertebral muscles to the picture, starting with the ones that lie deepest, the short and long rotator muscles.

21.56

Each short rotator goes from a transverse process, to the base of the spinous process of the vertebra above. Each long rotator goes to the same point, on the next vertebra but one.

22.10

The rotators are overlaid by this series of more obliquely running strips of muscle which together form one long muscle, the multifidus muscle. Each segment of the multifidus arises from a transverse process, and inserts on the sides of the spinous processes two to four vertebrae above.

22.34

The rotators and the multifidus extend the whole length of the spine. Their action is to produce rotation of the upper part of the spine, towards the opposite side

22.45

These deep, rotating muscles are overlaid by much larger muscles. To get a picture of the remaining paravertebral muscles, we’ll divide them into a lower group, the long muscles of the lumbar and thoracic regions, and an upper group, the long muscles of the back of the neck. The two groups overlap. We’ll look at the lower group first. They’re known collectively as the erector spinae muscles. They form a large mass of muscle, extending all the way from the sacrum, to the upper part of the thorax.

23.22

At their origins, they’re joined together. Passing upward, they separate out into three somewhat distinct muscles, the spinalis, the longissimus thoracis, and the iliocostalis lumborum.

23.41

The erector spinae muscles arise from this massive common tendon of origin, which is attached to the spinous processes of the lumbar vertebrae, to the back of the sacrum, and to the iliac crest.

23.58

Spinalis inserts on the spinous processes of the upper thoracic vertebrae. Longissimus thoracis inserts on the lower nine ribs, and the adjoining transverse processes. Iliocostalis lumborum inserts further out, on the lower six ribs.

24.23

The erector spinae muscles are important in keeping the body upright. The action that they have depends on whether they contract on both sides at once, or on one side only. When they contract on one side only, they produce lateral flexion of the spine, to one side, or the other .

24.46

When they contract on both sides at once, their action produces extension of the lumbar and thoracic spine, straightening our back as we stand up from a stooping position, and keeping it straight as we lean forward..

25.00

The action of the erector spinae group is counteracted by muscles of the abdominal wall, which we'll see later in this tape.

25.10

Above the erector spinae muscles, and overlapping with them, are the long muscles of the back of the neck, which we'll look at just briefly at this point. They're the obliquely running splenius and longissimus muscles, and beneath them the vertically running semispinalis - here's its upper end.

25.34

We'll look at the muscles of the neck in more detail, in volume 4 of this atlas. Now we'll move on, to look at the vitally important contents of the vertebral canal - the spinal cord, the spinal nerves, and the protective layers of tissue that surround them.

25.57

SPINAL CORD

We'll look first at a cross-sectional view of the vertebral canal. This is a cut through the 6th thoracic vertebra. Here's the spinal cord. It only part-way fills the vertebral canal.

26.11

On each side there are two lines of nerve filaments, one arising from the ventral aspect, and one from the dorsal aspect of the cord. These filaments form the spinal nerves, as we'll see in a minute.

26.27

The spinal cord lies within this strong protective layer, the dura. The dura is lined on the inside by a loosely attached membrane, the arachnoid.

26.38

The cord is covered on the outside by a firmly attached membrane, the pia. The space between the arachnoid and the pia is called the sub-arachnoid space. In life it's filed with cerebrospinal fluid.

26.56

The space between the dura and the wall of the vertebral canal is called the epidural space. It's filled with fat, loose connective tissue, and blood vessels.

27.06

To see the contents of the vertebral canal from end to end, we'll take a look from behind, at a dissection in which all the laminae have been divided along these lines, and removed.

27.19

Here’s the sacrum. Here’s the base of the skull. The tissues that occupy the epidural space have been removed, to give us a clear look at the dura. This is the dura. The sleeve of dura is called the dural sac. It’s open at the top end, and closed at the bottom.

27.42

Here at the base of the skull,, the dural sac passes through the foramen magnum, becoming continuous with the layer of dura that surrounds the brain.

27.53

At the bottom end, within the vertebral canal of the sacrum, the dural sac tapers down to a point, at the level of the second sacral segment.

28.05

To look at the spinal cord, we’ll divide the dura in the mid-line and lay it aside. Here’s the spinal cord.

28.23

In the early embryo, the spinal cord extends the whole length of the vertebral column, but as development progresses the vertebral column grows much more rapidly than the cord. The cord ends up filling only the upper two thirds of the vertebral canal. The lower end of the cord is at the level of the first lumbar vertebra. Let’s see some more details

28.55

These are nerve roots - we’ll look at them in a minute. The cord is attached to the dura by a series of fine, triangular ligaments, the denticulate ligaments. To see how the spinal nerves arise, we’ll go up to the cervical region.

29.14

Each spinal nerve arises from a small bundle of dorsal filaments, which unite to form the dorsal, sensory root of the nerve, and a similar bundle of ventral filaments, which unite to form the ventral, motor root.

29.35

In the cervical region, the nerve roots follow a slightly oblique, downward course. In the thoracic region their course becomes more oblique.

29.52

Here right at the lower end of the spinal cord, this continuous line of nerve filaments gives rise to a large number of nerve roots, which run vertically downward, almost hiding the very end of the cord, which is here.

30.08

Below this point, the dural sac is occupied not by the cord, but by this leash of vertically running lumbar and sacral nerve roots, the cauda equina. The nerve roots leave the vertebral canal, two at at a time, all the way down to the lower end of the sacrum.

30.25

Let’s follow the course of one spinal nerve, as it passes from inside the subarachnoid space, to its emergence from the intervertebral foramen.

30.38

To see this we’ll look at the cervical spine, in a dissection in which all the surrounding muscles have been removed, and in which the laminae have also been removed, along these lines, as in the previous dissection.

30.50

Here are the roots of the nerve, leaving the dural sac. Here’s the nerve emerging from the intervertebral foramen. To see the whole course of the nerve, we need to remove this part of the vertebra.

31.14

Here’s the dorsal root of the nerve, here’s the ventral root. The sleeve of dura that surrounds the converging nerve roots merges with the outer layer of the spinal nerve. This thickening at the very beginning of the spinal nerve is the dorsal root ganglion.

31.37

The spinal nerve passes forward and laterally, to emerge from the intervertebral foramen. To see that more clearly, we'll go back to the preceding stage of the dissection. As the spinal nerve emerges, it divides, into this small posterior primary ramus, and this much larger anterior primary ramus.

32.02

The posteror primary rami of the spinal nerves pass backward, to supply the muscles and skin on the back of the body. The anterior rami pass forward and laterally, to supply all the rest of the body. This anterior ramus is an unusually large one.

32.20

It's one of a set of five rami, between C5 and T1, which form the brachial plexus. The major nerves to the upper extremity emerge from the brachial plexus. The anterior rami from L1 to S3 are also large: they form the lumbar and sacral plexuses, which give rise to the nerves for the lower extremity. These plexuses are shown in volumes One and Two of this atlas.

32.46

There's a man-made puzzle that we need to clear up, regarding the numbering of the spinal nerves. In the cervical region, each spinal nerve takes its number from the vertebra below it. But from T1 on down, each nerve takes its number from the vertebra above it. The result is that there's one nerve, the one that emerges between C7 and T1, for which there's no corresponding vertebra. It's called "C8".

33.15

Now we're almost ready to move on, to Section Two of this tape. Before we do that, let's briefly review what we've seen of the muscles of the back, and the contents of the vertebral canal.

33.27

REVIEW OF MUSCLES AND SPINAL CORD

Here are the short rotators, the long rotators, and the multifidus. Here's the erector spinae: spinalis, longissimus thoracis, and iliocostalis lumborum.

33.52

Now the features of the vertebral canal: here's the spinal cord, the dura, the arachnoid, the pia, the subarachnoid space, the epidural space. Here are the dorsal filaments, the dorsal root; the ventral filaments, and the ventral root.

34.15

Here's the dorsal root ganglion, here's the spinal nerve, the anterior primary ramus, and the posterior primary ramus. Lastly, here's the cauda equina.

34.30

That brings us to the end of the first section of this tape. In the next section, we'll look at the thorax.

34.44

END OF PART 1

PART 2

THE THORAX

00.00

The thorax is commonly known as the chest. In this section we'll be looking mainly at the musculo-skeletal structures of the thorax, and at its principal blood vessels and nerves. We will see the lungs and the heart, but only briefly. They'll be shown fully in Volume [6] of this Atlas We'll start, as always, with the bones. Then we'll look at the plleural membrane, then at the muscles, then at the blood vessels and nerves.

00.38

BONES

The bones of the thorax are the thoracic vertebrae, the twelve pairs of ribs, and the sternum. Connecting the upper ten pairs of ribs to the sternum are the costal cartilages.

00.59

The first rib is quite small. Like all the ribs, it's angled downward from back to front. We'll take a special look at the first rib in a little while.

01.14

From the first rib to the third, the thorax widens in the shape of a dome, to about two thirds of its full width. From the third rib to the seventh the thorax widens a little further, in the shape of a cone. From the seventh rib to the twelfth, the thorax narrows slightly, and the ribs become very much shorter.

01.36

The sternum, commonly known as the breast-bone, consists of three parts: the manubrium, the body, and the xiphoid process, or xiphisternum.

01.52

The manubrium is attached to the body of the sternum by a cartilaginous joint, at which a little movement is possible. There's a slight angle between the manubrium and the body, the sternal angle, that's easy to palpate, as is the upper border of the manubrium.

02.11

The costal cartilages form a series of flexible, springy links between the ribs and the sternum. The first costal cartilage articulates with the manubrium; the second onearticulates with the joint between the manubrium and the body; and the third to the sixth or seventh costal cartilages articulate with the body.

02.33

Here's what the costal cartilages look like in the living body. They're quite flexible. These are the costo-chondral junctions, where the cartilages join the ribs.

02.45

The lowest four costal cartilages, the seventh, eighth, ninth, and tenth, join on to one another in series, forming the costal arch.

02.56

The angle between the two costal arches is called the infrasternal angle. The xiphoid process projects downwards in the infrasternal angle, where it can easily be palpated.

03.11

The eleventh and twelfth ribs aren't attached to the costal arch.. Since they're not linked to the sternum, they're called "floating ribs".

03.23

The ribs, sternum and costal cartilages form an expandable container for the lungs and heart. This large opening, formed on each side by the costal arch and the last two ribs, is called the inferior or lower thoracic aperture. It's almost completely filled in by the diaphragm, which separates the thorax from the abdomen.

03.48

The much smaller opening above, that's formed by the manubrium, the first ribs, and the first thoracic vertebra, is called the superior of upper thoracic aperture .

04.01

Now that we've looked at the thorax as a whole, let's take a look at a typical rib, the sixth rib. The rib is thin and flat, and curved in the form of a spiral..

04.17

At the back there are two thickenings, the head and the tubercle, which are separated by the neck. The curvature of the rib is interrupted by this angle, which marks the insertion of the iliocostalis, a back muscle that we've seen already.

04.35

At the front, the end of the rib is hollowed out, for the attachment of the costal cartilage. The outer aspect of the rib is smoothly curved. Its inner aspect is marked on the underside by this groove, in which the intercostal vessels and nerve run.

04.59

As we saw in the section on the spine, the rib articulates with the adjoining vertebrae at two points, the head, and the tubercle. The head of the rib has two articular facets. The two facets articulate with the vertebral bodies above, and below, to form the costovertebral joint .

05.26

This surface on the tubercle of the rib articulates with the tip of the transverse process, to form the costo-transverse joint. These two joints are synovial joints. They permit the movements of the rib that occur in respiration.

05.47

The joints between the ribs and the vertebrae are held together by ligaments,. The strongest of these are the radiate ligament here, and the superior costo-transverse ligament here.

06.01

The movement of the ribs is important in respiration, as we'll see later in this section. Next we'll take a further look at the first rib, a landmark structure where the thorax becomes continuous with the neck.

06.16

The first rib is the most tightly curved of all the ribs. It's also the broadest of the ribs. When seen from the side, its upper border lies in a plane that's about 30º from the horizontal. In addition, when seen from in front its flat upper surface slopes downward, also at about 30º.

06.37

The costal cartilage of the first rib articulates with the manubrium of the sternum not at the top, but lower down at its broadest part. The first costal cartilage is short and massive. It hardly permits any movement, so the two first ribs, together with the manubrium, move up and down together as one solid arch.

07.00

Here's a dissection of the manubrium, and the two first ribs, with all the other ribs removed. Here's the movement these structures make, when we take a deep breath in, and out.

07.17

The upper part of the thorax is almost completely surrounded by the muscles of the shoulder region, which arise from the ribs, and also from the vertebrae. These muscles are shown in Volume 1 of this atlas. Just to appreciate how greatly the structures of the shoulder affect the shape of the upper part of the body, we'll add to our picture at this point the bones of the shoulder region: the clavicles and the scapulae.

07.44

Here's the clavicle, or collar bone, here's the scapula, or shoulder blade. These two bones articulate with the bones of the thorax at one point only, here. The medial end of the clavicle articulates with the highest point on the manubrium, forming the sterno-clavicular joint.

08.10

It's easy to palpate the clavicle. Here's its medial end. The first rib is difficult to palpate. That's because it lies both below and behind the clavicle, and also because there's a thick layer of muscle in front of it.

08.30

The lateral end of the clavicle articulates with this projection on the scapula, the acromion, forming the acromio-clavicular joint. Apart from this one very movable bony attachment, the scapula is held on to the body entirely by muscles.

08.48

It's thus capable of a wide range of movement, upward and downward, and also forward and backward around the chest wall. The mobility of the scapula contributes greatly to the mobility of the upper extremity.

09.00

Before we move on, let's briefly review what we've seen of the bones of the thorax.

09.06

REVIEW OF BONES

Here are the thoracic vertebrae, and the ribs. Here's the head of the rib, the tubercle, the neck, and the angle. Here's the costovertebral joint, and the costo-transverse joint .

09.31

Here are the costal cartilages, here's the costal arch, here's the sternum the manubrium, the body, and the xiphoid process. The upper thoracic aperture and the lower thoracic aperture.

09.56

Here's the clavicle, the scapula, the sterno-clavicular joint, and the acromio-clavicular joint .

10.07

PLEURAL CAVITY, PLEURA

Next we need to look at the important layer of tissue which lines the thoracic wall on the inside - the pleura. To understand the pleura, we need to take a brief look at the way the main stuctures inside the thorax are arranged.

10.30

To see what's inside the thorax, we'll look at a dissection in which ribs two through seven have been divided on each side along this line and removed, along with most of the sternum, leaving the costal arches intact.

10.48

Here are the divided ends of the ribs that were removed, here's the intact eighth rib, here's the costal arch, here's the divided lower end of the sternum, here's the upper part of the manubrium, and here's the intact first rib. Here are the bodies of the thoracic vertebrae.

11.13

This is our first look at the diaphragm, which forms an almost complete partition between the thorax and the abdomen. We'll take a good look at the diaphragm when we look at the muscles of respiration.

11.27

With everything removed, the thoracic cavity looks like one continuous space. In reality it's divided into two separate cavities by a partition, the mediastinum, which extends from the vertebral bodies behind, to the sternum in front . The heart, the great blood vessels, the esophagus, and the trachea are contained within the thickness of the mediastinum.

11.52

To see the mediastinum, we'll put the sternum back in place. Here's the sternum. Here are the divided ends of the costal cartilages. This is the mediastinum. This is the hilum, or root, of the lung. This glistening layer of smooth lining tissue is the pleura, also called the pleural membrane. It forms a complete lining for this cavity, which is called the pleural cavity.

12.27

Here, the pleura is reflected off the vertebral bodies and onto the mediastinum. Here behind the sternum the pleura continues round, onto the front of the chest wall. Below, the pleura is reflected off the chest wall, and onto the diaphragm, and off the diaphragm, onto the mediastinum.

12.53

Above, the pleura fills in the gap that's created by the curvature of the first rib. Here's the first rib, seen from below. Here's the highest part of the pleura, known as the dome or cupola of the pleura. Here it is, seen from the outside.

13.16

We'll take a better look at the dome of the pleura from the outside, in a more intact dissection. Here's the fist rib, here's the manubrium. Here's the divided end of the trachea, going down into the mediastinum. Here's the dome of the pleura.

13.38

When seen from the side, the dome of the pleura is level with the proximal end of the first rib. When the pressure inside the chest is raised, the pleura rises well above the first rib.

13.54

So far we've been looking at the right side. The left pleural cavity is similar, except that the heart, enclosed here within the pericardium, projects into it. In the living body the two pleural cavities are completely filled by the lungs, which we'll add to the picture.

14.18

Here are the lungs, discolored by a moderate degree of smoke damage. The layer of smooth tissue which covers the outside of the lung is also pleura. All the way round the pleural cavity, the two layers of pleura touch, with nothing between them except a thin film of fluid.

14.37

The layer that covers the lung is called the visceral pleura , the layer that lines the cavity is called the parietal pleura. The two layers of pleura, the parietal, and the visceral, are continuous with each other here, around the hilum of the lung.

15.05

Each lung occupies a completely sealed space. Its volume can never be greater or less than the volume of the pleural cavity. When the volume of the cavitiy is increased, whether by downward movement of the diaphragm, or by forward and upward movement of the ribs, the parietal pleura exerts a pull on the visceral pleura, the lung expands, and we breathe in. When the volume of the cavity is decreased, the lung is compressed, and we breathe out.

15.38

MUSCLES

Now we'll move on, to look at the muscles that are involved in breathing in, and breathing out.

15.47

The act of breathing in is called inspiration, the act of breathing out is expiration. The whole process of breathing is called respiration. In looking at the muscles of respiration, we'll look first at the diaphragm, then at the muscles that produce movements of the ribs. The best way to understand the diaphragm is to look at it from below.

16.12

Here are the lower ribs. The muscles between them are the intercostals, which we'll see shortly. Here's the left costal arch, here's the xiphoid process. The anterior abdominal wall, and all the abdominal organs have been removed. Now we'll take a look from below.

16.38

Here's the diaphragm. It's a thin, continuous sheet of muscle, with fibers that converge from all around the circumference, to insert on this flat tendon, the central tendon of the diaphragm. The diaphragm arises from a line that goes right around the inside of the lower thoracic aperture, with one interruption, here.

17.03

To see the line of attachment, we'll remove one half of the thorax, and look from inside. The line of attachment of the diaphragm goes from here on the back of the sternum, along the inside of the costal arch, and round to the tip of the twelfth rib.

17.25

Between the twelfth rib and the body of the second lumbar vertebra, the diaphragm arises on each side from the fascia which overlies the two big muscles of the posterior abdominal wall. These are the quadratus lumborum, and psoas major muscles.

17.47

Three important structures pass through the diaphragm: the esophagus, and the two main blood vessels of the lower half of the body, the inferior vena cava, and the descending aorta. This is the opening for the inferior vena cava, the vena caval foramen. This is the opening for the esophagus, the esophageal hiatus. This is the opening for the aorta .

18.15

On each side of these two openings there's a thickening of the diaphragm called a crus, the plural of which is crura . The left crus arises all the way down here, on the body of L2 . The right crus arises even further down, on L3. The two crura arch over the aortic opening, forming the median arcuate ligament. Fibers of the two crura cross over, to surround the esophageal hiatus.

18.48

When the diaphragm contracts, the whole sheet of muscle, together with the central tendon, moves downward, expanding the lungs, and causing us to breathe in.

19.00

As the diaphragm contracts, the structures below it, the contents of the upper part of the abdominal cavity are pushed downwards, which leads to this bulging of the abdominal wall when we take a quiet breath in.

19. 16

When we're at rest and breathing quietly, inspiration is produced almost entirely by the downward pull of the diaphragm, with little or no movement of the ribs. In quiet expiration, the upward, return movement of the diaphragm is produced passively by elastic forces, notably by elastic contraction of the lungs themselves.

19.36

When we're breathing vigorously, the diaphragm is pushed upward actively by contraction of the muscles of the abdominal wall. These raise the pressure in the abdomen, forcing the upper abdominal organs, and the diaphragm, upward.

19.53

Now that we've looked at the diaphragm, we'll move on to look at the muscles that produce movements of the ribs. First we'll look at the principal muscles that produce inspiration, the external intercostals, and the scalene muscles.

20.08

Here are the external intercostal muscles. They're thin sheets of muscle, that connect each rib to its neighbor. Each external intercostal runs from here on the rib above, to here on the rib below. They extend from the tubercles of the ribs behind, round to the middle of the costal cartilages in front. The fibers of the external intercostals run forward, from above, downward.

20.45

To understand how the external intercostals act, we'll look at a simplified model of two ribs. When we apply a pulling force in the direction of the external intercostal fibers, the ribs move upwards. As the ribs move upwards, their ends, together with the sternum, move forwards. So the action of the external intercostals produces an upward and forward movement of the anterior chest wall.

21.23

Next we'll look at the scalene muscles, which assist in inspiration by raising the first and second ribs. Here's the manubrium, here's the first rib, here's the second rib. Here are the scalene muscles: anterior, middle, and posterior.

21.45

The anterior scalene muscle arises from the anterior tubercles of the transverse processes from C3 to C6. It inserts here on the first rib. The middle scalene muscle arises from the posterior tubercles of the transverse processes from C2 to C6, and inserts here on the first rib. The posterior scalene muscle arises from the posterior tubercles, from C4 to C6, and inserts down here, on the second rib.

22.17

The action of the scalene muscles raises the first and second ribs, and the manubrium, in deep inspiration.

22.25

Now we'll look at the principal muscles that produce expiration: the internal intercostals, and the muscles of the abdominal wall. The internal intercostals lie just beneath the external ones, which we'll remove.

22.39

Here are the internal intercostal muscles Each internal intercostal runs from here on the rib below, to here on the rib above. The internal intercostals extend from the angles of the ribs behind, to the end of the intercostal spaces in front.

23.03

The fibers of the internal intercostals run forward, from below, upward. To show how they act, we'll look at the model again, with the force now applied in the direction of the internal intercostal fibers.

23.17

As the force is applied, the ribs move downwards. As the ribs move downwards , their ends, together with the sternum move backwards. The action of the internal intercostals moves the anterior chest wall downwards and backwards.

23.37

The other important muscles of expiration are the muscles of the abdominal wall. They have two important effects. We've noted already that they raise the intra-abdominal pressure, and so push the diaphragm up. In addition to this, abdominal wall muscles pull the lower ribs downward, assisting the action of the internal intercostals. We'll be seeing these muscles in detail in the next section. Here, we'll just take a quick preview of them.

24.05

On either side of the midline are the rectus abdominis muscles, which go from the fifth, sixth and seventh ribs, down to the pubis. Between the rectus muscles in front, and the posterior abdominal wall behind, there are three sheets of muscle, one inside the other. This one, the innermost, is the transversus abdominis. Its fibers run horizontally, the uppermost ones go from the lowest four ribs, to insert on this sheet of tendon which goes to the midline.

24.41

Outside transversus is the internal oblique Its fibers arise from the iliac crest and fan out in many directions, the highest ones inserting on the lowest three ribs. Outside the internal oblique is the external oblique. It arises from the lower seven ribs, and inserts partly on the iliac crest, partly into this broad tendinous sheet, the external oblique aponeurosis.

25.17

The most important contribution that the abdominal wall muscles make to the movements of respiration is in the powerful action of forced expiration, as in coughing or sneezing.

25.30

In addition to the muscles of respiration that we've seen, there are some minor ones that we're going to leave out, since they're unimportant. These are the levators of the ribs and the serratus posterior muscles on the outside, and the transversus thoracis and innermost intercostal muscles on the inside.

In addition to being an expandable container for the heart and lungs, the thorax also forms the foundation from which the upper extremity arises. The muscles of the shoulder region, which cover up most of the ribs in front, and all the ribs behind, are shown in Volume 1 of this Atlas.

26.12

Now we're nearly ready to move on, to look at the blood vessels and nerves of the thorax. Before we do that, let's review what we've seen of the musscles of respiration.

26.22

REVIEW OF PLEURAL CAVITY AND MUSCLES

Here’s the parietal pleura, and the visceral pleura. Here’s the pleural cavity, and the mediastinum. Here’s the dome of the pleura. Here’s the diaphragm, the right and left crus, the vena caval foramen, the esophageal hiatus, the aortic opening.

27.02

Here are the external intercostals muscles, the scalene muscles, anterior, middle, and posterior, the internal intercostals. Lastly here are the rectus abdominis, transversus abdominis, internal oblique, and external oblique muscles.

27.38

BLOOD VESSELS

Now that we’ve seen the bones and muscles of the thorax, we’ll look at the principal blood vessels and nerves of the thoracic region. Of the blood vessels that we’ll look at, there are some that we’ll see only in passing, the pulmonary vessels. These are the major vessels which pass between the heart and the lungs. We’ll see these more fully in Volume [6]. We’ll start with the arteries, and we'll begin with the largest artery in the body, the aorta.

28.09

Here's the left pleural cavity with the lung removed, and the heart and mediastinum undisturbed. Here's the aorta, partly hidden beneath the pleura. It emerges from the left ventricle of the heart, arches over, and runs down alongside the vertebral bodies. It leaves the thorax by passing through the diaphragm, into the abdomen.

28.35

To get a better look at the aorta, we'll remove the overlying pleura, and the pericardium that surrounds the heart. We'll also remove the body of the sternum, and the lower half of the manubrium.

28.48

The part of the aorta that lies within the thorax is called the thoracic aorta. It's spoken of as having three parts, the ascending aorta, the arch, and the descending aorta.

29.03

The aorta arises here from the left ventricle. To its left is the pulmonary trunk. To its right is the superior vena cava. The ascending aorta runs upwards with a slight curve to the left. It has no branches.

29.27

The arch of the aorta makes a complete 180º turn. Beneath the arch of the aorta is the pulmonary trunk, dividing into the two pulmonary arteries: here's the left one. This is the ligamentum arteriosum. Also beneath the arch are the left main bronchus and the left pulmonary veins. To the right of the arch is the lower end of the trachea.

29.54

Before we move on to the descending aorta, we'll take a look at the three major arteries which arise from the arch. These are the brachiocephalic trunk, the left common carotid artery, and the left subclavian artery.

30.11

The brachiocephalic trunk, also known as the innominate artery, divides to form the right subclavian and the right commmon carotid ateries. Here are the origins of these three arteries: brachiocephalic, left common carotid, left subclavian.

30.35

Here they are emerging through the upper thoracic aperture. To see them clearly, we'll remove these veins, the right and left brachiocephalic veins, which unite to form the superior vena cava. We'll also remove the rest of the manubrium, and the two first ribs, from here to here.

31.02

The brachiocephalic artery divides here into the right subclavian and the right common carotid. Here's the left common carotid, here's the left subclavian. The subclavian and common carotid arteries are shown in Volumes 1 and 4 respectively.

31.27

In this section we'll look at one branch of the subaclavian that's important in the thorax, the internal thoracic artery. To look at it, we'll put the first rib and the manubrium back in place. The subclavian artery arches over the upper surface of the first rib, passing behind the anterior scalene muscle. Before passing behind the anterior scalene, it gives off these branches, the thyro-cervical the vertebral, and this one the internal thoracic.

32.04

The internal thoracic artery runs downward and forward over the dome of the pleura, and passes behind the first costal cartilage. To see where it goes, we'll look at a dissection of the anterior chest wall by itself, seen from behind. Here are the two internal thoracic arteries.

32.26

After passing behind the first rib, which is here each one runs down the inside of the chest wall, just lateral to the sternum, in front of the transversus thoracis muscle. Its branches supply the anterior chest wall. Its distal continuation, known as the superior epigastric artery, supplies the upper part of the anterior abdominal wall, as we'll see in the next section.

32.51

Now we'll return to the aorta. We've seen the arch; now we'll look at the descending aorta in the thorax. To get a clear look at it, we'll take the heart , and the arch of the aorta, out of the picture.

33.05

The descending aorta runs downwards in close company with the esophagus. The esophagus lies medial to it up here, in front of it down here. We'll remove the esophagus.

33.33

On each side the descending aorta gives off this series of posterior intercostal arteries, one for each of the intercostal spaces except the first two. Each posterior intercostal artery passes along the deep aspect of an internal intercostal muscle, in company with an intercostal vein and nerve. It stays close to the lower border of the rib, in this groove that we saw earlier.

33.50

Now we'll move on to look at the principal veins of the thorax. We'll look at the two largest veins in the body, the superior and inferior vena cava, which enter the thorax from above and below, and empty into the right atrium of the heart through two separate openings. We'll also see the veins of the wall of the thorax, the azygos veins. We'll start by looking at the major veins which contribute to the superior vena cava, the subclavian and internal jugular veins.

34.23

On each side, the subclavian vein, the principal vein of the upper extremity, joins with the internal jugular, the principal vein of the head and neck, here, behind the medial end of the clavicle forming the brachiocephalic vein. The two brachiocephalic veins enter the thorax and unite, forming the superior vena cava.

34.47

To see the subclavian and internal jugular veins, we'll remove the major muscles which lie in front of them - the pectoralis major, and sternocleidomastoid muscles.

35.00

Here's the subclavian vein, coming up from beneath pectoralis minor, and passing beneath the clavicle. Here's the internal jugular vein, with the omohyoid muscle in front of it. To see where these two veins join, we'll remove the clavicles.

35.24

The subclavian vein passes over the flat, anterior part of the first rib. The anterior scalene muscle separates the subclavian vein from the subclavian artery. The dome of the pleura is just behind and beneath the subclavian vein. The internal jugular vein lies in front of the common carotid artery and lateral to it.

35.52

On each side the subclavian and internal jugular veins unite, to form the right and left brachiocephalic veins. The two brachiocephalic veins pass downwards into the thorax behind the manubrium. To follow them, we'll remove the anterior chest wall, as we did before.

36.14

The lungs and the pericardium have also been removed. The cut ends of the two first ribs are here, and here. Here are the two brachiocephalic veins, the right, and the left, joining to form the superior vena cava. The superior vena cava lies well to the right of the mid-line. Because of this the right brachiocephalic vein is short, and runs straight downwards; the left one is longer, and runs quite obliquely.

36.47

The superior vena cava passes straight downwards, entering the pericardial sac here. To its left is the ascending aorta. Behind it is the trachea. The superior vena cava ends by entering the highest part of the right atrium of the heart. The azygos vein, which we'll see in a minute, joins the vena cava from behind, just before the vena cava enters the pericardium.

37.15

Next we'll look briefly at the inferior vena cava, which brings all the blood from the lower half of the body to the right atrium. The reason we'll just look at it briefly is that within the thorax, the inferior vena cava has no length at all: it enters the right atrium as soon as it passes through the diaphragm.

37.37

To see the inferior vena cava, we'll move the diaphragm downward, and move the heart to the left. Here's the inferior vena cave. After coming up through the diaphragm it passes almost immediately into the lower part of the right atrium. It enters separately form the superior vena cava, which is here.

38.01

We'll look at the course of the inferior vena cava below the diaphragm in the next section of this tape. Now we'll look at the azygos vein and its tributaries.

38.15

Here's the azygos vein, arching over the right main bronchus, and joining the superior vena cava. To see where it comes from, we'll remove the heart, and all the other structures of the mediastinum.

38.36

Here's where the zygos vein has been divided. The azygos vein begins below the diaphragm and runs up along the right side of the vertebral column. The azygos vein receives blood from the posterior and lateral parts of the chest wall. On the right side, the posterior intercostal veins empty directly into it. On the left side, the posterior intercostals empty into these two hemi-azygos veins which in turn empty into the azygos.

39.10

Now that we've looked at the arteries and veins of the thorax, we'll move on to look at the nerves.

39.18

NERVES

Now that we've looked at the arteries and veins of the thorax, we'll move on to look at the nerves. The nerves that we'll see are the phrenic nerve, the vagus nerve, the sympathetic trunk, and the intercostal nerves.

39.27

We'll look at the phrenic and vagus nerves first. The phrenic is the motor and sensory nerve of the diaphragm. The vagus provides the parasympathetic supply for all the organs of the thorax and abdomen.

39.42

The courses of these two nerves are similar: they both start in the neck, run downward in the mediastinum, and pass through the diaphragm. We'll look at them first in the neck.

39.53

In this dissection the clavicles and the sternocleidomastoid muscles have been removed. Here's the phrenic nerve. It runs down on the front of the anterior scalene muscle, and passes in front of the subclavian artery, and behind the subclavian vein.

40.13

To see the vagus nerve we'll retract the internal jugular vein. Here's the vagus nerve. It lies behind and between the internal jugular vein and the common carotid artery. It passes in front of the subclavian artery.

40.34

On the right side only, the vagus gives off this branch, the recurrent laryngeal, which curls around the artery and passes upwards to the larynx. To follow these two nerves, we'll remove the anterior chest wall.

40.49

Here's the phrenic nerve, here's the vagus nerve. The phrenic nerve passes behind the subclavian vein, which has been divided here, and runs downward in the mediastinum in front of the root of the lung, close to the superior vena cava and right atrium. The phrenic nerve passes through the diaphragm.

41.12

In the intact mediastinum, the phrenic nerve runs here, just beneath the pleura. On the left side, the course of the phrenic nerve is similar: in its course in the mediastinum it passes over the aorta, the pulmonary trunk, and the left ventricle.

41.33

To see the course of the vagus nerves, we'll remove the brachiocephalic veins, and the superior vena cava. On the right side, the vagus nerve passes downward and backward, close to the trachea, to reach the esophagus. It breaks up into several branches as it runs down along the esophagus.

42.00

On the left side, the vagus nerve crosses the arch of the aorta, and passes backward to run down alongside the esophagus and through the diaphragm. On the left side, the recurrrect laryngeal branch is given off here, and curls around the arch of the aorta to return to the neck.

42.26

Now we'll look at the intercostal nerves and at the sympathetic trunk.

42.29

Here are the vertebral bodies, here's the proximal end of one of the ribs. Here are three of the intercostal nerves. They're the direct continuationof the anterior rami of the thoracic spinal nerves. They give motor innervation to the intercostal muscles, and sensory innervation to the chest wall. They run closely with the intercostal blood vessels, which have been removed in this dissection. This slender, irregular cord is the sympathetic trunk.

43.03

We won't go into a description here, of themany functions of the sympathetic system, or of its somewhat complex arrangement. The details that follow are shown on the premise that you've either just learned about these things, or that you're just about to do so.

43.19

The sympathetic trunk runs alongside the vertebral column, all the way from T1, down to the sacrum. This thickening is one of the ganglia of the sympathetic trunk. These fine connections between the sympathetic trunk and the anterior rami of the spinal nerves, are the rami communicantes.

43.40

The nerves passing medially from the sympathetic trunk are the splanchnic nerves, on their way to the celiac and mesenteric gangla.

43.48

Now let's review what we've seen, of the blood vessels and nerves of the thorax.

43.57

REVIEW OF BLOOD VESSELS AND NERVES

Here’s the ascending aorta, the arch of the aorta, and the descending aorta. Here’s the brachiocephalic artery, the right subclavian, the right common carotid, the left common carotid, and the left subclavian arteries. Here’s the internal thoracic artery.

44.29

Here are the subclavian veins, the internal jugular veins, the brachiocephalic veins, the superior vena cava, the inferior vena cava, the azygos vein, and the hemi-azygos veins.

44.56

Here’s the phrenic nerve, and the vagus nerve, and in the chest, the vagus nerve, and the phrenic nerve; and the recurrent laryngeal nerve on the right, and on the left. Here are three of the intercostal nerves. Here's the sympathetic trunk, a ramus communicans, and a splanchnic nerve.

45.39

BREAST

There’s one more important structure to include while we’re looking at the thorax, the breast. The female breast varies greatly in size, and also in shape. From above down the breast extends from about the level of the second rib, to the sixth rib. From side to side, it extends from the edge of the sternum, to about the mid-axillary line. This prolongation of the breast behind is called the axillary tail.

46.18

This pigmented area is the areola. It surrounds the nipple, which is the point at which the lactiferous ducts emerge.

46.27

To see the internal structure of the breast, we’ll remove one half of it, along this line. The breast consists largely of fat. This is the breast of a post-menopausal individual, in whom the glandular breast tissue has shrunk to a rather small proportion of the whole breast. The breast lies directly in front of the fascia that covers the pectoralis major muscle.

46.53

Beneath the areola, the lactiferous ducts - here’s one of them - converge on their separate openings on the nipple.

47.03

That brings us to the end of this section on the musculo-skeletal system of the thorax. In the next section, we’ll look in a similar way at the abdomen.

47.12

END OF PART 2

PART 3

THE ABDOMEN

00.00

In this section we'll look at the musculo-skeletal structures that surround the abdomen. We'll look first at the bones that lie above, behind, and below the abdominal cavity. Then we'll see the layers of muscle and tendon that form the wall of the abdomen. After that we'll take a detailed look at the lowest part of the abdominal wall, the inguinal region. Lastly we'll look at the principal blood vessels and nerves of the region.

00.32

We'll look at the abdomen in this tape as a container, as we did with the Thorax. We'll look at what it contains in Volume [6] of this Atlas.

00.42

BONES

Let's start with the bones that we're concerned with: the lower ribs, the lumbar vertebrae, and the bones of the pelvis. We're familiar with the rib cage already. The lower edge of the rib cage, formed by th elast three ribs and the costal arch, is called the costal margin .

01.05

Just above the costal margin on the inside, the diaphragm arises, as we've already seen. The diaphragm forms the upper limit of the abdominal cavity. Because of the shape of the diaphragm, the upper part of the abdominal cavity extends a long way above the the costal margin.

01.24

The rib cage is also a major site of attchment for abdominal wall muscles, as we began to see in the last section.

01.32

The lumbar vertebrae provide the foundation for the posterior part of the abdominal wall. The massive bodies of the vertebrae project forward into the abdominal cavity.

01.43

Next we'll take a further look at the bones of the pelvis. For a start, we need to understand something about the word "pelvis". The pelvis is commonly used as the short name for two different things: the bony pelvis, and the pelvic cavity.

02.00

This is the bony pelvis, consisting of the sacrum, and the two hip bones. This is the pelvic cavity: it's the deep and narrow space that's enclosed by the sacrum, the lower parts of the hip bones, and by ligaments and muscles that we'll see in the next section. The pelvic cavity is continuous with the abdominal cavity here, at the pelvic brim, which we'll return to in a minute.

02.30

To understand the abdomen, we need to understand the upper and anterior parts of the bony pelvis. We took a good look at the sacrum in the first section of this tape. The only parts of it that we'll mention here are the most anterior part, the sacral promontory and this broad part, the ala or wing of the sacrum

02.53

Now we need to take a look at some important features of the hip bone. The hip bone is also known as the innominate bone. It develops by the fusion of three originally separate bones, the massive ischium below and behind, the more lightly constructed pubis below and in front, and the broad ilium above. We'll look at the ilium first

03.29

The thick lower part of the ilium is the body. The broad expanse of bone that fans out above the body is the ala, or wing of the ilium. The concavity on the inner surface of the ala is known as the iliac fossa. This roughened area, the auricular surface, articulates with the sacrum, forming the sacro-iliac joint .

03.59

The broad, roughened edge of the ala of the ilium is the iliac crest. The iliac crest ends behind at the posterior superior iliac spine. It ends in front at this important projection, the anterior superior iliac spine. The iliac crest lies close to the surface all the way along its length. The anterior superior iliac spine is here.

04.32

Next we'll look at the pubis. This is the superior pubic ramus. This is the body of the pubis; and this is the ischio-pubic ramus. This thick ridge is the pubic crest, which ends at this prominence, the pubic tubercle.

04.55

Lateral to the tubercle, the superior ramus of the pubis has a sharp upper border, called the pecten.

05.01

The two hip bones are held together in front by a cartilaginous joint, the pubic symphysis. The front of the pubic symphysis is here.

05.15

The pelvic brim, the narrowing which forms the open end of the pelvic cavity, is made up by the pubic symphysis in front; by the promontory of the sacrum behind; and on each side by the ala of the sacrum, this shoulder on the body of the ilium called the arcuate line, and by the superior ramus of the pubis.

05.41

The parts of the bony pelvis that lie below the pelvic brim, the ischium, and the ischio-pubic ramus, don't concern us at present. We'll look at them in the next section.

05.54

As we've looked at the features of the bony pelvis, we've been seeing them in the position they're in, when we're standing upright. It's useful to keep in mind certain basic planes and angles. In the normal standing position, the anterior superior iliac spines, and the front of the pubic symphysis, are in the same vertical plane when seen from the side.

06.20

The plane of the pelvic brim is tilted at about 60º to the horizontal. The pelvic surface of the sacrum slopes at 30º to the horizontal. The pubic symphysis is tilted at almost the same angle.

06.39

It's also useful to keep in mind the distance between the costal margin above, and the pelvis below....and the way that distance changes from the front, to the side. In front, it's a long way from the xiphoid process, to the pubic symphysis. But at the side, the costal margin, and the iliac crest, are only this far apart.

07.06

Now let's review what we've seen of the bones of the abdominal region.

07.11

REVIEW OF BONES

Here's the costal margin, here are the lumbar vertebrae. Here's the ilium; the body of the ilium. the wing of the ilium, the iliac fossa, the iliac crest, the anterior superior iliac spine. Here's the pubis, with the superior pubic ramus, the body of the pubis, the ischio-pubic ramus, the pubic crest, the pubic tubercle, the pecten, and the pubic symphysis.

08.02

MUSCLES (POSTERIOR)

Before we look at the muscles, there's one important structure that we need to add to the picture: the inguinal ligament. Here's the inguinal ligament. It's a strong band of tendinous tissue, that goes from the anterior superior iliac spine, to the pubic tubercle.

08.27

There's a gap between the inguinal ligament, and the underlying bone. Through this gap some important structures pass from the abdomen, to the thigh, including the femoral vein, artery and nerve medially; and the belly of the psoas and iliacus muscles laterally.

08.47

The inguinal ligament isn't an isolated structure. As we'll see, it's the lowest part of the external oblique aponeurosis, which is the outermost of the muscular and tendinous layers of the anterior abdominal wall.

09.03

Now we'll move on to look at the muscles that make up the wall that surrounds the abdominal cavity. We'll begin with the muscles which, along with the vertebral column and the diaphragm, form the posterior part of the abdominal wall. We'll look at the erector spinae muscles and their surrounding fascia, then at quadratus lumborum, then at psoas major and iliacus.

09.27

We're looking from behind. Here's the iliac crest; here's the twelfth rib; here's the mid-line. Here are the muscles known collectively as the erector spinae. We looked at them in the first section of this tape. They arise from the sacrum and from this part of the iliac crest. They're inserted on the thoracic vertebrae, and on the the backs of the ribs.

09.53

The erector spinae muscles are enclosed on the front and on the back by this envelope of tendinous tissue called the thoraco-lumbar fascia. The layer on the back of the erector spinae arises from the spinous processes; the layer on the front arises from the transverse processes.

10.18

The two layers of thoraco-lumbar fascia fuse into one thick layer along the border of erector spinae. The thoraco lumbar fascia is an important attachment for muscles of the abdominal wall, as we'll see shortly.

10.32

Next we'll add quadratus lumborum to the picture. Here's quadratus lumborum. It lies in front of the erector spinae muscles and their investing fascia.

10.44

Quadratus lumborum arises from the twelfth rib, and the transverse processes of the upper three lumbar vertebrae. Its inserted on the most medial part of the iliac crest, and the transverse process of L 5. Quadratus lumborum assists in producing lateral flexion of the lumbar spine.

11.03

Lying medial to quadratus lumborum is psoas major. Psoas major arises from the transverse processes, vertebral bodies, and intervertebral disks, from T 12 to L 5. It runs down, across the ala of the sacrum, across the sacro-iliac joint, and along the pelvic brim. Before seeing where psoas major goes, we'll add its close neighbor, iliacus to the picture.

11.40

Here's the iliacus muscle. It fills the iliac fossa. Iliacus arises from this wide area on the wing of the ilium. Down here, the medial fibers of iliacus and the lateral fibers of psoas major join, forming a single muscle belly known as the iliopsoas. The iliopsoas runs beneath the inguinal ligament, and passes backwards, to insert here on the lesser trochanter of the femur .

12.12

As it slopes downward and forward toward the inguinal ligament, the iliacus and psoas muscles are covered by this layer of dense connective tissue, the iliacus fascia, which we'll meet when we look at the inguinal ligament. This is just the lower part of it. The iliacus fascia is covered in turn by the membrane which lines the abdominal cavity, the peritoneum. This is a preview of the peritoneum: we'll see it more fully later in this section.

12.41

When we're looking at the abdomen we tend to see psoas and iliacus as static background structures, but they have an important function: they're the principal muscles that produce flexion at the hip joint.

12.58

Now that we've looked at the individual muscles, let's take an overall look at the structures that form the posterior abodominal wall. To do that we'll add the diaphragm to the picture. The steeply rising diaphragm forms the highest part of the abdominal wall, not only at the back, but all around.

13.20

The diaphragm makes a dome-shaped partition, separating the abdominal cavity below, from the thoracic cavity above. At the bottom, the middle part of the posterior abdominal wall, formed by the vertebral bodies, becomes continuous with the wall of the pelvic cavity here at the sacral promontory.

13.44

On each side the psoas stands away from the vertebral bodies like a pillar. The iliacus muscles, with their investing fascia, form a continuation of the posterior abdominal wall, that slopes downward, forward and inward, ending here at the inguinal ligament.

14.0

This is the lowest part of the anterior abdominal wall. In this dissection all the abdominal blood vessels and nerves have been removed, together with most of the peritoneum. We'll add those structures to the picture, later in this section.

14.28

MUSCLES (ANTERIOR)

Now, with our focus still on muscles, we'll move on to look at the four muscles which form the great expanse of the lateral and anterior abdominal wall.

14.37

These muscles fill in the huge gap that's created by the costal margin above, the edge of the thoraco-lumbar fascia behind, and the iliac crest, the inguinal ligament, and the pubic crest below.

14.56

First we'll look at the rectus abdominis, which runs vertically next to the midline, from the lower anterior ribs to the pubis; then we'll look at the three large flat muscles, transversus abdominis, internal oblique, and external oblique.

15.14

There's a time-honored word that's used in describing the tendons of the flat muscles: aponeurosis. Aponeurosis is a word that's used to describe a tendon that's in the form of a sheet.

15.26

We'll look at the rectus abdominis muscle first. Here's the rectus abdominis, together with the innermost of the flat muscles, transversus. The rectus abdominis is a very long muscle, wide at the top, and tapering to a more narrow attachment at the bottom. It arises from the fifth, sixth and seventh costal cartilages. It's inserted on the pubic crest.

15.53

The rectus is divided on the front by these bands of tendon, called tendinous intersections. Sometimes there are three of them, sometimes four, as in this case.. The intersections go about halfway way through the muscle. The action of the rectus muscles is to produce flexion of the lumbar spine. The rectus muscles act in opposition to the erector spinae muscles.

16.26

Besides producing active flexion, the rectus muscles have an important static effect. They keep the the lumbar spine straight at times when the force of gravity tends to extend it.

16.38

In the intact body the rectus abdominis is enclosed on the front and the back by a tendinous envelope, that's formed by the aponeuroses of the three flat muscles. This is the posterior layer of the rectus sheath. The posterior layer ends here, about three-quarters of the way down the muscle. Sometimes it ends gradually, sometimes abruptly, with a distinct lower border known as the arcuate line. Below here there's just a little loose fascia between the back of the rectus and the peritoneum.

17.12

Now we'll add the anterior layer of the rectus sheath to the picture. The anterior layer extends all the way from the costal margin, to the pubis.

17.25

If we incise the anterior rectus sheath and try to retract it, we can see that it's firmly attached to the tendinous intersections. There's one here, another one here. Here we've divided those adhesions so that we can retract the anterior rectus sheath medially.

17.50

The two layers of the rectus sheath come together near the midline, here's the posterior layer. Both layers insert into this dense mid-line band of tendinous tissue, the linea alba. The linea alba extends from the xiphoid process to the pubis.

18.14

We'll see more of the rectus sheath, as we look at the aponeuroses of the three flat muscles. We'll look at the flat muscles next. Flat may not be the best word to decribe them - in the vertical plane, they're markedly curved, as we'll see. We'll look at all three of them, then we'll look at their actions.

18.32

We'll start with the innermost of the three flat muscles, transversus abdominis. Here's transversus abdominis. The fibers of transversus all run in the same transverse direction, except the lowest ones, which run obliquely downwards.

18.50

Transversus abdominis has a long line of origin, from here, to here. At the top, its fibers arise from the inner aspect of the costal margin, from the sixth rib, to the twelfth. Between the twelfth rib and the ilium, transversus arises from the edge of the thoraco-lumbar fascia. Below, it arises from the inner aspect of the iliac crest.

19.20

The lowest fibers of transversus arise from the most lateral part of the inguinal ligament. Transversus has a short free lower border.

19.31

The muscle fibers of transversus end in this broad sheet of tendon, the transversus aponeurosis. The transversus aponeurosis fuses here with the aponeurosis of the overlying internal oblique muscle, to form one aponeurotic layer.

19.48

Now we'll add the internal oblique muscle to the picture. The internal oblique arises from the thoraco-lumbar fascia, and from the iliac crest. The lowest fibers of the internal oblique arise, like those of transversus, from the lateral part of the inguinal ligament. Like transversus, the internal oblique has a short free lower border.

20.17

The internal oblique fans out, so that its highest and lowest fibers run in markedly different directions. Back here, the fibers of the internal oblique run steeply upward. Here they run less steeply, here they're transverse, and here towards the inguinal region they run downward.

20.42

The highest fibers of the internal oblique insert on the lowest three ribs. Its remaining fibers end in this internal oblique aponeurosis, which, as we noted, fuses on the underside with the transversus aponeurosis. It's also joined on its outer aspect by the external oblique aponeurosis - this is the cut edge of external oblique.

21.04

From here to here, the combined aponeurotic layer divides at the edge of the rectus into two layers, one passing behind, and one in front of the rectus. Below here, the combined layer doesn't divide, but passes entirely in front of the muscle.

21.20

Now that we've looked at the internal oblique, it's time to add the external oblique muscle to the picture. Here's the external oblique muscle, the outermost of the three flat muscles. The fibers of the external oblique spiral downwards and forwards at the side, downwards and medially in front.

21.45

The external oblique arises from a broad area on the outside of the rib cage, all the way from here on the twelfth rib, to here on the fifth rib. The zig-zag line of origin of the external oblique fits in with the line of origin of serratus anterior. Though it's all one continuous muscle, we'll look at the external oblique in two parts, a posterior part that arises from the twelfth to the tenth ribs, and an anterior part that arises from the ninth to the sixth rib.

22.24

The anterior part of the external oblique ends in this external oblique aponeurosis. This fuses with the combined aponeuroses of the other two flat muscles, to form the anterior rectus sheath.

22.40

The external oblique aponeurosis has a long free lower border between the anterior superior iliac spine, and the pubic tubercle. As we've seen already, this free lower border is the inguinal ligament, which we'll see in detail shortly.

22.58

The part of the external oblique that arises from the tenth to the twelfth ribs remains fleshy from its origin to its insertion. It inserts along the outer edge of the anterior half of the iliac crest. Here at the back, the external oblique has a short free border, between the twelfth rib and the iliac crest.

23.22

Now that we've looked at all three of the flat muscles, we'll review their actions. When the three flat muscles on both sides contract together, as they usually do, they raise the pressure inside the abdominal cavity.

23.36

When our airway is open the rise in intra-abdominal pressure pushes the diaphragm upwards, causing air to leave the lungs, as we saw in the last section. When we hold our breath by closing our larynx, the flat muscles provide the pressure that's needed to expel the contents of either the rectum, the bladder, or the uterus, through their respective openings.

23.58

When the oblique muscles contract individually, they also play a part in producing lateral flexion of the lumbar spine, and rotation of the thoracic spine.

24.10

ABDOMINAL CAVITY, INGUINAL CANAL

Now that we've looked at all the muscles that form the walls of the abdominal cavity, we'll take a look inside the cavity itself. To do that we'll look at a dissection in which the abdominal organs, and the left half of the anterior abdominal wall have been removed. Here's the serous membrane that lines the abdominal cavity, the parietal peritoneum. We'll see it in more detail in volume
[6].

24.40

Beneath the peritoneum there's a continuous layer of loose connective tissue, here as we've seen it's called the iliacus fascia. Here on the inside of the anterior abdominal wall it's called the transversalis fascia .

24.56

Now we'll move on to look at the inguinal region. An important feature that we'll see is a structure that passes obliquely through the abdominal wall, just above the inguinal ligament. In the female the structure is the round ligament of the uterus; in the male it's the spermatic cord, the lifeline of the testis. The passage that this structure passes through is called the inguinal canal. We'll start by taking a more detailed look at the inguinal ligament.

23.28

In this dissection, the body has been divided in the midline. Here's the anterior superior iliac spine, here's the pubic symphysis. Here's the inguinal ligament. It's the lowest part of the external oblique aponeurosis.

25.48

Laterally, the ligament is attached to the the anterior superior iliac spine. Medially, it's attached to the pubic tubercle. The cut edge here was created by dividing the external oblique aponeurosis along this line.

26.05

The edge of the inguinal ligament can't be seen from the outside because the fascia lata, the investing deep fascia of the thigh, is attached to the ligament along here.

26.15

To see the edge of the ligament we'll go round to the inside. Here's the edge of the ligament. The iliacus fascia, which has been removed in this dissection, comes down over the iliopsoas, and is attached to the ligament along here.

26.38

The lowest fibers of the inguinal ligament curl around to form this triangular extension, the lacunar ligament. The lacunar ligament runs backwards and a little upwards, to insert on the sharp upper edge of the superior pubic ramus, the pecten.

26.54

The lateral part of the inguinal ligament gives rise to the lowest fibers of the transversus and internal oblique muscles. Here's transversus. Its lowest fibers arise from about the lateral one quarter of the inguinal ligament. Now we'll add the internal oblique to the picture.

27.17

Here it is. The lowest fibers of the internal oblique arise from the lateral one third of the inguinal ligament. The tendinous fibers of these two muscles arch over and unite, to form this flat tendon, the conjoint tendon. The conjoint tendon is attached to the pubic crest, and also behind, to the pecten.

27.41

Now we'll bring this lowest part of the external oblique aponeurosis up to its natural position, and add the rest of the aponeurosis to the picture. Here it is. There's an opening in the external oblique aponeurosis, the superficial inguinal ring. Through this the spermatic cord (or the round ligament) passes as we'll see shortly .

28.08

The fibers below and above the opening are called the inferior crus and the superior crus of the superficial inguinal ring. They're attached to the pubic tubercle, and the pubic crest respectively.

28.22

The inguinal canal passes through the superficial inguinal ring, then beneath the free borders of the internal oblique muscle, and the transversus abdominis muscle.

28.38

To see where the inguinal canal begins, we'll go tround to the inside. It begins at this arch beneath the lower border of transversus, which is called the deep inguinal ring.

28.53

Now we'll look at the spermatic cord.   In the developing embryo, the migrating testis pushes its way through the abdominal wall, and into the scrotum, creating the inguinal canal as it does so. The testis drags behind itself its own blood vessels and the vas deferens; and it carries along as a covering, a little of each layer that it goes through. To see the result, we'll look at a dissection in which the spermatic cord has been kept intact.

29.22

Here's the spermatic cord,with its outer layers removed. To see the structures that run inside the cord, we'll go round to a rear view again. The deep inguinal ring is here, hidden by the transversalis fascia. The iliacus fascia has been removed.

29.40

The structures that pass through the deep inguinal ring and into the spermatic cord are the blood vessels to the testis, the testicular artery and vein and the vas deferens, which passes over the pelvic brim and into the pelvis .

29.55

Emerging from beneath transversus, the vas deferens and the blood vessels are surrounded by this coating of internal spermatic fascia. Now we'll add the internal oblique muscle.

30.11

The internal spermatic fascia is surrounded, by this layer of muscle, the cremaster muscle. Here's the cut edge of the external oblique aponeurosis. We'll add the rest of the external oblique aponeurosis to the picture.

30.33

As the cord emerges from the superficial inguinal ring, it lies in front of the pubic tubercle, here. This edge of the superficial ring is a dissection artifact. In reality it's continuous with the outermost layer of the spermatic cord, the external spermatic fascia. From here, the spermatic cord goes down into the scrotum.

31.00

We'll look at the testis in Volume [6] of this Atlas. Now we're about ready to move on, to look at the principal blood vessels and nerves of the abdomen. Before we do that, let's review what we've seen of the muscles, and the structures of the inguinal region.

31.18

REVIEW OF MUSCLES AND INGUINAL REGION

Here's the thoraco-lumbar fascia, quadratus lumborum, psoas major, and iliacus. Here's rectus abdominis, the tendinous intersections, the posterior rectus sheath, the arcuate line, the anterior rectus sheath.

31.48

Here's transversus abdominis, the internal oblique, and external oblique muscles.

31.58

Here's the inguinal ligament, the lacunar ligament, the deep inguinal ring, the superficial inguinal ring, and the spermatic cord.

32.18

BLOOD VESSELS

Now we'll move on to look at the blood vessels of the abdominal region - first the arteries, then the veins. We'll start by looking at the part of the descending aorta that lies below the diaphragm, the abdominal aorta.

32.40

Here's the posterior abdominal wall with the arteries in place and the veins removed. Here's the abdominal aorta. It enters the abdomen by passing though the aortic opening in the diaphragm at the level of the twelfth thoracic vertebra. The aorta runs down on the front of the lumbar vertebral bodies, just to the left of the mid-line. It ends by dividing at the level of L4, into the right and left common iliac arteries. The point where it divides is called the aortic bifurcation.

33.12

In looking at the branches of the abdominal aorta we'll begin with the three which arise in the midline and supply the gastro-intestinal organs. Then we'll look at the branches that arise in pairs. The three midline branches are the celiac trunk, the superior mesenteric, and the inferior mesenteric.

33.33

The celiac trunk arises immediately below the margin of the aortic opening at the level of T12. It divides into three branches: the common hepatic, the left gastric, and the splenic. Between them these supply the liver, stomach, duodenum, pancreas and spleen.

34.08

The superior mesenteric artery arises at the level of L 1. Its branches supply the small intestine and much of the large intestine. The inferior mesenteric artery arises at the level of L 3. Its branches supply the distal part of the large intestine.

34.28

Of the branches of the aorta that arise in pairs, much the largest are the right and left renal arteries, which supply the kidneys. They arise just below the level of the superior mesenteric artery.

34.41

Arising at about L2 are in the female, the ovarian, and in the male the testicular arteries, which run downward and laterally over the psoas muscle .

34.54

Four pairs of lumbar arteries arise from the back of the aorta. Here are the lower two. They pass behind psoas major, where they branch to supply the back, the spine, and the abdominal wall.

35.10

Lastly, here's the median sacral artery, which arises from the back of the aorta just above the bifurcation, and passes down into the pelvis .

35.20

Next we'll look at the common iliac arteries and at their branches. On each side the common iliac artery divides into the internal and external ilac arteries. The common iliac artery runs close to the medial border of psoas major. It divides here, at the pelvic brim. Here's the external iliac artery, here's the internal.

35.49

We'll look at the internal iliac in the next section. The external iliac artery is the main artery to the lower extremity. It runs along the pelvic brim just medial to psoas major, and passes beneath the inguinal ligament. Below the inguinal ligament the artery goes by a different name: the femoral artery .

36.09

Just before passing beneath the ligament, the external iliac gives off two branches, the deep circumflex iliac laterally, and the inferior epigastric medially .

36.22

The inferior epigastric supplies the lower part of the abdominal wall. We'll see where it goes in a minute, but first we'll add the principal veins of the abdominal region to the picture. We'll start down at the inguinal ligament.

36.37

Here's the femoral vein, lying medial to the femoral artery as it passes beneath the inguinal ligament. Above the ligament it's called the external iliac vein.

36.48

The external iliac is joined by the internal iliac to form the common iliac vein. The two common iliacs join just to the right of the aortic bifurcation, to form the inferior vena cava. The right common iliac artery passes in front of the left common iliac vein.

37.09

The inferior vena cava runs just to the right of the mid-line. It lies on the vertebral bodies from L4 to T12, then on the left crus of the diaphragm. It passes through the diaphragm here, to enter the right atrium as we saw in the last section.

37.26

The two large renal veins join the inferior vena cave at the level of L2. This is the left testicular vein. The right one has been removed.

37.40

There aren't any veins that directly correspond to the celiac trunk and the mesenteric arteries. The blood that goes out through those arteries comes back to the liver by way of the portal vein, as we'll see in Volume [6] of this atlas. The blood from the liver then returns to the main circulation through these large hepatic veins. The hepatic veins are very short. Their number varies: here there are three. They enter the vena cava just below the diaphragm.

38.11

Next we'll look briefly at the main blood vessels of the anterior abdominal wall, the superior epigastric and inferior epigastric. We've seen that the inferior epigastric artery arises from the external iliac. The superior epigastric artery is the continuation of the internal thoracic. We saw it in the last section.

38.32

In this dissection the peritoneum and fascia on the inside of the lower part of the anterior abdominal wall have been removed. Here are the external iliac vessels, here are the inferior epigastric artery and vein. They pass upward and medially, and run up the back of the rectus abdominis muscle. They enter the rectus sheath by passing in front of the arcuate line.

39.00

The superior epigastric vessels also lie behind the rectus abdominis. To see them, we've removed the upper part of the posterior rectus sheath. Here's the superior epigastric artery, emerging from behind the costal margin, and passing down onto the back of the rectus. Its branches anastomose with those of the inferior epigastric within the rectus muscle.

39.23

NERVES

Now we'll move on to look briefly at the principal nerves of the abdominal region. First we'll see the nerves that provide the motor and sensory supply to the lateral and anterior abdominal wall.

39.35

These nerves are continuations of the lower intercostal nerves, from T7 downwards. Here are four of them. They emerge beneath the costal margin. Here's the eleventh rib, here's the start of the costal arch. The nerves run obliquely downwards and forwards in the plane

between the transversus abdominis, and internal oblique muscles. The external oblique has largely been removed in this dissection.
40.06

Next we'll look at the nerves of the posterior abdominal wall. These are derived from the lumbar plexus, a complex joining and re-branching of the anterior primary rami from the twelfth thoracic, to the fifth lumbar segment. The lumbar plexus lies behind and witihin the psoas major muscle. The nerves that arise from the lumbar plexus emerge from beneath psoas major, or through it.
40.36

Here are the subcostal nerve, which comes from T 12, the ilio-hypogastric, and ilio-inguinal nerves, the lateral cutaneous nerve of the thigh, and the genito-femoral nerve .
40.55

Between them, these provide sensation to the inguinal region, and to the anterior part of the upper thigh. Here are two major nerves of the lower extremity: the femoral nerve, emerging lateral to psoas major, and the obturator nerve, emerging medial to it.
41.13

The femoral nerve runs alongside psoas major, and passes beneath the inguinal ligament, just lateral to the femoral artery. The obturator nerve runs just below the pelvic brim, and enters the obturator canal.
41.28

The femoral and obturator nerves are shown in more detail in Volume 2 of this atlas. Lastly we'll look at the principal autonomic nerves of the abdomen, the
the vagus nerves, the sympathetic trunks, and the aortic plexus.
41.46

Here's the aortic bifurcation, here's the upper part of psoas major, here's the right crus of the diaphragm. Here's the sympathetic trunk, emerging through the edge of the diaphragm, and running close to the vertebral bodies, down toward the pelvis.
42.02

Again, here's the right crus of the diaphragm. Here are the divided celiac trunk, and superior mesenteric artery.
42.14

This is a large sympathetic ganglion. It's connected to this smaller one, and to several others that have removed in this dissection. Together they form the celiac plexus, which distributes sympathetic innervation to most of the abdominal viscera.
42.34

To see the vagus nerves as they enter the abdominal cavity we'll look at a dissection in which the stomach has been left intact. This is the stomach. Here's the esophagus. It comes through the diaphram here. Here are two branches of the right vagus nerve, also passing though the esophageal hiatus. The branches of the left vagus are out of sight round here.
43.02

The vagus nerves break up into many smaller branches which provide the parasympathetic supply to the stomach, the small and large intestine, and other abdominal organs.
43.11

Now let's review what we've seen of the blood vessels and nerves of the abdominal region.
43.17

REVIEW OF BLOOD VESSELS AND NERVES

Here's the abdominal aorta, the celiac trunk, the superior mesenteric, and inferior mesenteric arteries. Here are the renal arteries, the testicular (or ovarian) arteries, the lumbar arteries, the median sacral artery. Here's the common iliac, internal iliac, external iliac, and femoral artery; the deep circumflex iliac, and inferior epigastric arteries. The inferior vena cava, the hepatic veins.

44.07

Here are the subcostal nerve, the ilio-hypogastric, and ilio-inguinal nerves, the lateral cutaneous nerve of the thigh, the genitofemoral nerve, the femoral nerve, and the obturator nerve.

44.26

Here's the sympathetic trunk, a sympathetic ganglion, and the vagus nerve.

44.36

That brings us to the end of this section on the abdomen. In the next section, we'll look at the pelvis.

44.47

END OF PART 3

PART 4

THE PELVIS

00.00

In this section we'll look at the pelvic cavity. We'll look first at the bones and ligaments that surround the cavity; then we'll look at the muscles of the pelvic walls and the pelvic floor; then we'll see the principal blood vessels and nerves of the region.

00.20

BONES

We'll start with the bones. We've already seen the upper parts of the bony pelvis. Now we need to look at the parts of it that lie below the pelvic brim. Let's get oriented. Here's the bony pelvis, together with the fifth lumbar vertebra. Here's the pelvic brim.

00.42

We'll be looking at the pelvic cavity from four different viewpoints. We'll look down into it from above; we'll look at it from the side, with the opposite half of the pelvis removed; we'll look at it from behind; and we'll look at it from below.

01.06

We looked at the features of the upper part of the bony pelvis in the last section. The bones that contribute to the walls of the pelvic cavity are the sacrum and the coccyx behind, and the lower parts of the hip bone in front and at the side.

01.32

We're looking at the bones in the position they occcupy, when we're standing upright. In the upright position the surface of the upper part of the sacrum is angled at 30º to the horizontal. The tip of the coccyx points forward at about 40º.

01.55

So the pelvic surfaces of the sacrum and coccyx form a curve of a bit more than a quarter circle. The lower end of the sacrum is on a level with the top of the pubic symphysis.

02.05

This big gap between the sacrum and the hip bone is called the sciatic notch. It's bridged by two major ligaments, as we'll see shortly.

02.16

Now we'll look at some details of the hip bone. This massively thick part of the hip bone is formed by the fusion of the ilium, the pubis, and the ischium.

02.31

It's smooth on the inside, and on the back. It's deeply indented on the outside, by the socket of the hip joint, the acetabulum. This is the body of the ischium. It ends below in this impressive projection, the ischial tuberosity, which is what we sit on .

02.54

This sharp prominence is the ischial spine. The large hole in the lower part of the hip bone is the obturator foramen. In the living body it's largely closed off by the obturator membrane.

03.12

This is the body of the pubis. The part of the hip bone below the obturator foramen is the ischio-pubic ramus. The two ischio-pubic rami, meeting in front at the pubic symphysis, form the pubic arch. When seen from the side, the ischio-pubic rami slope backwards and downwards, towards the ischial tuberosities.

03.44

There are important differences in shape between the male pelvis and the female pelvis, which is adapted to the important requirements of childbirth. The female pelvic cavity is wider from side to side, and deeper from front to back, than in the male.

04.01

In addition, the angle of the pubic arch is broader. When seen from below, the inferior pelvic aperture of the female is wider in all directions, than that of the male.

04.13

LIGAMENTS

Now that we've looked at the dry bones, we'll look at some major ligaments which are important in holding the sacrum and the hip bones together.

04.23

The weight of the body is transmitted from the vertebral column to the hip bone, at the sacro-iliac joint. The sacro-iliac joint is strengthened behind and in front by ligaments, the anterior sacro-iliac ligament in front and the massive posterior sacro-iliac ligament behind.

04.51

In addition, the sacro-iliac joint is strengthened by two major ligaments which pass from the sacrum to the ischium, the sacro-tuberous, and sacro-spinous ligaments.

05.01

Here's the sacro-tuberous ligament. The sacro-tuberous ligament arises here on the back of the sacrum. It passes laterally, downward, and slightly forward. It's inserted here on the ischial tuberosity.

05.23

Now we'll add the sacro-spinous ligament to the picture. Here it is. The sacro-spinous ligament lies in front of the sacro-tuberous ligament, and medial to it. It goes from here in the edge of the sacrum, to here on the ischial spine.

05.44

These two ligaments divide the gap between the sacrum and the ischium into two openings: the greater sciatic foramen and the lesser sciatic foramen.

05.56

Let's take a look at a complete pelvic specimen, from behind, and from below. The sacro-tuberous ligaments behind, and the ischio-pubic rami in front, form the boundaries of an opening beneath the pelvis that's called the inferior pelvic aperture.

06.15

Seen from beneath, the opening looks like an ellipse, but it's not a flat ellipse. Because of the steep downward curve of the sacrotuberous ligaments behind, and the slight downward slope of the ischio-pubic rami in front, the ellipse has a marked bend in it.

06.36

Here's the inferior pelvic aperture, seen from above. When we look at it from up here, it's not so easy to appreciate the three dimensional shape of the opening.

06.48

Now, let's review what we've seen of the bones and ligaments that surround the pelvic cavity.

06.56

REVIEW OF BONES AND LIGAMENTS

Here's the hip bone, the sacrum, and the coccyx. Here's the sciatic notch. Here's the pelvic brim.

07.13

Here’s the obturator foramen, the body of the ischium, the ischial spine, and the ischial tuberosity. Here’s the body of the pubis, the ischio-pubic ramus, the pubic symphysis, and the pubic arch.

07.33

Here are the sacro-iliac ligaments anterior, and posterior. Here's the sacro-tuberous ligament, and the sacro-spinous ligament, here's the greater sciatic foramen, and the lesser sciatic foramen.

07.53

MUSCLES

Now we’ll look at the muscles of the pelvic cavity. First we’ll look at two muscles which form part of the wall of the pelvic cavity, piriformis, and obturator internus. Then we’ll look at the complex sheet of muscles, collectively called the pelvic diaphragm, which form the floor of the pelvic cavity.

08.21

We'll look at these structures first in a male specimen. Piriformis and obturator internus are both hip rotator muscles, which arise within the pelvis, and pass outward through the sciatic foramina.

08.36

Here’s piriformis. Piriformis arises from here on the sacrum. It passes laterally, and leaves the pelvis through the greater sciatic foramen. We’ll see where it goes in a minute.

08.54

Next we’ll add obturator internus to the picture. Obturator internus arises from the obturator membrane, and from this wide area around it. Obturator internus leaves the pelvis through the lesser sciatic foramen. In doing so, it makes a 90º turn around the lower part of the ischium.

09.18

Piriformis and obturator internus pass laterally, to insert on the greater trochanter of the femur. Their actions as lateral hip rotators, are shown in volume 2 of this atlas. In this section, we’re concerned to understand these two muscles simply as parts of the wall of the pelvic cavity.

09.44

The obturator internus muscle is covered on the inside by this layer of pelvic fascia. There’s an important line of thickening in the fascia, called the tendinous arch. The tendinous arch goes from the body of the pubis, to the ischial spine. We’ll see why the tendinous arch is important in a moment.

10.08

Now we’ll move on, to look at the muscles of the pelvic diaphragm. These muscles form a sling, which closes off the inferior pelvic aperture, and supports the organs which lie within the pelvic cavity.

10.23

On each side, the pelvic diaphragm is formed by two most unequal muscles, the small coccygeus muscle behind, and the much larger and more important levator ani muscle in front.

10.36

Here's the coccygeus muscle. It runs from the ischial spine, to the edge of the lower sacrum and coccyx. Coccygeus is a vestigial muscle, with no demonstrable function.

10.50

Now, we’ll add the levator ani muscle to the picture. Here’s the levator ani. The levator ani has a line of origin that’s partly bone and partly fascia. In front, it arises from the body of the pubis. Behind, it arises from the ischial spine. Between these two bony origins, it arises from the tendinous arch in the fascia that overlies obturator internus.

11.20

The fibers of levator ani pass downwards, backwards and medially, to meet in the midline with those of the opposite side, as we'll see shortly.

11.31

Let's go round to the back, to see the underside of levator ani. Here's the ischial tuberosity, here's the sacro-tuberous ligament. The space between these structures and the underside of the levator ani is called the ischio-rectal fossa. In the living body it's filled with fat.

11.55

The levator ani is described as having a number of parts, which are named as though they were separate muscles. Unfortunately t he names of these parts are somewhat irrational. This part of levator ani is known as ilio-coccygeus. Ilio-coccygeus is very thin. This part is pubo-coccygeus. It's much more substantial. Pubo-coccygeus is sub-didivided further, in ways that we won't go into.

12.28

Now that we've looked at one levator ani muscle, let's look at the two of them together. We're looking from above. Here's the upper part of obturator internus, here's the tendinous arch. The ischial spines are here, here's the tip of the coccyx.

12.50

Here are the coccygeus muscles, here are the two levator ani muscles. Between them, in front, there's a gap, the urogenital hiatus, though which pass the rectum, the urethra, and in the female the vagina..

13.08

The fibers of levator ani which arise more posteriorly unite in the midline with this fibrous band, the ano-coccygeal ligament.

13.20

The fibers which arise more anteriorly form a loop which passes around the back of the urogenital hiatus. Some fibers along the edge of the hiatus attach to the sides of the rectum, the urethra, and in the female the vagina.

13.36

We'll add the urethra and the rectum to the picture. Here's the lowest part of the rectum, here's the urethra, with the lowest part of the prostate in front of it. We'll see these structures in Volume [6] of this atlas.

13.59

The levator ani and coccygeus muscles are covered over by this dense layer of pelvic fascia, which completes the pelvic diaphragm on the inside.

14.09

The pelvic diaphragm supports the pelvic organs and closes off the pelvic outlet, while allowing passage for the rectum, vagina and urethra. When we're upright, the levator ani muscles are in a constant state of tonic contraction, which becomes greater or less in response to changes in abdominal pressure.

14.32

The main action of the levator ani muscles is to keep a set of downwardly mobile structures, the pelvic organs, constantly in one place. In addition, vigorous contraction of the levator ani muscles pulls the lower end of the rectum upwards and forwards.

14.49

Now that we've seen the intact pelvic diaphragm from above, let's look at it from behind, and from beneath.

14.57

Here are the ischial tuberosities, here's the tip of the coccyx, here are the sacro-tuberous ligaments. Here are the two levator ani muscles. This is the ischiococcygeus part, this is pubo-coccygeus. Here's the urogenital hiatus. Here's the ano-coccygeal ligament.

15.35

The levator ani muscles are continuous on the underside with this cone-shaped sleeve of muscle, the external anal sphincter, which maintains closure of the anus. Here's the opening of the anus.

15.52

The external anal sphincter is tethered to the ano-coccygeal ligament by its most posterior fibers. In front, here's the divided urethra. The muscle surrounding it is the bulbo-spongiosus.

16.08

Till now we've been looking at the pelvic diaphragm in a dissection of a male body. Here's a similar dissection of the pelvic diaphragm of a female body. The overall structure of the pelvic diaphragm is the same as in the male, except that the pelvic diaphragm is also traversed by the vagina. Here's the opening of the urethra.

16.33

The whole region between the coccyx, the ischial tuberosities, and the pubic symphysis is called the perineum. The area between the ischio-pubic rami is the urogenital triangle. We'll look at the important structures of the urogenital triangle in Volume [6] of this atlas.

17.00

We've been looking from behind at an isolated dissection of the pelvic diaphragm, with everything else removed. To get a more complete view of where we are, we'll now add the main surrounding structures to the picture.

17.14

To see the pelvic diaphragm clearly we've been looking at an unnaturally empty pair of ischio-rectal fossae. In the living body the ischio-rectal fossa is filled with fat, which is traversed by nerves and vessels, as we'll see. Here are the sacrro-tuberous ligaments, here are the ischial tuberosities. Here are piriformis and obturator internus, going to their insertions on the femur, along with the gemelli and quadratus femoris.

17.51

Here's the sciatic nerve, emerging below piriformis. Here's gluteus medius, , here are the origins of the hamstring muscles. Here's the line of origin of gluteus maximus, which we'll add to the picture. The lower edge of gluteus maximus covers up the ischio-rectal fossa, when seen from behind.

18.20

On the inside, the walls of the pelvic cavity are covered with a layer of loose connective tissue, which is lined in part by peritoneum. We'll see this in a minute, when we move on to look at the blood vessels and nerves of the region. Before we do that, let's review what we've seen of the pelvic muscles.

18.41

REVIEW OF MUSCLES

Here's piriformis, here's obturator internus, here's the tendinous arch. Here's coccygus, here's the levator ani. This part is ilio-coccygeus, this part is pubo-coccygeus.

19.14

BLOOD VESSELS

Now we'll move on to look at the blood vessels and then the nerves of the pelvis and perineum. First, the blood vessels.

19.27

Here's the pelvic cavity, seen from above, with the abdominal and pelvic organs removed, and the soft tissue lining of the cavity intact. The pelvic cavity is lined, somewhat irregularly, with peritoneum. Beneath that, there's a layer of pelvic fascia that's continuous with the endo-abdominal fascia.

19.48

The internal iliac artery, which we saw in the last section, is hidden, just under here. To see the pelvic blood vessels, we'll remove one half of the pelvis and go round to a medial view. We'll also remove the lining of peritoneum and pelvic fascia. In this dissection the veins, which follow the arteries closely, have been removed to simplify the picture.

20.18

The arteries of the pelvic region are all branches of the internal iliac artery. The way they arise is quite variable. This is the superior gluteal artery, this is the inferior gluteal. They pass through the greater sciatic foramen to supply the buttock region.

20.35

This is the internal pudendal artery, which we'll return to in a minute. This is the obturator artery, passing forwards into the obturator canal,
along with the obturator nerve. The most anterior branch of the internal iliac comes to a blind end; in the fetus it's the umbilical artery .

20.55

Branches to the pelvic organs arise in a widely varying fashion. These are the divided ends of the vesical arteries, superior and inferior, which supply the bladder. This is the middle rectal artery, which supplies the lower part of the rectum.

21.13

In the female, the uterine arteries also arise, directly or indirectly, from the internal ilac. The branch of the internal iliac that concerns us most closely here is the internal pudendal artery .

21.29

It supplies the blood supply to the perineum. To reach the perineum, the internal pudendal artery goes out through the greater sciatic foramen, around the sacrospinous ligament, and back in through the lesser sciatic foramen In this way, the pudendal artery ends up below the pelvic diaphragm. To follow its course we'll go round to the back. The gluteal vessels and the sciatic nerve have been removed.

22.09

Here's the internal pudendal artery, emerging below piriformis. It passes behind the sacro-spinous ligament, which is here, and behind this small muscle, the superior gemellus .

22.23

The internal pudendal artery runs downwards and forwards, along the medial aspect of obturator internus. Its branches supply the anal sphincter, the pelvic diaphragm, the external genital structures in the female, and the penis in the male.

22.39

NERVES

Now that we've looked at the blood vessels, we'll look at the principal nerves of the pelvic region. We'll look at the sacral plexus, then at the pudendal nerve, then at the autonomic nerves of the region.

22.57

Here's the sacral plexus. Its lower part lies on the front of the piriformis muscle. The sacral plexus is formed mainly by the anterior primary rami of the spinal nerves S1 through S4. In addition, the plexus receives a contribution from L4 and 5, through this big nerve bundle, the lumbo-sacral trunk. The major branches of the sacral plexus leave the pelvis by passing through the greater sciatic foramen, either above piriformis, or below it.

23.31

Almost all the nerves that arise from the sacral plexus go to the lower extremity. They're shown in Volume 2 of this Atlas. The branches of the sacral plexus that do concern us here, are the pudendal nerve, which is the principal nerve of the perineum, and also the small motor nerves to the pelvic diaphragm.

23.53

A small branch or branches from S3 or 4 supply most of the levator ani muscle, and the coccygeus muscle, on their pelvic surfaces.

24.03

Here's the pudendal nerve. It's derived from S2, 3 and 4. It arises from the plexus just above the sacro-spinous ligament, which is here, and passes immediately through the greater sciatic foramen. To see where it goes, we'll go round to the back.

24.21

Here's the pudendal nerve again. Here next to it is the internal pudendal artery, which we've already met. We'll go to an underneath view to follow the pudendal nerve.

24.34

It passes forwards on the side of obturator internus along with the internal pudendal artery. Its branches supply the anal sphincter, the muscles of the urogenital diaphragm, and the external genitals.

24.48

Lastly we'll look at the autonomic nerves of the pelvic region. The autonomic nerves in the pelvis that belong to the sympathetic nervous system are the tail end of the sympathetic trunk, and the so-called hypogastric nerve. The parasympathetic nerves in the pelvis are the pelvic splanchnic nerves.

25.13

All these nerves, sympathetic and parasympathetic, are connected to a diffuse and extensive plexus of autonomic nerves called the pelvic plexus. The pelvic plexus lies within the fascia that covers this part of the pelvic wall and floor.

25.32

A small part of the pelvic plexus has been partially dissected out here. The pelvic plexus distributes the sympathetic and parasympathetic supply to the distal colon, the pelvic organs, and the external genital organs.

25.48

Feeding into the pelvic plexus from above is the hypogastric nerve, single here, but often taking the form of several small nerves. It's the distal continuation of the aortic plexus.

26.00

Here's the distal end of the sympathetic trunk. It enters the pelvis deep to the common iliac vessels, and descends just medial to the sacral foramina. It gives rami communicantes to the anterior rami of the sacral nerves.

26.17

Lastly, here are the pelvic splanchnic nerves, sometimes called the nervi erigentes. These are the source of all parasympathetic innervation in this region. They arise in this case from S3, also often from S2 and S4. They break up into branches which enter the pelvic plexus. From the plexus their fibers are distributed to the pelvic organs and external genitals.

26.44

Now, let’s review what we’ve seen of the blood vessels and nerves of the pelvic region.

26.50

REVIEW OF BLOOD VESSELS AND NERVES

Here's the internal ilac artery, the superior gluteal, and inferior gluteal arteries, the obturator artery, the ends of the vesical vessels, the middle rectal artery, the start of the pudendal artery, and its further course.

27.25

Now the nerves: here's the sacral plexus, and the lumbo-sacral trunk. Here's the pudendal nerve from the inside, and from behind.

27.38

Here's the area of the pelvic plexus, here's the hypogastric nerve, the sympathetic trunk, and the pelvic splanchnic nerves.

27.54

That brings us to the end of this section on the pelvis, and also to the end of Volume 3 of the Video Atlas of Human Anatomy.

28.09

END OF VOLUME 3

Acland's DVD Atlas of Human Anatomy

Transcript for Volume 4

INTRODUCTION TO VOLUMES 4 AND 5

00.00

In this tape, the first of two on the anatomy of the head and neck, we'll look first at the structures involved in support and movement of the head; then at the facial skeleton and base of the skull, then at the structures involved in breathing, eating, swallowing and speaking.

00.19

In the second tape we'll look at the blood vessels of the head and neck, then at the brain, the cranial nerves, the ear, and the eye.

00.29

As in other parts of the body, understanding the bones provides the foundation for everything else we need to learn. The skull is such a complicated piece of bony anatomy that we won't try to understand all of it at once. Instead, we'll build up our picture of it a little at a time in the course of this tape. In each section we'll add the parts of the skull that are new, to the parts that we've seen already. In that way we'll end up with a complete picture.

01.00

VOL 4 : THE HEAD AND NECK PART 1

PART 1 OF VOL 4

SUPPORT AND MOVEMENT OF THE HEAD

In this first section we'll look at the way the head is attached to the body, and how it moves. We'll start by looking at the bones that are involved, then we'll look at the joints and ligaments that connect them. After that we'll look at the muscles that maintain the position of the head and cause it to move.

01.19

BONES

The bones that are involved in support and movement of the head are the thoracic and cervical vertebrae, the upper ribs, the clavicles, and this part of the underside of the skull, that's called the occiput.

01.44

The skull consists of the cranium and the facial skeleton. The cranium is the bony container for the brain, and the foundation for the facial skeleton. The cranium is made up of a number of originally separate bones. These lines of fusion, known as sutures, show where the bones are joined.

02.15

The principal bones that form the cranium are the occipital bone behind and below, the parietal bone, and temporal bone on each side, the sphenoid bone, and the frontal bone.

02.40

The two bones of the cranium that we're concerned with at present are the occipital bone, and the lower part of the adjoining temporal bone.

02.54

To see the full extent of the occipital bone, we'll take the mandible out of the picture. The occipital bone extends all the way from here at the back, to here underneath. The most striking feature of the occipital bone is this large opening, the foramen magnum, through which the spinal cord and its accompanying structures pass.

03.20

The part of the occipital bone in front of the foramen magnum is called the basilar part, often referred to as the base of the occiput. The two temporal bones converge on it from each side. We'll look at them in a minute.

03.34

Let’s look at the occipital bone on the inside, in a skull that’s been divided in the mid-line. Here’s the foramen magnum, here’s the basilar part of the occipital bone. It slopes forwards and upwards, more steeply on the inside than on the underside, since it’s triangular in sagittal section.

03.59

Let’s look at some more details in a skull that hasn’t been colored.
On each side of the anterior half of the foramen magnum are the two occipital condyles. The occipital condyles are the joint surfaces which articulate with the atlas vertebra to form the atlanto-occipital joints. We'll look at these joints in a minute.

04.25

The outline of the front and the top of the cranium is well known
to us from our everyday observation of surface anatomy. It's perhaps surprising to see how far round the back of the cranium curves, and what an extensive overhang there is behind. The overhang is formed by the part of the occipital bone that's behind the foramen magnum, the squamous part.

04.51

The overhang is obscured by the neck muscles that are attached to this broad area on the occipital bone. The bone bears the marks of their attachment.

05.02

This lump in the middle is the external occipital protuberance. This faint ridge, leading out toward the mastoid process, is the superior nuchal line, below it is the inferior nuchal line. We’ll meet the structures that are attached here, later in this section.

05.23

Now that we’ve looked at the occipital bone, let’s take a look at the temporal bone. It's quite a complicated bone. To see its full extent, we'll again remove the mandible. The temporal bone goes from here on the outside, to here underneath. This is the petrous part of the temporal bone, this is the squamous part.

05.55

The feature of the temporal bone is this large projection, the mastoid process. As we’ll see, it’s the origin of some of the muscles that move the head, including the sternocleidomastoid. It's easy to feel the mastoid process here, behind and below the ear.

06.18

While we're getting introduced to the temporal bone, we'll take a first look at some of its other important features, which we'll appreciate in later sections of these two tapes. We'll also meet some of the small openings through which important blood vessels, nerves and other structures enter and leave the cranium. There are many of these openings! Here, we'll just look at the openings on the outside of temporal and occipital bones.

06.46

This is the zygomatic arch, formed largely by the temporal bone, and partly by the adjoining zygomatic bone. Here on the underside of the root of the zygomatic arch, this complex curved surface articulates with the condyle of the mandible to form the temporomandibularjoint.

07.13

This is the external auditory meatus, leading to the middle ear. This long, sharp projection is the styloid process. Just at the base of the styloid is the little stylo-mastoid foramen, for the facial nerve.

07.31

Medial to the styloid process are two major openings for blood vessels - the carotid canal, passing forwards, for the internal carotid artery, and the jugular foramen, passing backwards, for the internal jugular vein. Just above the occipital condyle is the hypoglossal canal for the hypoglossal nerve.

07.54

Let's also take a brief look the the occipital and temporal bones from the inside. Here's the squamous part of the occipital bone, here's the basilar part, here's the foramen magnum. Here's the squamous part of the temporal bone, here's the petrous part, which contains the structures of the inner and middle ear.

08.28

Here's the jugular foramen on the inside. This big groove behind it is for the sigmoid sinus , the main venous drainage channel for the brain. Below and medial to the jugular foramen is the hypoglossal canal. Above the jugular foramen is the internal auditory meatus for the vestibulocochlear, and facial nerves. The carotid canal ends here at the foramen lacerum, as we'll see in the next section.

09.00

Now we've looked at the part of the skull that we're concerned with in this section. We'll move on now to look at the bones below it. First we'll look at the special features of the first two cervical vertebrae - the atlas and the axis. Then we'll look at the continuity of the cervical spine with the bones of the upper part of the trunk.

09.25

Here's the atlas, here's the axis. These two vertebrae are adapted to allow movement of the head. Forward flexion and extension of the head take place up here at the atlanto-occipital joints, Lateral flexion of the head takes place at these joints too. Rotation of the head, together with the atlas, happens here, at the joints between the atlas and the axis, the atlanto-axial joints

09.59

Because of their special functions, the atlas and the axis differ in several ways from typical cervical vertebrae. As we've seen in Volume 3, a typical cervical vertebra has a body in front and a neural arch behind, enclosing the vertebral foramen.

10.23

It has a spinous process behind with two tuberosities, and a transverse process on each side, also with two tuberosities. On each side there are two articular surfaces one above, and one below, which form the intervertebral joints. The articular surfaces slope upward and forward. They're connected by this mass of bone, the articular pillar.

10.58

Each vertebra is joined to its neighbors by an interbertebral disk in front, and by two intervertebral joints behind, one on each side. Now let's look at the ways in which the atlas and the axis are different.

11.16

The atlas vertebra doesn't have a body. In front it just has this narrow anterior arch which matches the posterior arch. The two arches of the atlas, together with these two lateral masses, enclose an unusually large vertebral foramen. This part is occupied by the spinal cord, this part by the odontoid process of the axis, which we'll meet in a moment.

11.14

The upper articular surfaces of the atlas are shaped like parts of the inside of a cup, to match the shape of the occiptal condyles. The lower articular surfaces are shaped like parts of the inside of a cone.

11.58

Now let's look at the axis vertebra. The body of the axis is prolonged by this important projection, the odontoid process. In terms of development the odontoid process represents the missing body of the atlas. In terms of function it's the pivot around which the head, together with the atlas, rotates.

12.23

The upper articular surfaces of the axis are placed well in front of the lower ones. The upper surfaces are in a straight line with the odontoid process. As rotation occurs between these surfaces and those of the atlas, the odontoid process stays in the middle.

12.44

The odontoid process is surrounded in front and on each side by bone. It's held in place behind by a strong ligament, the transverse ligament of the atlas. The odontoid process is also held in place from above by two strong ligaments, the alar ligaments, which are attached here and here. We'll see these ligaments shortly.

13.08

The odontoid process has two small articular surfaces, one behind for the transverse ligament, and one in front for the anterior arch of the atlas.

13.20

To see how these structures relate to the base of the skull, we'll take an inside look from behind at a specimen in which the neural arches, and (the back of the occipital bone have been removed.

13.37

Here's the foramen magnum, here's the inside of the basal part of the occipital bone. Here's the atlas, here's the axis, here's the odontoid process. Here are the atlanto-occipital joints, and the atlanto-axial joints.

13.59

Now that we've looked at the atlas and the axis, we'll look at the bones below them that are involved in support and movement of the head. The lowest cervical vertebra, the seventh, articulates with the highest of the twelve thoracic vertebrae.

14.17

The two first ribs slope downward and forward from the first thoracic vertebra. The costal cartilages of the first two ribs articulate here with the upper part of the sternum, the manubrium.

14.28

The manubrium, the first ribs, and the body of the first thoracic vertebra form the margins of this opening, the superior thoracic aperture through which many important structures pass.

14.42

To complete our picture of the bones in this section, we'll add the clavicles and the scapulae. On each side the clavicle articulates with the highest part of the manubrium, to form the sterno-clavicular joint. The sternocleidomastoid muscle is inserted here.

15.04

The scapula is attached to the clavicle here, at the acromio-clavicular joint. In addition the scapula is held in place by powerful muscles, the highest of which, the trapezius, arises here on the skull, and is inserted here.

15.23

JOINTS AND LIGAMENTS

Now let's move on to look at the ligaments that connect the skull and the cervical vertebrae. Like ligaments elsewhere in the body, these structures hold the bones together, permit the bones to move in relation to one another, and set limits to their movements.

15.41

We'll look first at the structures that permit movement between individual vertebrae, the intervertebral disks and the intervertebral joints. Then we'll look at three ligaments that run the length of the cervical spine - the nuchal ligament, and the anterior and posterior longitudinal ligaments. Lastly we'll look at the special ligaments around the odontoid process.

16.07

Here's what the cervical spine looks like in the living body. Here are the spinous processes, the articular pillars, the transverse processes, and the vertebral bodies. The intervertebral joints are here. They're synovial joints. To get a better look at them we'll make a cut through the articular pillars along this line

16.34

As with all synovial joints, each bony surface is covered by a layer of smooth articular cartilage. The space between the cartilages is filled with lubricating synovial fluid. The fluid is contained within a fibrous joint capsule, which permits movement.

16.54

Between each vertebral body and its neighbor there's an intervertebral disk. To see the disks we'll make a cut in the mid-line. The disks are made of fibrocartilage that's attached firmly to the vertebra above and below. The fibrous joints formed by the disks permit only a little movement between the regular cervical vertebrae.

17.21

The movements that can occur between these vertebrae are forward flexion, extension, and a twisting movement that's a combination of rotation and lateral flexion. In the intervals between the occiput, the atlas, and the axis, where so much movement occurs there are no disks, only synovial joints.

17.48

Now we'll look at the three ligaments that run the length of the cervical spine, starting with the nuchal ligament.

17.55

Here's the nuchal ligament, also called the ligamentum nuchae. It's a sheet of strong fibrous tissue that extends from the spinous process of the first thoracic vertebra, to the external occipital protuberance. The nuchal ligament limits forward flexion of the head and the cervical spine. It also serves as the attachment for some major muscles.

18.23

Next we'll go round to the front to see the anterior longitudinal ligament. This broad band is the anterior longitudinal ligament. It runs the whole length of the vertebral column, connecting the fronts of the vertebral bodies. It ends up here, at this tubercle on the arch of the atlas.

18.44

The anterior longitudinal ligament is not as impressive in the neck as it is lower down. In the neck, the ligament that's impressive is the posterior longitudinal ligament, which runs down the backs of the vertebral bodies, inside the vertebral canal.

19.00

To see the posterior longitudinal ligament we'll remove the arches of the vertebrae, and also the back of the skull along this line. The spinal cord and the brain have been removed, together with their covering layer of dura. Here's the base of the occiput, here's the foramen magnum, here are the divided vertebral arches.

19.28

This is the posterior longitudinal ligament. It's much broader and thicker here in the neck, than it is lower down the spine. The highest part of this ligament goes by a different name - it's called the tectorial membrane.

19.43

To get a different view of it we'll look at a specimen that's been divided in the mid-line. Here's the foramen magnum, here's the anterior arch of the atlas, here's the odontoid process.

20.01

Here's the tectorial membrane. It's attached to the base of the occiput, and to the body of the axis. Continuing as the posterior longitudinal ligament, it's attached to the backs of the vertebral bodies, all the way down the spine.

20.19

Now we'll look at the ligaments which hold the odontoid process in place, making it the stable pivot round which rotation of the head occurs. We'll see the transverse ligament of the atlas, the cruciform ligament (which the transverse ligament is part of), and the alar ligaments. To see them, we'll go back to the previous rear view, and remove the tectorial membrane.

20.44

Directlly beneath the tectorial membrane is this strong and important ligament, the transverse ligament of the atlas. The transverse ligament is attached on each side to these two tubercles on the atlas. The transverse ligament prevents the odontoid process from being displaced backwards.

21.08

A slender ligament, the superior band, runs upward from the transverse ligament to the base of the occiput, another one, the inferior band runs downward to the body of the axis. These, along with the transverse ligament of the atlas, are referred to collectively as the cruciform ligament.

21.29

We'll remove all of the cruciform ligament to see the odontoid process and the alar ligaments. Here's the odontoid process. Here are the massive alar ligaments. They pass from here on the odontoid process, to here on the inside of the occipital condyles. The alar ligaments limit rotation of the head, specially in lateral flexion.

21.54

Here's the side view again. Here's the tectorial membrane, here in front of it is the divided transverse ligament of the atlas. It's quite an impressive structure.

22.11

Lastly, we'll look at the ligaments that connect the vertebral arches. The arches of the regular cervical vertebrae are held together by strips of yellow fibrocartilage, known collectively as the ligamentum flavum.

22.27

The arches of the axis and the atlas, and the edges of the foramen magnum are held together by these loose and flexible sleeves of fibrous tissue, the atlanto-occipital and atlanto-axial ligaments.

22.42

We've looked at a lot of anatomy already! Before we move on to look at the muscles, let's review what we've seen of the bones, joints and ligaments of this very fundamental part of the head and neck.

22.56

REVIEW OF BONES, JOINTS AND LIGAMENTS

Here's the occipital bone, and the temporal bone. Here are the basal part, and the squamous part of the occipital bone; the foramen magnum, the occipital condyles, the external occipital protuberance, the superior, and inferior nuchal lines.

23.29

On the temporal bone here's the petrous part, and the squamous part. Here are the mastoid process, the zygomatic arch, the surface for the temporomandibular joint,

23.48

Here's the external auditory meatus, and the styloid process; the stylo-mastoid foramen, the carotid canal, the jugular foramen, and the hypoglossal canal.

24.11

On a typical cervical vertebra, here's the body, the neural arch, the vertebral foramen, the spinous process, the transverse processes, the articular surfaces, and the articular pillar.

24.37

On the atlas vertebra, here's the anterior arch, the posterior arch, and the lateral bodies. On the axis vertebra here's the odontoid process. Here are the intervertebral joints, and the intervertebral disks.

25.02

Here are the atlanto-occipital, and atlanto-axial joints. Here's the nuchal ligament, the anterior longitudinal ligament, the posterior longitudinal ligament, and the tectorial membrane.

25.24

Here's the cruciform ligament consisting of the transverse ligament of the atlas, the superior band, and the inferior band, and here are the two alar ligaments.

25.40

MUSCLES

Now we'll look at the principal muscles of the neck. We'll build up our picture from the inside, to the outside. We'll start with four short muscles on the underside of the occiput, the two oblique muscles, and the two rectus muscles. Collectively these are called the suboccipital muscles.

26.06

Here are the rectus capitis muscles, minor, and major. Rectus capitis minor goes from the middle of the posterior arch of the atlas, to this area on the occiput. Rectus capitis major goes from the spinous process of the axis, to here on the occiput.

26.31

Here are the two oblique, or obliquus capitis muscles, the inferior, and the much smaller superior. The inferior oblique goes from the spine of the axis vertebra, to the transverse process of the atlas. The superior oblique goes from the transverse process of the ~~atlas~~ [axis], to here on the occiput. The action of the suboccipital muscles is to extend the head, and to rotate it toward the same side.

27.06

Next we'll go round to the front to see the longus muscles, and the scalene muscles. Here are the longus muscles: longus cervicis here, merging with longus capitis higher up.

27.22

Longus capitis arises from the base of the occiput, and inserts on the transverse processes of C3,4, and 5. Longus cervicis arises from the bodies of C1 to 4, and inserts on the bodies of the vertebrae from C5, all the way down to T4. Longus capitis and cervicis are weak flexors of the head and cervical spine.

27.48

Next we'll add the three scalene muscles to the picture, the anterior scalene, middle scalene, and posterior scalene. They arise from the transverse processes of the lower five cervical vertebrae, the anterior scalene from the anterior tubercles, the middle and posterior scalene from the posterior tubercles. The anterior, and middle scalene muscles insert on the first rib, the posterior scalene inserts on the first and second ribs.

28.22

The scalene muscles are involved not in movements of the neck, but in elevating the upper ribs in deep inspiration. The scalene muscles have important relationships to the subclavian artery and the brachial plexus, shown in Volume 1 of this atlas.

28.39

Now we'll add the clavicles and the scapulae to the picture, and go round to the back again to look at three large muscles that shape the back of the neck: semispinalis, splenius, and trapezius. We'll add semispinalis to the picture first. Here's semispinalis. It arises by many tendons of origin from the articular processes of C4 to C7, and from the transverse processes of T1 to T6.

29.14

Semispinalis runs almost vertically, to insert here on the occiput, just behind the two rectus muscles. The action of semispinalis is to extend the head. In addition, when we're upright, or leaning forward the tonic action of semispinalis prevents gravity from flexing of the head.

29.37

Next we'll add splenius to the picture. Here's splenius. It's a broad strap of muscle, which arises from the spinous processes to T3 to C7, and from the lower half of the nuchal ligament. Splenius passes upward and laterally, to insert on the lateral half of the superior nuchal line, and on the back of the mastoid process. Splenius assists in rotating the head, toward the same side. This muscle beside splenius is levator scapulae, which is shown in Volume 1 of this atlas.

30.20

Lastly we'll add trapezius to the picture. Here's trapezius. Trapezius is a large and complex muscle. As shown in Volume one, its lower part extends all the way down to T12. Here we're concerned only with its upper part.

30.42

The upper part of trapezius arises from the medial part of the superior nuchal line, and from the ligamentum nuchae. Its fibers fan out downward and laterally, to insert on the spine of the scapula, the acromion, and the lateral third of the clavicle.

30.58

The trapezius muscles largely define the shape and outline of the neck, both from behind (here are the two trapezius muscles) and from in front. This is trapezius again.

31.14

Trapezius is thought of mainly as a shoulder muscle. Its upper part raises the scapula. In addition, when the scapula is held steady by the action of other muscles, trapezius acts in the same way as semispinalis, in extending the head, and in keeping the head upright when we lean forward.

31.35

The last muscle to add to our picture is the sternocleidomastoid. Here it is. It arises from here on the mastoid process and just behind it. Ther sternocleidomastoid muscle runs downwards, forwards and medially to insert partly on the medial end of the clavicle, and partly on the manubrium.

32.09

Contraction of one sternocleidomastoid muscle produces rotation of the head toward the opposite side. Contraction of both sternocleidomastoids together produces flexion of the head and cervical spine. When we're leaning backwards, their tonic action prevents gravity from extending the head and neck.

32.32

The tendons of insertion of the two sternocleidomastoid muscles, together with the medial ends of the clavicles, which are back here, define this hollow in the lower part of the neck.

32.42

Now, we've seen the muscles that produce movements of the head and neck. Let's review the muscles that we've seen.

32.52

REVIEW OF MUSCLES

Here’s rectus capitis minor, and major, and obliquus capitis inferior, and superior. Here’s longus capitis, and longus cervicis.

33.14

Here are the scalene muscles: anterior, middle, and posterior. Here’s semispinalis, splenius, and trapezius. And here’s the sternocleidomastoid.

33.32

That brings us to the end of this section on support and movement of the head.

33.44

END OF PART 1

PART 2

THE FACAL SKELETON AND THE BASE OF THE CRANIUM

00.00

In this section we'll look at the bones of the facial skeleton, and at the part of the skull the facial skeleton is attached to, the base of the cranium. Understanding the bony anatomy of this region will give us a good foundation for understanding some large and important parts of the head and neck. We'll begin by taking an all around look at the main bony features of the region. Then, we'll look at the individual named bones that make up the facial skeleton and the base of the cranium. Lastly, we'll look at the openings in the base of the cranium, which some important nerves and blood vessels pass through.

00.45

MAIN BONY FEATURES

The facial skeleton consists of a number of named bones. We'll look at them individually later in this section, but we'll start by looking at the main overall features of the facial skeleton. To simplify the picture, we'll remove the mandible.

01.02

The cavity for the eye is called the orbital cavity. It's protected on the outside by the thickened orbital margin. The opening for the nose leads to the right and left nasal cavities, which are separated by the nasal septum.

01.22

The upper jaw, or maxilla bears the upper teeth. The prominence of the cheek bone leads back to this bony arch, the zygomatic arch.

01.33

The deepening hollow here is the temporal fossa. It's enclosed by this ridge, the temporal line; by the lateral orbital margin, and by the zygomatic arch. The temporal fossa contains the large temporalis muscle.

01.53

The temporal fossa is continuous with this deeper hollow, the infratemporal fossa. The walls of the infratemporal fossa are formed by this part of the base of the skull, and by the posterior part of the maxilla. The infratemporal fossa contains the pterygoid muscles, and also this part of the mandible, the coronoid process.

2.18

On the underside of the skull we come to structures that we've seen already. Here's the foramen magnum, the basilar part of the occipital bone, and the petrous part of the temporal bone.

02.33

Two thin sheets of bone project down from the base of the skull behind the maxilla. They're the pterygoid plates, lateral, and medial. Between the two medial pterygiod plates are the posterior openings of the nasal cavities, the posterior nares, or choanae.

03.00

The hard palate forms the roof of the mouth, and the floor of the nasal cavities. Here inside the nasal cavities are the conchae, or turbinate bones. We'll look inside the nasal cavity in the next section.

03.14

The posterior nares open into the nasopharynx, which lies in the space between the medial pterygoid plates, the base of the occiput, and the anterior arch of the atlas vertebra.

03.25

In a minute we'll look at the individual named bones that form the facial skeleton. Before we do that, we need to take a look at some of the features of the inside of the skull.

03.40

This special skull has been cut away at a series of levels that are just above the floor of the cranium. The way it's been cut reflects the fact that there are two big steps in the floor of the cranium, formed by the sphenoid ridges, and the petrous temporal bones. These divide the floor of the cranial cavity into three parts, the anterior cranial fossa, the middle cranial fossa, and the posterior cranial fossa.

04.16

We saw the posterior cranial fossa in the previous section. In this section we'll look at the main features of the anterior and middle cranial fossae. The bone that forms this upward bulge in the floor of the anterior fossa is the same bone that forms the roof of the orbit

04.40

This midline crest is called the crista galli. On either side of it is a depression, the base of which is formed by these small areas of thin, perforated bone, the cribriform plates. The cribriform plate forms the very narrow roof of the nasal cavity. Here we can see it from below. The filaments of the olfactory nerve, which transmits the sense of smell, pass through the openings in the cribriform plate.

05.13

This flat area behind the cribriform plates is the roof of a cavity that we'll see later, the sphenoid sinus. Now we'll move back to the middle cranial fossa.

05.27

The bone that forms the side wall and floor of the middle cranial fossa also forms, on the outside of the skull, the wall of the temporal fossa, and of the infratemporal fossa.

05.43

We've seen that this is the roof of the orbit. The bone that forms the anterior wall of the middle temporal fossa also forms part of the orbit: it forms this posterior part of the lateral orbital wall.

06.03

This complicated raised area in the middle is called the sella turcica. The main features of the sella turcica are this deep depression, the pituitary fossa for the pituitary gland, this shallow groove for the two optic nerves, and these four projections, the anterior, and posterior clinoid processes. This sloping surface behind the posterior clinoid processes, the dorsum sellae, is continuous with the base of the occiput.

06.39

The floor of the middle cranial fossa is marked by numerous openings for nerves and blood vessels, which we'll come back to later in this section.

06.51

INDIVIDUAL NAMED BONES

Now that we've looked at the shape of the facial skeleton, and the parts of the cranium that it's attached to, let's look at the individual facial bones, and see how each of them contributes to the features that we've seen. We'll look at the five largest facial bones first. They're the frontal and zygomatic bones, the maxilla, the sphenoid bone, and the ethmoid bone.

07.22

The frontal bone is a very large bone. The lower part of the frontal bone forms the beginning of the root of the nose, the upper part of the orbital margin, a small part of the temporal fossa, and a large part of the roof of the orbit.

07.41

The frontal bone also forms most of the floor of the anterior cranial fossa. The part of the frontal bone near the midline is hollow. The hollow space is the frontal sinus, one of the paranasal sinuses, which we'll look at shortly. Next we'll look at the zygomatic bone.

08.10

The zygomatic bone forms the bony prominence of the cheek. It also forms the lower lateral part of the orbital margin, and this part of the lateral orbital wall. The zygomatic bone extends backward to meet the zygomatic process of the temporal bone, forming the zygomatic arch. Now we'll move forward and look at the maxilla.

08.36

Here's the maxilla. The right and left maxillae are joined together in the midline. On each side the maxilla forms the lower medial part of the orbital margin, and almost all of the floor of the orbit. The maxilla bears the upper teeth. On the underside it forms much of the hard palate.

09.01

The maxilla is hollow. It contains the largest of the paranasal sinuses, the maxillary sinus. To see the posterior part of the maxilla, we'll remove the zygomatic arch. Here's the back of the hollow part of the maxilla. Down here the maxilla is joined to the bone behind it, the sphenoid bone.

09.25

Apart from this attachment the maxilla is separated from the sphenoid by this impressive cleft, which has a vertical part and a horizontal part. The vertical part of the cleft is called the pterygo-maxillary fissure. The horizontal part of the cleft is called the inferior orbital fissure.

09.45

The inferior orbital fissure - here it is from in front - separates the floor of the orbit, formed by the maxilla, from the lateral wall that's formed by the sphenoid.

09.58

Now we'll move on to look at the sphenoid bone. The sphenoid bone is extremely complex! It extends all the way from one side of the skull to the other. The sphenoid bone forms important parts of the underside, and outside of the skull; and it forms part of the orbit. The sphenoid bone also forms this large and complicated part of the floor of the cranium.

10.38

Here's a sphenoid bone all by itself. The sphenoid bone has a central part, and three major projections on each side - the lesser wing, the greater wing, and the pterygoid process. The central part part of the sphenoid includes the clinoid processes, and the pituitary fossa. The central part of the sphenoid bone is hollow, as we'll see.

11.12

The lesser wing, which is the highest part of the sphenoid bone, forms the sphenoid ridge, which separates the anterior and middle cranial fossae.

11.25

The underside of the lesser wing forms this small but important part of the back of the orbit. The greater wing of the sphenoid forms the front wall and part of the floor of the middle cranial fossa.

11.44

On the outside the greater wing forms this part of the temporal, and infratemporal fossae, and it also forms this large part of the lateral wall of the orbit .

11.59

The greater wing and the lesser wing are joined here, but more medially they're separated by this triangular gap, the superior orbital fissure, which forms an large opening between the orbit, and the inside of the cranium.

12.16

Here's the superior orbital fissure from the inside. We'll get a better look at it in a minute. The pterygoid process of the sphenoid bone projects downward behind the maxilla.

12.35

The pterygoid process includes the lateral, and medial pterygoid plates, which are the attachments for some important muscles that we'll see later. This hollow between the

pterygoid plates is the pterygoid fossa. This little hook is the pterygoid hamulus. It's a pulley, as we'll see later.
13.02

The last bone on our list of large facial bones is another quite complicated bone, the ethmoid. The ethmoid bone is a little hard to understand at first, because in the intact skull most of it is hidden from view.
13.16

The only parts of the ethmoid bone that we can readily see are this small part of the floor of the anterior cranial fossa, the two cribriform plates with the crista galli in between, and this part in the medial wall of each orbit .
13.35

It'll be easier to understand the ethmoid bone when we look at the nasal cavity in the next section. Till then we'll leave the ethmoid bone alone. There are three smaller facial bones that we'll look at briefly: the nasal, lacrimal, and palatine bones.
13.54

This is the nasal bone, this is the lacrimal bone. The two thin nasal bones form just the upper part of the bridge of the nose. The structural supports for the projecting parts of the nose are made of cartilage, as we'll see later.
14.12

The little lacrimal bone forms the most medial part of the inferior orbital margin. This opening between the lacrimal bone and the ethmoid bone is for the nasolacimal duct, which takes tears from the corner of the eye to the nasal cavity.
14.28

Last of all we'll look at the palatine bone. Here's the lower part of it. On each side the palatine bone forms the posterior part of the hard palate, and part of the side wall of the nasal cavity. We'll get a better look at the palatine bone when we look at the nasal cavity.
14.53

OPENINGS IN THE BASE OF THE CRANIUM

Now we'll move on, to take a look at the openings in the floor of the anterior and middle cranial fossa that we saw earlier. We'll look at three openings that pass forwards, two openings that pass downwards, and one that, in spite of appearances, passes obliquely backwards. We'll start with the ones that pass forwards.
15.25

This round opening just in front of the anterior clinoid process is the optic canal, for the optic nerve. Lateral to it, this large triangular opening is the superior orbital fissure, which we've seen already. Numerous nerves and blood vessels pass through it into the orbit.
15.45

Below and behind the medial end of the superior orbital fissure, this smaller round opening, the foramen rotundum, is for the maxillary branch of the trigeminal nerve. We'll put this pointer in the foramen rotundum, and go round to the outside. Here's the superior orbital fissure again. Here, medial to it, is the optic canal. The foramen rotundum emerges not into the orbit, but into the ptreygo-maxillary fissure.
16.19

The two openings that pass downward are the foramen ovale, for the mandibular branch of the trigeminal nerve, and just behind and lateral to it, the foramen spinosum, for the middle meningeal artery.
16.38

To see where those two come out we'll go round to the underside. Here's the foramen ovale, just behind the lateral pterygoid plate. Here's the foramen spinosum, just behind and lateral to the foramen ovale.

17.00

The last opening to look at is this untidy looking opening, the foramen lacerum, for the internal carotid artery. In a dry skull the appearance of the foramen lacerum is quite misleading: it appears to pass straight down through the base of the skull emerging here, at the tip of the petrous temporal bone.

17.22

In the living body the apparent opening on the underside is filled in with dense fibrous tissue, represented by this material. Fibrous tissue also fills in this ragged part of the internal bony opening.

17.40

What's left of the foramen lacerum is a clean cut opening, through which the internal carotid artery emerges from its obliquely runnning bony tunnel, the carotid canal. The other end of the carotid canal, as we saw in the previous section, is back here, just medial to the styloid process.

18.03

In front of the opening for the carotid canal there's one further opening that we haven't seen yet, the opening for the auditory tube, also called the eustachian tube. The auditory tube passes backwards and laterally, to emerge here in the middle ear.

18.23

The auditory tube is longer than this: medially it's prolonged by a tube of cartilage, represented by this colored material. The auditory tube opens into the nasopharynx, as we'll see.

18.43

We'll look at these openings again, in the sections of these two tapes that deal with the blood vessels and cranial nerves. We've seen a lot of bony anatomy in this section! Let's review what we've seen of the anatomy of the facial bones and the base of the cranium.

19.00

REVIEW OF BONES

Here's the frontal bone, the zygomatic bone, the maxilla, the sphenoid bone, and the ethmoid bone. Here's the nasal bone, the lacrimal bone, and the palatine bone.

19.25

Here's the orbital cavity, the orbital margin. and the opening for the nasolacrimal duct

19.34

Here's the zygomatic arch, the temporal line, the temporal fossa, and the infratemporal fossa. Here's the pterygo-maxillary fissure, and the inferior orbital fissure.

19.52

On the sphenoid bone, here's the lesser wing, the greater wing, and the pterygoid plates, medial, and lateral. Here's the pterygoid fossa, here's the hamulus.

20.07

On the inside, here's the anterior cranial fossa, the middle cranial fossa, and the posterior cranial fossa. Here's the sphenoid ridge, the crista galli, and the cribriform plates. Here's the sella turcica, consisting of the anterior, and posterior clinoid processes, the pituitary fossa, and the dorsum sellae.

20.36

Here's the optic foramen, the superior orbital fissure, and the foramen rotundum. Here's the foramen ovale, and the foramen spinosum, and the foramen lacerum. Here's the true opening of the carotid canal. Here's the opening for the auditory tube, here's the cartilage of the auditory tube,

21.03

That brings us to the end of this section on the bony anatomy of the facial skeleton, and the base of the skull. In the next section we'll move on to look at the upper part of the air passage. You'll recall that there's one important bone that we haven't yet understood - the ethmoid bone. We'll take a good look at it in the next section.

21.30

END OF PART 2

INTRODUCTION TO PARTS 3, 4 AND 5

00.00

In the next three sections we'll look at the parts of the head and neck that are involved in two vital functions: breathing, and eating and drinking. To get a preview of these major topics, we'll look at a specimen that's been divided in the mid-line.

00.21

The passage for air, and the passage for food and liquid, begin separately at the nose and the mouth. Air passes backward through the nasal cavity, and the nasopharynx. Food and liquid pass backward through the oral cavity. The two passages unite here.

00.44

Air, food and liquid all pass through this common passage, the oropharynx. The two passages separate again here, in the hypopharynx. Food and liquid pass backward into the esophagus on their way to the stomach. Air passes forward through the larynx and into the trachea, on its way to the lungs.

01.06

So the lines of travel for air, and for food and liquid, cross over in the oropharynx. It's important that air on the one hand, and food and liquid on the other hand, don't pass upward or downward into the wrong passageway.

01.21

To take care of this, there are important mobile structures above and below the oropharynx that act as separators. These are the soft palate above, and the epiglottis, and vocal cords below.

1.36

As we'll see in later sectrions of this tape, the structures that form the passages for air, and for food and liquid, are also involved in a further important function: the production of voice sounds.

PART 3

THE NASAL CAVITY AND ITS SURROUNDINGS

BONY FEATURES

01.52

In this section we'll look at the upper part of the air passage. We'll look at the external nose, the nasal cavities, the paranasal sinuses, and the nasopharynx. We'll start by looking at the bony structures that surround these spaces.

02.21

The bony opening for the nose is called the piriform aperture. Inside it there are two nasal cavities, a right and a left, separated in the midline by the nasal septum. To get a better look inside we'll divide the skull in the frontal plane along this line.

02.30

There's a lot to see here. Let's get ourselves oriented. Here's the hard palate. Here's the floor of the anterior cranial fossa. Here are the medial walls of the orbits. Here are the two nasal cavities. The septum dividing them is a little off center, which is not unusual. The roof of each cavity, formed by the cribriform plate, is very narrow.

03.04

The medial wall of each nasal cavity, formed by the septum, is smooth and featureless, so is the floor. By contrast the lateral wall is marked by a number of features, most notably by these three delicate bony projections, the conchae, also known as the turbinate bones. This is the inferior concha, this is the middle concha, this is the much smaller superior concha.

03.30

The three conchae partially divide the air passage into three parts, the inferior meatus, the middle meatus, and the superior meatus. Here's the back of the orbital cavity. Below it is the hollow space in the maxilla, the maxillary antrum, which we'll look at later.

03.53

At about the level of the floor of the orbit, the nasal cavity becomes much narrower. The narrowing is caused by the presence of this collection of small hollow spaces, the ethmoid air cells. We'll see more of these in a minute.

04.08

To see more of the septum and the nasal cavity we'll look at it in a skull that's been divided just to the left of the mid-line. Here's the bony part of the nasal septum. It's formed by this part of the ethmoid bone, the perpendicular plate, and by this small bone that we haven't encountered up till now, the vomer. The lowest part of the septum is formed by the maxilla and by the palatine bone.

04.37

Here's the divided left cribriform plate. This projection above it is something we've seen before: it's the crista galli. The frontal section we were looking at was divided here, just behind the crista galli.

04.53

Now we'll remove the septum to get a good look at the lateral wall of the nasal cavity. The roof of the nasal cavity runs along this line, rising to its highest point along the length of the cribriform plate. Here are the conchae again, superior, middle, and inferior.

05.17

There are several openings in the lateral walll of the nasal cavity. They're partly hidden by the conchae. We'll see these in a minute. The lateral wall of the nasal cavity is formed partly by the maxilla, partly by the ethmoid bone, and partly by the perpendicular part of the palatine bone. Further back, where the nasal cavity becomes the nasopharynx, the lateral wall is formed by the medial pterygoid plate.

05.50

The large facial bones that surround the nasal cavity - the frontal bone, the maxilla, the sphenoid and ethmoid bones - are hollow to a greater or lesser extent. The hollow spaces in these bones contain the paranasal sinuses, which in the healthy living body are filled with air. The paranasal sinuses all communicate with the nasal cavity.

06.15

To see the sinus cavities we'll look at a skull in which part of the bone overlying the various sinuses has been removed. Here's the cavity for the right frontal sinus. There's a left one too, on the other side of this partition.

06.31

The frontal sinus extends upward, behind the lower part of the forehead, and also to a variable extent backwards, between the roof of the orbit and the floor of the anterior cranial fossa. Here's the cavity for the right maxillary sinus, also known as the maxillary antrum.

06.57

It extends backwards to the part of the maxilla that borders the pterygo-maxillary fissure. It extends downwards almost to the root of the upper molar and premolar teeth. The medial wall of the maxillary sinus is also the lateral wall of the nasal cavity. Its roof forms a large part of the floor of the orbit.

07.32

The sphenoid sinuses occupy the central part of the sphenoid bone. This opening has been made to show the right sphenoid sinus. To see it better we'll look at the skull divided in the midline. Here's the right sphenoid sinus again.

07.52

Above the sphenoid sinus is the floor of the anterior cranial fossa, and the sella turcica. Behind it is the basilar part of the occipital bone. In front of it is the high part of the nasal cavity. Below it is the roof of the nasopharynx.

08.12

Lastly we'll come round to the front, to look at the collection of small cavities that contain the ethmoid air cells, collectively referred to as the ethmoid sinus. These extend from just behind the naso-lacrimal duct, all the way back along the medial wall of the orbit. As we've seen already, the ethmoid air cells lie between the medial wall of the orbit, and the lateral wall of the upper part of the nasal cavity.

08.42

Before we go further, we need to catch up on something that we left unfinished in the previous section: understanding the ethmoid bone. We've encountered the various parts of the ethmoid bone, but till now we've put off seeing the whole of it.

08.59

We'll do that now, then we'll come back and look at the openings of the paranasal sinuses. The ethmoid bone is a fragile coalition of parts. The best way to see all of them is to go back to go back to the skull that was divided in the frontal plane.

09.17

All of this is the ethmoid bone. This part, the perpendicular plate of the ethmoid, forms a large part of the bony nasal septum. This upward projection is the beginning of the crista galli, which rises up in the floor of the anterior cranial fossa.

09.36

On each side of the crista galli are the cribriform plates. We've seen the cribriform plates from above, and from below. The most lateral part of the ethmoid bone is this paper-thin layer, the lamina papyracea, which forms this part of the medial wall of the orbit.

09.56

Between the lamina papyracea and the upper part of the nasal cavity are the ethmoid air cells, as we've seen. The superior and middle conchae are also parts of the ethmoid bone. The ethmoid bone is joined to the frontal bone above, the maxillae below, and the central part of the sphenoid bone behind.

10.22

Now that we've seen the ethmoid bone, we'll return to the cavities for the paranasal sinuses, and see how they connect with the nasal cavity. We'll look at the openings for the frontal and maxillary sinuses first.

10.35

Here's the frontal sinus cavity, here's the maxillary sinus cavity, seen through an artificial opening. The frontal and maxillary sinuses both open in this complex area beneath the middle concha, which we need to look at in more detail. In a dry skull there are two large irregular openings from the nasal cavity into the maxillary sinus, separated by this flake of bone, the uncinate process.

11.05

In the living body all of this opening, and much of this one, are closed off by soft tissue. The real opening of the maxillary sinus is back here. If we look in from in front, we can see that the opening is quite high on the medial wall of the maxillary antrum.

11.25

The frontal sinus opens into the nasal cavity by way of a narrow passage, the fronto-nasal duct. The fronto-nasal duct starts above the uncinate process, and runs upward and forward to reach the frontal sinus.

11.43

The frontal and maxillary sinuses open into the nasal cavity not directly, but into a narrow side chamber located here, called the infundibulum. The infundibulum isn't apparent in a bony specimen. We'll see it when we look at the soft tissues.

12.04

Now we'll look at the openings for the other sinuses. The sphenoid sinus opens into the nasal cavity here, above and behind the superior concha. The ethmoid air cells, which are up in this region, have several small openings into the nasal cavity. Some of these are behind the middle concha some of them are below it.

12.26

There are two more openings to see in the lateral wall of the nasal cavity: the opening for the nasolacrimal duct, or tear duct, and an opening for nerves and blood vessels, the spheno-palatine foramen.

12.42

As we've seen, the bony passage for the naso-lacrimal duct starts here.
The naso-lacrimal duct, which is quite short, passes downwards and backwards to open beneath the inferior concha: here's its opening.

13.00

The last opening to look at, the sphenopalatine foramen, is the inner end of a short tunnel for blood vessels and nerves to the nose and palate. On the inside it opens near the back of the superior meatus. We'll go all the way round to the outside to see the other end of the sphenopalatine foramen which is here, in the depths of the pterygo-maxillary fissure.

13.30

Now that we've seen the bony features of the nasal cavity, we'll move back and look at the bones that surround the nasopharynx. Here's the posterior opening of the nasal cavity, the choana, or posterior naris. Its lateral wall is formed by the medial pterygoid plate.

13.51

The medial pterygoid plate ends in the hamulus. This piece of colored material, represents the cartilage of the auditory tube. The cartilage forms an incomplete tube, open on the underside.

14.12

Close to the medial end of the cartilage are a group of openings in the base of the cranium that we've seen before from a different angle: the foramen ovale, foramen spinosum, the opening of the carotid canal, and the jugular foramen.

12.28

The roof of the nasopharynx, formed by the underside of the sphenoid, and the basal part of the occipital bone, slopes downward toward the foramen magnum.

14.41

To complete our picture of the bones around the nasopharynx, we'll add the cervical vertebrae. Here's the anterior arch of the atlas, and here's the odontoid process of the axis .

14.57

Now let's review what we've seen of the bony structures that surround the upper part of the air passage.

15.06

REVIEW

Here's the piriform aperture and the nasal septum. Here are the posterior nares, or choanae. Here's the inferior concha, the middle concha, and the superior concha. Here are the superior meatus, middle meatus, and inferior meatus.

15.36

Here's the cavity for the frontal sinus, the maxillary sinus, the sphenoid sinus; and here are the ethmoid air cells. Here are the cribriform plates, the uncinate process, and the vomer.

15.55

Here are the fronto-nasal duct, the openings for the maxillary sinus, the sphenoid sinus, and the ethmoid air cells, posterior, and anterior. Here are the openings for the nasolacimal duct, and the sphenopalatine foramen.

16.15

NASAL CAVITY AND ITS SURROUNDINGS: MUCOSAL FEATURES

Now that we’ve seen the bony features of the nasal cavity, the paransal sinuses, and the nasopharynx let’s see what this region looks like in the living body. We’ll start with the entry to the air passage that forms such a distinctive feature of the face, the external nose.

16.38

The skin over the upper, bony part of the nasal framework is thin and mobile. The skin over the lower, cartilaginous part is thicker, and fixed to the underlying structures.

16.53

The openings which form the beginning of the air passage are the nostrils, also called the anterior nares. We’ll remove the skin from one half of the nose so that we can see the underlying structures. The edge of the bony opening for the nose, the piriform aperture, is here.

17.14

Here’s the nasal bone. The two nasal bones, united in the midline, form the bridge of the nose down to here. From here almost to the tip, the bridge of the nose is formed by the front edge of the septal cartilage, which we’ll see more fully in a minute. On each side the framework of the nose is formed by two slender pieces of cartilage, the lateral cartilage, and the alar cartilage.

17.42

The lateral cartilage is thin and flat. In front it’s continuous with the septal cartilage. The alar carilage has two parts, the lateral crus, and the medial crus.

17.58

The lateral crus forms the curved outer framework of the nostril. The medial crus turns sharply backwards, ending here. Together the two medial crura form the framework of the lowest, most anterior part of the nasal septum, which is called the columella.

18.18

To get a good look at the nasal septum, we’ll divide the bone and soft tissues along this line, and remove the left side of the face. Here’s the nasal septum. Before we look at it let’s get oriented. Here’s the anterior cranial fossa. Here’s the bony palate, or hard palate, with the soft palate extending behind it. Here’s the oral cavity. Here’s the opening of the right nasal cavity. Behind it is the nasopharynx, which we’ll look at in a minute.

18.55

The nasal septum extends from here behind, to here in front. This small part of the septum is covered with skin. The rest of it is covered with this layer of mucous membrane. We’ll remove a small piece of the mucous membrane so that we can appreciate its thickness.

19.19

The highest part of the septum is the specialized olfactory area. It contains some of the fibers and nerve endings of the olfactory nerve, which are the sensory receptors for our sense of smell. The cribrifom plate, which the olfactory nerve fibers go through, is at this level.

19.38

Now we’ll remove all the mucous membrane from the septum so that we can see the underlying cartilage and bone.

19.46

This part of the septum is bone, as we've already seen. This part is formed by the septal cartilage. In this specimen there's an unusual defect in the cartilage, here. In front, the septal cartilage forms the bridge of the nose down to here, then runs downwards and backwards to attatch to this bony prominence on the maxilla, the anterior nasal spine.

20.12

Now we'll remove the whole of the nasal septum nasal septum so that we can see the lateral wall and floor of the nasal cavity. The inside of the nostril, up to the lower border of the lateral cartilage which is here, is called the nasal vestibule. It's lined with skin. The rest of the nasal cavity is lined with mucous membrane.

20.35

Here are the conchae, superior, middle, and inferior. The mucous membrane that covers them is richly supplied with mucus glands, and with blood vessels. The complex surfaces of the conchae have imporatant functions in humidifying the inspired air, and warming it. This olfactory area, like the corresponding area on the septum, contains olfactory nerve fibers and nerve endings.

21.02

All the paranasal sinuses, and the nasolacrimal duct for the tears, open into the nasal cavity. To see their openings into openings into the nasal cavity, we'll remove the conchae. The inferior concha was here. Here beneath it is the opening for the nasolacrimal duct. Beneath the middle concha, which was here, is a deep groove called the semilunar hiatus.

21.32

To see where this leads, we'll retract its lower border with this thread. The semilunar hiatus leads into a narrow, irregular shaped side chamber called the infundibulum. The infundibulum receives the openings of the frontal sinus, and the maxillary sinus.

21.54

Sometimes the more anterior ethmoid air cells open into the infundibulum too. Sometimes, as in this case, they open separately, below the middle concha. Here's where the superior concha was . The more posterior ethmoid air cells open below the superior concha. The sphenoid sinus, which is this cavity, opens forwards into the highest part of the nasal cavity, the spheno-ethmoidal recess.

22.25

Here's the frontal sinus cavity, in a different specimen. The opening to the fronto-nasal duct is behind here. To see the other sinus cavities we'll take a look from the outside, at a dissection in which all the facial soft tissues have been removed.

22.46

Here's the maxillary sinus cavity, opened from in front. The opening from the sinus into the infundibulum is all the way up here on the medial wall. Here are the ethmoid air cells, with the lamina papyracea removed. This bony opening in the medial wall of the orbit also exposes the infundibulum.

23.12

Now we'll move back, and look at the nasopharynx. To do that, we'll put the nasal septum back in place. Here's the right half of the nasopharynx. The openings from the two nasal cavities into the nasopharynx, (here's the right one) are called the choanae, or posterior nares.

23.34

The roof of the nasophaynx lies underneath the basilar part of the occipital bone. The back of the nasopharynx lies in front of the atlas vertebra: here's the anterior arch of the atlas.

23.47

In the mucosa of the lateral wall of the nasopharynx there's a pronounced inward fold called the torus tubarius. It's produced by the inward projection of the cartilage of the auditory tube. The mucosal opening of the tube is here. Behind the torus tubarius is a deep recess, the pharyngeal recess.

24.07

The floor of the nasopharynx is formed by the soft palate, which forms a highly mobile partition between the nasopharynx and the back of the oral cavity. The nasopharynx opens downward, into the oropharynx.

24.22

The soft palate can move upwards, backwards and downwards. Its movements, which are important in swallowing and in speech, are produced by several small muscles. These converge on the soft palate from above and from below on. Most of them insert on a sheet of aponeurosis or tendon like material that occcupies this part of the palate.

24.47

In this section we'll see only the palatal mucles that come from above. We'll see the ones that come from below in the next section. The two that we'll see now are the levator palati and the tensor palati.

25.03

To see these muscles, we'll remove the mucosa of the nasopharynx. Here's the end of the cartilage of the auditory tube. Here below it is the levator palati muscle: its full name is the levator veli palatini.

25.21

Levator palati arises here on the petrous temporal bone. It passes along the underside of the auditory tube, runs downwards and medially, and joins in the midline with its fellow from the other side, forming a sling. Levator palati moves the soft palate upwards and backwards.

25.48

To see the tensor palati muscle we'll remove the remove the levator. Here's tensor palati. Tensor palati arises from this area just above the root of the medial pterygoid plate. Here's the edge of the medial pterygoid plate. The fibers of tensor palati pass downward and fdrward towards the pterygoid hamulus, which is here.

26.18

The tendon of tensor palati makes a complete 90º turn round the pterygoid hamulus. Here's the tendon emerging. It passes medially to insert on the palatal aponeurosis.

26.39

The action of tensor palati is to tighten the palate when the tongue presses up against it in the act of swallowing. It also may help to open the auditory tube. We'll end this section with a look at the auditory tube.

26.58

Here's the end of the cartilage of the auditory tube. The cartilage doesn't form a complete tube: it's open on the underside. Here's the cut edge of the mucous membrane which forms the real auditory tube. It passes backwards and laterally to reach the cavity of the middle ear. The function of the auditory tube is to keep the pressure inside the middle ear the same as the pressure outside it.

27.30

Now let's review what we've seen of the upper part of the air passage.

27.36

REVIEW

Here are the nostrils or anterior nares, the columella, the lateral cartilage, the alar cartilage, the septal cartilage, the nasal vestibule, and the olfactory area.

28.00

Here are the conchae again, superior, middle, and inferior. Here's the nasopharynx, with the torus tubarius, the pharyngeal recess, and the soft palate.

28.16

Here's the semilunar hiatus, and the infundibulum, Here's the levator palati, the tensor palati, and the cartilage of the auditory tube.

28.32

That brings us to the end of this section on the upper part of the air passage. In the next section we'll look at the upper and lower jaws, and the oral cavity.

28.48

END OF PART 3

PART 4

THE ORAL CAVITY AND ITS SURROUNDINGS

00.00

In this section we'll look at all the structures, other than nerves and blood vessels, that are connected with the oral cavity and oropharynx. We'll look at the upper and lower jaw and the muscles of mastication; then we'll look at the the hyoid bone and the tongue and their muscles; then we'll see the muscles of the cheek and lips, then the teeth and the salivary glands, and lastly we'll look at the pharynx. It's going to be a long section! Don't aim to watch it all at once.

00.38

UPPER AND LOWER JAWS: BONY FEATURES

In looking at the jaws we'll start, as always, with the bones. The word jaw is used in two ways. When we speak of "jaws " in the plural, we're referring to both the upper jaw, the maxilla, and the lower jaw, the mandible. When we say "jaw" in the singular, as in jaw movement or jaw bone, we're referring to the mandible.

01.03

We'll take a good look at the mandible in a minute. Before doing that, let's take a fresh look at the parts of the facial skeleton that we'll be seeing in this section. Here's the zygomatic arch enclosing the temporal fossa, and the infratemporal fossa.

01.22

Here's the joint surface of the temporomandibular joint, with the external auditory meatus and the styloid process just behind it. Here's the styloid process. Here are the pterygoid plates, with the pterygoid fossa between them. This sharp projection just medial to the temporomandibular joint is the spine of the sphenoid bone.

01.44

The part of the maxilla that bears the teeth is called the alveolar process. We'll look at the teeth later in this section. The alveolar process ends behind at the tuber.

02.01

Now we'll bring the mandible into the picture. The mandible develops from two originally separate bones, one on each side, which fuse together here at the symphysis. The mandible is described as consisting of the body, and the right and left ramus.

02.27

The corner between the ramus and the body is the angle of the mandible. The rounded projection that articulates with the temporal bone is the condyle, or condylar process. The narrowing below the condyle is the neck.

27.46

The sharp, slender projection in front of the condyle is the coronoid process, a major muscle attachment, as we'll see. The dip between the coronoid process and the condyle is the mandibular notch.

03.01

The angle of the mandible is roughened on the outside, and on the inside, by the insertions of a matching pair of muscles, the medial pterygoid on the inside and the masseter on the outside, which we'll see shortly.

03.16

The body of the mandible is described as consisting of the base and the alveolar process. The side of the body slopes upward and inward, slightly on the outer aspect, markedly on the inner aspect. The posterior part of the alveolar process bulges medially above this hollow, the submandibular fossa.

03.42

This projection in the mid-line is the mental protuberance. On the inside, this roughened area is the mental spine; two pairs of muscles are attached to it, the genio-hyoid and genioglossus muscles.

04.01

On the inner aspect of the mandible this thickening below the coronoid process is the buttress. In the middle of the ramus, level with the tops of the teeth, is the mandibular foramen. Just in front of it is a small upward projection, the lingula.

04.19

The mandibular foramen is the start of a tunnel for the inferior alveolar nerve and blood vessels. A major branch of the nerve emerges on the outside, at the mental foramen.

04.30

TEMPOROMANDIBULAR JOINT, JAW MOVEMENT

Now that we've seen the mandible, let's take a look at the joint that enables it to move: the temporomandibular joint. It's a synovial joint, with articular cartilage on the bone surfaces, and a joint capsule that encloses synovial fluid. It's a double joint: there are two separate synovial cavities, one above the other. These are separated by an articular disk that's flexible and highly movable. This arrangement permits two kinds of movement, as we'll see.

05.04

Here's what the two joint surfaces look like in the living body: they're shaped quite differently. The articular surface of the condyle is curved sharply from front to back. It's almost pointed on the top. The articular surface of the temporal bone has a double curve: this concave part is the mandibular fossa; this convex part is formed by the downward bulge of the articular tubercle.

05.36

Here's the temporomandibular joint with its joint capsule intact. Most of the capsule is thin and loose, to allow the variouus movements that we'll see. On the lateral aspect the capsule is thickened by this lateral ligament.

05.58

The articular disk is inside the joint here. To see it, we'll remove part of the capsule above and above and below it. Here's the upper joint cavity, here's the lower one. Here between them is the articular disk. It's made of dense fibrous tissue. It's attached to the joint capsule all the way round its edge. Here's the articular disk by itself: it's thin in front, and thick behind. It's quite flexible.

06.32

The two kinds of movement that can occur at the temporo-mandibular joint are a hinging movement and a forward and backward gliding movement. The hinging movement takes place between the condyle and the disk, the backward and forward movement takes place mainly between the disk and the temporal surface.

07.00

The normal opening and closing of the jaw is a combination of the two movements. If you put your finger here, you can feel the condyle moving forwards as the jaw opens.

07.14

MUSCLES OF MASTICATION

Forward movement of the body of the mandible is held in check by two ligaments that lie outside the temporomandibular joint. We'll add these to the picture after we've looked at the four principal muscles that move the jaw. We'll move on now, to look at those four muscles. They're known collectively as the muscles of mastication.

07.33

The muscles that close the jaw are much more powerful than the ones that open it. Closing is produced by three large muscles on each side, the medial pterygoid, the temporalis, and the masseter. Opening is produced by the lateral pterygoid muscle, which we'll see in a moment, and by some smaller muscles below the mandible that we'll add to the picture later in this section.

07.59

Of the four muscles that we'll look at now, we'll start with the one that's hardest to see, the lateral pterygoid. To get a look a look at it, we need to remove the coronoid process, and the zygomatic arch. This lets us see the infratemporal fossa, and behind it, the lateral pterygoid plate.

08.23

Here's the lateral pterygoid muscle. It's quite small. The lateral pterygoid muscle arises partly from the underside of the greater wing of the sphenoid, and partly from the lateral aspect of the lateral pterygoid plate.

08.41

The fibers of the lateral pterygoid run backward and a little laterally. We'll go round to a medial view to see where they go. The main insertion of the lateral pterygoid is into this hollow on the front of the condylar process.

09.01

The lateral pterygoid also inserts onto the capsule of the temporomandibular joint, and into the front edge of the articular disk. These windows in the capsule were made artificially, as in the shot that we saw previously.

09.23

Now that we've seen the lateral pterygoid, we'll add the medial pterygoid muscle to the picture. The medial pterygoid muscle is larger than the lateral pterygoid, and runs in a quite different direction. The medial pterygoid muscle arises from both the pterygoid plates: the medial aspect of the lateral one, and the lateral aspect of the medial one, also from this corner of the maxilla, the tuber.

09.53

The fibers of the medial pterygoid muscle run downards, backwards and laterally. They insert here along the inner aspect of the angle of the mandible.

10.07

Before adding the next muscle, the temporalis, to the picture we'll put the coronoid process back in place, since that's where the temporalis inserts.

10.21

Here's the temporalis, the largest of the muscles of mastication. It's shaped like a fan. The temporalis arises from the wide area on the side of the skull that lies within the temporal line.

10.38

The fibers of temporalis converge from above, and from behind, on the coronoid process. They insert insert on the outer aspect, and the inner aspect of the coronoid process, and also here on the anterior part of the ramus of the mandible.

10.59

Now we'll put the zygomatic arch back into back into the picture. The temporalis muscle lies inside the zygomatic arch. Near its insertion the temporalis is a thick muscle. It occupies the whole of the infratemporal fossa.

11.22

The temporalis muscle is covered over by this dense layer of deep temporal fascia. The fascia is attached to bone along the zygomatic arch, and all the way round the temporal line .

11.37

Lastly we'll add the masseter muscle to the picture. Here's the masseter. It's a thick, powerful muscle. The masseter arises from the anterior two thirds of lower border of the zygomatic arch on its outer aspect and from the whole length of the arch on its inner aspect.

12.04

The fibers of the masseter muscle that arise on the outside run downwards and backwards, those on the inside run straight downwards. The masseter inserts into this wide area on the angle and ramus of the mandible. The masseter muscle on the outside, and the medial pterygoid muscle on the inside, converge on the angle of the mandible in very similar ways.

12.38

Now let's take a look at the actions of the muscles that we've just seen. The action of closing the jaw is performed by the upward pull of the temporalis, the masseter, and and the medial pterygoid muscles.

12.59

Opening of the jaw is brought about partly by the force of gravity, partly by the forward pull of the lateral pterygoid muscles, and partly by the backward and downward pull of muscles we'll see in a minuite, that act by way of the hyoid bone.

13.14

We've not yet seen the two accessory ligaments that restrain forward movement of the mandible. These are the stylomandibular ligament and the sphenomandibular ligament. The stylomandibular ligament goes from the styloid process, to the angle of the mandible. The sphenomandibular ligament goes from this small projection, the spine of the sphenoid, to the lingula.

13.41

HYOID BONE AND ITS ASSOCIATED MUSCLES

Now that we've looked at the mandible and the principal muscles that move it, we'll move on to look at a small but important bone that we haven't seen yet, the hyoid bone.

13.55

The hyoid bone is a slender, U-shaped bone. It's suspended just beneath the mandible. It isn't directly attached to any other bone. You can feel your own hyoid bone here, and you can move it from side to side.

14.17

Together with its attached muscles, the hyoid bone has two important functions: it holds up the tongue, which sits above it, and it holds up the larynx, which hangs below it. It also transmits the force of muscles which help to open the jaw. Let's take a closer look at the hyoid bone.

14.38

This broad central part is the body. Its forward facing upper surface is convex, with facets for the attachment of numerous muscles that we'll see shortly. The backward facing lower surface of the body is deeply concave.

14.54

On each side this long slender part of the hyoid bone is the greater horn or greater cornu. The greater horn is attached to the body by a small synovial joint, which gives it a little mobility. This small projection is the lesser horn, or lesser cornu.

15.11

When the structures above and below it are at rest, the hyoid bone lies slightly below the lower border of the mandible. In the frontal plane the body of the hyoid is about in line with the last molar tooth.

15.26

From its resting position the hyoid bone can be moved upwards and downwards, and forwards and backwards, by the muscles that are attached to it.

15.38

Now we'll look at the muscles that hold the hyoid bone in place, and cause it to move. There are seven pairs of them: two that pull the hyoid bone upwards and forwards, one that pulls it upwards and backwards, one that pulls it upwards by means of a pulley, and three that pull it downwards.

15.59

We'll start with the two that pull upwards and forwards: the mylohyoid, and geniohyoid muscles. Here are the two mylohyoid muscles. Between them they form a continuous sling of muscle that forms the mobile floor of the oral cavity.

16.16

The mylohyoid muscle arises from the mylohyoid line on the mandible. Most of its fibers pass downwards and medially, joining in the midline with the fibers from the opposite side, all the way from the symphysis of the mandible, to the body of the hyoid bone.

16.34

The more posterior fibers of the mylohyoid insert here on the body of the hyoid bone. The mylohyoid muscle has a free posterior border which runs straight downwards when seen from the side, also a little inward when seen from behind.

16.53

Now we'll add the two geniohyoid muscles to the picture: here they are: They lie above the mylohyoid: On each side the geniohyoid arises from the lower part of the mental spine. It inserts here, on the body of the hyoid bone.

17.12

Now we'll add the base of the skull to the picture, and add the muscle that pulls upwards and backwards, the stylohyoid. Here's the stylohyoid. It's a long, slender muscle. Just above its insertion there's an opening in the stylohyoid. The digastric muscle passes through this opening as we'll see.

17.34

The stylohyoid arises from the lateral aspect of the styloid process. It's inserted on the base of the greater horn of the hyoid bone.

17.44

Next we'll add the digastric muscle to the picture. Here it is. The digastric muscle is unusual in that it has two bellies, an anterior and a posterior, that are connected in the middle by a tendon.

17.58

The posterior belly of the digastric arises from the digastric notch on the underside of the temporal bone, and from the medial aspect of the mastoid process. The origins of the sternocleidomastoid and splenius muscles, which have been removed in this dissection, lie lateral to it.

18.18

The posterior belly narrows to a tendon which passes between the two slips of the stylohyoid. The digastric tendon then passes through a sling of fibrous connective tissue, by which it's tethered to the hyoid bone, here.

18.32

The tendon then broadens out into the anterior belly of the digastric, which runs almost straight forward beneath the mylohyoid. It's attached low down on the inner aspect of the body of the mandible, just lateral to the midline.

18.49

Lastly we'll take a brief look at the attachments of the three muscles that pull the hyoid bone downwards. They're the omohyoid, sterno-hyoid, and thyrohyoid muscles, known collectively as the infrahyoid muscles.

19.05

Here's the body of the hyoid bone. Here's the upper end of the omohyoid muscle, which goes all the way down to the scapula. Medial to it is the sternohyoid muscle, which goes to the sternum.

19.20

Behind these two is the short thyro-hyoid muscle, which goes down to a structure we haven't seen yet, the thyroid cartilage. These muscles insert on the edge of the body of

the hyoid bone, the thyrohyoid here, the omohyoid here, and the sternohyoid here. We'll see these three muscles more fully, later in this tape.
19.45

The infrahyoid muscles pull the hyoid bone downwards. Acting together with the digasric muscle, the infrahyoid muscles assist in opening the jaw. The actions of the other hyoid muscles that we've seen are evident from the direction of their fibers.
20.03

TONGUE

Now that we've seen the hyoid bone and the muscles that hold it in place and move it, we'll move on to look at the tongue.
20.12

The shape of the of the mobile anterior part of the tongue is familiar to us from everyday encounters. What's perhaps surprising is how much of the tongue we don't see from in front. The tongue goes a long way back, and a long way down.
20.29

To understand the overall shape of the tongue, let's look at a specimen that's been divided in the mid-line. All this is the tongue, right back to here. The tongue consists almost entirely of muscle, covered by specialized mucous membrane. The freely mobile anterior part of the tongue almost fills the oral cavity. The massive posterior part of the tongue, which is much less mobile, faces backwards into the oropharynx.
21.03

This structure below and behind the back of the tongue is the epiglottis. We'll see it in the next section.
21.10

To get a look at the whole tongue, we'll look at a specimen consisting of just the tongue, the mandible, and the hyoid bone. Here's the mylohyoid muscle. The body of the hyoid bone is here; here's the greater horn.
21.28

We'll look at the outside of the tongue first. The tongue is covered with mucous membrane, on top, on the sides, and also here in front, on the underside. The mucous membrane of the tongue is continuous with the mucous membrane that covers the floor of the mouth, and the alveolar process.
21.50

There's a deep valley between the alveolar process and the side of the tongue. This projecting fold in the mid-line is the frenum. On either side of it the submandibular ducts open, as we'll see later.
22.07

The mucous membrane over the root of the tongue is thin and mobile. Over the sides and the upper surface the mucous membrane is thick, firmly attached to the underlying muscle, and covered by projections called papillae. The largest of these, the valleculate papillae, are in a row back here. This shallow pit in the mid-line is the foramen cecum.
22.38

The muscles that form the bulk of the tongue are intrinsic muscles, which run from one part of the tongue to another, and extrinsic muscles, which are attached to bone. There are three extrinsic muscles on each side. Of these the two largest, which we'll see now, are hyoglossus, and genioglossus. The other one, stylo-glossus we'll see later.
23.05

To get a view of the major extrinsic muscles we'll divide the mandible along this line and remove the ramus, and the alveolar process. We'll also remove all of the mucous membrane, from this line downwards.
23.22

Here are the hyoglossus, and genioglossus muscles, which together form the root of the tongue. To see the full extent of genioglossus, we'll remove hyoglossus for a moment. All this is genioglossus. Genioglossus arises just above the genio-hyoid, from the upper part of the mental spine.

23.51

Its fibers fan out, the highest ones arching forward almost to the tip of the tongue, the lowest ones running straight backward to the most posterior part of the tongue. Genioglossus compacts the tongue, and pulls it forwards.

24.08

Now we'll put hyoglossus back back in the picture. Hyoglossus is a thin, flat sheet of muscle. Its fibers run upwards and forwards. Hyoglossus arises from the whole length of the greater horn of the hyoid bone, (here's the greater horn) and ends here, along the side of the tongue. Hyoglossus flattens the tongue, and pulls it backwards and downwards.

24.36

Here alongside hyoglossus is the third extrinsic tongue muscle, styloglossus, coming in from behind. We'll see it later. Here's the mylohyoid muscle, seen from behind.

24.50

The space between the mylohyoid and hyoglossus muscles is the pathway for the nerves to the tongue, and the submandibular duct, as we'll see in the next tape.

25.00

The intrinsic muscles of the tongue, which we won't look at in detail, run both longitudinally and transversely, above and between the extrinsic muscles. They're responsible for many of the fine movements that are involved in handling food, and in speech.

25.17

We've looked at a lot of muscles in this section: the muscles of mastication, the muscles of the hyoid bone, and the extrinsic tongue muscles. Later in this section, when we look at the salivary glands, and at the pharynx, we'll have a chance to see how all the muscles fit together, that we've seen up to now. Before we move on, let's review the structures that we've seen so far in this section.

25.42

REVIEW

Here's the ramus of the mandible, here's the body, formed by the alveolar process, and the base.

25.57

Here's the angle, the condyle, the neck, the coronoid process, and the mandibular notch. Here are the symphysis, the mental protuberance, the buttress, the mandibular foramen, the lingula, the mylohyoid line, the submandibular fossa, and the mental spine.

26.23

Here's the temporomandibular joint, the articular disk, the stylomandiblar ligament, and the spheno-mandibular ligament.

26.35

Here are the lateral pterygoid muscle, the medial pterygoid muscle, the temporalis, and the masseter. On the hyoid bone, here's the body, the greater horn, and the lesser horn.

26.53

Here are the mylohyoid muscles, the geniohyoid, the stylohyoid, the digastric, the omohyoid, sternohyoid, and the thyrohyoid. Here's the genioglossus muscle, and here's the hyoglossus.

27.13

ORAL CAVITY

Now we'll move on to take an overall look at the oral cavity, and at some important, closely related structures. We'll look first at the shape and extent of the oral cavity, then we'll look at the muscles of the cheek and lips, then at the teeth, then at the salivary glands.

27.37

To understand the shape of the oral cavity, and its extent, we'll look at it in a living model. Here's the tongue, here's the palate, here's the inner aspect of the alveolar process of the maxilla, and of the mandible.

27.54

The alveolar processes of the maxilla, and mandible, together with the upper and lower teeth, project into the oral cavity from above and below. They divide the oral cavity into an inner part, and an outer part.

28.12

The upper and lower gums, or gingivae, are formed by mucous membrane that covers the alveolar processes on the outside, and on the inside.

28.23

The outer part of the oral cavity, the vestibule, lies between the teeth and gums on the inside, and the cheek and lips on the outside. The mucous membrane of the lips and the cheek is continuous above and below with the mucous membrane of the gums.

28.42

The inner part of the cavity is closed off above by the hard palate, and further back by the soft palate, which ends back here at the uvula. It's closed off below largely by the tongue, and partly by the mucous membrane of the floor of the mouth.

28.58

To see the features of the posterior part of the oral cavity, we'll look at a dissected specimen that's been divided in the mid-line. This specimen is missing a number of teeth.

29.10

The mucous membrane that lines the cheek passes medially behind the last molar teeth and becomes continuous with the mucous membrane of the inner part of the oral cavity. The front of the ramus of the mandible is here. To look at the wall of the oral cavity further back, we'll move the soft palate backward.

29.32

This fold in the mucous membrane running from the soft palate to the side of the tongue is the palato-glossal arch. It acts as a dam, preventing liquid from spilling backward past the side of the tongue. This less noticable fold is the palatopharyngeal arch.

29.50

This triangle between the two arches is occupied in early life by a prominent mass of lymphoid tissue, the tonsil. In later life, as in this specimen, the tonsil atrophies. Here's the palatoglossal arch in a young person. Here behind it is the tonsil.

30.09

MUSCLES OF CHEEK AND LIPS

We'll look at the soft palate along with the oropharynx, at the end of this section. Now that we've looked at the overall shape of the oral cavity, we'll move on to look at the muscles of the cheek and lips. The muscles we'll look at are the buccinator, which forms the muscular lining of the cheek, and the complex of muscles that surround the mouth, collectively called the orbicularis oris.

30.34

Before looking at these muscles, we need to get acquainted with a ligamentous structure that the posterior fibers of the buccinator are attached to, the pterygo-mandibular band also called the pterygo-mandibular raphé. The pterygo-mandibular band, represented by this piece of material, passes from the pterygoid hamulus, to the posterior end of the mylo-hyoid line.

31.02

Two muscles arise from it: the buccinator in front, and the superior constrictor of the pharynx behind. The pterygomandibular band can stretch to accomodate jaw movement.

31.13

Now, to see the muscles of the cheek and lips, we'll look at a dissection in which the skin and subcutaneous fat have been removed from the lower part of the face. The muscles of facial expression have also been removed. Here's the orbicularis oris, here's the buccinator. The two are closely associated.

31.35

We'll look at the buccinator first. Here it's partly hidden by the masseter muscle, which we'll remove. The buccinator is a thin pouch of muscle that closely follows the contours of the mucous membrane of the vestibule. It has a long line of origin.

31.55

The buccinator arises from the maxilla and from the mandible along these lines. Above, the line of attachment curls round behind the tuber of the maxilla. Below, it curls round onto the buttress of the mandible. Between these two points, the most posterior fibers of the buccinator arise from the pterygo-mandibular band.

32.20

The buccinator muscle passes forward, and divides at the corner of the mouth. Its fibers continue forwards to become the deepest part of the orbicularis oris.

32.33

The orbicularis oris muscle complex surrounds the opening of the mouth. It consists partly of intrinsic fibers, but it's formed mainly by the fibers of other muscles: on the deep aspect by the continuing fibers of the buccinator, and on a more superficial level by these by these muscles of facial expression. We'll take a good look at them in the last section of this tape. The action of the orbicularis muscle is to press the lips together, closing the mouth.

33.07

The action of the buccinator is to prevent the cheek from distending when we raise our intra-oral pressure. When we let the buccinators relax, this happens.

33.19

TEETH

Now that we've looked at the muscles of the cheek and lips, we'll move on to look at the teeth.

33.24

These are the lower teeth of a young adult. In the full dentition there are sixteen teeth above and sixteen below, thirty two in all. In each quadrant there are two incisors, one canine, two premolars, and three molars. (This individual's third molars have been removed.)

33.49

The incisor teeth are flat and chisel shaped. The canine teeth have a crown that's cone shaped, and a massive root which forms a prominence in the gum. The premolar teeth are broad, and short from front to back. They have two projecting cusps.

34.10

The molars are longer from front to back than the premolars, and have from three to five cusps.

34.19

Each tooth consists of a crown, which projects above the gingiva, and a root or roots which are embedded in bone. The tip of the root is called the apex. The crown and the root meet at this slight narrowing, the neck. The crown is covered on the outside with enamel, which is extremely hard. The inner part of the crown, and the root, are made of dentin.

34.48

The tooth is fixed to the surrounding bone by a layer of specialized periosteum, the periodontal membrane or ligament. The space within the tooth is the pulp cavity. The pulp of the tooth contains blood vessels and nerves, which enter through the apical canal.

35.04

The incisors and canines have one root, the premolars have a single root that's forked at the end. The molar teeth have multiple roots: the upper ones have three, the lower ones usually have two.

35.21

SALIVARY GLANDS, MUSCLE OVERVIEW

Now that we've looked at the teeth we'll move on to look at the glands that produce saliva, the salivary glands. There are three salivary glands, the parotid gland on the side of the face, the submandibular gland beneath the body of the mandible, and the sublingual gland in the floor of the mouth. We'll look at the parotid gland first.

35.40

Part of the parotid gland lies superficially in the posterior part of the cheek, part of it lies deep in the space between the ramus of the mandible and the sternocleidomastoid muscle. We'll look at the deep part first.

35.58

To look at the deep part of the parotid gland we'll start with a dissection in which the whole of the gland has been removed. This is a good opportunity to see all in one place a number of structures that we've learned about separately. Let's take a good look round.

36.16

Here's the posterior border of the ramus of the mandible, here's the zygomatic arch, here's the external auditory meatus, here's the mastoid process. Here's the sternocleidomastoid muscle, here's the masseter muscle. Here's the space that's occupied by the deep part of the parotid gland.

36.40

Here's the posterior belly of the digastric muscle, lying deep to the sternocleidomastoid. Here's the styloid process, and the stylohyoid muscle. Here, emerging behind the styloid process, is the trunk of an important nerve, the facial nerve.

36.59

The facial nerve, which provides the motor innervation to all the muscles of facial expression, has an important relationship to the parotid gland: it runs right through it, dividing into several branches as it does so.

37.13

Now that we've seen the space that's occupied by the deep part of the parotid gland, we'll add the deep part of the gland to the picture. Here's the cut surface of the parotid gland. Again, here are the sternocleidomastoid muscle, the masseter, and the ramus of the mandible. Before we add the superficial part of the parotid gland, we'll add the facial nerve to the picture.

37.37

Here's the trunk of the facial nerve, entering the parotid gland from behind. The branches of the facial nerve fan out upwards, forwards and downwards. We'll take a more complete look at the facial nerve in the next tape in the series. Here, we're concerned only with its relationship to the parotid gland.

38.04

Now we'll add the superficial part of the gland to the picture. Here it is. The superficial part of the parotid gland covers the posterior part of the masseter muscle. Its extent varies. It usually extends up as far as the zygomatic arch, and down to the angle of the mandible. It can also overlap the anterior border of the sternocleidomastoid muscle.

38.31

The saliva that's secreted by the parotid gland passes into the parotid duct, which emerges from the anterior border of the gland, and passes forward around the anterior border of the masseter. The parotid duct enters the oral cavity by passing through the buccinator muscle and through the underlying mucous membrane, at about the level of the second upper molar tooth.

38.55

Next we'll look at the submandibular gland. The submandibular gland lies under the posterior part of the body of the mandible.

39.06

We'll start by looking at a dissection in which the gland has been removed. Again, we'll take the opportunity to review the bony and muscular anatomy.

39.16

Here's the body of the mandible, here's the body of the hyoid bone. Here's the anterior belly of the digastric, here's the digastric tendon, passing through the stylohyoid muscle. Here's the mylohyoid muscle, here's the styoglossus. Here, deep to the digastric, is the the hyoglossus muscle.

39.42

Now we'll add the submandibular gland to the picture. Here it is. The submandibular gland curls around behind the free border of the mylohyoid muscle, so that it has a superficial part, which we can see here, and a deep part. To see the deep part we'll remove the superficial part.

40.05

Here's the cut edge of the deep part of the submandibular gland, between the mylohyoid and styloglossus muscles. It extends forward to about here.

40.17

The saliva that's produced by the submandibular gland passes into the submandibular duct, which runs forwards in the floor of the mouth. To see the duct, and also to see the third salivary gland, the sublingal gland, we'll look at a specimen consisting of the mandible, the tongue, and the floor of the mouth. We'll remove the alveolar process, and we'll remove the mucous membrane.

40.46

Here, just beneath the mucous membrane, is the sublingual gland which we'll see in a moment. For now, we'll remove it too, to see the submandibular duct. The submandibular duct runs forward in the floor of the mouth alongside the base of the tongue. It ends here, just beside the frenum. To see where it starts we'll go round to the back.

41.12

Here's the submandibular duct, here's the submandibular gland. The duct passes forward in the interval between the mylohyoid muscle, and the muscles of the side of the tongue, the hyo- and styloglossus muscles.

41.26

Now we'll go round to the front again, and put the sublingual gland back in the picture. The sublingual gland is thin, flat, and somewhat diffuse. It lies alongside the base of the tongue, just lateral to the genioglossus muscle.

41.45

The saliva formed by the sublingual gland enters the oral cavity by way of several very small openings in the mucous membrane of the floor of the mouth. The openings are too small to see.

41.59

THYROID AND CRICOID CARTILAGES

Now that we've looked at the salivary glands, we'll move on to complete our picture of the structures around the oral cavity, by looking at the pharynx. To understand the lower part of the pharynx we need to look at two important structures that we haven't seen yet, the thyroid cartilage, and the cricoid cartilage.

42.18

The thyroid cartilage is here, below the hyoid bone. The cricoid cartilage is here, just below the thyroid cartilage.

42.29

Here are the thyroid cartilage and the cricoid cartilage together. The cricoid cartilage is partly enclosed by the larger thyroid cartilage. We'll look at the thyroid cartilage first.

42.48

The thyroid cartilage consists of two slightly curved plates, the laminae. The laminae are joined together in front. They're widely separated behind. The laminae meet at an angle of 120º in the female, 90º in the male. This is a female specimen. In the male, the thyroid cartilage projects forwards, giving rise to the laryngeal prominence, also known as the "adam's apple".

43.19

Above, the two laminae meet in a V-shaped notch, the superior thyroid notch that's easy to feel just above the laryngeal prominence. On the sides of the lamina are two projections, the superior and inferior tubercles. They're joined by this slight ridge, the oblique line, which is a major muscle attachment, as we'll see.

43.43

The posterior border of each lamina is prolonged upward and downward to form two projections, the superior horn, and the inferior horn. The superior horn points upwards and backwards, the inferior horn points downwards.

44.02

The thyroid cartilage hangs directly below the hyoid bone. The upper border of the thyroid cartilage has the same curvature as the arch of the hyoid bone. The thyroid cartilage is suspended from the hyoid bone by this membrane, the thyro-hyoid membrane. On each side the posterior part of the membrane is thickened forming the lateral thyrohyoid ligament.

44.29

The inferior horn of the thyroid cartilage articulates with the cricoid cartilage at the cricothyroid joint. Unlike the thyroid cartilage, which is open at the back, the cricoid cartilage forms a complete ring. Let's look at the cricoid cartilage by itself. It's much taller behind, than in front.

44.59

The narrow part in front is the arch, the tall part behind is the lamina. The inferior horn of the thyroid cartilage articulates here. Below, the cricoid cartilage is continuous with the upper end of the trachea.

45.18

The cricoid and thyroid cartilages form the framework for the larynx. We'll see them in that context in the next section of this tape. We're concerned with them in this section because they also give attachment to some important muscles of the lower part of the pharynx. Now that we've seen them, let's look at the pharynx.

35.37

PHARYNX

To get a view of the pharynx from the side, we'll start with a dissection in which all the neck muscles are present. The only parts of the pharynx we can see are here, and here.

45.54

To get a better view we'll remove the sternocleidomastoid muscle. We'll also remove all the underlying nerves and blood vessels. Here, just in front of the vertebral column, are the longus capitis and longus cervicis muscles.

46.13

Here, below them, are the scalene muscles. Here's the lower half of the pharynx. The pharynx lies just in front of the longus muscles. To see the whole of the pharynx, from behind, we'll remove the vertebral column and all the neck muscles.

46.32

Here's the pharynx. The pharynx extends from the base of the occiput, to the level of the top of the clavicle. The upper part of the pharynx is partly hidden by the digastric muscle, which we'll remove.

46.49

The upper part of the pharynx is hidden also by the styloid process, and the three muscles that descend from it, stylohyoid which we'll remove, and two other slender muscles, which we'll meet shortly, styloglossus, and stylopharyngeus. For now, we'll remove them too, along with the styloid process.

47.15

Now we can finally get a clear view of the whole of the pharynx. Here above the pharynx is the base of the occiput. These are the occipital condyles. Here's the medial pterygoid muscle, sloping downwards from the medial pterygoid plate, which is here.

47.37

The wall of the pharynx is formed by an almost continuous layer of muscle, lined by mucous membrane. The muscular layer consists of three sheets of muscle, the constrictor muscles, superior, middle, and inferior. These overlap behind, the one above inside the one below. Here's the inferior constrictor, here's the middle constrictor, here's the superior constrictor.

48.09

The superior constrictor is very thin. Its fibers arise from the lower part of the medial pterygoid plate, the hamulus, and the pterygo-mandibular band, and also from the side of the tongue.

48.28

The superior constrictor has a free upper border. Above this the wall of the pharynx is formed by this layer of fascia, the pharyngo-basilar fascia. The highest fibers of the superior constrictor insert on the base of the occipital bone. The remaining fibers meet in the midline with the fibers from the opposite side, extending down inside the middle constrictor.

48.52

Here's the middle constrictor. It's a thicker muscle. The middle constrictor arises from the lesser horn, and the greater horn of the hyoid bone. Here's the tip of the greater horn of the hyoid bone, heres the edge of the lateral thyrohyoid ligament. The fibers of the middle constrictor fan out, meeting with those of the opposite side, from here, down to here inside the inferior constrictor.

49.21

Here's the upper border of the inferior constrictor. It's thicker again than the middle constrictor. The inferior constrictor arises from just behind the oblique line on the thyroid cartilage, and also from the side of the cricoid cartilage. Its fibers fan out, meeting with the fibers from the other side all the way from here, down to here.

49.51

The lower end of the inferior constrictor muscle is continuous with the muscular coat of the esophaus. The lowest part of the inferior constrictor, which is functionally separate from the rest of the muscle, is referred to as the cricopharyngeus muscle. It forms a sphincter round the upper end of the esophagus,

50.10

To complete our picture of the upper part of the pharynx, we'll put the styloid process back, along with two of its three muscles. The longer one is styloglossus, the shorter one is stylopharyngeus.

50.27

Stylopharyngeus runs down outside the superior constrictor, and passes into the wall of the pharynx between the superior and middle constrictors. Styloglossus passes downwards and forwards alongside the superior constrictor, and enters the posterior part of the tongue, joining with hyoglossus.

50.49

To complete our picture of the pharynx we'll look at a specimen that's been divided in the midline. Looking at the pharynx from the inside will also let us see the muscles of the palate that we left out of the picture in the previous section.

51.08

Here's the pharynx. Throughout its length, the back wall of the pharynx lies just in front of the vertebral bodies and the longus muscles, with a layer of loose fascia in between that permits movement. The pharynx opens forwards into the nasal cavity, the oral cavity, and the larynx.

51.36

Up here, it opens laterally into the auditory tube as we've seen. Down here it opens downward into the esophagus. The pharynx is often described in three parts, the nasopharynx, which we've looked at already, the oropharynx, and the hypopharynx, also sometimes called the laryngopharynx.

51.57

The muscles of the palate that we haven't seen yet lie directly beneath the mucosa, which we'll remove.

52.08

Here's palatoglossus. It arises here from the palatal aponeurosis, and passes downwards and forwards to insert on the side of the tongue. Palatoglossus pulls the soft palate downward and forward.

52.24

Here's palatopharyngeus. It arises partly from the edge of the hard palate, partly from the palatal aponeurosis. Palatopharyngeus passes downwards and backwards to blend with an almost continuous layer of longitudinal muscle that lines the lower part of the pharynx. The lowest fibers of palatopharyngeus insert here, on the posterior border of the thyroid cartilage.

52.50

The palatoglossus muscle lies inside the constrictor muscles, hiding them almost completely in this medial view. From here we only see the upper part of the superior constrictor.

53.01

We'll take a closer look at it. Here's the upper free border of the superior constrictor muscle. Coming in towards us from above are structures we met earlier in this tape, the levator palati muscle, the tensor palati muscle, and the cartilage of the auditory tube.

53.23

Now, let's review what we've seen of the oral cavity, the muscles of the cheek and lips, the teeth, the salivary glands, and the pharynx.

53.36

REVIEW

Here are the gingivae, the hard palate, the soft palate, and the uvula.
53.50

Here are the palatoglossal arch, and the palatopharyngeal arch. Here’s the tonsil. Here’s the pterygo-mandibular band, the buccinator muscle, and the orbicularis oris muscle.
54.06

Here are the teeth: the incisors, the canine, the premolars, and the molars. Here’s the crown of the tooth, the root, and the apex. Here’s the neck, here’s the pulp cavity, here’s the apical canal, and the periodontal membrane.
54.28

Here’s the parotid gland, and the parotid duct. Here’s the submandibular gland, and its duct. Here’s the sublingual gland.
54.39

Here’s the thyroid cartilage, here’s the cricoid cartilage. Here are the superior constrictor, the middle constrictor, and the inferior constrictor.
54.51

Here’s styloglossus, and stylophyaryngeus. Here’s palatoglossus, and palatopharyngeus.
55.02

That brings us to the end of this long section on the oral cavity and the structures that surround it. In the next section we'll look at the larynx and its surrounding structures.
55.19

END OF PART 4

PART 5

THE LARYNX AND ITS SURROUNDINGS

00.00

The larynx controls the passage of air into and out of the trachea. The muscles of the larynx can both open and close the airway. In addition the muscles of the larynx adjust the length and tension of the vocal folds, leading to the production of voice sounds.

00.24

INTRODUCTION, LARYNGEAL OPENING

We'll start by seeing where the larynx is, and what it looks like from behind and from above. Next we'll look at the cartilages of the larynx and the vocal ligaments. Then we'll look at the muscles, and the movements they produce. At the end of this section we'll also see the infrahyoid muscles that are in front of the larynx, and the thyroid gland that's just below it.

00.48

We'll start by looking at the front front of the neck with just the skin and subcutanous tissue removed. We'll remove the sternocleidomastoid muscles, and the clavicles, and we'll also remove these slender muscles, the infrahyoid muscles. We'll see them later. This is the thyroid gland. We'll see it later too. For now, we'll remove it.

01.15

Here's the thyroid cartilage, here below it is the cricoid cartilage, hidden by the cricothyroid muscle. These two cartilages form the framework of the larynx. The thyroid cartilage is suspended from the hyoid bone, which is here, by the thyrohyoid membrane. Below, the cricoid cartilage is continuous with the upper end of the trachea.

01.40

Here on each side this sleeve of connective tissue, the carotid sheath, contains the major blood vessels of the head and neck. We'll remove the carotid sheaths.

01.52

We'll also remove the musculo-skeletal structures behind and below the larynx. Here's the trachea, here's the esophagus, here's the lower part of the pharynx. To see the larynx from behind, we'll remove the posterior wall of the pharynx.

02.10

Here's the opening to the larynx, the superior laryngeal aperture. It faces almost directly backwards. The opening is formed in front by the epiglottic cartilage, on each side by this fold of soft tissue, the ary-epiglottic fold, and behind by two important structures that we'll meet in a minute, the arytenoid cartilages. The space that's lateral to the ary-epiglottic fold is the piriform recess. Here in front of the epiglottis is the back of the tongue. The space between the tongue and the epiglottis is the vallecula.

02.50

To see the larynx from inside we'll look at a specimen that's been divided in the mid-line. Here's the epiglottis, here's the ary-epiglottic fold. Here's the divided thyroid cartilage, and the divided arch and lamina of the cricoid cartilage.

03.16

The important features of the wall of the larynx are this small side cavity, the vestibule, and these two folds in the mucous membrane, the vestibular fold above, and the vocal fold below. Just beneath the mucosa of the vocal fold is an important structure, the vocal ligament, which we'll see shortly.

03.37
Here’s the larynx in the living body, seen from above with an endoscopic camera. Here’s the epiglottis, here's the left ary-epiglottic fold. Here are the vestibular folds, here are the vocal folds, here between them, we’re looking down through the vocal opening into the trachea.
04.01
To get a preview of the muscles of the larynx, we’ll remove the mucous membrane from here, down to here. Some of the muscles of the larynx are visible here, others are hidden by the thyroid cartilage. We’ll see these muscles later in this section.
04.19

LARYNGEAL CARTILAGES

Before we look at the muscles, we need to take a further look at the cartilages of the larynx, then we need to understand the vocal ligaments, and the vocal opening.
04.30
In looking at the cartilages, we’ll first revisit the thyroid and cricoid cartilages, which we saw in the last section, then we’ll add to our picture the epiglottic cartilage, and the small but important arytenoid cartilages.
04.45
We took a good look at the thyroid cartilage, and the cricoid cartilage in the last section. As we saw, the two cartilages articulate here. When the arch of the cricoid moves up and down, the top of the lamina moves backward and forward. The two cartilages are held together at the front by the strong crico-thyroid membrane, which is part of a larger structure, as we’ll see later.
05.16
Now we’ll add the epiglottic cartilage to the picture. The epiglottic cartilage is shaped like a leaf, with a slender stem that’s attached here to the thyroid cartilage.
05.30
The epiglottic cartilage is also attached to the body of the hyoid bone by fibrous tissue that runs through this pad of fat. The epiglottic cartilage is covered by mucous membrane here on the back, and on the front down to here. The epiglottic cartilage is highly flexible.
05.50
Next we’ll add the arytenoid cartilages to the picture. Here they are. The arytenoid cartilages, which are highly mobile, sit on top of the lamina of the cricoid cartilage, just to each side of the mid-line. They articulate with the cricoid cartilage at these two surfaces.
06.11
Here’s the right arytenoid cartilage seen from behind. This tall upward projection is the colliculus. This pointed forward projection is the vocal process. The vocal ligament is attached here.
06.29
On the underside, this inward facing surface articulates with the cricoid cartilage. Next to the articular surface, this projection on the lateral aspect is the muscular process.
06.43
Muscles are attached to the muscular process, and also to the lateral border, and to this broad convex surface, which faces forwards. The top of the colliculus is prolonged by this tiny corniculate cartilage, which faces backwards.
06.59
In the intact larynx the arytenoid cartilages are here. When seen from the side, the arytenoid cartilage is here, with the vocal process just in line with the vocal fold. The arytenoid cartilages can move laterally, and medially, and they can rotate about

a vertical axis. When the muscular process moves backward and forward, the vocal process is abducted, and adducted.

07.37

VOCAL LIGAMENTS, VOCAL OPENING

Now that we've looked at the skeleton of the larynx, it's time to get acquainted with the vocal ligament and the vocal opening. To see the vocal ligament, we'll look at a specimen in which the lamina of the thyroid cartilage, has been removed on the right side.

07.53

Here are the vocal processes of the arytenoid cartilages. We'll add the vocal ligaments to the picture. Here they are. The vocal ligaments run from the thyroid cartilage in the mid-line, to the tips of the vocal processes of the arytenoid cartilages. They're fixed in front, and highly mobile behind. Their tension is affected by the tilt of the cricoid cartilage.

08.19

The gap between the vocal ligaments is affected by rotation of the arytenoid cartilage. The vocal ligament isn't an isolated structure. It's the free upper border of this cone-shaped sheet of membrane, the conus elasticus.

08.40

The conus elasticus is attached below, all the way along the upper border of the cricoid cartilage. Its upper border, which is free from here to here, forming the vocal ligament is attached further back to the arytenoid cartilage. The anterior part of the conus elasticus is firmly attached to the thyroid cartilage, forming the crico-thyroid ligament, which we saw earlier.

09.07

Here's the right half of the larynx with the mucous membrane intact.
The conus elasticus is just beneath the mucous membrane, here. The mucous membrane is closely attached to the vocal ligament, and also to the inner aspect of the arytenoid cartilage.

09.28

At the level of the vocal folds, there's a narrowing betwen the walls of the larynx. Its anatomical name is the rima glottidis, but in this tape we'll refer to it as the vocal opening. Its shape is extremely variable, depending on the movements of the arytenoid cartilages.

09.46

Here's the vocal opening in a living person, seen from above. In quiet breathing the opening is diamond shaped. When we breathe deeply it widens to a triangle. When we speak or sing it narrows to a slit. When we hold our breath, it closes completely.

10.06

MUSCLES

Now we'll look at the muscles that produce movement betwen the cartilages of the larynx. First we'll see the cricothyroid muscle, then the two crico-arytenoid muscles, then the thyro-arytenoid, transverse arytenoid and ary-epiglottic muscles. Here are the thyroid and cricoid cartilages with all the muscles removed.

10.31

We'll add the crico-thyroid muscle to the picture. Here it is. The cricothyroid muscle arises from here on the cricoid cartilage. It inserts on the thyroid cartilage partly here on the lower border, and partly here, on the inner aspect of the lamina..

10.52

The cricothyroid muscle pulls the arch of the cricoid cartilage upwards. In doing so, it pulls the arytenoid cartilages backwards, making the vocal folds longer and tighter.

11.06

To see the remaining muscles, we'll remove this half of the thyroid cartilage, together with the cricothyroid muscle. Here are the internal laryngeal muscles. To begin understanding them, we'll take them all out of the picture for a moment.

11.25

Here's the cricoid cartilage, here's the arytenoid cartilage. Here's the conus elasticus. The vocal ligament is up here. This is the mucosa of the vestibule. The first muscles to add are the two crico-arytenoid muscles. Here's the posterior one, here's the lateral one.

11.54

They both converge on the muscular process of the arytenoid cartilage. The posterior crico-arytenoid muscle arises from here on the back of the lamina of the cricoid cartilage.

12.05

The lateral crico-arytenoid muscle arises from the upper border of the cricoid cartilage. The posterior crico-arytenoid pulls the muscular process backwards. This rotates the arytenoid cartilage, thus widening the vocal opening.

12.25

The lateral crico-arytenoid muscles pulls the arytenoid cartilage forwards and laterally, producing a maximal widening of the back of the vocal opening.

12.37

The crico-arytenoid muscles act to widen the vocal aperture in two different ways. The next two muscles that we'll see, the thryro-arytenoid and transverse arytenoid muscles, act to shorten and narrow the vocal opening.

12.53

We'll add the thyro-arytenoid muscle to the picture first. Here it is. The thyro-arytenoid muscle arises from here on the inner aspect of the thyroid cartilage. It inserts here in front of the lateral border of the arytenoid cartilage.

13.13

Next we'll add the transverse arytenoid muscle. Here it is. The transverse arytenoid muscle, also called the arytenoideus, is a sheet of muscle that bridges the gap between the posterior surfaces of the two arytenoid cartilages.

13.30

Let's see how these two muscles work. Contraction of the thyro-arytenoid muscle rotates the arytenoid cartilage inward and pulls it forward, along with the cricoid cartilage. This action slackens the vocal ligaments, and shortens the vocal opening from font to back.

13.48

Contraction of the transverse arytenoid muscle brings the two arytenoid cartilages closer together, thus closing the posterior part of the vocal opening.

14.00

The sphincter action of the last two muscles is augmented by a pair of slender muscles that pass upward toward the epiglottis, the ary-epiglottic muscles. These begin behind the transverse arytenoid muscle, cross the mid-line, and extend upward and forward a little below the ary-epiglottic fold.

14.22

Acting together, the thyro-arytenoid, transverse arytenoid and ary-epiglottic muscles act as a sphincter that can completely close the larynx. We close our larynx every time we swallow, cough, and hold our breath.

14.40

The most medial part of the thyro-arytenoid muscle, which is attached to the vocal ligament, has a special function. It's known as the vocalis muscle. It makes fine adjustments to the tension of the vocal ligament.

14.53

INFRAHYOID MUSCLES, THYROID GLAND

We'll end this section on the larynx by looking at the structures that are close to it in front and below: the infrahyoid muscles and the thyroid gland. In addition, we'll see the parathyroid glands.

15.09

Here again are the thyroid cartilage, the cricoid cartilage, and the trachea. These are the rings of cartilage which reinforce the wall of the trachea. We'll add the carotid sheaths to the picture

15.24

Here, just on each side of the trachea, are two of the four parathyroid glands. They're recognizable by their brownish color. The other two parathyroid glands are further down.

15.38

Next, we'll add the thyroid gland to the picture. Here it is. This is the left lobe of the thyroid gland, this is the right lobe. The two lobes are connected across the mid-line by the isthmus. The top of each lobe of the thyroid gland is level with the lower border of the thyroid cartilage. The top of the isthmus is about level with the third ring of the trachea.

16.07

Now we'll add the four infrahyoid muscles to the picture, starting with the two deepest ones, the thyrohyoid, and the sternothyroid muscles.

16.18

In effect they're one continuous muscle. The thyrohyoid arises from the back of the body of the hyoid bone, and inserts on the oblique line of the thyroid cartilage. The sternothyroid arises from the same oblique line, and passes down behind the upper end of the sternum. It inserts on the back of the sternum, down here.

16.39

Now we'll add the other two infrahyoid muscles to the picture, the omohyoid, and the sternohyoid. The omohyoid muscle arises here, the sternohyoid here on the body of the hyoid bone.

16.54

The sternohyoid runs straight downwards, close to the mid-line, and inserts on the back of the sternum, here. The omohyoid muscle runs downwards, laterally and backwards.

17.06

It lies in front of the carotid sheath, and the brachial plexus, which is under here. The omohyoid muscle passes beneath the trapezius muscle, to insert on the upper border of the scapula.

17.20

Finally, we'll return the clavicles, and the sternocleidomastoid muscles to the picture. In looking at the intact neck, it's useful to remember that when the neck isn't extended, the bottom of the cricoid cartilage imay be no higher than the top of the clavicle.

17.39

Now, let's review what we've seen of the larynx and its surroundings.

17.444

REVIEW

Here’s the thyroid cartilage, heres the cricoid cartilage, here’s the arytenoid cartilage, with its colliculus, vocal process, and muscular process.

18.05

Here’s the trachea, here’s the crico-thyroid ligament, here’s the conus elasticus, here are the vocal ligaments. Here’s the epiglottis, the ary-epiglottic fold, the vallecula, and the piriform recess. Here’s the vestibule, the vestibular fold, and the vocal fold.

18.30

Here’s the crico-thyroid muscle, the crico-arytenoids, posterior, and lateral, the thyro-arytenoid muscle, and the transverse arytenoid muscle. Here are the parathyroid glands, and the thyroid gland. Here are the thyrohyoid sternothyroid, omohyoid, and sternohyoid muscles.

18.59

That brings us to the end of this tape, “The Head and Neck Part 1”. In the next tape we’ll look at the face, the brain, the blood vessels and nerves of the head and neck, the eye, and the ear.

19.20

END OF VOLUME 4

Acland's DVD Atlas of Human Anatomy

Transcript for Volume 5

PART 1

THE FACIAL MUSCLES AND THE SCALP

00.00

This tape is the second of two that describe the head and neck. In it, we'll look first at the facial muscles and the scalp, then at the brain and its surroundings, then at the nerves and blood vessels of the head and neck, then at the eye, and the ear.

00.18

FACIAL MUSCLES

We'll start by looking at the face. Some important parts of the face, the nose and the orbit, are covered separately in these two tapes. In this section we'll focus on the facial muscles, which produce the movements of facial expression. We'll go from above down, starting with the muscle that closes the eye, the orbicularis oculi.

00.39

All this is the orbicularis oculi. It surrounds the opening between the upper and lower lids, the palpebral aperture. Orbicularis oculi has an inner or palpebral part, and an outer or orbital part. The palpebral part is extremely thin, the orbital part is more substantial

01.03

Orbicularis oculi arises medially from this underlying structure, the medial palpebral ligament, and from the bone above and below it. Its fibers pass above and below the palpebral aperture, joining with each other here.

01.19

When the palpebral part of the muscle contracts, the eyelids close gently. When the whole muscle contracts, they close tightly. Opening the eye is caused by elastic forces acting on the lower lid, and by a more deeply placed levator muscle acting on the upper lid, that we'll see later in this tape.

01.39

Now we'll move down to look at the muscles around the mouth and the nose. The opening between the lips, the oral commisure, is surrounded by the orbiculartis oris muscle. Here's part of it. The orbicularis is joined and overlaid by several other facial muscles which we'll remove from the picture for a moment.

02.01

Here's the orbicularis oris by itself. Its more superficial fibers encircle the oral commisure, some of them arising from bone here. Its deeper fibers are continuous with those of the buccinator muscle, as we saw in the previous tape. The action of orbicularis oris is to close the oral commisure, and press the lips together.

02.25

The deep hollow here between the buccinator and masseter muscles is filled with this buccal fat pad, which is continuous with the fat that covers the front of the cheek.

02.39

Now we'll return to the picture all except one of the muscles that pull on the orbicularis oris. Pulling on it from above and behind is the zygomaticus major, which arises from here on the zygomatic bone. Pulling on it from behind is the risorius muscle. We use both these muscles when we smile.

03.00

Pulling on the orbicularis from above are zygomaticus minor, absent in this instance, levator anguli oris, and levator labii superioris. These arise from here on the maxilla. Together they raise the upper lip.

03.18

The most medial corner of levator labii superioris, which goes by this very impressive name, [levator labii superioris alaequae nasi] attaches to the alar cartilage of the nose. It does this. Here on the side of the external nose is the nasalis muscle. It helps to wrinkle the nose.

03.35

The three muscles that join the orbicularis from below are quite hard to tell apart. They're depressor anguli oris, depressor labii inferioris, and mentalis.

03.37

The last two run into one another, and are embedded in this mass of fat and fibrous tissue which forms the prominence of the chin. These three muscles arise from here on the mandible. Between them they pull the lower lip downward, and pucker the chin.

04.03

The last muscle we'll add to the picture, the platysma, lies partly in the face but mainly in the neck. Here's the neck as we saw it in the last tape, without the platysma. Here are the sternocleidomastoid muscle, the infrahyoid muscles, and the digastric muscle.

04.23

Now we'll add the platysma to the picture. All this is platysma. It lies within the subcutaneous fascia of the neck. Its lowest fibers extend below the clavicle, onto the chest. Platysma has a free posterior border here, and a free anterior border here near the midline.

04.48

Most of the fibers of platysma insert here along the border of the mandible, but its more posterior fibers cross the mandible, and insert into the orbicularis oris muscle complex. The platysma muscle pulls the corner of the mouth downwards and backwards, producing these ridges to appear beneath the skin.

05.07

SCALP

Now we'll move on to look at the scalp. To understand the scalp we'll start with a dissection in which all its layers have been removed, exposing the skull.

05.16

The dome of the skull, known as the calvaria, is formed by bones that we've seen in the previous tape, the frontal, parietal, and occipital, bones, and on the side by the squamous part of the temporal bone. The temporal bone is covered by the investing deep fascia of the temporalis muscle.

05.39

Overlying the calvarium is a layer of loose connective tissue, the areolar layer. It overlies the deep temporal fascia, too. The areolar layer separates the bone from the next layer that we'll add, the assembly of structures known collectively as the epicranium. The epicranium is formed partly by tendon, partly by muscle. To see it better, we'll add all of it to the picture.

06.12

Over the dome of the skull the epicranium is formed by a sheet of tendon that's known as the galea, or galea aponeurotica. Two muscles are attached to the galea, in front, the frontalis, and behind, the occipitalis.

06.32

The occipitalis muscle arises from here on the occipital bone, above the superior nuchal line. It inserts into the galea. The frontalis muscle arises from the galea, and inserts into the skin of the lower part of the forehead, close to the eyebrow.

06.54

These two muscles produce important movements of facial expression. When occipitalis and frontalis act together, the eyebrows rise. When frontalis acts by itself, the forehead is pulled downward in a frown.

07.11

The full effect of a frown comes from the added effect of these not very separate muscles, depressor supercilii and procerus, and by the more deeply placed corrugator supercilii, which pulls the eyebrow medially causing these vertical wrinkles.

07.32

On the side of the head, the epicranium is formed by this area of dense connective tissue, the superficial temporal fascia. In some individuals, as in this this different specimen, the epicranium includes the vestigial auricularis muscles, which can move the external ear.

07.57

Now we'll add the more superficial part of the scalp to the picture. Firmly attached to the epicranium is a layer of fibrous tissue interlaced with fat. Above this is the hair bearing skin of the scalp. These are the hair follicles, which extend through the thickness of the skin.

08.22

That brings us to the end of this brief section. Now, let's review what we've seen of the facial muscles and the scalp.

08.30

REVIEW

Heres the orbicularis oculi: its palbebral part, and its orbital part. Here's orbicularis oris. Here are the risorius, zygomaticus major, levator anguli oris, levator labii superioris and nasalis muscles. Here are depressor anguli oris, depressor labii inferioris, and mentalis, and here's platysma.

09.06

Here's the areolar layer of the scalp, here's the epicranium, consisting of the galea, the frontalis, and occipitalis muscles, and the superficial temporal fascia. Here are the procerus, the depressor, and the corrugator supercilii.

09.29

That brings us to the end of this section on the facial muscles and the scalp. In the next section we'll move on to look at the brain.

09.42

END OF PART 1

PART 2

THE BRAIN AND ITS SURROUNDINGS

00.00

In this section we'll first take a brief look at the shape of the brain and its main parts, then we'll look at the cavity that contains it and the layers of tissue that surround it, then we'll return to the brain itself and look at it in more detail.

0020

BRAIN: INITIAL OVERVIEW

Here's the brain. Much the largest part of the brain is the cerebrum. The cerebrum is partly divided in the mid-line into two cerebral hemispheres. Below the cerebrum and separate from it is the smaller cerebellum. The cerebrum and the cerebellum both grow out of the brainstem. The brainstem becomes continuous below with the spinal cord. The brain is contained within the cranial cavity.

00.56

CRANIAL CAVITY AND MENINGES

Here's the cranial cavity in a dry skull. It's almost the same shape as the brain. As we saw in the last tape, two big steps divide the floor of the cavity into three parts.

01.10

The sphenoid ridges separate the anterior cranial fossa from the middle cranial fossa. This part of the cerebrum, the frontal lobe, occupies the anterior cranial fossa, this part, the temporal lobe occupies the middle cranial fossa.

01.27

The petrous temporal bones separate the middle cranial fossa from the posterior cranial fossa. The posterior cranial fossa contains the cerebellum and the brainstem. Here's the foramen magnum.

01.41

Now let's see how the cranial cavity looks in the living body. The cranial cavity is lined throughout by this layer of tough, shiny fibrous tissue, the dura.

01.53

Below, the layer of dura passes through the foramen magnum, becoming continuous with the dura that lines the vertebral canal. Two important extensions of the dura create partitions within the cranial cavity. They're the falx and the tentorium.

02.11

Here's the tentorium. Its full name is tentorium cerebelli. It separates the posterior cranial fossa from the rest of the cranial cavity, and separates two major parts of the brain, the cerebrum above from the cerebellum below.

02.31

This opening in the tentorium is called the tentorial incisure. The brain stem passes through it. The tentorium is attached along this lie on the occipital bone, and along the edge of the petrous temporal bone. Its attachment ends at the posterior clinoid process.

02.53

The upper surface of the tentorium is continuous with the dura of the floor of the middle cranial fossa. In the midline, the tentorium is attached to the other major partition, the falx, which we'll add to the picture.

03.07

This is the falx. Its full name is falx cerebri. The falx forms a mid-line partition between the two cerebral hemispheres. Here's its attachment to the tentorium.

03.23

Along its length it's attached to the occipital, parietal and frontal bones. Here in front the falx is attached to the crista galli. To see the falx in cross section we'll divide it along this line.

03.39

Near its attachment the falx splits into two layers, leaving a triangular space for the superior sagittal sinus, an important part of the brain's venous drainage system, as we'll see later in this tape.

03.53

Now we'll move on to look at the layers of tissue that give the brain a protective covering, and maintain its special fluid environment. These three layers, the dura, the arachnoid and the pia, are collectively called the meninges. We've already taken an inside look at the outer layer, the dura.

04.11

To see the two inner layers, the pia and the arachnoid, we need to add the brain itself to the picture. We're looking at the right cerebral hemisphere. The blood vessels on its surface have been filled with red latex. The surface of the brain is richly folded. An outward fold is called a gyrus, an inward fold is a sulcus.

04.36

The pia is almost invisibly thin. It's just the glossy surface that we see here. To see the extent of the pia we'll look at a frontal section. Here's a typical sulcus. The pia extends down into each sulcus, and back up onto the next gyrus. Each sulcus contains blood vessels which lie just outside the pia. Each vessel that enters the brain carries a sleeve of pia with it.

05.08

Now we'll add the arachnoid to the picture. This is the arachnoid. It's a delicate transparent membrane. Here's the arachnoid again. Unlike the pia, the arachnoid doesn't extend into the sulci. It bridges over, from one gyrus to the next. In this specimen the subarachnoid space is empty. Here we're injecting water to fill it.

05.45

Over most of the brain the subarachnoid space is narrow, but in a few places it's quite wide, notably here below the cerebellum, here above the cerebellum, and here in front of the top of the brainstem. These spaces are called cisterns.

06.02

Outside the arachnoid is the dura. We'll add it to the picture. The dura is a much tougher layer of tissue than either the pia or the arachnoid. The dura has almost no attachment to the arachnoid. The dura can be separated from the overlying bone, but is normally quite closely attached to it.

06.28

Now we'll add the rest of the dura to the picture. Here's the intact dura. These branches of the middle meningeal artery, which runs in the thickness of the dura.

06.42

To look at the openings in the dura, we'll again look at it from the inside in an empty skull. The vessels and nerves that enter and leave the cranial cavity pass though openings in the dura. At each opening the dura forms a tunnel around the nerve or vessel for a short distance.

07.02

Typically a nerve or a blood vessel runs beneath the dura for a distance between its opening in the dura and its opening in the bone, so the openings in the dura often don't match the openings in the bone. The difference between dural and bony openings is specially marked here in the middle cranial fossa.

07.22

As we saw in the previous tape, the bone here has many openings. By contrast the dura here has no openings. The corresponding openings in the dura are either up here, or back here.

07.37

As we'll see in later sections the central part of the middle cranial fossa is a specially busy area. Let's take a further look at it.

07.48

In the dry skull this hollow, the pituitary fossa, is partly enclosed by these four bony projections, the clinoid processes. In the living body the dura bridges over the roof of the pituitary fossa, leaving this round opening. The clinoid processes are here.

08.09

The pituitary fossa, which contains the pituitary gland, is lined with dura. Just lateral to the pituitary fossa is the cavernous sinus, which is hidden beneath the dura here.

08.22

This opening in the dura, which is for the trigeminal nerve, leads into a side cavity under here, the trigeminal cave, which is occupied by the trigeminal ganglion.

08.33

We'll see more of this busy area later in this tape, when we look at the vessels and nerves. Now we're almost ready to move on to look at the brain. Before we do that, let's review what we've seen of the cranial cavity and the meninges.

08.49

REVIEW

Here are the sphenoid ridges, and the petrous temporal bones, the anterior cranial fossa, middle cranial fossa, and posterior cranial fossa. Here's the dura on the outside, and on the inside.

09.17

Here are the falx, the tentorium, and the tentorial incisure. Here's the arachnoid, here's the pia. Here are the cisterns.

09.35

Here are the clinoid processes, and the pituitary fossa in the dry skull. Here are the same structures in a dissected specimen. Here's the site of the cavernous sinus, and of the trigeminal cave.

09.58

BRAIN

Now we'll move on to look at the brain. The internal structure of the brain, which is extremely complex, lies outside the scope of this atlas. In this section we'll look at the main external features of the brain, and also at the cavities within it, the ventricles.

10.22

This model shows the shape of the ventricular system. It's formed by two small cavities in the mid-line, the third ventricle, and fourth ventricle, and two much larger cavities, the lateral ventricles, which connect to the third ventricle here. It's the third ventricle, because the lateral ventricles are counted as the first two.

10.46

The ventricles are filled with cerebrospinal fluid. We'll see more of them as we go along. To understand the external features of the brain we'll start with the central stalk, which is known as the brainstem. To look at it, we'll take the rest of the brain out of the picture.

11.07

Here's the brainstem. It consists of the medulla, the pons, and the midbrain. The brainstem contains tracts that connect the cerebrum, the cerebellum and the spinal cord; and it contains nuclei that serve basic autonomic functions. It's also the origin of nearly all the cranial nerves.

11.29

The medulla is cone shaped. It tapers down to become continuous with the spinal cord. The medulla becomes continuous with the spinal cord here at the foramen magnum.

11.42

The medulla, the pons and the midbrain are located just behind the basilar part of the occipital bone, and the dorsum sellae. The dorsal aspect of the medulla faces almost directly backwards. The back of the upper part of the medulla forms the floor of the fourth ventricle. On the model, this is the fourth ventricle, this is the floor.

12.11

This arch of tissue is the superior medullary velum, which forms the roof of this part of the ventricle. This delicate tissue, the inferior medullary velum, forms this part of the roof.

12.32

This cut surface is the attachment of the cerebellum. It's described as consisting of the superior, middle, and inferior cerebellar peduncles, which are somewhat fused together. The ventral aspect of the medulla is marked on each side by these bulges, the pyramid, and the olive.

13.00

Emerging from the ventral and lateral surfaces of the medulla are the filaments of the four lowest cranial nerves, the twelfth, the hypoglossal; the eleventh, the accessory; the tenth, the vagus; and the ninth, the glossopharyngeal.

13.19

Here's the brain stem in situ, seen from behind,. The tentorium has been removed to give us this view. Here's the cerebellum, divided in the midline. Here's the divided cerebellar peduncle. Here are the filaments of the hypoglossal nerve making their exit from the cranium.

13.44

Here are the accessory, vagus, and glossopharyngeal nerves making their exit together through one opening. Above the medulla is the pons. On each side the pons becomes continuous with the middle cerebellar peduncle.

14.02

Arising from the groove between the pons and the medulla are the next three cranial nerves. They're the eighth, the vestibulo-cochlear; the seventh, the facial; and the sixth, just visible, the abducent. The fifth cranial nerve, the trigeminal emerges from the upper part of the pons.

14.26

Here's the middle cranial fossa, here's the petrous temporal bone, here's the pons. Here are the facial and vestibulo-cochlear nerves together, here's the trigeminal nerve, here's the abducent nerve.

14.48

The part of the brainstem above the pons is the mid-brain. Features of its dorsal surface are the upper part of the roof of the fourth ventricle, the superior cerebellar peduncles, these bulges, the inferior and superior colliculi, and in the mid-line the pineal body. The fourth cranial nerve, the trochlear, emerges from the dorsum of the midbrain.

15.18

The mid-brain spreads out into these two massive columns, the cerebral peduncles, which connect the brainstem to the cerebrum.

15.30

Here are the cerebral peduncles in the intact brain. They're largely hidden by the lower parts of the cerebral hemispheres, the temporal lobes. To see the cerebral peduncles better, we'll look at a brain in which the temporal lobe, and the cerebellum have been removed.

15.56

Here are the cerebral peduncles again. Here on the outside of the cerebral peduncle are the medial geniculate body, and the lateral geniculate body, which gives rise to the optic tract. Between the cerebral peduncles the third cranial nerve, the oculomotor, emerges.

16.16

We'll return to the intact brain. Here are the two oculomotor nerves. Here are the two optic tracts. They meet at the optic chiasm. From the optic chiasm the two optic nerves emerge. They're the second cranial nerves.

16.37

Here's the brain in situ with the right cerebral hemisphere removed. Here's the corpus callosum, which joins the two cerebral hemispheres, here's the divided cerebral peduncle, here's the midbrain. Here's the floor of the middle cranial fossa. Here's the optic nerve, running forwards beneath the dura toward the optic canal. Here's the oculomotor nerve, here's the trochlear nerve.

17.11

The ventral aspect of the brain passes upwards to here, then turns a corner and continues forwards into a complicated area that we'll look at later in this section.

17.23

Now that we've looked at the brainstem, we'll move on to look at the cerebellum.

17.30

Here are the brainstem and the cerebellum together. The main functions of the cerebellum have to do with balance, motor co-ordination, and the control and monitoring of intentional movements. The cerebellum occupies most of the posterior cranial fossa. The tentorium is just above it.

17.51

To see the cerebellum better, we'll look at it by itself. The surface of the cerebellum is marked by many parallel fissures, some deeper than others. This deep primary fissure divides the cerebellum into a small anterior lobe and a large posterior lobe.

18.16

A deep groove on the underside partially divides the cerebellum into two hemispheres. These are joined by this midline mass, the vermis, which extends all the way round from the top, to the underside.

18.35

Here are the divided cerebellar peduncles, the superior one from the midbrain, the inferior one from the medulla, and the middle one As we've seen, the middle cerebellar peduncle becomes, continuous with the pons.

18.52

This cavity in the anterior aspect of the cerebellum is the most posterior part of the roof of the fourth ventricle, that's this part on the model.

19.05

Now we'll move on to look at the cerebrum. Here's the cerebrum with the brainstem attached and the cerebellum removed.

19.15

The functions of the cerebrum include the senses of, vision, hearing, smell, touch and spatial perception, and also speech and language, memory, thought and voluntary action. The cerebrum is formed mainly by the two cerebral hemispheres. These are separated in the midline by the falx, which occupies this longitudinal cerebral fissure.

19.40

Though they look hemispherical from in front, the shape of each cerebral hemisphere is more complex when seen from the side. In front this part, the frontal lobe, occupies the anterior cranial fossa. This part below, the temporal lobe, occupies the middle cranial fossa. This part behind, the occipital lobe, lies above the tentorium.

20.07

The two cerebral hemispheres are connected across the midline by the corpus callosum, which runs all the way from here in front, to here behind. The two cerebral hemispheres are connected below by the two cerebral peduncles converging on the brainstem. They're also connected by the structures of this area, the floor of the third ventricle.

20.34

To see these connecting structures better we'll look at a brain that's been divided in the mid-line. Here's the corpus callosum. This is the cerebral peduncle.

20.51

The third ventricle is here. Here's the third ventricle on the model: it's quite narrow from side to side. This is the floor of the third ventricle.

21.04

The surface of each cerebral hemisphere is richly folded. Each inward fold, or sulcus, and each outward fold, or gyrus, has a name, but here we'll name only two, the central and the lateral sulci.

21.24

This is the lateral sulcus. It's very deep. It extends all the way round to here on the underside. Here's the medial end of the lateral sulcus in the intact brain. The lateral sulcus separates the frontal lobe above from the temporal lobe below.

21.46

This long sulcus running upwards and backwards is the central sulcus. It's the only one that runs all the way to the medial surface of the hemisphere.

21.56

The cerebral hemisphere is described as consisting of four lobes, the frontal, temporal, and occipital lobes that we've mentioned already, and the parietal lobe. Between the frontal lobe and its neighbors the central and lateral sulci form natural boundaries. The other boundaries are somewhat arbitrary.

22.20

Here are the four lobes on the medial surface: frontal, parietal, occipital, and temporal. The sloping underside of the occipital lobe conforms to the upward slope of the tentorium.

22.36

Here are the two temporal lobes seen from below. This part of the tip of the temporal lobe is the uncus. The uncus lies just above the tentorial incisure, which is here.

22.54

Here on the underside of the frontal lobe is the olfactory tract. It ends in the olfactory bulb, from which the fibers of the first cranial nerve, the olfactory nerve, emerge.

23.05

Each cerebral hemisphere contains a cavity, the lateral ventricle, that's filled with cerebrospinal fluid. The lateral ventricle has an anterior horn, a body, a posterior horn, and an inferior horn. The anterior horn is in the frontal lobe, the body is in the parietal lobe, the posterior horn is in the occipital lobe, and the inferior horn curls downward and forward into the temporal lobe.

23.42

To see where the lateral ventricle communicates with the third ventricle we'll go round to a medial view. The communication is here, at the interventricular foramen.

23.55

To see how the lateral ventricle, the third ventricle, and the fourth ventricle are connected, we'll look at a brain that's been divided in the midline.

24.07

Here's a midline section through the third ventricle. Here's the third ventricle. This strand of vascular tissue in the roof of the ventricle is the choroid plexus, which produces cerebrospinal fluid. Here's the interventricular foramen, opening into the lateral ventricle.

24.27

The choroid plexus passes through the foramen, and continues into the lateral ventricle. The cerebrospinal fluid that's formed in the lateral and third ventricles passes through this narrow passage, the cerebral aqueduct, and into the fourth ventricle.

24.44

Fluid leaves the fourth ventricle through three openings, the lateral apertures (the right one is in the depths of this recess) and the medial aperture, which is in the mid-line here. It's easier to visualize the medial opening in this dissection. Here it is, in the inferior medullary velum. The lateral openings are here.

25.09

The medial opening comes out here between the cerebellum and the medulla. The lateral opening on each side comes out just below the cerebellar peduncles.

25.22

These openings lead to the subarachnoid space surrounding the brain and spinal cord. We'll see where the cerebrospinal fluid is absorbed later in this tape, when we look at the blood vessels.

25.35

We'll return now to the underside of the cerebrum, to look at the structures that form the floor of the third ventricle, which is here. Here's the optic chiasm. Behind it this tubular structure that's been divided, is the infundibulum, the stalk of the pituitary gland. These two projections are the mamillary bodies.

26.00

To see how the pituitary gland is attached to the brain we'll look at an intact specimen divided in the midline. Here's the floor of the third ventricle, here's the optic chiasm, here's the infundibulum, leading down to the pituitary gland or hypophysis. The anterior and posterior parts of the pituitary gland are quite distinct.

26.29

The pituitary gland sits in the pituitary fossa. The pituitary fossa bulges downwards into the roof of the sphenoid sinus. This area just above the pituitary stalk is the hypothalamus.

26.44

In the dissections we've seen so far, including this one, the picture has been simplified by removing the important arteries that surround the base of the brain and run in the major sulci. We'll see these later in this tape. Now let's review what we've seen of the brain.

27.07

REVIEW

Here's the cerebrum, the cerebellum, and the brainstem. Here are the medulla, the pons, and the midbrain

27.25

Here's the superior medullary velum, the floor of the fourth ventricle, and the inferior medullary velum. Here are the cerebellar peduncles, superior, middle, and inferior. Here are the pyramid, and the olive

27.47

Here are the filaments of the hypoglossal, accessory, vagus, and glossopharyngeal nerves, the vestibulo-cochlear, and facial nerves, the abducent nerve, and the trochlear nerve.

28.06

Here are the colliculi, inferior and superior and the pineal body. Here's the medial geniculate body, the lateral geniculate body, and the optic tract.

28.21

On the cerebellum, here's the primary fissure, the anterior, and posterior lobes, the vermis, and the roof of the fourth ventricle.

28.34

Here are the cerebral hemispheres, here's the corpus callosum. Here are the frontal, parietal, occipital, and temporal lobes.

28.46

Here are the oculomotor nerve, the optic chiasm, the optic nerves, the infundibulum, and the mammillary bodies.

28.59

In the model here are the lateral ventricles, the third ventricle, and the fourth ventricle. Here's the third ventricle, the interventricular foramen, the choroid plexus, the cerebral aqueduct, and the fourth ventricle. Here's the hypothalamus. Here's the infundibulum, and the pituitary gland.

29.29

That brings us to the end of this section on the brain. In the next section we'll look at the cranial nerves.

29.41

END OF PART 2

PART 3

THE NERVES OF THE HEAD AND NECK

00.00

In this section we'll look at the twelve cranial nerves, the sympathetic trunk, and the cervical nerves.

00.16

The cranial nerves are numbered by the order in which they leave the cranial cavity. Earlier in this tape we saw them emerging from the brain. In this section we'll follow the course of each nerve, look at its principal branches, and summarize its functions.

00.30

CRANIAL NERVES I - VI

We'll begin with the first six cranial nerves. The first, the olfactory, and the second, the optic transmit our senses of smell and of eyesight. The third, the oculomotor, the fourth, the trochlear, and the sixth, the abducent, are motor nerves to the eye muscles; and the fifth, the trigeminal is a large motor and sensory nerve to the face and jaws.

00.56

The first cranial nerve, the olfactory nerve is extremely short. It consists of a series of fine filaments which arise from the olfactory bulb on the underside of the frontal lobe. On each side the olfactory bulb lies here, just above the cribriform plate.

01.17

Here's a frontal section in the dry skull that goes through the cribriform plates: they're here. On each side the cribriform plate forms the narrow roof of the nasal cavity. Here's a medial view of the nasal cavity. The cribriform plate is here.

01.35

The filaments of the olfactory nerve, here they are in close-up, pass through the cribriform plate and run just beneath the mucous membrane to reach nerve endings in this olfactory area on the lateral and medial surfaces of the nasal cavity.

01.50

The next nerve we'll look at is the second cranial nerve, the optic nerve. We've seen the proximal ends of the optic nerves, emerging from the optic chiasm.

02.02

Here's the optic nerve, passing forward beneath the dura to enter the optic canal, which starts here. Here's the optic canal in the dry skull. Here on each side of the optic chiasm are the divided internal carotid arteries.

02.28

Just beneath the chiasm is the roof of the pituitary fossa: here's the divided stalk of the pituitary gland. To follow the optic nerve, we'll remove the roof of the orbit, leaving the optic canal intact. We'll remove this nerve, and the orbital fat, and these two muscles, which we'll see later.

02.58

Here's the optic nerve. It enters the orbit between the tendons of origin of the rectus muscles. It passes forwards and laterally, to enter the back of the eyeball.

03.11

Strictly speaking the optic nerve isn't a nerve, it's an extension of the brain. It's covered throughout its course by extensions of all three meningeal layers, dura, arachnoid and pia.

03.23

Here we've made a window in the dura surrounding the optic nerve. Here's the edge of the dura, here's the nerve itself, here's the arachnoid. The dura is continuous with the outer layer of the eyeball, the sclera. We'll be returning here shortly. For now we'll put the contents of the orbit back in place.

03.50

The optic chiasm is a cross-over point for optic nerve fibers. The fibers of each nerve that connect to the medial half of the retina cross over into the opposite optic tract. The fibers that connect to the lateral halves of the retinae stay on the same side.

04.08

Now we'll move on to look at the third, fourth and sixth cranial nerves: the oculomotor, trochlear, and abducent. They're motor nerves. Between them they supply the six muscles that move the eye, and also the levator of the upper lid. As we've seen, the oculomotor nerve arises between the cerebral peduncles, the trochlear nerve arises from the back of the midbrain, and the abducent nerve arises below the pons.

04.39

The bony opening that these three nerves pass through is the superior orbital fissure, but their openings in the dura quite a bit further back. The oculomotor nerve passes through the dura just alongside the posterior clinoid process, which is here. The trochlear nerve passes through the dura here, the abducent nerve down here.

05.06

To follow them we'll remove the dura over this area. We'll also remove this structure that we'll see later, the trigeminal ganglion.

05.17

This cavity that we've opened into is the cavernous sinus. In the living living body it's filled with venous blood. Within the cavernous sinus lies the internal carotid artery.

05.35

The third, fourth and sixth nerves pass forward in the lateral wall of the cavernous sinus. Here's the oculomotor, here's the trochlear, here's the abducent. All three nerves pass forward into the orbit through the superior orbital fissure, which is here.

05.54

The seven muscles in the orbit that these nerves supply are the four rectus muscles, the two oblique muscles, and the levator of the upper eyelid. The oculomotor nerve supplies five muscles, the trochlear and abducent nerves supply just one muscle each.

06.12

To follow these nerves we'll move forward to the orbit again. We'll divide and displace the two muscles in the roof of the orbit. These are the levator of the upper eyelid, levator palpebrae superioris, and beneath it, the superior rectus muscle.

06.37

Here's the optic nerve, as we've seen already. Here's the superior oblique muscle, going round its pulley or trochlea. Here are the medial rectus, and lateral rectus muscles.

06.54

We'll go round to a front view to see the nerves better. The oculomotor nerve divides into an upper and lower branch.

07.03

Here's the upper branch, supplying the levator palpebrae superioris and superior rectus muscles. To see the lower branch we'll remove the optic nerve. Here again are the medial and lateral rectus muscles, down here is the inferior rectus.

07.25

The only muscle not on view here is the inferior oblique, which is beneath the eyeball here. Here's the lower branch of the oculomotor nerve. It supplies the medial rectus and inferior rectus, and the inferior oblique muscles.

07.44

In addition, by these tiny short ciliary branches, the oculomotor nerve gives parasympathetic motor supply to muscles within the eye that cause constriction of the pupil: the sphincter pupillae and ciliary muscles.

08.00

Here's the trochlear nerve, the fourth cranial nerve. It supplies just the superior oblique muscle. Here's the abducent nerve, the sixth, supplying its one muscle, the lateral rectus, which abducts the eye.

08.19

We'll be returning to the orbit once again in just a minute, to look at branches of the fifth nerve, the trigeminal. For now we'll replace the contents of the orbit, including this nerve, the frontal nerve, which is part of what we'll come to next.

08.40

Now we'll move on, to look at the fifth cranial nerve, the trigeminal. It's the largest of the cranial nerves, and by far the most complex. It's named from the fact that it has three major branches, the ophthalmic, the maxillary and the mandibular. The main functions of the trigeminal nerve are to provide sensation to the face, the nasal cavity and the oral cavity, and to provide motor supply to the muscles of mastication.

09.08

As we saw in the last section, the trigeminal nerve emerges from the pons, and passes forwards. To follow it we'll go to an earlier stage of the dissection that we've been looking at. The trigeminal nerve passes forwards from the pons into a tunnel in the dura. The tunnel leads into a side cavity, the trigeminal cave, which we'll expose by removing the overlying dura.

09.35

Here's the trunk of the nerve. Here are its three branches: the ophthalmic, the maxillary, and the mandibular. All the sensory fibers of the trigeminal nerve synapse in this massive ganglion, the trigeminal ganglion. In relation to the dry bone, the trigeminal gangion is here.

10.03

The openings for the three branches are the superior orbital fissure for the ophthalmic, the foramen rotundum for the maxillary, and the foramen ovale for the mandibular.

10.14

The first branch of the trigeminal, the ophthalmic nerve, passes forwards through the superior orbital fissure. As it does so it divides. It gives off the frontal nerve which runs just beneath the roof of the orbit, and divides into cutanous branches which go to the forehead.

10.35

In addition the ophthalmic nerve gives rise to the lacrimal nerve, which supplies the lacrimal gland, and the nasociliary nerve, which gives off one or more ethmoidal nerves and a cutaneous branch, the infratrochlear nerve. Through two long ciliary nerves (here's one of them), the nasociliary nerve provides sensation to the eyeball,

11.07

The branches of the frontal nerve that we saw, emerge onto the face around the orbital margin, or through openings in it. The branches of the frontal nerve are the supra-orbital, the supratrochlear, and the infratrochlear.

11.27

Through these branches the ophthalmic nerve supplies the forehead, the upper eyelid, and the upper part of the nose. The ethmoid branches of the nasociliary nerve supply this part of the lining of the nasal cavity.

11.40

Now we'll move on to look at the second and third divisions of the trigeminal, the maxillary and mandibular nerves. Before we look at these two nerves, which are both quite complex, we'll spend a minute reviewing the region into which they emerge. It's a little complex too. To see it, we'll first look at a dry skull in which the zygomatic arch has been removed.

12.05

Here's the area we'll be looking at. Here's the underside of the greater wing of the sphenoid bone, here's the lateral pterygoid plate, here's the back of the maxilla. This gap between the pterygoid process and the maxilla is the pterygo-maxillary fissure. It's continuous with this gap between the maxilla and the greater wing of the sphenoid, the inferior orbital fissure. Here's the inferior orbital fissure seen from in front.

12.36

The maxillary nerve emerges here, deep in the pterygo-maxillary fissure. The mandibular nerve emerges here, behind the lateral pterygoid plate .

12.47

To get to this remote area in a dissected specimen we have to remove several major structures: first the masseter muscle, then the deep temporal fascia, then the zygomatic arch, and then the temporalis muscle, and the ramus and coronoid process of the mandible, and finally this muscle, the lateral pterygoid, together with the condyle of the mandible.

13.28

This brings us into the infratempral fossa. Before we look at the nerves, let's get oriented. Heres the underside of the greater wing of the sphenoid, here's the lateral pterygoid plate, the back of the maxilla, the pterygo-maxillary fissure, and the superior orbital fissure.

13.51

This is the medial pterygoid muscle. It slopes downwards and outwards towards its insertion on the medial aspect of the mandible. This muscle is the buccinator.

14.05

Now that we're oriented, let's look at the maxillary nerve. As we've seen, seen, the maxillary nerve runs forwards from the trigeminal ganglion, and enters the foramen rotundum, which is here.

14.20

Here's the foramen rotundum in the dry bone. We'll go round to the outside to see where it emerges. Here it is, well hidden in the pterygo-maxillary fissure. The foramen rotundum goes out of sight as we go round to a lateral view of the pterygo-maxillary fisure. Now we'll return to the dissection.

14.44

Here's the maxillary nerve, running forwards across the pterygo-maxillary fissure. As it approaches the maxilla it divides into branches. The continuing trunk of the nerve is known as the infra-orbital nerve. We'll follow it first.

15.02

The infra-orbital nerve runs forward into a bony tunnel in the floor of the orbit. It emerges again here, at the infra-orbital foramen. The infra-orbital nerve divides into palpebral, labial and nasal branches. These supply the lower eyelid, part of the nose and cheek, and the upper lip.

15.27

The branches of the maxillary nerve supply the upper teeth, the nasal cavity and palate, and the upper part of the cheek. Most of them run through tunnels in the bone. Because of this, and because they're small, they're hard to show in a dissection. To indicate where they run, we'll add lines to the picture.

15.49

The upper teeth are supplied by the superior alveolar nerves, posterior and anterior, which together form a loop.

15.16

The posterior superior alveolar nerves (in this case there are two) branch off behind the maxilla, and run down to enter tunnels in the maxilla here. The anterior superior alveolar nerve arises from the infra-orbital nerve within its tunnel, and runs downwards and forwards within the bone.

16.22

The superior alveolar nerves, anterior, and posterior, form a loop within the maxilla. From this loop dental and gingival branches arise that supply the upper teeth, and the upper gums.

16.38

The maxillary nerve also gives off palatine and nasopalatine branches that supply the palate, and parts of the nasal cavity. To see where these go we'll look at a skull that's been divided in the mid-line. The opening that's illuminated is the sphenopalatine foramen, which opens into the pterygo-maxillary fissure. The maxillary nerve enters the fissure from behind, here.

17.07

Two palatine nerves, the greater and lesser, arise from the maxillary nerve and run down through a bony tunnel that's been partly opened here. The palatine nerves emerge here, through the palatine foramen. The palatine nerves provide sensation to the palate from here to here.

17.38

In addition the greater palatine nerve has nasal branches. Together with nasal branches from the trunk of the maxillary nerve, these supply this part of the lining of the nasal cavity.

17.51

The nasopalatine nerve passes through the sphenopalatine foramen, round the front of the sphenoid sinus, and onto the nasal septum. The nasopalatine nerve supplies the nasal septum, then passes through the incisive foramen, in the maxilla, to supply the anterior part of the hard palate.

18.17

Last of all, the maxillary nerve gives off a zygomatic branch. This divides into the zygomatico-facial and zygomatico-temporal nerves. These pass through the zygomatic bone, emerging here, to supply this part of the cheek.

18.35

Now we'll move on to look at the third division of the trigeminal, the mandibular nerve. Here's the mandibular nerve leaving the trigeminal ganglion. The mandibular nerve passes downward through the foramen ovale. The foramen ovale emerges under here. The foramen is just behind the root of the lateral pterygoid plate.

19.04

Returning to the dissection, here's the mandibular nerve, branching as it emerges from the foramen ovale. The mandibular nerve has both motor and sensory branches. Its motor branches (here they are) go to the muscles of mastication: masseter, temporalis, and the pterygoid muscles. Small branches, not seen here, supply tensor tympani and tensor palati.

19.35

The other branches of the mandibular nerve are almost entirely sensory. This branch is the buccal nerve. It runs downwards and forwards to supply sensation to the cheek, both outside and inside.

19.45

This branch is the auriculo-temporal nerve. It passes deep to the neck of the mandible, which is here, then runs upwards to supply sensation to this region on the side of the head.

20.00

This leaves two major branches which run downward on the medial pterygoid muscle. They're the inferior alveolar nerve, and just in front of it, the lingual nerve.

20.12

Seen from the inside, the lingual nerve is here, the inferior alveolar nerve is here. The insertion of the medial pterygoid muscle is here. The inferior alveolar nerve follows the medial pterygoid muscle down toward the mandible.

20.31

It enters the mandible through this opening, the mandibular foramen. As it enters the bone, the inferior alveolar nerve lies just behind this projection, the lingula. To follow the course of the inferior alveolar nerve in the mandible, we'll remove the overlying bone.

20.56

Here's the inferior alveolar nerve entering its tunnel in the bone, the mandibular canal. Just before it does so it gives off this mylohyoid branch, which runs downwards in this groove to supply the mylohyoid muscle and the anterior belly of the digastric.

21.15

Passing along the mandibular canal, the inferior alveolar nerve gives off branches that supply the lower teeth and gums. A large branch, the mental nerve, emerges through the mental foramen, which is here. The mental nerve supplies the chin and the lower lip.

21.38

Now we'll look at the lingual nerve. To follow it, we'll first remove the inferior alveolar nerve, and the buccinator muscle. This brings us into the oral cavity. The lingual nerve passes close to the mandible. To follow its course, we'll remove this part of the mandible.

22.01

We'll also remove the mucosa from the side of the tongue, and the floor of the mouth. Here's the lingual nerve. Now that we can see it all, we'll follow it from the top.

22.16

Up here the divided stump of the inferior alveolar nerve has been displaced forward so that we can see an important detail. Early in its course the lingual nerve is joined by this nerve, the chorda tympani, which is a special branch of the facial nerve. The lingual nerve runs down toward the corner of the medial pterygoid muscle, passing just medial to the buttress of the mandible.

22.43

The lingual nerve passes forwards along the base of the tongue, giving off branches along its length. The lingual nerve provides common sensation, and also taste sensation, to the anterior two-thirds of the tongue. The taste fibers that travel in the lingual nerve are carried by the chorda tympani.

23.02

Now we've looked at the first six cranial nerves. Let's review what we've seen so far in this section.

23.10

REVIEW

Here are the filaments of the first cranial nerve, the olfactory, here's the second cranial nerve, the optic.

23.23

Here's the third nerve , the oculomotor: its upper division, and its lower division. Here's the fourth nerve, the trochlear, and here, out of order, is the sixth, the abducent

23.37

Here's the trigeminal nerve: the main trunk, the trigeminal ganglion, and the three divisions: the ophthalmic, the maxillary, and the mandibular. Here are the main branches of the ophthalmic: the frontal nerve, the nasociliary nerve, the lacrimal nerve.

24.01

The main branches of the maxillary: the infra-orbital, the posterior, and anterior superior alveolar; the palatine nerves, greater and lesser, the nasopalatine nerve, and the zygomatico-facial, and zygomatico-temporal nerves.

24.24

Here are the main branches of the mandibular nerve: the buccal nerve, the motor branches, the auriculo-temporal nerve, the lingual nerve, and the inferior alveolar nerve.

24.38

CRANIAL NERVES VII - XII

We'll move on now to look at cranial nerves seven through twelve. We'll begin with the seventh and eighth, the facial and vestibulo-cochlear nerves. As we've seen, these two nerves leave the brainstem just below the pons. Here's the facial, here's the vestibulo-cochlear.

25.05

To follow them we'll look at a dissection of the posterior cranial fossa, in which the cerebellum has been removed. Here's the back of the petrous temporal bone. Here are the facial and vestibulo-cochlear nerves. This is the vestibulo-cochlear nerve, this is the facial nerve. Together they pass through this opening, the internal auditory meatus.

25.31

Here's the internal auditory meatus in the dry skull. It's a short tunnel with three openings. The facial nerve passes forwards through this one, to enter its own bony tunnel, the facial canal. In the facial canal, the facial nerve has a complex course in the temporal bone, passing round the wall of the tympanic cavity, and coming out behind the styloid process, here.

26.05

To get a view of its course we've we've removed the front wall of the external auditory meatus along this line. We've also unroofed a small part of the petrous temporal bone, here. To represent the facial nerve we'll add this green wire to the picture.

26.29

Entering its canal the facial nerve passes forward briefly, then makes an abrupt U-turn called the genu and passes backward. To follow it we'll come round to the outside and look into the tympanic cavity.

26.49

The facial nerve passes backwards high in the medial wall of the tympanic cavity, above the oval window. It then turns downwards, to emerge here at the stylomastoid foramen, just behind the root of the styloid process.

27.03

On its way through the temporal bone the facial nerve gives off three branches, the greater petrosal nerve which is an autonomic branch, a branch in the middle ear to the stapedius muscle, and a special branch, the chorda tympani, represented by by this wire. The chorda tympani passes upwards on the inside of the tympanic membrane, and leaves the cranium here to join the lingual nerve.

27.35

Weve seen already that the chorda tympani transmits taste sensation from the anterior two thirds of the tongue. Now we'll follow the trunk of the facial nerve.

27.45

As we saw in the previous tape, the facial nerve passes through the parotid gland. In the dissection we'll look at now, the parotid gland gland has been completely removed. Here's the external auditory meatus, the sternocleidomastoid muscle, and the posterior belly of the digastric. Here's the styloid process.

28.08

Here's the trunk of the facial nerve, emerging from the stylomastoid foramen here. Now we'll add its branches to the picture. Between them they supply all the muscles of facial expression.

28.23

These temporal branches supply the frontalis muscle. These orbital branches supply the muscles around the eye, including orbicularis oculi. These buccal branches supply buccinator, orbicularis oris, and the muscles that move the upper lip.

28.44

These marginal mandibular branches, which pass just below the body of the mandible, supply the muscles that move the lower lip. They also supply the platysma.

28.58

In addition to supplying the muscles of facial expression the facial nerve gives this branch that supplies the posterior belly of the digastric, and the stylohyoid muscle.

29.08

Now that we've looked at the facial nerve, we'll look very briefly at the eighth cranial nerve, the vestibulo-cochlear. The vesstibulo-cochlear nerve enters the internal auditory meatus, dividing as it does so into the vestibular and cochlear nerves.

29.27

The vestibular nerve passes through this opening into the inner ear, the cochlear nerve passes through this one. The two nerves transmit our senses of balance and hearing respectively.

29.39

Let's move on to look at the last four cranial nerves. They're the glossopharyngeal, number nine, the vagus, number ten, the accessory, number eleven, and the hypoglossal, number twelve. These four nerves leave the skull close together.

29.58

Here are the ninth, tenth and eleventh nerves. The ninth and tenth nerves arise from a line of filaments that emerge from the lateral aspect of the medulla.

30.12

Here's the glossopharyngeal nerve, the ninth cranial nerve. It's quite small. Below it is the vagus, the tenth nerve, arising by one large root, and a line of smaller ones that emerge from the medulla all the way down to here.

30.28

Below the vagus, is the accessory nerve. Its full name is the spinal accessory. It arises from a procession of filaments that emerge from the spinal cord from C1 as far down as C5. The spinal accessory runs upwards through the foramen magnum to join the ninth and tenth nerves.

30.50

The hypoglossal nerve, the twelfth cranial nerve, arises more anteriorly. Here are its filaments converging. The hypoglossal nerve passes through the dura by itself, the ninth, tenth and eleventh nerves pass through the dura together to enter the jugular foramen.

31.10

Nerves nine, ten and eleven leave through this part of the jugular foramen. The hypoglossal nerve leaves through this opening, the hypoglossal canal.

31.23

We'll go round to the outside of the skull to see where the nerves emerge. Here's the jugular foramen, with the hypoglossal canal opening just in front of it. Nerves IX, X and XI emerge through this part of the jugular foramen.

31.46

Here are the four nerves emerging in front of the upper end of the internal jugular vein. Here's the internal carotid artery, the styloid process was here.

31.58

Here's the glossopharyngeal nerve, here's the vagus, here's the accessory, here's the hypoglossal. To get this view we've removed the styloid process and its muscles, the posterior belly of the digastric muscle, and the ramus of the mandible, as we did in the last section.

32.22

We'll follow these four nerves one at a time, adding or removing the overlying structures as we progress.

32.29

The small glossopharyngeal nerve - this is it - is mainly a sensory nerve. It runs lateral to the internal carotid artery, then passes downward and forward through or lateral to the stylopharyngeus muscle, which it supplies. The glossopharyngeal nerve enters the wall of the pharynx here, between the superior and middle constrictor muscles.

32.58

The glossopharyngeal nerve provides sensation, including taste, to the posterior third of the tongue, and also sensation to the back of the oral cavity and the oropharynx.

33.08

Now we'll move on to look at the vagus nerve. Its name means wandering: it goes all the way to the abdomen. The principal role of the vagus is to provide parasympathetic supply to organs throughout the thorax and upper abdomen. It also gives sensory and motor supply to the pharynx and larynx.

33.30

To see the upper end of the vagus we'll take this nerve, the hypoglossal, out of the picture for now. Here's the vagus. Its trunk is thickened by this ganglion, the lower of two.

33.48

To follow the vagus in its course down the neck we'll move the internal jugular vein aside. The vagus runs down the neck with the internal jugular vein behind it, and the internal and common carotid arteries in front of it, all the way down to the superior thoracic aperture. The clavicles have been removed in this dissection: here's where they were. Here's the first rib.

34.15

The vagus continues down into the thorax: its further course is shown in Tape 3 of this Atlas. The vagus nerve has important branches in the neck. We'll remove the common and internal carotid arteries to see them.

34.29

High in the neck the vagus gives off a pharyngeal branch or branches, and this large branch, the superior laryngeal nerve. Right down in the thorax the vagus also gives off the important recurrent laryngeal nerve: we'll come to it in a minute.

34.48

The pharyngeal branch or branches of the vagus enter the wall of the pharynx. They supply the superior and middle constictor muscles, and all the muscles of the palate except the tensor palati.

35.01

The superior laryngeal nerve passes downwards and forwards towards the hypopharynx. We'll follow the superior nerve in another dissection. The hyoid bone is here, the thyroid cartilage is here.

35.19

The superior laryngeal nerve - here it is - divides into an external branch, and an internal branch. The internal branch enters the wall of the hypopharynx by passing through the thyrohyoid membrane here. It provides sensation to the hypopharynx, the epiglottis, and the part of the larynx that lies above the vocal folds. The external branch gives motor supply to the cricothyroid muscle and the inferior constrictor muscle.

35.52

Now we'll look at the recurrent laryngeal nerve. To see it we'll go to a different dissection in which the internal jugular vein, which was here, has been removed. Here's the common carotid artery, here's the vagus.

36.10

Down here the vagus passes in front of the subclavian artery. As it does so it gives off the recurrent laryngeal nerve. As we saw in Tape 3, the recurrent laryngeal nerve goes round the subclavian artery on the right, and round the arch of the aorta on the left.

36.31

To see the recurrent laryngeal nerve in this dissection, we'll remove the common carotid artery. Here's the recurrent laryngeal nerve. It runs upwards and medially alongside the trachea, and passes behind the lower pole of the thyroid gland.

36.51

To follow its course we'll remove the thyroid gland, and the infrahyoid muscles. Here's the upper end of the trachea, joining the cricoid cartilage, which is here. This is the cricothyroid muscle. Here's the recurrent laryngeal nerve. It runs upwards and reaches the larynx here, behind the arch of the cricoid cartilage.

37.16

In its upward course it crosses the branches of the inferior thyroid artery, or runs between them, as in this case. The recurrent laryngeal nerve gives motor supply to all the muscles of the larynx, except the cricothyroid. It also provides sensation to the larynx below the vocal folds.

37.35

Let's move on, to look at the eleventh cranial nerve, the accessory. It's a motor nerve, supplying just two muscles. The spinal accessory nerve passes around the upper end of the internal jugular vein, then passes downward and backward behind the posterior belly of the digastric. It runs beneath the sternocleidomastoid muscle, which we'll add to the picture. The spinal accessory supplies the sternocleidomastoid muscle, sometimes running deep to it, sometimes through it.

38.16

Emerging near the posterior border of the sternocleidomastoid, the spinal accessory nerve runs downward and backward across the splenius muscle, and passes beneath the other muscle that it supplies, the trapezius.

38.28

Lastly we'll look at the twelfth cranial nerve, the hypoglossal. It's a motor nerve, supplying all the muscles of the tongue, and partly supplying the infrahyoid muscles.

38.41

The hypoglossal nerve emerges between the internal carotid artery and internal jugular vein. It runs downward and forward across the external carotid artery.

38.56

We've added the styloglossus muscle to the picture here. Missing from the picture are the stylohyoid muscle, and the posterior belly of the digastric.

39.05

The hypoglossal nerve gives off this descending branch, then turns and runs forward. It runs just below the styloglossus muscle, and passes forward into the gap between hyoglossus medially, and the mylohyoid muscle laterally: the same gap that the lingual nerve runs in. The hypoglossal nerve supplies all the muscles of the tongue including the intrinsic muscles, and also the geniohyoid muscle.

39.32

To look at the descending branch of the hypoglossal nerve, we'll go further down the neck. Here's the descending branch of the hypoglossal nerve. Its fibers in fact come from C1. It passes downwards and forwards in front of the internal jugular vein. It's joined by this branch from C2 and 3 to form a loop, called the ansa cervicalis. The branches that arise from the ansa cervicalis provide the motor supply to all four of the infrahyoid muscles.

40.09

In looking at the twelve cranial nerves we've concentrated on the main aspects of each nerve and omitted many of the smaller branches and cross-connections. We've also left out of the picture the complex autonomic nerve supply to the head and neck. The details of both the sympathetic and parasympathetic systems in the region are too small to be shown clearly in straightforward dissections. They're more readily understood from diagrams, to which I'm sure have access.

40.39

To end this section we'll look at the one part of the autonomic system that is clearly visible: the sympathetic trunk. We'll also look briefly at the cervical nerves.

40.50

To see the sympathetic trunk, we've removed all the cranial nerves, and the internal jugular vein. We'll also move the common and internal carotid arteries aside. Here's the cervical sympathetic trunk. It runs up the neck on the fascia that lies in front of the longus muscles.

41.16

This massive thickening at the top of the sympathetic trunk is the superior cervical ganglion. From its upper end this nerve, the internal carotid nerve arises, and joins the internal carotid artery as it enters the carotid canal.

41.33

Now we'll move on to look at the cervical plexus. To see it, we'll look at a dissection in which only the skin and subcutaneous tissue have been removed.

41.45

Here's the cervical plexus. It's formed from the anterior roots of C1, 2, 3 and 4. These emerge in front of the middle scalene muscle. Most of the branches of the plexus run laterally, this one runs straight downward: its the phrenic nerve.

42.07

The phrenic nerve runs downwards into the thorax on the front of the anterior scalene muscle, to innervate the diaphragm.

42.14

Many of the branches of the cervical plexus emerge here, around the posterior border of the sternocleidomastoid muscle. These are the supraclavicular nerves, which pass downward and laterally to supply the upper chest and shoulder region.

42.34

This is the great auricular nerve, which supplies this area on the side of the face. This is the posterior auricular, which supplies this area.

42.44

Here just beneath the sternocleidomastoid is the lesser occipital nerve. Here more posteriorly, is the greater occipital nerve, arising from the posterior root of C2. The occipital nerves supply this area on the back of the scalp.

43.06

Now, let's review what we've seen in the second half of this section on the nerves of the head and neck.

43.13

REVIEW

Here's the facial nerve inside, and outside the skull, with its frontal, orbital, buccal and marginal mandibular branches. Here's the vestibulo-cochlear nerve. Here's the glossopharyngeal nerve on the inside, and on the outside.

43.41

Here are the roots of the vagus, here's the vagus emerging. Here are its pharyngeal, superior laryngeal, and recurrent laryngeal branches. Here's the spinal accessory nerve, inside, and outside.

44.01

Here's the hypoglossal. Here it is again, here's its descending branch, here's the ansacervicalis. Here's the sympathetic trunk. Here's the phrenic nerve

44.16

Here are the supraclavicular, great auricular, posterior auricular, lesser occipital, and greater occipital nerves.

44.29

That brings us to the end of this section on the nerves. In the next section we'll look at the blood vessels of the head and neck.

44.43

END OF PART 3

PART 4

THE BLOOD VESSELS OF THE HEAD AND NECK

00.00

In this section we'll look at the arteries and veins of the head and neck. First we'll look at the two major arteries that supply the region. Then we'll look at the blood vessels inside the cranial cavity, then at the ones outside it.

00.23

MAJOR ARTERIES

On each side two major arteries, the common carotid and the subclavian, emerge through the opening at the top of the chest, the superior thoracic aperture. To see them we'll look look at a dissection in which we've already removed the overlying structures: the sternocleidomastoid muscle, the infrahyoid muscles, and the internal jugular vein. Here's the clavicle, the first rib is here.

00.54

This is the anterior scalene muscle. Here's the trachea, here's the thyroid gland. Here are the common carotid and subclavian arteries, coming up through the superior thoracic aperture. As seen in Tape 3, these arise from the arch of the aorta, the two on the left directly, the two on the right indirectly from the brachiocephalic artery. We'll look at the subclavian artery first.

01.24

On each side the subclavian artery passes upward and laterally, giving off these branches which we'll see in a moment. It then passes behind this muscle, the anterior scalene, crossing the underlying first rib as it does so. Emerging here, it runs down beneath the clavicle towards the axilla to supply the upper extremity.

01.48

The branches that arise from the subclavian artery in the base of the neck are the internal thoracic, the thyro-cervical trunk, which we'll remove, and this important branch, the vertebral artery, which we'll come back to shortly.

02.08

We'll leave the subclavian artery for now, and follow the common carotid artery. The common carotid artery runs upward lateral to the thyroid gland, the trachea and the larynx. A little below the level of the angle of the mandible, which is here, the common carotid divides into the external, and internal carotid arteries.

02.33

To see these more clearly we'll take the parotid gland, and the ramus of the mandible out of the picture. At the bifurcation of the common carotid, which is better seen in this more typical specimen, there's a widening, the carotid sinus. Usually the internal carotid artery runs almost straight upward, but in this dissection, the one we'll be following, it takes quite a forward curve.

02.59

The branches of the external carotid arteries supply the skull, the dura, and all of the head outside the cranial cavity, apart from the orbit. The brain is supplied by the internal carotid arteries and the vertebral arteries. We'll move on now, to follow those arteries into the cranium, and look at their branches.

03.22

INTRACRANIAL ARTERIES

To follow the internal carotid artery we'll take the external carotid and its branches out of the picture. We'll also remove the posterior belly of the digastric, the styloid process, and the muscles that arise from it.

03.39

The internal carotid artery runs upwards to the base of the skull without branching. The internal jugular vein is lateral to it, here. The internal carotid artery enters the carotid canal which is here in the dry skull.

03.57

The carotid canal immediately turns, to run forwards and medially. To see the other end of the carotid canal we'll go all the way round to the inside. The carotid canal comes from this direction and ends here at the foramen lacerum.

04.17

To expose the internal carotid artery we'll first remove the dura of the middle cranial fossa, then we'll remove this structure, the trigeminal ganglion, and finally these three cranial nerves: the third, fourth, and sixth. Here's the internal carotid artery coming up out of the foramen lacerum.

04.44

The internal carotid artery here lies within an irregular cavity, the cavernous sinus, that's a passageway for venous blood. We'll see it later in this section. The artery turns to run forwards, then makes a complete 180º turn. This turn takes it under the anterior clinoid process, and brings it out here, just below and behind the optic canal.

05.17

The internal carotid artery finally emerges through the dura just beneath the optic nerve. As it completes its backward turn, it gives off a branch, the ophthalmic artery. To see that, we'll remove the optic nerve, and the dura beneath it.

05.35

Here's the start of the ophthalmic artery. It runs forwards into the optic canal along with the optic nerve. The ophthalmic artery supplies the contents of the orbit and continues forward to supply the central part of the forehead.

05.50

To see how the internal carotid artery ends we'll add its last part, and the optic chiasm to the picture. The internal carotid artery ends by emerging from beneath the chiasm, curving laterally as it does so. We'll follow its branches in a minute.

06.08

Now we'll follow the course of the other major artery to the brain, the vertebral artery. As we've seen, seen, the vertebral artery arises from the subclavian artery in the root of the neck. It runs straight upwards, and disappears to pass through the opening in the transverse process of the sixth cervical vertebra.

06.28

To follow its course we'll remove all the neck muscles, and the tissues between the transverse processes. The vertebral artery runs upwards through the transverse processes of the upper six cervical vertebrae. Here's the vertebral artery. The two vertebral arteries pass through these openings in each vertebra.

06.55

After passing through the transverse process of the atlas it turns backwards, and then medially, to pass through the atlanto-occipital membrane and the dura, just below the foramen magnum, which is here.

07.09

To follow the vertebral artery we'll divide the cranium along this line, and remove the brain. Here are the two vertebral arteries passing through the dura. The vertebral arteries join together, forming this large artery, the basilar artery, which runs upwards and forwards above and behind the basilar part of the occipital bone.

07.38

Now that we've followed the internal carotid and vertebral arteries into the cranial cavity we'll see how they supply the brain. We'll also see the set of arterial connections known as the arterial circle, or circle of Willis.

07.51

So far we've seen, seen the internal carotids entering up here, the vertebral arteries entering down here and joining to form the basilar artery. Now we'll complete the picture.

08.06

To name the vessls we're looking at, we'll start with the main branches of the internal carotid. The internal carotid gives off the anterior cerebral, and posterior communicating arteries, then continues with a different name: from here the vessel is called the middle cerebral artery.

08.34

The two anterior cerebral arteries curve towards each other above the chiasm, then pass upwards and forwards close together to enter the longitudinal cerebral fissure between the two cerebral hemispheres.

08.50

Just above the optic chiasm, the two anterior cerebral arteries are connected to each other by this very short anterior commumicating artery, which is part of the arterial circle.

09.05

The middle cerebral artery, which is the direct continuation of the internal carotid, curves laterally. It enters the lateral cerebral fissure between the frontal and temporal lobes. We'll follow it there shortly. The pale areas on this artery are patches of atheroma.

09.28

Now we'll go round to a view from behind, to see the vertebral and basilar arteries, and the vessels that arise from them. Here are the two vertebral arteries, joining together to form the basilar artery.

09.47

Down here four inferior cerebellar arteries usually arise, two posterior and two anterior. These are the posterior ones. In this specimen the anterior ones are represented by this one vessel. In addition the basilar artery gives off small branches to the pons, and this labyrinthine artery that supplies the inner ear.

10.10

Four branches arise from the top of the basilar artery, these two superior cerebellar arteries, and the two terminal branches of the basilar, the posterior cerebral arteries.

10.23

The posterior cerebral artery curves backwards and laterally above this nerve, the oculomotor. It curls around the cerebral peduncle. We'll look at its course in a few minutes. Just as it turns, the posterior cerebral artery is joined by this small artery that we've seen already: the posterior communicating artery.

10.47

The posterior communicating artery completes the arterial circle. The arterial circle provides connections between the right and left sides, and also connects the vertebral and internal carotid systems. It's more of a hexagon than a circle.

11.05

Its component parts, from front to back, are the anterior communicating artery, the anterior cerebral arteries, the internal carotids, the posterior communicating arteries, and the posterior cerebral arteries. The arrangement is often somewhat asymmetrical: here, the left posterior communicating artery is very small.

11.29

The vessels we're looking at lie in the confined space between the floor of the cranial cavity and the underside of the brain. To see how they're related to the brain, we'll look at a brain that's been removed from the body together with its arteries. The arteries have been filled with red latex.

11.50

Over this area, the arachnoid layer and the many small vessels in it have been removed, so that we can see the major arteries. Here's the optic chiasm, here beneath it are the divided ands of the internal carotid arteries.

12.04

Here's the the anterior cerebral artery, passing around the optic chiasm, which we'll pull downwards. Here's the anterior communicating artery. The two anterior cerebral arteries turn upwards to enter the longitudinal cerebral fissure. We'll follow them shortly.

12.26

The internal carotid, which we'll go back to, gives off the posterior communicating artery, then continues, to become the middle cerebral artery. The middle cerebral artery enters the lateral cerebral fissure, between the frontal and temporal lobes of the cerebral hemisphere.

12.52

Coming from below, here are the two vertebral arteries joining to form the basilar artery, which is quite off-center in this specimen. Here are three of the possible four inferior cerebellar arteries, here are the two superior cerebellar arteries. Here's the division of the basilar, into the two posterior cerebral arteries.

13.10

To follow the course of the anterior, middle and posterior cerebral arteies, we'll divide the brain in the midline and look at just one cerebral hemisphere.

13.24

Each anterior cerebral artery runs upwards and then backwards close to the corpus callosum. It gives off branches which supply this area on the medial aspect of the cerebral hemisphere, and which then reach over the superior margin of the hemisphere, to supply this area on the lateral aspect.

13.48

Next we'll follow the middle cerebral artery. Here it is again, running in the depths of the lateral cerebral fissure. The middle cerebral artery gives off branches which emerge along the length of the lateral cerebral fissure to supply this area on the lateral aspect of the cerebral hemisphere.

14.16

Lastly we'll follow the posterior cerebral artery. It runs laterally just above this nerve, the oculomotor, then runs backward, passing around the cerebral peduncle. To follow it we'll again look at the cerebral hemisphere hemisphere by itself.

14.36

Here's the posterior cerebral artery. It winds around between the cerebral peduncle, which has been divided here, and the most medial part of the temporal lobe.

14.51

The posterior cerebral artery gives off branches which supply this area on the medial aspect and underside of the hemisphere, and this [area] on the lateral aspect.

15.08

INTRACRANIAL VEINS AND VENOUS SINUSES

Now that we've seen the principal arteries of the the brain, we'll move on to look at its veins, and at the channels that its veins drain into, the venous sinuses.

15.18

The brain is richly covered with veins. Over the surface of the cerebral hemispheres, the veins emerge from the sulci, join with one another, and run upwards within the arachnoid layer. Here behind the midbrain veins converge from many directions to form this great cerebral vein. We'll see where that goes shortly.

14.42

These veins drain into the venous sinuses which are a special feature of the cranial cavity. We'll look at these next. The sinuses that drain almost all the blood from the brain are the two sagittal sinuses, the straight sinus, and the two transverse sinuses. These sinuses are closely related to the major folds in the dura that we that we saw in an earlier section: the falx, and the tentorium.

16.11

In this specimen there are some openings in the falx, which is not unusual. The two sagittal sinuses run the length of the falx. The smaller inferior sagittal sinus runs within its free border, the larger superior sagittal sinus within its attached border. Blood in both the sagittal sinuses flows from front to back.

16.34

Here we've removed one side of the superior sagittal sinus so that we can look into it. As we saw in a previous section, the superior sagittal sinus is contained in a triangular space that's enclosed on all three sides by dura. At several places side passages called lacunae open into the sinus.

16.57

Veins from the surface of the brain open into the lacunae. The superior sagittal sinus ends where the attachments of the falx and the tentorium meet. Also running toward the same point is the straight sinus, which we'll lay open.

17.12

The straight sinus runs along the junction between the falx and the tentorium. At its upper end the it receives the inferior sagittal sinus, and also the great cerebral vein.

17.27

Here there's a major joining and branching of sinuses called the confluence of sinuses. We'll look at it in a different dissection of just the back of the head. The confluence of the sinuses is here. To see it we'll remove the falx and the tentorium, leaving just their lines of attachment. Here's the confluence laid open. Leading from it on each side are the two major outflow channels for venous blood, the transverse sinuses.

18.05

Each transverse sinus runs within the attached border of the tentorium. Starting here in the mid-line, the transverse sinus follows the attachment of the tentorium round to here, then continues by turning sharply downwards in this s-shaped groove just behind the petrous temporal bone.

18.24

The sinus goes by two different names: this part is the transverse sinus, this part is the sigmoid sinus. To follow the sigmoid sinus we'll look at a different skull. Here's the groove for right sigmoid sinus. Here's the groove for the left one. They're usually unequal in size.

18.45

The sigmoid sinus leaves the cranial cavity by passing through this irregular opening, the jugular foramen, along with three cranial nerves that we saw in the previous section. Here we're looking into the posterior cranial fossa from behind. The cerebellum has been removed. We'll remove the dura that covers the sigmoid sinus.

19.08

Within the jugular foramen the end of the sigmoid sinus turns sharply downwards, becoming continuous with the the internal jugular vein.

19.18

As we'll see in a minute, there are also venous sinuses that drain the base of the skull. Before we see them, we need to go back to the superior sagittal sinus, and look at the structures on each side of it that absorb cerebrospinal fluid.

19.33

These structures, the arachnoid granulations, were left out of the picture in the earlier section on the brain. To see them we'll return to this view of the surface of the brain. This central strip of dura contains the superior saggital sinus. We'll remove the dura that forms the roof of the sinus.

19.52

These small projections in the floor of the sinus, and on its sides, are arachnoid granulations. They're upward protrusions of the arachnoid membrane. At their surface, cerebrospinal fluid from the subarachnoid space is transferred back into the bloodstream.

20.16

Now we'll complete our picture of the venous sinuses by looking at the ones that drain the base of the skull. The most important of these are the two cavernous sinuses, one on each side.

20.28

We saw this view of the cavernous sinus when we looked at the internal carotid artery. The cavernous sinus is the space around the artery. It extends forwards to the superior orbital fissure, and backwards almost to the dorsum sellae. It's bounded medially by the dura that lines the pituitary fossa. As we've seen, the lateral wall of the cavernous sinus contains these three cranial nerves, the third, fourth and sixth.

20.59

Outside these lies the trigeminal ganglion, and outside that, the dura of the middle cranial fossa. To get a cross-sectional view of the cavernous sinus we'll go to a different specimen and divide it in the frontal plane along this line. This is the cavernous sinus. The big cavity in the midline is a sinus of a different order: it's the sphenoid sinus. Here's the divided internal carotid artery passing forwards.

21.41

Here are cranial nerves three, four and six. Here's the trigeminal ganglion, here's the dura. Here's the pituitary gland, contained within the dura that creates the pituitary fossa.

21.58

The two cavernous sinuses are connected to each other behind the pituitary gland. The cavernous sinus receives blood from several sources, including the superior orbital vein, a major vein from the orbit, which connects the cavernous sinus to veins in the upper part of the face.

22.19

The cavernous sinus drains into the two petrosal sinuses, superior and inferior, which have been exposed on the right side. The petrosal sinuses also receive veins from the cerebellum. They empty into the sigmoid sinus up here, and under here.

22.42

EXTRACRANIAL ARTERIES

Now we've finished looking at the intracranial blood vessels. We'll follow the internal jugular vein in a few minutes. Let's move on now, to look at the blood supply of the head and neck outside the cranial cavity. We'll look first at branches of the subclavian artery that make a contribution, then at the external carotid artery and its branches.

23.04

Here's the subclavian artery again. Here's the vertebral artery which we've seen already. Arising here in front of it is the thyro-cervical trunk, a short vessel that immediately divides, giving off these branches to the shoulder region, and the inferior thyroid artery.

23.28

The inferior thyroid artery gives off this small ascending cervical artery, then runs medially, deep to the common carotid artery, to reach the lower pole of the thyroid gland.

23.41

Now we'll go to a different dissection, to look at the external carotid artery and its branches. We've removed the sternocleidomastoid muscle, the internal jugular vein, and the parotid gland. Here's the common carotid artery, dividing into the internal carotid, and the external carotid.

24.06

The external carotid artery runs upward, passing beneath the posterior belly of the digastric muscle, and the stylohyoid muscle. It ends above the stylohyoid by dividing into its two terminal branches, which we'll see in a minute.

24.21

The first branch of the external carotid is the superior thyroid artery. It runs downwards alongside the larynx, to reach the upper pole of the thyroid gland.

24.33

The next branch is the lingual artery. It runs downwards and forwards, passing deep to the hyoglossus muscle, to supply the tongue. To see the remaining branches of the external carotid, we'll remove the posterior belly of the digastric, and the stylohyoid muscle.

24.55

This is the facial artery. The facial artery runs forwards, passing between the submandibular gland and the angle of the mandible, and emerging here. The facial artery crosses the mandible (it's extremely tortuous in this specimen) and runs upwards and forwards, branching to supply the lower part of the face.

25.25

Here, arising posteriorly, is the occipital artery. The occipital artery runs steeply upwards, then passes deep to the digastric and splenius muscles. It re-emerges here and runs upwards, branching to supply the posterior part of the scalp.

25.48

Also arising posteriorly up here is the smaller posterior auricular artery. It runs more superficially to supply the scalp behind the ear.

26.01

We'll remove these two posterior branches to see one more branch that arises deeply, the ascending pharyngeal. It passes upwards deep to the external carotid to supply the upper part of the pharynx.

26.17

Now we'll move upward to look at the last two branches of the external carotid artery. The highest part of the external carotid artery lies within the deepest part of the parotid gland, which has been removed in this dissection.

26.32

This branch is the superficial temporal artery. Just as it arises, it gives off this branch, the transverse facial. The superficial temporal artery then runs upwards and laterally, emerging from behind the neck of the mandible. It crosses the zygomatic process of the temporal bone just in front of the external ear, which we'll add to the picture. The superficial temporal artery continues within the superficial temporal fascia, branching to supply the upper and lateral parts of the scalp.

27.10

To see the final branch of the external carotid, the maxillary artery, we'll remove this transverse facial artery. Here's the start of the maxillary artery. It arises as the continuation of the external carotid, behind and medial to the neck of the mandible. It passes forwards. To follow it , we'll remove the masseter, the zygomatic arch, the temporalis muscle, and the ramus of the mandible.

27.44

This brings us into the infratemporal fossa. This is the lateral pterygoid muscle. It's been divided here. The maxillary artery runs forward, passing either below the lateral pterygoid muscle, as it does here, or through it.

28.03

The maxillary artery has many branches. These include branches to the muscles of mastication, and alveolar branches to the upper and lower jaws. This important early branch, the middle meningeal artery, passes upward. It goes through this opening in the bone, the foramen spinosum.

28.28

From the foramen spinosum, which is here, the middle meningeal artery fans out, creating these grooves on the inside of the cranium. The middle meningeal artery runs within the thickness of the dura. It supplies the dura, and much of the skull.

28.48

We'll return to where we were, on the maxillary artery. Here it gives off an infra-orbital branch that passes through the inferior orbital fissure. Then the maxillary artery turns medially, entering the pterygo-maxillary fissure, where it ends by branching to supply the lining of the nasal cavity, and the palate.

29.11

EXTRACRANIAL VEINS

Now we'll move on to take a look at the major veins of the head and neck. Outside the cranial cavity, the smaller veins generally run close to the corresponding arteries. We'll look only at the larger veins, starting with the principal vein of the head and neck region, the internal jugular vein.

29.28

To see the internal jugular vein we'll start with a dissection in which it's been removed. Here's the internal carotid artery, about to enter the carotid canal. The internal jugular vein begins here at the jugular foramen, where, as we've seen, it's continuous with the sigmoid sinus.

29.51

Now we'll add the internal jugular vein to the picture. The upper part of the internal jugular vein lies behind the internal carotid artery. It lies just medial to the styloid process, and medial also to the the styloid muscles, and the posterior belly of the digastric. Just below the level of the angle of the mandible, which we'll add to the picture, the internal jugular vein receives this large vein, the common facial vein.

30.28

The common facial vein is formed by a joining together of veins that drain the face, the infratemporal region, the oral and nasal cavities, and the larynx. The internal jugular vein continues down the neck, behind the common carotid artery and lateral to it. It's crossed by the omohyoid muscle.

30.51

Down here behind the clavicle the internal jugular vein ends by joining with the subclavian vein to form the brachiocephalic vein. As shown in Tape 3, the two brachiocephalic veins pass through the superior thoracic aperture. In the thorax the two brachiocephalic veins join to form the superior vena cava.

31.16

The internal jugular vein is covered over by the sternocleidomastoid muscle. We'll add just the upper and lower ends of the muscle to the picture. Here's the lower end of it, here's the upper end. Above, the vein lies slightly in front of the sternocleidomastoid muscle.

31.39

Below, it lies just lateral to the interval, between the sternal and clavicular insertions of the muscle. We'll add the rest of the sternocleidomastoid muscle to the picture, then we'll add the major superficial veins of the neck.

31.59

This is the external jugular vein. Its formed below the ear by a joining of veins from the scalp and face. The external jugular vein crosses the lateral border of the sternocleidomastoid muscle, and passes behind the clavicle to join the subclavian vein, which is here.

32.19

This is the anterior jugular vein, it's quite small in this individual. It also empties into the subclavian vein.

32.27

To make the veins clearly visible in the dissection we've seen, they were filled with a colored material. Normally when we're upright and at rest, gravity keeps the veins of the head and neck almost empty. They fill up when we lie down, or raise our intrathoracic pressure.

32.45

Now that we've looked at the principal veins, let's review what we've seen of the blood vessels of the head and neck.

32.52

REVIEW

Here's the subclavian artery, the thyro-cervical trunk, the inferior thyroid artery, and the vertebral artery. Here's the common carotid, dividing into the external, and internal carotids.

33.17

Within the cranium here are the vertebral and internal carotid arteries, the ophthalmic artery, the anterior cerebral, anterior communicating, posterior communicating, and middle cerebral arteries.

33.36

Here are the inferior cerebellar arteries, the superior cerebellar arteries, and the posterior cerebral arteries.

33.46

Here's the superior sagittal sinus, the straight sinus, the transverse sinus, the sigmoid sinus, the cavernous sinus, the superior petrosal and inferior petrosal sinuses.

34.05

Here's the external carotid again, here's the superior thyroid artery, the lingual artery, the facial artery, the occipital, and posterior auricular arteries, the ascending pharyngeal, the superficial temporal, and maxillary arteries.

34.30

Here's the internal jugular vein, the common facial vein, the external jugular, and anterior jugular veins.

34.42

That brings us to the end of this section on the blood vessels of the head and neck. In the next section, we'll look at the eye and its surroundings.

34.57

END OF PART 4

PART 5

THE EYE AND ITS SURROUNDINGS

00.00

In this section we'll look at the eye and its surroundings. We've already seen the nerves of the orbital region in part 3 of this tape. In this section we'll first look at the bony features of the orbital cavity, then we'll look at the eye itself, then at th eeye muscles, and lastly the eyelid and lacrimal apparatus.

00.28

ORBITAL CAVITY

Let's start with the bones. This is the bony orbit, or orbital cavity. It's described as having a roof, a floor, a medial wall, and a lateral wall. The rim of the orbit, is called the orbital margin. It's thick and clearly defined above, laterally , and below. Here medially the orbital margin is less distinct: the medial wall of the orbit blends with the countours of the nose and the central part of the forehead.

01.11

The orbital margin curves distincly backwards, both above, and below. Because of this the orbital margin is much further back laterally, than it is medially.

01.27

This reflects an imortant fact about the orbital cavity: it doesn't face directly forwards. We can see this best in a skull in which the roof of the orbit has been removed. This lets us look down into the orbit from above.

01.45

The medial wall of the orbit faces directly forward, but the lateral wall is angled outward by about 45º, so that the center line of the orbit is a little over 20º off the mid-line.

02.00

As we saw in tape 4, several bones are involved in forming the orbit. Starting medially this is part of the ethmoid bone, this is the underside of the frontal bone, this is the zygomatic bone, this is part of the maxilla, so is this, and this is the lacrimal bone.

02.23

Back here are the greater, and lesser wings of the sphenoid bone. Here at the narrow apex of the orbit are the optic canal and the superior orbital fissure.

02.38

The optic canal transmits the optic nerve and ophthalmic artery; the superior orbital fissure transmits the other nerves that enter the orbit and the superior orbital vein. In the living body the inferior orbital fissure, which forms an apparent gap between the floor and the lateral walls is bridged over with fibrous tissue.

03.04

This groove, the lacrimal groove leads downwards into the opening for the naso-lacrimal duct, which takes tears to the nasal cavity. The rim of the lacrimal groove is formed by the posterior lacrimal crest behind, and the anterior lacrimal crest in front.

03.25

The medial palpebral ligament is attached here, the lateral one here. The palpebral ligaments hold many of the anterior structures of the orbit in place.

03.38

EYE AND EXTRA-OCULAR MUSCLES

Now we'll move on, to look at the main externally visible parts of the eye itself. In life we see only a small part of the eye: even at the limit of eye movement we see less than half of its circumference.

03.33

Here's the eye seen from above. It occupies only the anterior part of the orbit. The space behind it is largely occupied by fat, that's been removed in this dissection.

04.05

The tough outer coat of the eye is the sclera. The sclera extends from here behind, where the optic nerve passes though it, all the way round to here in front, where it becomes continuous with the transparent cornea

04.21

The cornea is the transparent window that allows light to enter the eye. The cornea is more sharply curved than the sclera: it bulges forwards. Behind the cornea, the colored iris forms an incomplete partition within the eye.

04.40

At the center of the iris is a clear opening, the pupil. The size of the pupil is constantly changing, to limit the amount of light that enters the eye. The iris is formed chiefly of muscle fibers. Fibers arranged radially cause the pupil to dilate, fibers arranged circumferentially both here, and out here, make it constrict.

05.05

The lens of the eye is just behind the iris and the pupil. Here light from a slit lamp is coming in from the left side. Down here where it's very bright the light is hitting the iris. Here it's hitting the anterior surface of the lens.

05.23

The internal structures of the eye are so delicate and so readily displaced that they can't be well shown by dissection. They're better understood by referring to microscopic images and diagrams, to which I hope you'll have acess.

05.38

Now we'll move on to look at the extra-ocular muscles. There are seven of them. One, as we'll see, raises the upper eyelid. The other six, the four rectus muscles and the two oblique muscles, move the eye. The best way to look at these muscles is from above.

05.57

Here we're looking down into the obit, in a dissection in which the orbital roof has been removed

06.04

We'll start by looking at the rectus muscles. To see them, we'll take these two muscles, the levator and the superior oblique, out of the picture. We'll also remove some of the fat that largely fills the posterior part of the orbit.

06.20

Here are three of the rectus muscles: superior, lateral and medial. To see the inferior rectus we'll remove the superior rectus, the optic nerve, and the rest of the orbital fat. Here's the inferior rectus muscle. Between the origins of the rectus muscles the optic nerve emerge.

06.50

The rectus muscles arise together from inside a ring of fibrous tissue, the anulus tendineus, of which this is the upper part. The anulus is attached to the periosteum of the apex of the orbit. Its ring of attachment, represented in blue here, encircles the optic canal, and this part of the superior orbital fissure. The optic nerve, the ophthalmic artery, and several of the nerves to the orbit pass through the anulus.

07.23

The rectus muscles thin out into flat tendons as they pass forwards around the eye. They insert into the sclera quite far forward. To see where they insert, we'll go round to a view from in front. Here's the insertion of the superior rectus, here's the lateral, here's the inferior, here's the medial.

07.51

The main actions of the rectus muscles are obvious. The superior and inferior rectus muscles turn the eye upwards, and downwards, the lateral and medial ones turn it outwards and inwards.

08.09

The inferior and superior rectus muscles have another action too. They don't only pull the top or bottom of the eye straight backwards, they also tend to rotate it a little, about its long axis.

08.24

The superior rectus muscle acting alone would rotate the top of the eye inward as we look up, the inferior rectus would rotate it outward as we look down.

08.34

In fact the rectus muscles don't act alone. They act in conjunction with the two oblique muscles, the inferior oblique, and the superior oblique. We'll add those to our picture, starting with the superior one.

08.49

Here's the superior oblique muscle. Like the rectus muscles it arises from the anulus. The superior oblique narrows into a tendon, which passes around this sling of fibrous tissue, the trochlea.

09.06

The trochlea is attached to bone here, behind the orbital margin. The trochlea acts as a pulley. The superior oblique tendon fans out, passing deep to the superior rectus to insert into the sclera on the top of the eyeball.

09.26

We'll go round to our view from in front, and add the oblique muscles to that picture. Here's the trochlea, here's the superior oblique tendon. The superior oblique muscle, acting alone, would rotate the top of the eye medially.

09.47

The inferior oblique muscle is down here. It's the only extra-ocular muscle that doesn't arise from the anulus. It arises here, behind the inferior orbital margin. It inserts into the sclera quite far back. To see that we'll go round to our view from above and behind.

10.11

Here's the inferior oblique, inserting into the sclera between the lateral rectus and the inferior rectus muscles. The inferior oblique, acting alone, would rotate the top of the eye laterally.

10.31

The oblique muscles act in conjunction with the rectus muscles, the inferior oblique with the superior rectus and vice versa. This prevents our eyes from rotating about their long axes, as we look up and down.

10.45

The last of the seven extra-ocular muscles to look at is the levator of the upper eyelid, levator palpebrae superioris.

10.53

The levator lies just above the superior rectus muscle: here it is. Arising from the anulus fibrosus back here, the levator fans out to become a broad tendon which inserts, as we'll see later, mainly into the tarsus of the upper lid.

11.15

Incorporated in the underside of the levator is a strip of smooth muscle, the superior tarsal muscle, that's innervated by sympathetic fibers. Changes in the tone of this smooth muscle cause our upper lids to droop when we're tired, and open wide when we're excited.

11.36

As we saw in the section on the cranial nerves, the extra-ocular muscles get their nerve supply from the third, fourth and sixth cranial nerves. The superior oblique is supplied by the fourth nerve, the trochlear; the lateral rectus is supplied by the sixth nerve, the abducent. The other five are supplied by the third nerve, the oculomotor.

12.00

In the images that images that we've seen so far, the muscles have been dissected bare to show them clearly, but in reality each of the muscles as it passes forwards becomes surrounded by a sliding sheath of fibrous tissue. The fibrous sheaths of adjoining muscles blend together to form a hood above and below the eye. This hood is firmly attached to periosteum at two points: here laterally and here medially

12.35

These fibers of attachment form the posterior parts of the lateral and medial palpebral ligaments. Indirectly, they hold the eye in position in the orbit. The tendon sheaths of the muscles are also continuous with this sheath of fibrous tissue, the capsule of the globe, that surrounds the posterior two thirds of the eyeball.

12.58

EYELIDS AND LACRIMAL APPARATUS

Now that we've looked at the extra-ocular muscles, we'll move on to look at the eyelids and the lacrimal apparatus. The eyelids form a movable protective covering for the eye.

13.11

The upper and lower lids are much alike: we'll look mainly at the upper one. In looking at the structures that form the eyelids, we'll switch between a dissection from in front, to one in which the structures have been divided in steps, a layer at a time, giving us this lateral view.

13.33

The eyelids are covered on the outside with skin that's extremely thin and mobile. They're covered on the inside inside by a thin sensitive membrane, the conjunctiva. This is the conjunctiva. Conjunctiva also covers the front of the sclera,

13.54

The conjuctiva that covers the eye - the bulbar part - and the conjunctiva that lines the lid - the palpebral part - are continuous at this fold, the conjunctival fornix. The conjunctiva is continuous with the skin at the margin of the eyelid.

14.11

Directly beneath the skin of the eyelids, which we'll remove, is the orbicularis oculi muscle. As we saw in part 1 of this tape, the orbicularis extends beyond the margins of the orbit, onto the forehead and the cheek.

14.29

It's such a thin muscle, it's almost colorless. Medially, many of its fibers arise from this structure, the medial palpebral ligament, which is attached to bone here at the anterior lacrimal crest. The more outlying fibers of orbicularis arise from bone here around the lacrimal groove

14.52

Laterally, the innermost fibers of orbicularis insert into bone here. The more outlying fibers have no bony attachment. This is part of the orbicularis. It's been divided along this line.

15.09

Directly beneath it is this layer of fibrous tissue, the orbital septum, that extends into the lid from the periosteum at the orbital margin. The orbital septum separates the contents of the orbit from the facial soft tissues. Here beneath the orbicularis is the structure that gives the eyelid its shape, the tarsus. It extends from here, to the lid margin.

15.36

To see the tarsus from in front we'll remove the orbicularis muscle, and then the orbital septum. We've also removed much of the orbital fat. The tarsus is here.

15.54

If we put something underneath it we can see its upper border. The tarsus is tethered at each end to the palpebral ligaments. The tarsus is quite flexible. It stiffens the eyelid, and gives it a curvature that varies so that the shape of the eyelid conforms to the changing curvature of the underlying eye.

16.17

Within the thickness of the tarsus are numerous tarsal glands. This is one of them. The tarsal glands open here, right along the margin of the lid. The tarsal glands produce an oily secretion which prevents the spillage of tears.

16.38

This structure coming down from behind is the levator muscle. This is its tendon. The levator tendon inserts mainly into the tarsus; its most lateral and medial fibers are attached to the palpebral ligaments.

16.58

Here's the orbital margin. Here just below and behind it is the lacrimal gland, which secretes tears. It lies in this hollow in the roof of the orbit, the lacrimal fossa. The many small ducts of the lacrimal gland open into the conjuctival fornix up here.

17.18

Tears leave the space in front of the eye through two small openings called puncta: here's the lower punctum. To see the upper one we'll roll the upper lid outwards. Here's the upper punctum.

17.35

To see where those lead we'll look at a dissection in which the orbicularis has been removed, and blue material has been injected into the puncta. Here's the upper punctum, here's the lower one.

17.50

Leading from them are the canaliculi: here's the upper canaliculus, here's the lower one. The two canaliculi converge behind the medial palpebral ligament, which we'll remove. The canaliculi join together, and enter this reservoir, the lacrimal sac.

18.12

The lacrimal sac is surrounded by the fibers of origin of the orbicularis muscle. When we blink, the pressure from these muscle fibers squeezes tears from the lacrimal sac, down into the nasolacrimal duct.

18.28

Now that we've looked at the eyelids and lacrimal apparatus, let's review what we've seen of the eye and its surroundings.

18.37

REVIEW

Here’s the orbital margin, the optic canal, the superior orbital fissure, the inferior orbital fissure, the lacrimal groove, the posterior lacrimal crest and the anterior lacrimal crest.

19.00

Here’s the sclera, the cornea, the iris, and the pupil. Here are the rectus muscles: superior, lateral, medial, and inferior; and the oblique mucles: superior, and inferior. Here’s the trochlea, here’s the anulus tendineus,

19.29

Here’s the conjunctiva, palpebral, and bulbar. Here's the orbicularis oculi muscle, the orbital septum, the tarsus, and the tarsal glands.

19.45

PART 6

THE EAR

00.00

In this section on the ear we'll look mainly at the external and middle ear. The inner ear is so delicate, and so encased in hard bone, that it can't be well shown by dissection. We'll start with the external ear.

00.23

EXTERNAL EAR, TYMPANIC MEMBRANE

The external ear consists of the auricle, which projects from the side of the head, and the external auditory meatus or ear canal, which passes inwards to the tympanic membrane. We'll look at the auricle first.

00.37

The folded outer rim of the auricle is the helix. The helix spirals down into the floor of the central concavity, the concha. The rim of the concha is defined by this curved ridge, the antihelix.

00.52

Two projections, the tragus, and the antitragus, partly hide the entrance to the external auditory meatus. The shape of the upper three quarters of the auricle is determined by the cartilage that forms its framework. We'll divide the auricle along this line to see the cartilage.

01.11

Here's the cut edge of the auricular cartilage. It's highly elastic. The skin of the the auricle is attached to the cartilage closely on the front, less closely on the back. The lowest part of the auricle, the lobule, contains no cartilage. To look at the external auditory meatus we'll remove the auricle, and the surrounding skin.

01.37

The external auditory meatus is lined with skin. It isn't straight: it curves slightly upwards, then slightly backwards. The external meatus ends medially at the ear drum, or tympanic membrane. This is part of the tympanic membrane: we'll see all of it in a minute.

02.06

The outer part of the external meatus is supported by a partial tube of cartilage. Here's the cut edge of the cartilage: it's continuous with the cartilage of the auricle. To see it better we'll remove the surrounding soft tissue.

02.25

Here's the cartilage of the external auditory meatus: it extends much further below, than it does above. To see where we are we'll take a look at the same area in a dry skull. Here's the bony opening of the external auditory meatus. The cartilage of the external auditory meatus is attached to bone here.

02.48

Here's the beginning of the zygomatic arch, here just below it is the temporomandibular joint. The condyle and neck of the mandible lie just in front of the external auditory meatus.

03.;01

Going back to the dissection, here's the capsule of the temporomandibular joint. With a finger in the external meatus, it's easy to feel the condyle moving.

03.17

Now we'll remove the mandible, so that we can look at the external meatus from in front. Here's where the cartilage of the external meatus attaches to bone. We'll remove the cartilage, to see the bony part of the external auditory meatus. This brings us closer to the tympanic membrane: here it is. To get a complete view of it we'll remove this part of the bone.

03.47

This is the tympanic membrane. It separates the external meatus from the middle ear, or tympanic cavity. The tympanic membrane is so thin that it's partly transparent. This small upper part of the tympanic membrane, the pars flaccida, is slack. This much larger part below, the pars tensa, is tense.

04.14

The tense part of the tympanic membrane has the shape of a shallow cone: it's drawn inwards by its attachment to the handle of the malleus, which we can just see here. The apex of the cone, where the tip of the malleus is attached, is called the umbo.

04.33

The tympanic membrane faces downwards and forwards. This is a true lateral view of it. When seen from the side, it's tilted in this plane. When sound waves strike it, the tense part of the tympanic membrane vibrates. Its vibration is transmitted to the malleus.

04.56

The tympanic membrane is formed of a layer of skin on the outside and a layer of mucous membrane on the inside, lying back-to-back on a layer of supporting fibers.

05.06

The support fibers within the tympanic membrane are attached around the circumference, except between these two points, to a ring of fibrocartilage, the anulus. The anulus fits into a groove in the bone.

05.22

To see beyond the tympanic membrane we'll remove this part of the bone, leaving the anulus intact.

05.32

This brings us into the lower part of the tympanic cavity, or middle ear. We'll see a little more of it by dividing the tympanic membrane along this line, and removing it. Here's the handle, or manubrium, of the malleus, attached to the tympanic membrane. Here below it we can see how thin the membrane is.

5.55

TYMPANIC CAVITY, AUDITORY TUBE

Now we'll remove the rest of the tympanic membrane. Here we're looking into the lower part of the tympanic cavity. There's more of it back here, and up here, as we'll see.

06.10

This is the handle of the malleus, this is our first look at the incus, and the stapes. We'll get a much better look at them later. Here in front is the opening for the auditory tube, which connects the tympanic cavity with the nasopharynx.

06.26

We’ll look at the auditory tube, then come back to the tympanic cavity, but first let’s look at a dry bone specimen to see where we’ve been and where we’re going next. After taking the mandible out of of the picture, we've been looking up at the underside of the petrous temporal bone from below. To see the tympanic membrane we removed this part of the bone.

06.53

Here's the bony external meatus, here's the groove for the anulus. To see into the tympanic cavity we removed more bone here. This is the lower part of the tympanic cavity with the three small bones removed.

07.11

This is as far as we’ve come till now. The auditory tube, which is where we're going next, begins at this opening at the front of the tympanic cavity. It passes forwards and medially in a narrow tunnel in the bone. The tunnel is quite short: it starts here, and ends here.

07.36

Only the lateral third of the auditory tube goes through bone; its medial two thirds pass though a partial tube of cartilage that's represented by this added material. The cartilage of the auditory tube is attached to the base of the skull. Its medial end projects beneath the mucosa of the nasopharynx.

07.59

To see the auditory tube itself, we'll go back to a dissected specimen. In this deep dissection of the infratemporal region we've removed the zygomatic arch, the mandible, and all the muscles of mastication.

08.19

The external auditory meatus, and the tympanic cavity have been exposed, as in the previous dissection. Here's the lateral pterygoid plate. The nasopharynx is here. This is the superior pharyngeal constrictor. Its upper border is here.

08.40

The auditory tube is up here. It's concealed between these two small muscles. This one is the levator palati, passing down above the free border of the superior constrictor. This one is the tensor palati, passing downward and forward to go round the hamulus.

09.00

To see the auditory tube, we'll remove the tensor palati, and the lateral pterygoid plate. Here's the cartilage of the auditory tube. Here beneath it is the tube itself. To see the auditory tube all the way to the tympanic cavity we'll open it along this line, and remove this part of the bone.

This is the bony part of the auditory tube, connnecting with the tympanic cavity. This is its cartilaginous part. The narrowest part of the tube is here, where it emerges from the bone.

09.46

The auditory tube enters the nasopharynx here. We saw its emergence into the nasopharynx from the inside in Tape 4. Here's the nasopharynx, here's the back of the nasal cavity, here's the soft palate, here's the opening of the auditory tube.

10.09

The auditory tube, also called the eustachian tube, is normally closed. It's opened momentarily when we swallow or yawn, by the action of the tensor and levator palati muscles. Occasional opening of the auditory tube keeps the air pressure the same on both sides of the tympanic membrane.

10.30

Now that we've seen the auditory tube we'll come back to the tympanic cavity. In it we'll see the three small bones, the auditory ossicles, that conduct sound vibrations from the tympanic membrane to the inner ear.

10.45

So far we've just had a preview of this lower part of the tympanic cavity. To see the whole of the tympanic cavity we'll remove the bone that lies above and behind the external auditory meatus. Now if we look up from below we can see the full extent of the tympanic cavity.

11.07

With the auditory ossicles in place the picture is rather busy. We'll remove them for now, along with the bone here, and here, to give ourselves a clear look at the medial wall of the tympanic cavity.

11.22

These two openings in the medial wall both lead to the vestibule of the inner ear. The oval one above, the vestibular window, is occupied by the stapes. This round one below it, the cochlear window, is closed off by an inactive membrane.

11.42

This bulge, the promontory, is formed by the basal turn of the cochlea. The facial nerve runs here in the facial canal, just beneath the bony surface. In front, as we've seen, the tympanic cavity is continuous with the auditory tube.

11.59

Up here behind, it's continuous with a collection of air-filled spaces, the mastoid air cells, which we'll look at in a dry specimen. Here's the tympanic cavity. In this skull we've made an opening in the upper part of the mastoid process to expose the mastoid air cells. Here are the air cells. The tympanic cavity is through here. The mastoid air cells don't go anywhere: collectively they're a dead end.

12.35

AUDITORY OSSICLES

Now we'll put the three auditory ossicles back into the picture. They're the stapes, the incus and the malleus. We'll start with the tiny stapes, the smallest bone in the body.

12.48

The stapes consists of a head which articulates with the incus, an arch that's formed by the posterior crus, and anterior crus, and an oval base or footplate, which occupies the vestibular window.

13.06

Here's the vestibular window. We'll add the stapes to the picture. The edge of the footplate is attached to the inside of the window by a membrane that allows it to move. Movement of the stapes sets up sound vibrations in the perilymph of the inner ear.

13.28

The tendon of the tiny stapedius muscle is attached to the head of the stapes from behind. Here's the tendon of stapedius. Its muscle belly is enclosed in bone back here. The stapedius muscle tilts the stapes backwards.

13.48

The head of the stapes articulates with the incus, which we'll add to the picture. Here's the incus. The incus moves the stapes, and is in turn moved by the malleus.

14.05

The incus has a body, a short crus, and a long crus. The long crus curves medially, ending at the lenticular process, wich articulates with the stapes. The short crus points backwards. The tip of the short crus is tethered to the wall of the tympanic cavity here, by the posterior ligament of the incus.

14.34

On the front of the body of the incus there's a saddle-shaped joint surface, at which the incus articulates with the malleus. Here's the joint surface.

14.49

We'll add the malleus to the picture, together with the ligaments that hold it in place, and the bone those ligaments are attached to.

15.00

We've already seen that this part of the malleus that hangs downwards, the handle or manubrium, is attached to the tympanic membrane.

15.08

In the dry bone, this is the manubrium. This is the head of the malleus. This joint surface, facing backwards, articulates with the incus. The malleus is suspended by two ligaments which are attached here behind, and here in front. This is the anterior ligament, this is the posterior one. The two ligaments are in line with each other.

15.39

The malleus makes a rotating movement through just a few degrees, around an axis of rotation that's in line with the anterior and posterior ligaments. There's very little movement at the joint between the malleus and the incus. The two bones move together.

15.58

The movement of the lenticular process causes a tilting movement of the stapes. Movement of the stapes is restrained by the action of the stapedius muscle.

16.15

Movement of the malleus is restrained in a similar way by a second small muscle, the tensor tympani. Here's the tendon of the tensor tympani. The tensor tympani muscle is enclosed in a bony tunnel here above and parallel to the auditory tube. Its tendon turns a corner as it emerges from the bony tunnel. The tensor tympani pulls the manubrium, and the tympanic membrane medially.

16.47

The stapedius and tensor tympani muscles act in response to loud noise. Their action helps to protect the inner ear from noise damage. Lastly we'll add to our picture of the tympanic cavity one highly unusual nerve, the chorda tympani.

17.06

The chorda tympani, a branch of the facial nerve, emerges from bone back here, passes between the malleus and the incus, and leaves the tympanic cavity up here on its way to join the lingual nerve. As we saw in a previous section, the chorda tympani conveys the sense of taste to much of the tongue.

17.27

Now, let's review what we've seen of the structuresof the external and middle ear.

17.33

REVIEW

Here's the auricle, the external auditory meatus, the helix, the antihelix, the tragus, the antitragus, and the concha. Here's the cartilage of the auricle, and the cartilage of the auditory meatus.

18.01

Here's the tympanic membrane, the pars flaccida, the pars tensa, the umbo, and the anulus.

18.13

Here's the tympanic cavity, the vestibular window, the cochlear window, and the opening for the auditory tube.

18.25

Here's the malleus, the incus, and the stapes. Here's the tendon of stapedius, and of tensor tympani, and here's the auditory tube.

18.41

I hope that in future editions of this atlas we'll find ways to show the inner ear as well. For now, we're at the end of this section of the ear. We're also at the end of this tape, the second of two that describe the head and neck. In the next and final tape in this series, we'll look at the internal organs.

19.07

END OF VOLUME 5

Here’s the lacrimal gland, the upper and lower puncta, the canaliculi, the lacrimal sac, and the nasolacrimal duct.

20.01

That brings us to the end of this section on the eye and its surroundings. In the next section, we'll look at the ear.

END OF PART 5

Acland's DVD Atlas of Human Anatomy

Transcript for Volume 6

PART 1

THE THORACIC ORGANS

00.00

This tape shows the internal organs of the thorax and of the abdomen, and the male and female reproductive organs. In this first section we'll look at the organs of the thorax: first the heart, then the lungs. We'll also look briefly at the esophagus.

00.25

The thorax itself, the upper part of the trunk which contains the heart and lungs, is shown in Tape 3 of this atlas. Here, we're looking at the contents.

00.35

THE HEART: INTRODUCTION

To understand the heart we'll begin by seeing where it is. We tend to put the heart here in our imagination, but in reality it's much closer to the mid-line. Seen from in front, the heart is here. It lies behind the sternum, and directly above the diaphragm.

00.57

Seen from the side, the heart is here, occupying almost all the space between the vertebral bodies behind, and the sternum in front. When the diaphragm moves, the heart moves with it.

01.12

To get our first look at the heart, we'll start by removing the upper extremities, and all the shoulder muscles that surround the upper thorax, so as to leave just the thorax itself, enclosed by the ribs and intercostal muscles.

01.29

Then we'll remove this part of the rib cage on each side, revealing the lungs, which are fully inflated here. When we let the lungs deflate we can see the heart behind the sternum, contained within its protective jacket of pericardium. To see it better we'll take the lungs, the sternum and the pericardium out of the picture.

01.56

This is the heart. This is the diaphragm. The major blood vessels that lead into and out of the heart take up almost as much space as the heart itself.

02.11

Now that we've seen where the heart is we'll take a detailed look at it. We'll look at its four chambers, and its four valves; then we'll look at the great vessels that enter and leave the heart, and lastly we'll look at the coronary arteries.

02.29

Because we so often see simplified diagrams of the heart like this, we tend to think the atria, the inlet chambers, are above, and the ventricles, the pumping chambers, are below. It's perhaps surprising to see that in reality the atria aren't above the ventricles, they're behind them.

02.48

Here's the heart in isolation. Here are the ventricles in front, here are the atria behind. This generous coating of epicardial fat makes it hard to see the four chambers distinctly.

03.13

To see them more clearly, we'll go to a heart in which almost all the fat has been removed. In this specimen all four chambers have been distended with equal pressure, making the atria somewhat larger than normal. This is a directly posterior view of the heart, this is a directly anterior view. The massive thick walled left ventricle projects forward and to the left. The thinner walled right ventricle is partially wrapped round the left one.

03.48

ATRIA AND INLET VALVES

We'll see the ventricles by themselves in a minute. For now, let's go round to the back, and look at the two atria. This the left atrium, this is the right atrium.

04.06

Blood coming from the upper part of the body enters the right atrium by way of the superior vena cava. Blood coming from the lower part of the body enters it by way of the much larger inferior vena cava.

04.20

In a more intact dissection, here's the inferior vena cava, coming through the diaphragm and almost immediately entering the right atrium.

04.34

In addition to the two venae cavae, blood from the heart itself enters the right atrium
under here, by way of the coronary sinus, which we'll see later. From the upper part of the right atrium this blind pouch, the right auricle, or atrial appendage projects forwards.

04.53

The thin wall of the right atrium is formed largely of muscle. When the atrium contracts in diastole the blood in it passes forwards into the right ventricle, through the right atrio-ventricular valve, or tricuspid valve, which is here. The left atrium and the right atrium are in contact here, where they share a common wall, the inter-atrial septum, which lies quite obliquely.

05.20

To look at the inside of the right atrium, we'll remove this part of its wall. Here's the opening of the superior vena cava above, and of the inferior vena cava below. Here's the opening of the coronary sinus. This is the part of the atrial wall that's shared with the left atrium, the inter-atrial septum.

05.52

This thin oval patch in the septum is the fossa ovale: the remnant of the foramen ovale that connected the two atria in intrauterine life. Here, we're looking forwards into the tricuspid valve: we'll see more of it when we look at the right ventricle.

06.10

Now we'll move on, to look at the left atrium. Blood coming from the lungs enters the left atrium by way of the four pulmonary veins, two from the right lung, two from the left. The left atrium, like the right one, has a blind pouch, the left auricle or atrial appendage, which projects upwards and forwards. In diastole, the blood that's in the left atrium passes forwards into the left ventricle through the left atrio-ventricular valve, or mitral valve, which is here.

06.47

To see inside the left atrium we'll remove this part of its wall. With the four pulmonary veins removed, the inside of the left atrium is relatively featureless. Here's the inter-atrial septum again, and here's the remnant of the foramen ovale, seen from the left side. Here, we're looking forwards into the mitral valve.

07.17

VENTRICLES AND OUTFLOW VALVES

Now we'll move on to look at the two ventricles and their inlet valves. To see them clearly, we'll look at a heart in which the right and left atrium have been removed, leaving just the two ventricles. Here's the right ventricle, seen from the right side, here's the left ventricle, seen from the front.

07.42

Going round to the back, this is the right ventricle, this is the left one. They're separated by the interventricular septum, which is here. We're looking forwards into the wide-open atrio-ventricular valves, the tricuspid on the right, the mitral on the left.

08.04

On the right side, blood passes downwards and forwards to fill the right ventricle in diastole, then in systole it passes upwards and to the left into the pulmonary trunk, passing through the pulmonary valve, which is here.

08.22

On the left, blood also passes downwards and forwards to fill the ventricle, then gets turned completely around in systole, passing upwards and backwards into the aorta. It passes through the aortic valve, which is out of sight, here.

08.41

To see inside the right ventricle, we'll remove this part of its wall. The tricuspid valve is here, we'll look at it in a minute. The pulmonary valve is up here.

09.00

The anterior part of the right ventricle, the apex, extends out of sight down here, among these intersecting bands of muscle called trabeculae. This is part of the the interventricular septum: the left ventricle is on the other side of it.

09.14

Now let's take a look at the tricuspid valve and its appendages. The tricuspid valve is also called the right atrio-ventricular valve. It usually has three cusps, sometimes only two. Here there are three. They're known as the septal, anterior, and posterior cusps. The posterior cusp is partly out of sight.

09.39

These strands of tendon-like material attached near the edges of the valve cusps are the chordae tendineae. They arise from papillary muscles, which project from the wall of the ventricle. The papillary muscles and chordae tendineae prevent the cusps of the valve from prolapsing back into the atrium during systole

10.04

Here's the tricuspid valve, set in motion passively by an intermittent current of water. When pressure in the ventricle rises, the cusps of the valve close together, along quite an irregular line.

10.20

The inside of the right ventricle is made irregular not only by the tricuspid valve and its appendages, but also by these numerous bands of muscle, the trabeculae carnae. The trabeculae form a dense criss-cross pattern over much of the ventricular wall, especially here toward the apex.

10.44

To see the outflow pathway of the right ventricle we'll go to a different specimen. The tapering part of the right ventricle that leads up to the pulmonary valve is known as the infundibulum, and also as the conus. Unlike the rest of the right ventricle, its lining is smooth.

11.07

We'll look at the pulmonary valve in a minute. Now, we'll move on, to take a look inside the left ventricle. We'll remove this part of its wall. The mitral valve is here, the aortic valve is out of sight up here. This is the apex of the ventricle. This part of the ventricular wall forms the interventricular septum.

11.38

Here's the left ventricle in cross section. Here's the right ventricle. The interventricular septum is curved.

11.48

The left ventricle has a much thicker wall than the right, and it's circular in cross section, while the right ventricle is C-shaped. Here, we're looking backward into the mitral valve. To see it better, we'll return to the previous dissection, and go round to a view from behind. The mitral valve, also called the left atrio-ventricular valve, has two cusps. They're called the anterior cusp and the posterior cusp, though in reality they're more upper and lower.

12.26

Chordae tendineae from both cusps converge on two sets of papillary muscles: these on the poseterolateral wall of the ventricle, and these on the antero-medial wall. Here are the same papillary muscles, seen from the apex of the ventricle. Each group of papillary muscles sends chordae tendinae to each of the cusps of the mitral valve.

12.54

Here's the mitral valve in motion, seen from the apex of the left ventricle. Here are the papillary muscles, seen very close.

13.05

Above the mitral valve we're looking upward and backward along the outflow tract of the left ventricle towards the aortic valve. In this cutaway dissection we can see the outflow tract of the left ventricle, from the side Here's the aortic valve. We've left intact part of the anterior cusp of the mitral valve, along with the chordae tendineae and papillary muscles. The anterior cusp of the mitral valve forms part of the wall of the outflow tract, so blood flows past it this way in diastole and this way in systole.

13.44

Here's the anterior cusp of the mitral valve in motion, with the mitral valve opening below it, and the outflow tract above it.

13.55

Now that we've seen both ventricles, we'll move on to look at the two outflow valves, the pulmonary valve and the aortic valve, and also at the pulmonary trunk and the first part of the aorta.

14.08

Here are the two ventricles, dissected so that we can see the outflow valves. Here's the aortic valve, here's the pulmonary valve. Each has three cusps. The pulmonary trunk and the aorta are markedly dilated at their origins. On each vessel the dilatation consists of three bulges, or sinuses, whose position matches the position of the valve cusps.

14.37

To get a better look at the cusps of the outflow valves we'll remove these parts of the vessel walls. Each cusp of an outflow valve is shaped like one third of a parachute. Here the cusps are hanging loose. Each cusp has a delicate free border which closes against those of its neighbors.

15.00

Here's the pulmonary valve in motion. In diastole, back-pressure closes the valve abruptly, the three cusps pressing against each other to meet exactly at a point.

15.13

Here's the aortic valve. It works in just the same way. Here's the opening of the right coronary artery, which we'll see in a minute. The left one is out of sight down here.

15.25

Now that we've seen the outflow valves, we'll move on, to look at the two major outflow vessels, the pulmonary trunk and the aorta. To see them we'll go to a more intact dissection. The pulmonary trunk passes backwards to the left of the aorta, then divides into the left pulmonary artery, and the right pulmonary artery.

15.54

The right pulmonary artery curves around above the left atrium, passing behind the root of the aorta, and behind the superior vena cava. This early branch supplies the superior lobe of the right lung.

16.09

This cord is the divided ligamentum arteriosum, the remnant of the ductus arteriosus which connects the pulmonary trunk and the aorta in intra-uterine life.

16.19

Here's the aorta. It starts to the right of the pulmonary trunk. Its beginning is well hidden in the epicardial fat. In front of it is the right atrial appendage. To its right is the superior vena cava, and behind it is the right pulmonary artery.

16.46

CORONARY VESSELS

Next we'll take a look at the coronary arteries, which provide the vitally important blood supply to the heart itself. The detailed branching pattern of these vessels is highly variable: what we'll see here is just one example.

17.01

To see the coronary arteries, we'll look from above at a heart from which most of the epicardial fat has been removed. Here's the pulmonary trunk, here's the aorta. To see where the coronary arteries arise we've removed both atrial appendages. The left atrial appendage was here, the right atrial appendage was here.

17.26

Here's the right coronary artery. It arises from the right aortic sinus, which is here. The right coronary artery gives off this branch to the upper part of the right atrium, then runs downwards in the right atrio-ventricular groove, giving off branches to the right ventricle. The right coronary artery passes round to the underside of the heart: here it is again. Its terminal branch is the right interventricular artery.

18.02

Now we'll look at the left coronary artery: here it is. It arises behind the pulmonary trunk, from the left aortic sinus. The left coronary artery soon divides, giving off this circumflex branch, and several branches to the left ventricle, the longest of which is the left interventricular artery, also called the left anterior descending artery.

18.30

The circumflex branch of the left coronary artery runs around to the underside of the heart in the left atrioventricular groove, sending further branches to the left ventricle.

18.41

The blood that goes out by way of the coronary arteries returns, mainly, by way of a system of coronary veins, which join to form a large venous channel, the coronary sinus. As we saw earlier, the coronary sinus ends by entering the underside of the right atrium, here.

19.04

Here's the coronary sinus in an intact heart. The coronary sinus passes around the left atrioventricular groove to the underside of the heart. Its opening into the right atrium is just below and in front of the inferior vena cava. Coronary veins from the right side of the heart also empty into the coronary sinus.

19.27

OVERVIEW OF EXTERNAL FEATURES OF HEART

Now that we've seen some dissected specimens, let's take a second all-around look at this intact heart, with all its epicardial fat intact. We'll take a second look at all four chambers, in the order in which blood passes through them.

19.46

Here's the right atrium, with the superior vena cava entering above, and the inferior vena cava below. Here's the right atrial appendage. Here's the location of the tricuspid valve. Here's the right ventricle: it's almost obscured by fat. Here's the infundibulum. The pulmonary valve is here.

20.13

Here's the pulmonary trunk, passing to the left of the aorta, and dividing into the left pulmonary artery, and the right pulmonary artery. Here's the left atrium, with two pulmonary veins entering on the right, and two on the left.

20.36

Here's the left atrial appendage. The mitral valve is here. Here's the left ventricle. Its outflow pathway is here, leading to the aorta. Here's the aorta; and the aortic valve is here.

21.00

PERICARDIAL SAC, GREAT VESSELS

So far we've been looking at the heart by itself, with the major vessels that leave and enter it divided. To see where those vessels go, and also to see the pericardial sac around the heart, we'll look at a dissection in which the anterior chest wall has been removed, from the first rib, to the eighth rib.

21.19

The diaphragm is here. On each side the lungs are quite collapsed. If they were fully expanded they'd be out to here. Here's the heart, hidden within its protective sac of pericardium. In the intact body the front of the pericardial sac is attached to the back of the sternum by this strip of mediastinal fat, all of which we'll remove.

21.48

All this is the pericardial sac. The only major vessels we can see at this point are the aorta emerging from the pericardial sac here, and the superior vena cava entering it here.

22.06

To see more, we'll remove this much of the pericardium. Here's the heart, well covered with epicardial fat. The ventricles are freely mobile within the pericardial sac. Below, the pericardium is reflected onto the upper surface of the diaphragm, to which it's densely adherent. To right and left, the pericardium lies back to back with the parietal pleura.

22.34

Here's the root of the aorta, and of the pulmonary trunk. Here's the superior vena cava, entering the right atrium from above. Each of the great vessels passes through an adherent cuff of pericardium as it enters or leaves the pericardial sac.

22.57

Here's the inferior vena cava coming up through the diaphragm. Here are the left pulmonary veins, and the left pulmonary artery, passing through the pericardium separately.

23.32

On the right, the pulmonary vessels are harder to see because they leave through a continuous cuff of percardium that they share with the inferior vena cava. Here are the pulmonary veins, the artery is out of sight up here.

23.39

Once we've understood the heart in three dimensions, understanding the great vessels that enter and leave it becomes straightforward. The superior and inferior vena cava, and the aorta, are shown in Tape 3 of this atlas; and we'll see more of the pulmonary artery and veins later in this section. Now, let's review what we've seen of the heart

24.04

REVIEW

Here's the right atrium, the atrial appendage, the superior vena cava, and the inferior vena cava,

24.16

Here's the inter-atrial septum, the fossa ovale, the opening for the coronary sinus, and the tricuspid valve. Here's the right ventricle, here are the papillary muscles, and the chordae tendineae, and the infundibulum.

24.39

Here's the pulmonary valve, and the pulmonary trunk, branching into the left pulmonary artery, and the right pulmonary artery. Here's the left atrium. Here are the pulmonary veins, right, and left. Here's the inter-atrial septum again, and the mitral valve.

25.02

Here's the left ventricle, the interventricular septum, the left ventricular outflow pathway, the aortic valve, and the aorta.

25.16

Here's the left coronary artery, here's the right one, here's the coronary sinus. Here are the pericardium, and pericardial sac.

25.28

THE LUNGS AND ESOPHAGUS

Now, we'll move on to look at the lungs. Before looking at the lungs, it's important to understand the structures that contain them. The thorax, the two pleural cavities that lie within it, and the structures that produce respiratory movement are shown in Tape 3 of this Atlas.

25.52

Seen from in front, the lungs are here. Seen from behind, they're here. Seen from either side, the lung is here. A large part of each lung lies behind the heart.

26.07

The lung extends from the ribs in front, to the ribs behind, and from the dome of the pleural cavity, down to the diaphragm. With each breath in, and each breath out there's an increase and a decrease in the volume of the lungs.

26.26

Here are the lungs by themselves, seen from in front. They're being inflated with air so as to maintain their shape. Here's the trachea, here are the two principal bronchi. This is the apex of each lung, this is the base. The space between the two lungs is occupied by the heart and great blood vessels.

26.54

Each lung has three surfaces. The medial or mediastinal surface is marked by the hilum where the bronchi and blood vessels enter; the concave inferior suface rests on the diaphragm; and the large convex costal surface faces the rib cage.

27.17

Each lung is divided by deep fissures into lobes. The right lung has a superior lobe, a middle lobe, and an inferior lobe. The left lung has only a superior and an inferior lobe.

27.37

Here are the lungs seen from behind. The fissures that separate the lobes extend all the way round onto the mediastinal surfaces. The space between the posterior parts of the lungs is occupied by the vertebral bodies.

27.54

To see the lungs in a more intact setting we'll look at a dissection in which the anterior chest wall has been removed. Again the lungs are being inflated with air to keep them expanded. The surface of these lungs is discolored by trapped carbon particles that come from a lifetime's exposure to smoke.

28.12

The two lungs are separated by the mediastinum, the midline partition that's occupied largely by the heart and great vessels, and also by fat and lymph nodes, and in childhood the thymus gland.

28.24

The surface of the lung is formed by the visceral pleura. The visceral pleura covers the lung completely, except here at the hilum, where it becomes continuous with the parietal pleura.

28.37

Taking a close look at the edge of the lung we can see the alveoli, the tiny air spaces where gas exchange occurs. The'yre opening progressively as we slowly inflate the lung.

28.49

Here we're letting the lung collapse, so that we can see the two separate pleural surfaces, parietal and visceral. The two surfaces are normally in close sliding contact with nothing between them except a film of serous fluid. When we have the thorax laid wide open like this it's hard to appreciate the seal that normally exists between the two pleural surfaces. To see that we'll go to a more intact dissection.

29.24

To expose the parietal pleura, we'll remove the intercostal muscles from these intercostal spaces. The parietal pleura that lines the chest wall is attached to the inner aspect of the ribs. The visceral pleura covering the lung slides just beneath it.

29.46

When we puncture the parietal pleura, we break the seal between it and the underlying lung. The lung, no longer pulled outward, collapses as air enters the pleural cavity. Here in an open dissection we're producing the same event, collapse of the lungs, by ceasing to inflate them.

30.15

The function of the lungs as organs of gas exchange depends on our ability to breathe in and out. In this, the lungs themselves are passive: their shape and volume conform from moment to moment to the shape and volume of the cavity they're in.

30.30

When the diaphragm contracts and moves down, and when the intercostal muscles move the front of the rib cage upward and forward, then the volume of the thorax increases, the lungs expand, and air is drawn into the lungs. When these movements are reversed, the lungs are squeezed into a smaller space, and air is blown out.

30.51

Now we'll look at the pulmonary vessels, and the trachea. To do that, we'll take the heart out of the picture, and draw the lungs out to the side. This gives us a view of the medial surfaces of the lungs.

31.06

There's a lot to see here. We'll look at blood vessels first. This the aorta, heavily calcified in this specimen. It's been divided just at the beginning of its arch. Here's the divided right pulmonary artery, entering the hilum of the right lung. Here's the left pulmonary artery.

31.29

A little below the pulmonary arteries on each side are the pulmonary veins, here on the right, here on the left. Above and behind all the great vessels, is the lower end of the trachea, or windpipe. It passes downward into the thorax just to the right of the aortic arch.

31.55

Here are the same structures in a different specimen. Here we've left the lower part of the pericardial sac intact. Here are the divided ends of the pulmonary arteries, and pulmonary veins. Remembering what we've seen of the heart, it's not hard to envision the pulmonary trunk and its bifurcation here, and the left atrium (if we were to stretch it out) here. If we take the aortic arch out of the picture we can see the trachea coming down through the superior thoracic aperture, behind the upper part of the sternum.

32.34

Here's the trachea by itself. Its upper end is continuous with the cricoid cartilage. It ends here, where it divides into the two main, or principal bronchi. The principal bronchi begin to branch as they enter the lung, first into lobar, then segmental branches.

33.04

The corrugated appearance of the trachea comes from the series of c-shaped cartilages that strengthen its wall and keep it open. In between them, the tracheal wall is soft, so that the trachea is highly flexible

33.20

Here we've divided the trachea close to its bifurcation. The cartilages end here, making the trachea somewhat D-shaped in cross section, with a posterior wall that's quite soft.

33.37

Before ending this section we'll briefly look at the esophagus. Here in a dissection where we've removed all of the pericardial sac we can see the lower end of the esophagus. The esophagus passes behind everything else in the mediastinum, to reach the esophageal hiatus in the diaphragm, through which it passes to enter the stomach. Now, let's review what we've seen of the lungs.

34.07

REVIEW

Here are the lungs; on the right here's the superior lobe, the middle lobe, and the inferior lobe; and on the left, the superior lobe, and inferior lobe. Here's the parietal pleura, and the visceral pleura. Here's the hilum of the lung, with the trachea, the principal bronchi, the pulmonary arteries, and the pulmonary veins. Lastly, here's the esophagus

34.43

That brings us to the end of this section on the thoracic organs. In the next section, we'll look at the abdominal organs.

34.57

END OF PART 1

PART 2

THE ABDOMINAL ORGANS

00.00

Before watching this section on the abdominal organs, you'll find it helpful to understand the structures that form the walls of the abdominal cavity, and its extension, the pelvic cavity. These musculoskeletal structures are shown in Tape 3 of this atlas.

00.20

In this section we'll look first at the organs of the gastro-intestinal tract: the stomach, the small intestine and the large intestine. Then we'll look at the liver, the pancreas and the spleen, then at the urinary tract: kidneys, ureters and bladder.

00.39

ABDOMINAL CAVITY, PERITONEUM

Before we look at any of these organs in detail, we'll take a brief look at the abdominal cavity, and at the membrane that lines it, the peritoneum. We'll look at a specimen in which the full thickness of the anterior abdominal wall has been removed, from an area bounded on each side by the costal margin, the mid-axillary line, and the inguinal ligament.

01.02

This presents us with a complex spectacle that we'll soon begin to understand, but first we'll focus on the important lining layer of the abdominal cavity, the peritoneum. Here round the edge, we've left a fringe of peritoneum intact.n Peritoneum is a thin serous membrane, quite similar to pleura. It provides a continuous lining for the abdomino-pelvic cavity.

01.28

To understand the shape and extent of the cavity we're gettting into, we'll look at a specimen in which all the abdominal organs have been removed.

01.39

From in front we don't see the whole of the abdominal cavity. There's much more of it up here, above the costal margin and beneath the diaphragm. All this is the diaphragm. This upper part of the abdominal cavity, which extends up to this line, contains almost all of the liver, most of the stomach, and the spleen.

02.08

Down here, we're looking into the pelvic cavity, which extends backwards and downwards. It's quite a small space. The pelvic brim, which is here, marks the arbitrary boundary between the abdominal and pelvic cavities.

02.27

In the midline, this massive projection is created by the bodies of the lumbar and lower thoracic vertebrae. It divides the posterior part of the abdominal cavity from top to bottom into two deep valleys. This shiny layer is parietal peritoneum. In this dissection all the parietal peritoneum in this central area has been removed. Its attachments in this area are quite complex, as we'll see.

03.02

The surfaces of the organs that lie within the abdominal cavity are also covered with a continuous layer of peritoneum. The visceral layer of peritoneum that covers the organs is continuous with the parietal layer that lines the cavity.

03.18

The space between adjoining peritoneal surfaces is normally occupied by just a trace of serous fluid. Those organs that lie freely mobile within the abdominal cavity, like the small intestine here, are attached to the wall of the cavity by double sheets of peritoneum, in which their blood vessels run.

03.43

As we progress, we'll see how the various peritoneal folds and attachments are arranged, and we'll get an appreciation of the complexities of the peritoneal space.

03.54

GASTRO-INTESTINAL TRACT: STOMACH

We'll move on now, to begin our trip along the continuous tube that forms the gastro-intestinal tract. We'll start where the esophagus joins the stomach, and we'll end at the exit, the anal canal.

04.06

The stomach is up here: this is part of it.To get a clear look at the stomach, we'll remove several structures in front of it and below it, starting with this bulky fold of peritoneum, the dependent part of the greater omentum.

04.24

Next we'll remove these numerous loops of jejuno-ileum, that make up the greater part of the small intestine. We'll remove them by dividing the double sheet of peritoneum that attaches them to the posterior abdominal wall, the mesentery.

04.39

After removing the removing the jejuno-ileum, we'll also remove the colon, which starts down here, and goes up, across and down.

04.51

Along with the colon we'll remove this double sheet of peritoneum that goes from the stomach to the transverse colon, the gastro-colic ligament.

05.02

With these structures of the way we start to get a much clearer view. The last structure hiding the stomach is the liver. We'll remove this left lobe of the liver.

05.14

Now we can see the stomach clearly. All this is the stomach. This is the underside of the diaphragm. Here's the esophagus, coming through its hiatus in the diaphragm. In this view we're looking up at the stomach from about this angle. Much of the stomach lies above the level the costal margin, which is here.

05.42

To see the stomach better we'll look at it in isolation. Here's the way in: the esophago-gastric junction. Here's the way out: the pylorus, which leads to the first part of the small intestine, the duodenum. The narrow part of the stomach leading to the pylorus is the pyloric antrum. In this specimen it's unusually narrow.

06.11

This broad curve, facing to the left, is the greater curve of the stomach. This much tighter curve, facing to the right, is the lesser curve. This upward and backward bulge is the fundus of the stomach: it sits right below the diaphragm.

06.28

Here's the inside of the stomach. Like all the parts of the gastro-intestinal tract, its wall is formed by an outer layer of smooth muscle, and an inner layer of mucosa. In the fundus the mucosal layer is smooth; in the pyloric antrum it's thrown into prominent longitudinal folds.

06.54

At the esophago-gastric junction the muscle coat of the esophagus forms a partly effective sphincter that keeps the contents of the stomach from passing upwards.

07.03

At the pylorus the thickened muscular coat forms a highly effective sphincter that relaxes intermittently to let the contents of the stomach into the duodenum a little at a time. Here are the mucosal folds of the pylorus, protruding into the duodenum.

07.21

GREATER AND LESSER OMENTUM

Two double-sided sheets of peritoneum, the greater omentum and the lesser omentum, extend from the greater curve and lesser curve of the stomach. We'll digress for a minute to look at them.

07.34

The greater omentum is attached along the whole length of the greater curve, the lesser omentum is attached along the lesser curve: up here its attachment is quite wide.

07.50

This is the lesser omentum. Parts of it are fatty, other parts are extremely thin. The lesser omentum goes from the lesser curve here, to the underside of the liver, where its attachment is just out of sight.

08.09

It's attached up here to the underside of the diaphragm. The lesser omentum extends down here onto the duodenum, where it has a free lower border as we'll see.

08.20

Behind the lesser omentum, which we'll divide along this line, is an extensive back-pocket of the peritoneal cavity, the omental bursa or lesser sac, that continues around behind the stomach. We'll see more of it later.

08.37

To see the greater omentum we'll go to an earlier stage in the dissection. All this is the greater omentum. We'll pick it up to see its free lower border. Here's part of its attachment to the greater curve of the stomach. Between its peritoneal layers there's a variable amount of fat. On the front, the greater omentum hangs free, in front of the coils of small intestine. On the back, it's attached to the front of the transverse colon.

09.12

The part of the greater omentum between the stomach and the transverse colon is called the gastro-colic ligament. If we divide it, which we've done here, we come again into the lesser sac, this time below the stomach.

09.30

We're looking at some puzzling structures! To understand why they're arranged as they are, it'll be helpful to see how they developed. Let's digress for a few minutes, and look at a sequence of highly simplified diagrams.

09.47

The foregut starts as a straight tube. As it develops, it rotates on its long axis, lengthens in a double curve, and expands to become the stomach, and the first part of the duodenum.

10.03

The foregut is different from the rest of the G-I tract. The hindgut and midgut are attached to the body wall by a double fold of peritoneum only along the back. The foregut is attached also at the front. Its two attachments are the dorsal mesogastrium behind, and the ventral mesogastrium in front. As the foregut rotates, the dorsal and ventral mesogastrium rotate with it.

10.30

The line of attachment of the ventral mesogastrium swings round to the right as the foregut develops. It ends up running along the lesser curve of the stomach, and the top of the proximal duodenum.

10.44

On the back, the attachment of the dorsal mesogastrium swings round to the left. It ends up running along the greater curve of the stomach, and the underside of the proximal duodenum. While the foregut is developing, there are important changes in the ventral and dorsal mesogastrium.

11.03

The liver develops in the ventral mesogastrium, the spleen develops in the dorsal mesogastrium. The liver grows rapidly, pressing against the body wall, and obliterating these layers of peritoneum. These changes produce this almost separate pocket behind the stomach, the lesser sac.

11.23

This part of the ventral mesogastrium is the lesser omentum. This part of the dorsal mesogastrium will become the greater omentum. We'll follow these changes from the start in a more three-dimensional way. To do that, we'll go to a view from below.

11.42

Here we're looking up into the upper part of the abdominal cavity This is the diaphragm. Here's the foregut, starting to develop, here's the liver developing in the ventral mesogastrium, and the spleen developing in the dorsal mesogastrium.

11.58

Here's the space that will be the lesser sac. This is the lesser omentum, this part of the dorsal mesogastrium will grow downwards to become the greater omentum. We'll move to a slightly lower vantage point so we can add the duodenum to the picture. The foregut ends here: so does the lesser omentum. This is the lower free border of the lesser omentum.

12.25

Below it the duodenum becomes stuck againt the liver, leaving this opening, the epiploic foramen, that leads into the lesser sac. The dorsal mesogastrium is shown as though it had a free lower border along here, but in reality this fold is continued all the way round to here, creating a sac that has only one opening, here.

12.51

To see how the greater omentum develops we'll first add the transverse colon to the picture. The dorsal mesogastium hangs down in front of the transverse colon. To follow its growth we'll look at a sagittal section made in this line.

13.06

Here's the lesser omentum, between the liver and the stomach. Here's the greater omentum, hanging down in a double fold. Below it is the transverse colon, suspended by the transverse mesocolon. This is the pancreas. The greater omentum grows downward in front of the transverse colon.

13.32

The greater omentum and the transverse mesocolon come together, and the duplicated layers are absorbed, so that we're left with the greater omentum stuck to the transverse colon, and hanging down below it. The lesser sac lies behind the lesser omentum, the stomach, and this part of the greater omentum, the gastro-colic ligament.

13.58

Now that we've seen in a very diagrammatic way how these structures developed, you may find it helpful either now or later to take another look at the previous five minutes of the tape.

14.10

SMALL INTESTINE

Now we'll continue our journey along the gastro-intestinal tract by looking at the small intestine. The small intestine consists of the duodenum and the jejuno-ileum.

14.23

The duodenum is the first part of the small intestine. It's also the hardest to see because there's so much in front of it. To see it we'll go to a dissection in which the lower ribs, which were here, have been removed. We've also removed the left lobe of the liver, the greater omentum, and the colon.

14.44

This is the duodenum. It begins here, and ends here. The duodenum is partly hidden by the root of the mesentery, which is the peritoneal attachment of the jejuno-ileum. To see all of the duodenum, we'll remove the mesentery, and the jejuno-ileum.

15.07

The duodenum starts at the pylorus by passing upwards and to the right, then turns to run in almost a full circle, ending here at its sharply angled junction with the jejunum, the duodeno-jejunal flexure. The discoloration up here is due to post-mortem staining from the nearby gall bladder.

15.29

The duodenum is often described as having four parts, numbered one through four. The inner aspect of the curve of the duodenum is largely occupied by this structure, the head of the pancreas, which we'll see later.

15.46

The pancreatic duct or ducts, which lie within the panreas, together with the common bile duct, join the second part of the duodenum, as we'll see.

15.55

The duodenum lies further to the back than any other part of the gastro-intestinal tract. It's there as a result of an important process that happens in the embryo, the rotation of the midgut. To understand how that happens, we'll look at another extremely simplified animation.

16.15

The GI tract, which ends up like this, starts out as a straight tube consisting of the foregut, the hindgut, and the midgut. The midgut forms a loop that twists counterclockwise on itself, ending up like this. In the course of this rotation, the part of the loop that becomes the proximal colon passes in front of the part that forms most of the duodenum, and that's the way we find it in the adult.

16.59

Understanding those developmental changes helps us understand not only where the duodenum lies, but also why the colon is where it is.

17.09

Before we leave the duodenum, we need to look at two special aspects of its peritoneal attachments: proximally, the distal part of the lesser omentum, and distally the suspensory ligament.

17.21

We'll go back to this earlier stage of the dissection to see these. Here's the part of the lesser omentum that we've seen already. The lesser omentum continues along the upper surface of the first part of the duodenum, and comes to an end here.

17.39

This is the free border of the lesser omentum, passing from the duodenum to the underside of the liver. Beneath the free border of the lesser omentum lies this hidden opening, the epiploic foramen, which is the only natural entry way to the omental bursa or lesser sac.

17.56

Going to the distal end of the duodenum, this is the suspensory ligament, also known as the ligament of Trietz. It's a fold of peritoneum, reinforced with fibrous tissue, that holds up the duodeno-jejunal flexure.

18.12

Now we'll move on to look at the jejunum and the ileum. They're the sites of absorbtion of digested foodstuffs. Jejunum and ileum are names given to the proximal and distal parts of one continuous tube. There's no distinct boundary between them, and they're often spoken of together as the jejuno-ileum.

18.33

We'll look at a dissection in which all the organs are present, with only the only the dependent part of the greater omentum removed. All of this seemingly haphazard arrangement of loops and coils is the jejuno-ileum. To make its orientation clearer, we'll re-arrange it re-arrange it like this.

18.53

The jejuno-ileum starts up here to the left of the mid-line. It runs downward and to the right, ending here. The jejuno-ileum lies within a space that's bounded by the ascending colon to the right, the descending colon to the left, and the transverse colon and its mesentery above.

19.21

Along its six metre length the jejuno-ileum changes gradually: it becomes narrower, thinner walled, and less vascular. The loops of jejuno-ileum are attached to the posterior abdominal wall by this peritoneal sheet, the mesentery.

19.40

Since the attachment of the mesentery to the intestine is about thirty times longer than its attachment to the body wall, the mesentery is arranged like a richly folded fan. The mesentery carries the blood vessels of the jejuno-ileum, and its nerves and lymphatics.

19.58

The blood vessels are arranged in arcades, which we can see when we hold the mesentery up to the light. Here in the proximal jejuno-ileum there's a single arcade. Here more distally there are multiple arcades: there's one here, another one here. The mesentery contains fat between its peritoneal layers, more so distally than proximally.

20.24

We'll take the jejuno-ileum out of the picture, to look at the attachment of the mesentery to the posterior abdominal wall. It begins here on the left in front of the last part of the duodenum, and runs downward and to the right, ending here close to the cecum.

20.50

Here's part of the jejunum that's been divided longitudinally. The mucosal lining is thrown into folds that project into the lumen. The folds are more pronounced here in the jejunum, than in the ileum.

21.04

Seen in close-up, the mucosal surface is a carpet of minute projections, villi, which vastly increase its absorbtive surface area. The jejuno-ileum ends down here. We'll remove some fat to see that better. The ileum joins the large intestine at the ileo-cecal valve, which is here.

21.34

LARGE INTESTINE

Now we'll move on to look at the large intestine, where water and electrolytes are absorbed from the intestinal contents, the contents changing from liquid to semi-solid in the process. The large intestine consists of the cecum and appendix, the colon, the rectum, and the anal canal.

21.54

The cecum is a blind side passage at the beginning of the large intestine. It hangs downward in the right iliac fossa, lying almost free of peritoneal attachments. Here's the appendix, sometimes called the vermiform appendix. It's a vestigial but potentially troublesome structure. It can lie in a variety of positions. This is its most usual location.

22.20

Here's a dissection of the terminal, ileum, cecum and appendix that's been opened longitudinally. The ileum projects a long way into the lumen of the cecum, opening here. It's suspended by these two folds of mucosa. Despite its name and valve-like arangement, this opening is not an effective one-way valve. The appendix opens into the cecum below the ileo-cecal valve. Here's its opening.

22.56

To see the rest of the large intestine we'll again take the jejuno-ileum out of the picture.

23.06

The colon has four named parts: ascending, transverse, descending and sigmoid.

23.16

Before we look at these let's look at the features of the colon that make it different from the small intestine. Here's a typical length of colon. In the colon the longitudinal muscle isn't continuous: it's gathered into three strips called the teniae coli, here's one of them, here's another.

23.38

The tenia are effectively shorter than the rest of the wall of the colon, they have the effect of drawstrings, producing these bulging sacculations. In many adults these diverticuli develop over time. They're protrusions of mucosa though the muscular layer.

23.55

Here's the colon on the inside. In between the outward bulges, which are called haustra, these impressive mucosal folds can divide the lumen into separate compartments when the muscle contracts strongly. Seen in close up, the mucous membrane of the colon is smooth: there are no villi. Here's the opening to that diverticulum.

24.21

Now we'll return to the dissection, to follow the course of the colon. Here's the ascending colon. It's held in place by the peritoneum of the posterior abdominal wall, which covers it on the front and sides. The ascending colon ends a long way back at this sharp 90° turn, the right colic flexure, or hepatic flexure. The hepatic flexure lies just below the lowest part of the liver, and the gall bladder, and in front of the lower part of the right kidney, which is back here.

24.57

The transverse colon crosses the abdominal cavity from right to left. Here the transverse colon has been pulled upward, along with the greater omentum. Here's where it's normally located.

25.13

In its natural location it's partly hidden by the geater omentum that clings to its anterior surface. The omentum isn't he real attachment of the transverse colon: it's only loosely adherent to it. The real attachment of the transverse colon, which we can see when we pull it upwards, is this double sheet of peritoneum, the transverse mesocolon. We'll take the transverse colon out of the picture to see its attachment.

25.42

Here's the divided transverse mesocolon. It goes from here, to here. It crosses the head of the pancreas, which is here, and also the duodenum, which is here. This is the divided root of the mesentery. The transverse colon hangs down in a curve that's parallel to the greater curve of the stomach.

26.13

The two structures are connected, as we've seen, by the part of the greater omentum that's known as the gastro-colic ligament. The transverse colon ends higher and even further back than it started, at this sharp downward turn, the left colic flexure, or splenic flexure.

26.35

With the colon in its natural location the splenic flexure is out of sight, right up here. The splenic flexure lies just below the spleen, and in front of the left kidney, which is back here.

26.56

Below the splenic flexure is the descending colon. Just like the ascending colon, it's fixed to the posterior abdominal wall. The descending colon is quite short. A little below the iliac crest, which is here, the descending colon is continuous with the sigmoid colon.

27.18

The sigmoid colon forms a large freely mobile loop that's attached by this double sheet of peritoneum, the sigmoid mesocolon. The sigmoid colon passes down into the pelvic cavity: there's a lot of it down there, which we'll bring out.

27.37

As it passes into the pelvic cavity the sigmoid colon approaches the midline. The sigmoid mesocolon becomes shorter as it enters the pelvis, and ends altogether down here. The sigmoid colon ends at the level of S3, where it merges with the rectum.

27.56

RECTUM

Now we'll look at the rectum, where fecal material is stored before being eliminated. Looking down into the pelvis from above, we can only see the most proximal part of the rectum. Here it is. To see all of it we'll look at two different specimens, one divided along this line, one along this line, going all the way down through the pelvis and perineum.

28.25

Before we look at the rectum, we need to get our bearings. On each side the cut went through the iliac crest, the blade of the ilium, the acetabulum, and the ischio-pubic ramus.

28.38

Here's the same cut made on a dry bone specimen. Here's the pelvic brim, and here's the pelvic brim in the dissection. Here's the cut edge of the peritoneum that lines the small upper part of the pelvic cavity. Here's the lower end of the sigmoid colon, here's the rectum.

29.04

From here, the peritoneum that covers the upper part of the rectum sweeps forwards, leaving most of the rectum with no peritoneal covering. We'll come back to this view in a minute.

29.19

To see what's behind the rectum and in front of it, we'll look at a different specimen that's been divided just to the left of the midline, the midline, leaving the rectum intact. Here's the promontory of the sacrum, here's the divided body of the pubis. Here's the rectum. Here's the lower limit of its peritoneal covering. The rectum lies in front of the lower half of the sacrum, and the coccyx. It conforms to their overall curve.

29.52

Here in its lower part the rectum runs downward and forward on this sling of muscle, the levator ani. The levator ani is the principal structure of an important partition, the pelvic diaphragm. The rectum turns sharply backwards as it passes through the pelvic diaphragm, becoming continuous with the anal canal.

30.13

In front of the rectum are the bladder, the seminal vesicles, and the prostate in the male, and the uterus and vagina in the female.

30.23

To see some more details, we'll go to the to the front view again. As the sigmoid colon merges into the rectum, the teniae broaden out, so that the rectum has a coat of longitudinal muscle that’s almost continuous.

30.39

The lower part of the rectum, known as the ampulla, is quite distensible. This space around the rectum isn't empty. In life it's occupied by fatty connective tissue that accommodates to changes in the size and shape of the rectum.

30.53

Here's the pelvic diaphragm, sloping down on each side. It's formed mainly by the levator ani muscle. This is the puborectalis part of the levator. As the rectum passes through the pelvic diaphragm, it becomes continuous with the anal canal, which ends here at the anus.

31.18

The lower end of the rectum runs downwards and forwards, the anal canal, runs downwards and backwards. The angulation between the rectum and anal canal, the perineal flexure, is maintained by the forward pull of the puborectalis part of the levator ani muscle.

31.37

Closure of the anal canal is maintained by the internal and external anal sphincter muscles. The involuntary internal sphincter is a continuation of the circular smooth muscle coat of the intestine. It's present in the proximal two thirds of the anal canal. The voluntary external sphincter runs the full length of the canal.

32.01

This is the external anal sphincter. It's somewhat funnel-shaped. Above, the external sphincter merges with the levator ani muscle. Its upper part consists largely of anular fibers that go all the way round.

32.19

Its lower part is formed mainly of fibers that pass from back to front. Behind, these fibers are attached to the anococcygeal ligament. In front they're attached to the perineal body, or central perineal tendon, which is here.

32.33

The levator ani muscle is shown in more detail in Tape 3 of this atlas. Now that we've looked at the whole length of the gastro-intestinal tract, let's review what we've seen.

32.48

REVIEW

Here's the stomach, with its greater curve, and lesser curve. Here's the esophago-gastric junction, the fundus, the pylorus, and the pyloric antrum.

33.09

Here's the dependent greater omentum, the gastro-colic ligament, the gastro-splenic ligament, the lesser omentum, and the epiploic foramen.

33.22

Here's the duodenum, the jejuno-ileum, the cecum, the vermiform appendix, the ascending colon, transverse colon, descending colon, and sigmoid colon. Here's one of the taeniae coli, and the haustra of the colon.

33.46

Here's the mesentery and its divided root. Here's the transverse mesocolon, and its divided root. and here are the rectum, and the anus.

34.02

End of time sequence

LIVER, PANCREAS, SPLEEN

Start of new time sequence

00.00

Now we'll move on to look at three major organs in the upper part of the abdominal cavity, the liver, the pancreas and the spleen.

00.10

The liver occupies the highest part of the abdominal cavity. It's just beneath the diaphragm, which is here. Much the greater part of the liver lies to the right of the midline. Since the liver doesn't usually come below the costal margin, which is here, we can't get a view of it from in front by just removing the anterior abdominal wall. To see it, we need also to remove this much of the rib cage.

00.45

In removing the lower part of the rib cage we've made a big opening into the chest. We've left the diaphragm in place. Here's the diaphragm, hanging loose along its former line of attachment.

01.00

To make a tidy picture we'll displace the diaphragm upward like this, and attach it with stitches to the rib cage all along here, closing off the pleural cavity. Here's the underside of the diaphragm, artificially flattened out, and here's the liver.

01.20

We're looking at a large part of its outward-facing surface. Most of the liver is covered by peritoneum. There's an area behinds that isn't, as we'll see. The liver is attached to its surroundings by peritoneal folds which we'll look at in a minute. First, let's look at the overall shape of the liver.

01.41

Here's the liver by itself, seen from in front. It has two main surfaces, an highly irregular posterior surface that's approximately flat, and this much larger outward facing surface that's smooth and highly convex. The outward-facing surface conforms to the shape of the diaphragm, with which it's in close contact. Here in front, the two surfaces meet at this quite sharply defined anterior border.

02.12

This is the gall bladder. It hangs down below the anterior border. Here's the liver seen from behind. Here's the anterior border. There is no distinct posterior border. Here's the gall bladder again; this is the inferior vena cava. There's a lot to see in the posterior aspect of the liver. We'll look at the details in a minute.

02.39

Next we'll look at the peritoneal folds and lines of attachment, along which the visceral peritoneum of the liver becomes continuous with the parietal peritoneum of the diaphragm, and posterior abdominal wall. Although these attachments are formed only of peritoneum, they're referred to as ligaments. We'll look first at the falciform ligament which is in front, then at the coronary ligament, the right and left triangular ligaments, and the lesser omentum.

03.08

Here's the falciform ligament. It's a slender fold that runs from the highest part of the liver, down to this pronounced notch on the anterior border, the hepatic notch.

03.25

Here's the falciform ligament in a more intact dissection Its anterior border is attached to the anterior abdominal wall, and its posterior border hangs free, all the way down to the umbilicus.

03.41

In its free border there's a cordlike structure, the ligamentum teres, the remnant of the umbilical vein. The ligamentum teres runs through the hepatic notch, onto the underside of the liver.

03.56

Along this line the two layers of peritoneum that form the ligament become continuous on each side with the peritoneum covering the liver. In the intact body the cut edge this ligament is attached to the underside of the diaphragm, along this line. Here, it still is attached.

04.21

That attachment ends back here, where the right and left sides of the falciform ligament diverge becoming continuous to right and left with this fold of peritoneal attachment, the coronary ligament. The line of attachment of the falciform ligament, and the hepatic notch, divide the liver into a small left lobe, and a much larger right lobe.

04.49

That division exists only on the surface: internally the liver is divided quite differently. To follow the peritoneal attachments of the liver round to the back we'll return to return to this view of the liver by itself.

05.04

Here, divided, is the part of the coronary ligament that we saw from in front. It continues round onto the back of the liver, surrounding this irregular bare area of the liver, which lies directly on the underside of the diaphragm, and the posterior abdominal wall.

05.24

The coronary ligament is continuous with a line of peritoneal reflection that goes round the front of the inferior vena cava, and back to the top. Four double folds of peritoneum extend from the edges of the line of reflection. Passing forward is the falciform ligament as we've seen.

05.44

Passing to right and left near the top of the liver are the two triangular ligaments. Seen from in front, here's the right triangular ligament. It ends here. Here's the left triangular ligament: it extends up onto the diaphragm a little beyond the tip of the left lobe.

06.08

The last peritoneal attachment to look at is the lesser omentum. This is the lesser omentum, it goes, all the way down to here. Its lower part emerges from this complex area, the porta hepatis, which we'll come back to. Here's the lesser omentum seen from in front. As we've seen, it passes from the liver, to the lesser curve of the stomach, all the way up to the diaphragm.

06.42

Now we'll take a further look at the part of the liver that faces backwards and downwards. We'll take another look at structures we've mentioned already. This huge vessel is the inferior vena cava. It's almost enveloped by the liver. Up here the hepatic veins enter it, as we'll see.

07.05

Here on the underside of the liver is the gall bladder, which we saw briefly from in front. We'll take a closer look at it in a minute. This busy area above the gallbladder is the porta hepatis, where the portal vein and hepatic artery enter the liver and the hepatic ducts leave it.

07.22

To see where the hepatic veins leave the liver, we'll remove the inferior vena cava. Up here, just below the diaphragm, two or three large hepatic veins emerge from the liver and join the inferior vena cava. Further down, numerous smaller hepatic veins also join the inferior vena cava.

07.46

The posterior surface of the liver is indented from top to bottom by this deep vertical groove, which ends down here at the hepatic notch. The lower part of the groove is formed by the ligamentum teres, which we've seen from in front. The upper part of the groove is formed by a continuation of the same cord-like structure, the ligamentum venosum.

08.16

These two cords are remnants of the umbilical vein, and ductus venosus. The porta hepatis lies just to the right of the middle part of the vertical groove. The part of the liver to the left of the vertical groove is referred to as the left lobe.

08.38

The large area to the right of the groove is subdivided into three named areas, the large right lobe, the quadrate lobe between the groove and the gallbladder (here's the quadrate lobe from in front) and this irregularly shaped portion between the groove and the vena cava, the caudate lobe. (More often, the caudate lobe is shaped like this.) In front, the division between the right and left lobes is the line of attachment of the falciform ligament

09.12

These named lobes are only surface features that have no functional significance. We'll look in more detail at the gallbladder and bile duct system in just a minute, but first we need to look at the pancreas, which is closely related to the bile duct.

09.31

The pancreas is a gland with endocrine and exocrine functions. It's closely applied to the posterior abdominal wall. To see it we'll look at a dissection in which all of the GI tract except the duodenum has been removed. Here's the pancreas. It's described as having a head, a neck, a body and a tail. The head of the pancreas is closely applied to the inner curvature of the duodenum.

09.59

The neck, body and tail of the pancreas extend to the left and slightly upward, ending here close to the spleen which we'll see shortly. Behind the pancreas are the body of L1, the inferior vena cava, the aorta and superior mesenteric artery, and the left kidney.

10.22

The lower part of the head of the pancreas curls around to the left, forming the uncinate process. The portal vein passes beneath the neck of the pancreas on its way to the liver.

10.34

The exocrine secretions of the pancreas empty into the duodenum by way of the pancreatic duct or ducts. Here we've removed part of the head of the pancreas, to show the main pancreatic duct, entering the duodenum. We'll see more of that in a minute.

10.53

Now that we've looked at the pancreas, we'll return to the liver and see the parts of the biliary sytem that lie outside it: the hepatic ducts, the cystic duct and gallbladder, and the common bile duct. We'll look from behind at a liver in which these structures have been dissected out.

11.12

Here at the porta hepatis our view of the structures of the biliary system is crowded by the portal vein, and the hepatic artery. We'll remove those blood vessels, to simplify the the picture. Here are the and left hepatic ducts, the main branches of a tree that extends throughout the liver. They unite here to form the common hepatic duct.

11.41

The common hepatic duct goes to here, where it's joined by the narrow cystic duct. The cystic duct, which runs in a spiral, fills and empties the gall bladder. Below this junction, the main passage for bile gets a different name: from here down to the duodenum it's the common bile duct. We'll follow it in a minute.

12.03

The gall bladder is a reservoir for bile. It fills and empties by way of the cystic duct, filling passively, and emptying by contraction of its muscular wall. The lower part of the gallbladder hangs down below the free border of the liver. Its upper part is held against the underside of the liver by a common sheet of peritoneum, most of which has been removed here.

12.31

To follow the common bile duct, we'll go to an intact dissection, seen from in front. We've removed the left lobe of the liver, and the transverse colon. Here's the gall bladder. Here's the lesser curve of the stomach.

12.51

Here, between the liver and the first part of the duodenum, is the thickened lower part of the lesser omentum, also called the hepatoduodenal ligament. It's quite darkly stained with bile in this specimen.

13.08

The common bile duct lies within it, quite close to the epiploic foramen, which is here. To see the common bile duct, we'll dissect into this part of the hepatoduodenal ligament.

13.18

Here's the common bile duct. It passes down, out of sight, behind the first part of the duodenum. To follow it we'll mobilize the duodenum and pull it over to the left. Here's the distal part of the common bile duct, dissected free from its surroundings. As it nears the duodenum it's almost embedded in the back of the head of the pancreas.

13.49

Here's a duodenum cut open so we can see where the common bile duct and pancreatic ducts end. On the outside here's the common bile duct, here's the main pancreatic duct. Here's a minor pancreatic duct.

14.07

On the inside, the bile duct passes downward beneath the duodenal mucosa, creating this bulge. The bile duct and the main pancreatic duct open here, at the duodenal papilla.

14.23

The last organ we'll look at, that lies within the abdominal cavity, is the spleen. Functionally the spleen doesn't have anything to do with the GI tract, but it does have peritoneal connections to the stomach and other viscera.

14.38

In the living body the spleen is here, well above the left costal margin. The ninth, tenth and eleventh ribs overlie it. To see the spleen we'll go back to back to this dissection, in which the lower ribs have been removed, and the diaphragm stretched flat, and stitched to the cut edge of the chest wall.

15.00

Here's the spleen, lying between the stomach and the rib cage. The spleen is an important filter of blood cells, and a significant component of the immune system. It's covered by peritoneum, except here at its hilum, where the splenic blood vessels enter.

15.24

This sheet of peritoneum, the gastro-splenic ligament, extends to the greater curve of the stomach. It's in fact an upward continuation of the greater omentum. If we divide the gastrosplenic ligament, which we've done here, we come into the lesser sac, which is no surprise when we recall the developmental anatomy here.

15.50

You'll recall that the spleen developed between the two layers of the dorsal mesogastrium. As it grew it bulged out within the outer layer, which forms its peritoneal covering.

16.00

Two double folds of peritoneum meet at the hilum: one in front, the gastrosplenic ligament which we just divided, and one behind, the lieno-renal ligament, which we haven't seen yet. Between the two folds is the left-hand limit of the lesser sac.

16.17

Going back to the to the dissection, here's the divided gastrosplenic ligament, here behind the spleen is the lieno-renal ligament. This gives the spleen a loose connection to the left kidney, which lies just behind it. Here in the posterior wall of the lesser sac, the tail of the pancreas comes almost to the hilum of the spleen.

16.43

The left flexure of the colon, the splenic flexure, lies in front of the spleen and just below it. Here in a different specimen is the same area seen from the left side. The lower ribs came down to here. As before, we've stitched the cut edge of the diaphragm to the chest wall, all the way along here.

17.07

Here's the spleen, with the diaphragm right behind it. Here's the splenic flexure and the descending colon. Here's the edge of the liver, here's the greater curve of the stomach, here's the gastrosplenic ligament, continuous here with the dependent greater omentum.

17.28

Now that we've looked at the GI tract and its associated organs, we'll move on to look at their blood vessels. Before we do that, let's review what w've seen of the liver, pancreas and spleen.

17.40

REVIEW

Here's the liver, the left lobe, the right lobe, the quadrate lobe, and the caudate lobe. Here's the falciform ligament, and the ligamentum teres. Here's the coronary ligament, and the right triangular, and left triangular ligaments.

18.09

Here's the inferior ven cava, the gall bladder, the porta hepatis, the portal vein, the hepatic artery, the common hepatic duct, cystic duct, and common bile duct.

18.28

Here's the pancreas, the head of the pancreas, the uncinate process, and the neck, the body, and the tail. Here's the spleen, the gastro-splenic ligament, and the lieno-renal ligament.

18.48

ABDOMINAL BLOOD VESSELS

The blood supply to all the organs in the abdomen that we've seen so far: the GI tract, the liver, pancreas and spleen, comes from three midline branches of the abdominal aorta. These are the celiac, the superior mesenteric and the inferior mesenteric arteries. We'll look at these, then we'll look at the special venous drainage of these organs.

19.17

We'll start with the celiac artery, which is more often called the celiac trunk or axis because it's so short. It supplies the structures that are derived from the foregut: the stomach, proximal duodenum, spleen, liver, and most of the pancreas.

19.35

To see the celiac trunk and its branches we'll start here in the upper abdomen, in a specimen in which the arteries have been injected with latex. We've removed the lower part of the rib cage, and we've removed the left lobe of the liver, which was here.

19.51

The celiac trunk arises back here. To see it we'll take the stomach and the lesser omentum out of the picture. We've also removed all the fatty connective tissue from this uppermost part of the posterior abdominal wall. Here's the opening in the diaphragm for the esophagus. Here below it is the opening for the aorta. Here's the aorta itself, just visible above the pancreas.

20.20

This short vessel coming straight forwards is the celiac trunk. It arises right at the top of the aortic opening, between the crura of the diaphragm. The celiac trunk gives off branches to the diaphragm, then divides into three main branches, the small left gastric artery which goes straight up, and the large common hepatic, and splenic arteries, which go to the right and left.

20.44

We'll look at the splenic artery first. The splenic artery follows a tortuous course towards the spleen along the upper border of the pancreas. Here's the pancreas, here's the spleen. The splenic artery ends by dividing into several large branches as it reaches the hilum of the spleen.

21.04

Now we'll follow the follow the other main branch of the celiac axis, the common hepatic artery. The common hepatic artery passes to the right, and divides into the hepatic artery, and the gastro-duodenal artery. The hepatic artery runs upwards and to the right, to supply the liver.

21.23

It runs close to the common bile duct, which is here, and the portal vein, which is beneath it here. To follow the hepatic artery, we'll look at the liver from behind. Here's the hepatic artery, dividing into right and left branches as it approaches the porta hepatis. This is the portal vein, which we'll come to shortly.

21.49

We'll return to the division of the common hepatic, into the hepatic and gastro-duodenal arteries. From near this division two branches to the stomach arise, the right gastric, which usually arises from the hepatic, and the right gastro-epiploic, which arises from the gastro-duodenal.

22.10

After giving off the right gastro-epiploic, the gastro-duodenal artery continues as the pancreatico-duodenal artery. It runs downward behind the duodenum, supplying it and the head of the pancreas. Here the divided duodenum has been retracted to the right. Normally, it's here.

22.30

Now we'll look at the blood supply to the stomach, which we'll put back into the picture. The stomach gets most of its blood supply from two vascular arcades, an outer one, that runs in the greater omentum or gastro-hepatic ligament, close to the greater curve, and an inner one that runs in the lesser omentum near the lesser curve.

22.55

The inner arcade is supplied at its two ends by the right gastric, and left gastric arteries. The outer arcade is supplied by the right gastro-epiploc, and the left gastro-epiploic which is a branch of the splenic. Often the right and left vessels join to form a continuous loop.

23.16

Now we'll move on to look at the artery of the mid-gut, the superior mesenteric artery. It supplies the distal duodenum, the jejuno-ileum, the ascending colon and part of the transverse colon. The superior mesenteric arises from the aorta just below the celiac trunk. To see it we'll look at a dissection similar to the last one.

23.40

Here's the pancreas, here's the celiac trunk, arising from the aorta. Here's the superior mesenteric artery. It arises up here beneath the pancreas. We'll remove this part of the pancreas to see it.

23.57

Here's the origin of the superior mesenteric artery. It runs almost straight downward, with a large vein in front of it, the splenic vein, and a large vein behind it, the left renal vein, both of which are empty here.

24.16

It gives off branches that supply the pancreas and duodenum, then emerges from beneath the pancreas, which we'll restore to its intact state. The superior mesenteric artery emerges here from beneath the neck of the pancreas, along with the superior mesenteric vein. It passes in front of the uncinate process of the pancreas, which is under here, and in front of the third part of the duodenum,

24.45

As it does so it gives off numerous branches. Some of these enter the mesentery, which has been removed here, two run down and to the right in the retroperitoneum, and one passes upward, to enter the transverse mesocolon.

25.02

To see all these branches better we'll go to an earlier stage in the dissection, in which all the viscera are intact. To get to where we were just now, we'll lift up the dependent part of the greater omentum, and with it the transverse colon. We'll dissect in this area to see the superior mesenteric artery and its branches.

25.29

Here's the superior mesenteric artery. Here's the duodenum beneath it. These branches, that pass downwards and to the left, fan out to supply the jejuno-ileum. This one, the ileo-colic, goes toward the cecum; these two, the right colic and middle colic go to the ascending colon and the transverse colon respectively. As they approach the intestine the superior mesenteric branches rejoin to form a set of vascular arcades that run close to the intestine along its length.

26.11

Next we'll look at the inferior mesenteric artery, the artery of the hind-gut. It supplies the distal colon and the rectum. Its origin from the aorta is below the pancreas and duodenum, at the level of L3. To see it we'll go to an earlier stage of the same dissection, and displace the jejuno-ileum to the right. Here's the transverse mesocolon, here are the descending colon, and sigmoid colon.

26.43

We'll dissect in this area to expose the expose the inferior mesenteric artery and its branches. Here's the distal part of the duodenum. Here's the aorta. It bifurcates down here.

27.01

Here's the inferior mesenteric artery arising from the aorta. It passes downwards, giving off these branches to the colon. This one is the left colic artery, which supplies the ascending colon and the distal part of the transverse colon. It anastomoses with the middle colic artery, forming an arcade in the transverse mesocolon.

27.22

These branches of the inferior mesenteric artery supply the sigmoid colon. This last branch is the superior rectal artery. It runs down into the pelvis, to supply the upper part of the rectum.

27.40

The lower parts of the rectum are supplied by branches of the internal iliac artery. Now we'll move on to look at the veins that drain the GI tract, the pancreas and the spleen.

27.53

The venous drainage of these organs is unlike that of the rest of the body. The arteries we've seen are accompanied by corresponding veins. These run back alongside the arteries, but they don't join the vena cava, they join to form the portal vein, which takes the blood from the GI tract, the spleen and the pancreas to the liver.

28.14

The portal vein is formed behind the pancreas. Here's the pancreas. Here's the duodenum; here it is again.

28.26

Here are the superior mesenteric, and inferior mesenteric veins, joining, and passing up behind the pancreas. To see more, we'll remove the left half of the pancreas. Here behind the pancreas is the large splenic vein coming in from the left.

28.48

The portal vein is formed by the confluence of these vessels. More often the inferior mesenteric vein joins the splenic rather than the superior mesenteric. To follow the portal vein we'll put the pancreas back in place.

29.02

Here's the portal vein emerging from behind the neck of the pancreas and running up and to the right towards the liver. It runs behind the first part of the duodenum, which goes here. Let's see that again at an earlier stage of the dissection. Here's the pylorus, here's the first part of the duodenum. We'll pull it downward.

29.29

Here's the portal vein. It runs up toward the liver within the hepato-duodenal ligament, which is the lower part of the lesser omentum. Here's the free border of the lesser omentum.

29.40

Close to the portal vein are the hepatic artery and the common bile duct. The portal vein ends here, dividing into left and right branches as it enters the liver at the porta hepatis.

29.59

Now that we've seen the blood vessels of the abdominal organs, we're about ready to move on to look at the urinary system. Before we do that, let's review what we've seen of the blood vessels.

30.10

REVIEW

Here's the celiac artery, dividing into the left gastric artery, the splenic artery and the common hepatic artery, which in turn divides into the hepatic artery, and the gastro-duodenal artery.

30.32

Here are the arteries that supply the stomach: the outer arcade, supplied by the right gastro-epiploic, and left gastro-epiploic; and the inner arcade spplied by the right gastric, and left gastric.

30.47

Here's the superior mesenteric artery, the branches to the jejuno-ileum, the ileo-colic, right colic, and middle colic arteries. Here's the inferior mesenteric artery, the left colic artery, branches to the sigmoid colon, and the superior rectal artery.

31.11

Here's the superior mesenteric vein, the splenic vein, and the portal vein.

31.19

URINARY SYSTEM

Now we'll look at the structures of the urinary system, the kidneys, the ureters, the bladder and the urethra. We'll start by looking at the kidneys, and also, since they're nearby, at the suprarenal glands.

31.19

The kidneys are located high in the posterior abdominal wall, behind the peritoneum. They lie in front of the eleventh and twelfth ribs. The right kidney is slightly lower than the left one.

31.55

To see the kidneys and ureters we'll look at a dissection in which all the intra-abdominal organs have been removed. The kidneys are here.

32.05

As we've done in other dissections, we'll remove the lower anterior ribs to get a better view. The kidneys are surrounded by a layer of fat which we'll remove. Here are the kidneys. Here's the aorta, emerging between the crura of the diaphragm.

32.29

Here's the vena cava, quite distended in this specimen. We'll look first at the blood vessels of the kidneys, the renal vessels. The veins lie in front of the arteries. The left renal vein crosses in front of the aorta, just below the origin of the superior mesenteric artery.

32.47

The right renal vein, which is much shorter, passes steeply backwards to reach the right kidney. To see the renal arteries we'll take the veins out of the picture. In this specimen the aorta and common iliac arteries are quite tortuou. The renal arteries arise just below the superior mesenteric artery.

33.12

The renal arteries pass quite sharply backward to reach the kidneys, which lie on each side of the great midline prominence formed by the vertebral bodies. The branches of the renal artery and vein enter the kidney at the hilum.

33.28

The renal pelvis, which we'll see shortly, emerges from the hilum behind the blood vessels. It narrows to become continuous with the ureter, which takes urine to the bladder.

33.39

To see the hilum in detail, in this isolated kidney, we'll remove the fat from around the hilum. At the hilum the surface of the kidney is rolled inward, creating a deep oval pocket, the renal sinus.

33.53

To see into the sinus we'll remove this part of the kidney. In the renal sinus the artery and vein divide into numerous branches. We'll remove them too, so that we can see the structures that form the collecting system for urine.

34.14

The renal pelvis is formed by the convergence of a number of broad drainage channels. Herre, we see more of them. Each of these is called a calyx. Usually three or four major calyces drain into the pelvis.

34.30

Each major calyx branches into several minor ones, that are seen better in this x-ray of an isolated kidney that has its collecting system full of contrast material. The outline of the kidney itself would be out here. This kidney has four major calyces. This one branches into three minor ones. Each minor calyx ends in a trumpet-like widening.

34.59

Here's the lower part of a kidney that's been dissected like the last one.
The ureter's been cut short. The end of each calyx spreads out, and attaches here to the surface of the kidney that faces in towards the renal sinus. If we remove the calyces we can see that at the end of each one the solid tissue of the kidney projects inward in a mound or ridge called a papilla. There are two more papillae here.

35.33

Here's a kidney that's been divided longitudinally. All the blood vessels have been removed. The solid tissue of the kidney, is called the renal parenchyma. It consists of an outer cortex, and an inner medulla,

35.53

The medulla is continuous with the papillae. Towards the tip of each papilla the collecting tubules, which are just visible, converge. They open into the calyces here, at the tips of the papillae.

36.07

Now that we've seen the kidneys, we'll look briefly at the suprarenal glands. These important endocrine glands, which are also known as the adrenal glands, lie just above the kidneys, but are not related to them functionally.

26.23

Here's the right suprarenal gland. It's embedded in the same layer of fat as the kidney. The inferior vena cava lies just in front of it. Here's the left suprarenal gland. It lies in front of the upper part of the left kidney, close to the left crus of the diaphragm.

36.43

Here's a suprarenal gland by itself. It is this color in the living body. We'll divide it along this line to see to see a little of its internal structure. This pale outer layer is the cortex, which secretes corticosteroids. This darker inner layer is the medulla, which secretes epinephrine and norepinephrine.

37.10

Now we'll return to the urinary system and follow the ureters down to the bladder. The ureter emerges from the hilum of the kidney and runs almost straight downward towards the pelvic brim, which is here. Behind the ureter is the psoas major muscle. The testicular vessels cross in front of the ureters in the male, the ovarian vessels do so in the female.

37.37

To follow the ureter as it passes into the pelvis, we'll continue the dissection down here. As the ureter runs over the pelvic brim and into the pelvis, it passes in front of the common iliac artery, just as it divides to become the internal and external iliac.

37.57

In both sexes the ureter passes downwards and forwards along the pelvic wall towards the bladder. It passes medial to the branches of the internal iliac vessels.
In the male, the ductus deferens crosses the ureter medially.

38.12

To see the ureter entering the bladder we'll look at a specimen that's been divided along this line. Here's the divided pubic symphysis, here's the bladder, which we'll see shortly.

38.30

Here's the left ureter, entering the bladder behind and well to the side. Here passing just above it is the ductus deferens, which we'll see later in this tape.

38.40

Now we'll return to our view from in front, and look at the course of the ureter in the female. As in the previous dissection, we've removed the sigmoid colon and rectum. Their peritoneal attachments were here. Here are the ureters, crossing the pelvic brim.

39.05

This is the uterus, we'll pull it forward a little. Here are structures that we'll see in detail later in this tape: the broad ligament, the round ligament, the fallopian tube, and the ovary. This fold is the infundibulo-pelvic ligament. Here passing into it are the ovarian vessels. They're lateral to the ureter.

39.35

If we pull on the ureter we can see where it goes: it runs downwards and forwards around the pelvic wall, passing through the base of the broad ligament. To follow it we'll remove peritoneum here, and here, removing the underlying fat so that we make a window right through the broad ligament.

40.00

Here's the ureter behind the broad ligament, here it is in front, approaching the base of the bladder, which is here. The uterine blood vessels cross just above the ureter within the broad ligament.

40.18

Now we'll take a further look at the bladder, first in the male, then in the female. Here's the bladder, here below it is the prostate. In this dissection the bladder has been filled slightly, which brings it just above the level of the pubic symphysis

40.38

When the bladder is full it rises up into the lower abdomen. When it's empty it flattens out. The bladder has a covering of peritoneum only on its upper surface.

40.49

Down here the bladder tapers towards its outlet, or neck. Here behind the bladder is the rectum. In this dissection the fatty connective tissue that lies between the bladder and the rectum has been removed.

41.04

To see the structures that are just behind the bladder we'll take the rectum out of the picture. We've also cut the ureter short. The ureter (here's its cut end) enters the bladder out to the side, passing through the bladder wall obliquely.

41.24

The ductus deferens comes around almost to the midline, widening to form the ampulla. Here lateral to the ampulla is the seminal vesicle. Here's the right ampulla and the right seminal vesicle.

41.38

On each side the ductus and the seminal vesicle join down here to form the ejaculatory duct, which passes through the prostate to enter the urethra, as we'll see when we look at the reproductive system.

41.50

To see the inside of the bladder we'll look at an isolated specimen that's been divided along this line.

41.58

The wall of the bladder consists of smooth muscle, lined with mucosa. On each side the ureter opens into the bladder obliquely at the ureteric ostium. Urine leaves the bladder through this opening, the internal urethal meatus, to enter the urethra.

42.21

This projection just above the urethral meatus is called the uvula. The mucosal lining of the bladder is thrown into irregular folds which flatten out as the bladder fills. The mucosal layer is relatively flat in this triangular area between the ureteric and urethral openings, which is called the trigone.

42.41

In the male the first part of the urethra passes downwards through the prostate. The prostate, or prostate gland, consists of smooth muscle, interlaced with glandular tissue which secretes a portion of the seminal fluid.

42.56

Down here at the apex of the prostate the urethra emerges. The proximal part of the urethra, the membranous urethra, passes downward through the sling of muscle that forms the pelvic diaphragm.

43.09

This part of the muscle sling is the levator prostatae: it's the most anterior and medial part of the pubococcygeus, which in turn is part of the levator ani muscle complex. Just below the pelvic diaphragm the urethra passes through the perineal membrane, which has been removed in this dissection.

43.31

The membranous urethra, which is here, is surrounded by the voluntary external urethral sphincter muscle, which is continuous with the levator prostatae.

43.41

Immediately beneath the pelvic floor the urethra enters the bulb of the penis. We'll follow its further course, later in this tape.

43.51

Now we'll look at the same area in the female. Let’s get oriented again. Here’s the pubic symphysis, here’s the coccyx. Here's the cut edge of the pelvic diaphragm. It’s being supported artificially on a wire frame. Here’s the vaginal opening, here’s the anus, and the external anal sphincter.

44.14

Here's the bladder, with the ureter entering here. Immediately behind the bladder is the vagina, and above it the uterus, very small in this specimen. We’ve removed the broad ligament, which was here.

44.31

Directly behind the vagina is the rectum. The female urethra is quite short. This is the urethra, surrounded by the external urethral sphincter muscle. The female urethra ends by entering the vestibule of the vagina.

44.52

We can see the urethra better in this isolated specimen. Here's the bladder, here's the vagina. Here's the entrance to the vagina: the vestibule. The urethra starts here, and runs parallel to the vagina. It's surrounded by the external urethral sphincter muscle.

45.19

The vagina and urethra pass through the pelvic diaphragm. We've left a fringe of the pelvic diaphragm intact here: it's attached both to the urethra, and the vagina.

45.30

To see the urethra, we'll look at a specimen that's been divided in the midline. Here's the lower part of the vagina, here's the vaginal vestibule. Here's the urethra. Here's the external urethral sphincter muscle, here's the internal urethral meatus, here's the external meatus. Here's the external urethral meatus seen from below, opening into the vestibule of the vagina.

46.02

We'll see more of the male and female urethra in the following section, on the reproductive system. Now, let's review what we've seen of the structures of the urinary system.

46.14

REVIEW

Here's the renal cortex, and medulla. Here's the hilum of the kidney, the renal pelvis, the ureter, the renal sinus, two calyces, and two renal papillae. Here are the suprarenal glands, the suprarenal cortex, and medulla.

46.46

Here's the ureter again. Here's the bladder, the prostate the ureteric ostia, and the internal urethral meatus. Here's the ampulla, and the seminal vesicle.

47.01

In the female, here are the bladder, and the urethra, with the internal, and external urethral meatus.

47.11

That brings us to the end of this section on the abdominal organs. In the next section, we'll look at the organs of the male and female reproductive system.

47.29

END OF PART 2

PART 3

THE REPRODUCTIVE SYSTEM

00.00

In this section we'll look at the reproductive organs, first in the male, then in the female.

00.10

MALE REPRODUCTIVE SYSTEM

In the male, we'll look first at the testes where spermatozoa are formed, then at the pathway by which they reach the urethra, then at the penis.

00.20

The testes are contained in the scrotum, the pendulous sac that keeps them at the low temperature needed for spermatogenesis. The thin skin of the scrotum is continuous with the skin of the lower abdominal wall, the upper thigh, and the perineum.

00.39

The scrotal skin, which we'll divide, is more or less wrinkled, and the whole scrotum is more or less compact, depending on the action of a fine layer of muscle, the dartos muscle, that lies just beneath the skin. To see the contents of the scrotum, we'll further divide the skin and subcutaneous tissue, along this line.

01.05

Here's the testis, protected by a number of covering layers. Here's the spermatic cord. The spermatic cord passes upwards, then laterally to enter the inguinal canal, which is here.

01.18

To see the testis and its surrounding layers more clearly, we'll take everything else out of the picture. The testis is surrounded by a thick layer of loose connective tissue, the spermatic fascia, that's formed by the fusion of two developmentally distinct layers, the internal and external spermatic fasciae, that are derived from different layers of the abdominal wall. We'll draw the spermatic fascia aside. Inside it is an inner membranous envelope, the tunica vaginalis, which we've already opened. This is the surface of the testis itself.

02.00

The tunica vaginalis creates a fluid-filled envelope around the testis. It's a remnant of peritoneum. Like peritoneum, it has an outer parietal layer, and an inner visceral layer that covers the testis itself.

02.13

We'll go to another specimen, to see more of the testis. This is the testis. Here behind it, partly hidden, is the epididymis, through which spermatozoa pass to reach the ductus deferens. The testis, which we've divided longitudinally here, has a tough fibrous coat, the tunica albuginea.

02.38

Spermatazoa are formed throughout the testis in the seminiferous tubules, which are just visible here. The seminiferous tubules pass upwards and backwards to converge on this fibrous area, the mediastinum of the testis, where they join to form a network of tubules, the rete testis, that's not visible here.

02.57

From the rete testis there emerge between four and twelve efferent ducts or vasa efferentia, which leave the testis, and pass into the upper part of the epididymis.

03.09

The epididymis is loosely attached to the posterior aspect of the testis. Here it is, more fully dissected. The epididymis has a head, a body and a tail. In the head of the epididymis the efferent ducts unite to form one tube, the duct of the epididymis. The duct, which is extremely convoluted, makes up almost all the bulk of the epididymis. Spermatozoa mature as they pass along it.

03.41

Here at the tail of the epididymis the convolutions of the duct are quite visible. The tail of the epididymis curls around, and becomes continuous with the ductus deferens, which passes upwards to enter the spermatic cord.

03.59

Now that we've looked at the testis, we'll move on to see the pathway by which spermatazoa reach the urethra. We'll look at the ductus deferens and spermatic cord, the seminal vesicles and the ejaculatory duct.

04.13

The spermatic cord is the lifeline to the testis. It contains the testicular blood vessels and the ductus deferens. To see these structures, we'll divide the coverings of the spermatic cord. Here are the covering layers spread out.

04.30

Here within the cord are the ductus deferens, and the testicular blood vessels. The veins that drain the testis are arranged around the artery in a plexus called the pampiniform plexus.

04.46

The testicular artery is out of sight here. The ductus deferens is a thick-walled tube. Its wall is made of smooth muscle. In this spermatic cord, we've divided the ductus deferens. The lumen is quite small.

05.05

Passing upwards in the spermatic cord, the ductus deferens reaches the inguinal canal, which is shown in Tape 3 of this atlas. Here, we're at the external inguinal ring. We'll divide these external oblique fibers, to get to the region of the internal inguinal ring, which is here.

05.30

As it passes through the internal ring, the ductus deferens passes backwards. To follow the ductus deferens, we'll divide the abdominal wall, and go round to the inside. The abdominal viscera have been removed.

05.50

The internal inguinal ring is down here. To see it better we'll remove the peritoneum, and we'll also remove some of the underlying fat. Here are the testicular vessels, passing downwards and forwards towards the internal inguinal ring.

06.09

Here's the ductus deferens. It runs backwards alongside the dome of the bladder, which is here, then crosses the ureter, which is lateral to it, and passes down behind the base of the bladder.

06.25

Here we're looking from behind at the base of the bladder, and the prostate. Part of the prostate has been removed, here. On each side the ductus deferens widens out to form the ampulla, where spermatozoa are stored. Lateral to the ampulla on each side is the seminal vesicle. The seminal vesicles produce a nutrient liquid that forms much of the total volume of the seminal fluid.

06.53

The walls of the ampulla and of the seminal vesicle are formed largely of smooth muscle. When this contracts the contents of both chambers pass together into the ejaculatory duct.

07.05

To see where the two ejaculatory ducts emerge, we'll look from in front, at a specimen that's been opened up. Here's the mucosa of the base of the bladder, here's the internal urethral meatus, here's the prostate, which we've divided coronally along with the urethra. The cut edges of the urethra are here. The ejaculatory ducts open into the urethra here, on either side of this mid-line projection, the colliculus.

07.38

Now that we've followed the course of spermataozoa and seminal fluid from the testis to the ejaculatory duct, we'll move on to look at the penis. There's more to the penis than meets the eye. The part of the penis that's seen externally is only about half of its overall length. The rest of it is hidden within the root of the scrotum, and back here in the perineum.

08.03

Along most of its length, the penis, seen here in cross-section, consists of three somewhat cylindrical masses of highly expandable tissue. On each side are the corpora cavernosa, the singular of which is corpus cavernosum.

08.19

The corpora cavernosa are the main erectile bodies of the penis. They're contained within a strong layer of fibrous tissue, the tunica albuginea. Within this there's a continuous space, intersected by an open network of fibromuscular tissue. The space is filled with blood: a little when the penis is flaccid, much more when it's erect.

08.42

The two corpora cavernosa are separated by an incomplete septum. Running along the underside of the penis is the corpus spongiosum which is continuous proximally with the bulb of the penis, and distally with the glans, as we'll see.

08.58

The urethra is contained within the corpus spongiosum. Like the corpora cavernosa, the corpus spongiosum consists mainly of expandable vascular tissue, but it remains soft during erection, while the corpora cavernosa become hard.

09.14

In the intact penis, the glans is covered by a retractable fold of skin, the prepuce or foreskin, which is often surgically removed in infancy. Here, the prepuce has been divided. The skin that lines the prepuce is continuous with the skin of the glans here, in the coronal sulcus. We can see the glans more clearly in this penis that's been circumcised. This is the glans.

09.45

To see its continuity with the corpus spongiosum we'll remove the skin and subcutaneous tissue. Here's the right corpus cavernosum. and the corpus spongiosum. The corpus spongiosum becomes continuous with the glans here. The two corpora cavernosa end bluntly, just behind the glans.

10.08

The skin on the underside of the penis is continuous with the skin of the scrotum. To see more of the penis, we'll remove the skin and subcutaneous fat from around its base, and we'll remove the anterior part of the scrotum.

10.27

The penis passes through the scrotum between the two spermatic cords. The penis is loosely suspended in this location by this sling of connective tissue from the anterior abdominal wall, the suspensory ligament.

10.41

Removing the suspensory ligament lets us see the front of the pubic symphysis. It's here. The penis is firmly attached to the sloping underside of the symphysis by this triangular ligament.

10.55

Let's get our bearings here in terms of bony anatomy. Here are the two hip bones, seen from directly in front. This is the pubic symphysis. The penis is attached to it along here. These are the two ischiopubic rami.

11.15

To see the rest of the penis, we'll remove this part of it up out of the way, remove the scrotum, and go round to a view almost from underneath.

11.27

We'll remove the remaining skin and subcutaneous fat. Now, we're looking up into the anterior part of the perineum. That gives us a major change in viewpoint. Let's get our bearings again. We've gone from this view, all the way to this view. Here are the two ischiopubic rami. They come together at the pubic symphysis, here.

12.00

Here are the ischial tuberosities. In the dissection, the pubic symphysis is here, the ischial tuberosities are here, the ischio-pubic rami are here. On each side the adductor magnus muscles of the thigh take origin from the ischio-pubic rami, along here.

12.24

Below and behind the pubic symphysis the three main components of the penis separate. The corpus spongiosum stays in the midline and broadens out to become the bulb of the penis.

12.38

The two corpora cavernosa diverge to each side, forming the crura of the penis. Here's the left crus, here's the right one. Before we look further at the penis we'll take a look at the muscles of the perineum that are on view in this dissection.

12.58

Both the bulb and the crura of the penis are surrounded by slender layers of muscle. The ischio-cavernosus muscles surround the crura, the bulbospongiousus muscle surrounds the bulb, and also the proximal corpus spongiosum. The bulbospongiousus muscle provides the propulsive force for ejaculation.

13.19

The most posterior fibers of bulbospongiosus pass backward to join a meeting point of muscles that's known as the perineal body. Joining the perineal body from behind are the most anterior fibers of the external anal sphincter.

13.36

Joining it from each side is an inconstant muscle, present here only on one side, the superficial transverse perineal muscle, which we'll remove. Just above the perineal body and the bulb of the penis is a thick triangular partition of fibrous and muscular tissue, the perineal membrane. We'll see it better in a minute.

13.57

Above the perineal membrane we're looking at the underside of the levator ani muscle complex, which is the main component of the pelvic diaphragm. The apparently empty space on each side is the ischio-rectal fossa, which is normally filled with fat.

14.17

Now that we've seen the perineal muscles, we'll take a further look at the base of the penis. To see the bulb and crura more clearly we'll remove the bulbo-spongiosus, and ischio-cavernosus muscles.

14.30

The crura of the penis are the proximal extensions of the corpora cavernosa. On this side we've kept intact the dense outer covering of the crus, the tunica albuginea, which is firmly attached to the ischio-pubic ramus. On the other side we've removed the tunica, to see the erectile tissue of the crus.

14.51

The bulb of the penis ends in a convexity that faces backwards. The urethra enters the bulb from above. To see it, we'll remove the bulb of the penis. This gives us a clear view of the perineal membrane, which stretches between the ischio-pubic rami.

15.10

Here's the membranous urethra coming through the perineal membrane, surrounded by the external sphincter muscle. Blood vessels and nerves that supply the base of the penis pass through the perineal membrane.

15.22

Now we'll move on to take a look at the male urethra. In the previous section of this tape, we've seen the isolated bladder, and the prostate, with the urethra beginning here, at the internal urethral meatus and running down through the prostate.
15.36

We've also seen the bladder, and prostate from the side, with the urethra emerging below the prostate, passing though the pelvic diaphragm and perineal membrane and into the bulb of the penis. To see more of the urethra we'll look at an isolated specimen of the bladder, prostate and penis, that we'll divide in the midline.
16.02

Here's the urethra. It's described as having four parts, the prostatic urethra that runs through the prostate, the short membranous urethra that passes through the perineal membrane, the curving bulbar urethra in the bulb of the penis, and the penile urethra.
16.27

The membranous urethra is surrounded by a sleeve of striated muscle, the external urethral sphincter, which exerts voluntary control on the passage of urine. The penile urethra passes along the corpus spongiosum and through the glans, ending at the external urethral meatus.
16.54

That brings us to the end of the reproductive organs in the male. Before we move on to look at the female reproductive organs, let's review what we've seen in the male.
17.06

REVIEW

Here's the testis, the tunica vaginalis, and the epididymis. Here's the ductus deferens, here it is again.
17.23

Here are the ampulla of the ductus deferens, and the seminal vesicle, converging on the ejaculatory duct. Here are the corpora cavernosa, and the corpus spongiosum. Here's the prepuce, the glans, the crura of the penis, and the bulb.
17.44

Here are the bulbospongiousus and ischiocavernosus muscles, and the perineal membrane. Here's the urethra: prostatic, membranous, bulbar, and penile.
18.01

FEMALE REPRODUCTIVE SYSTEM

Now we'll move on, to look at the reproductive organs in the female. We'll look at them from several different angles, as we did in the male. We'll look down at them from above, we'll look up at them from below, and we'll look in at them from the side but we'll start by looking at this isolated dissection that shows the whole of the female reproductive tract. Here we're seeing it from the left side.
18.33

Here behind are the ovaries. Here are the uterine tubes, and the uterus. Here's the vagina, passing down through the pelvic diaphragm. This is the base of the bladder: the bladder was here.
19.00

To see how these structures relate to their surroundings, we'll go to a more intact dissection. Here we're looking downwards and backwards into the pelvic cavity. Here are the inguinal ligaments in front, here's the pelvic brim, here's the sacral promontory. Here are the uterus, and the two uterine tubes, here's the left ovary, here's the right one. Behind the uterus is the sigmoid colon, in front of it beneath the peritoneum is the bladder.

19.41

These are the pelvic organs of an individual past chldbearing age: the uterus and the ovaries are quite small. We're looking down on the highest part of the uterus, the fundus. This is the body of the uterus. The cervix of the uterus is well hidden down here.

20.03

The fundus and body of the uterus are covered with peritoneum. On each side this complex peritoneal fold, the broad ligament, tethers the uterus to the side wall of the pelvis. We'll look at its component parts in a minute. When we lift the uterus up we can see that between it and the upper part of the rectum, there's a deep recess, the recto-uterine pouch or Pouch of Douglas. It's the lowest point in the peritoneal cavity. Here in front, where the peritoneum sweeps forwards from the uterus to cover the bladder, there's another recess, the vesico-uterine pouch, that's more evident when the bladder is full.

20.47

The body of the uterus tapers down toward the top of the vagina. Here's the line of peritoneal attachment. Just below it, distinct ligaments are attached to the uterus, here's one of them. These pass forward, laterally and backward, tethering the uterus to the walls of the pelvis. The lowest part of the uterus, the cervix, projects down into the vagina. To see it, we'll remove this part of the vaginal wall.

21.24

Here's the cervix, projecting into the vagina. In this specimen the cervix is somewhat flattened. Around the cervix, between it and the vaginal wall, there's a recess, the vaginal fornix. Here in the center of the cervix, is the ostium, or external os of the uterus.

21.47

To see a side view of these structures in their natural location, we’ll go to a dissection in which the left half of the pelvis has been removed. Here’s the pubic sysmphysis, here’s the coccyx. Here’s the pelvic diaphragm, held in position by a wire frame. Here’s the vagina, here’s the uterus. The broad ligament was here. Here’s the rectum behind the vagina, and the bladder in front of it.

22.21

Here’s the peritoneum coming down off the rectum, forming the recto-uterine recess behind the uterus, and the vesico-uterine recess in front of it. Down at the bottom, heres the vaginal opening, the anus, and the external anal sphincter muscle.

22.39

Let's take a closer look at the uterine tubes, and the ovaries. Close to them we're going to meet a number of structures known as ligaments. That's a word that's applied quite loosely in this region, to name anything from a distinct tendon-like cord to a delicate peritoneal fold.

22.57

The two uterine tubes, commonly called the Fallopian tubes, arise on each side from the upper part of the uterus. To see the tube more clearly, we'll look at it underwater. The uterine tube widens along its length. It's divided arbitrarily into the isthmus, the ampulla, and the infundibulum. The uterine tube opens into the peritoneal cavity.

23.30

The opening of the uterine tube is surrounded, and concealed, by these delicate mucosal fronds, the fimbriae. The opening, the abdominal ostium, is here. Normally the infundibulum is curled around so that the fimbria touch the ovary. The uterine tube is attached to the broad ligament by this double fold of peritoneum, the mesosalpinx

24.03

Next we'll look at the ovary, and at the broad ligament and its associated structures. These are the mesovarium, mesosalpinx, the round ligament, and the suspensory ligament of the ovary.

24.19

We'll pull the uterus forwards to see the ovary. Here's the ovary. In a young adult it's much larger, as we'll see. The ovary hangs from the back of the broad ligament, on its own peritoneal fold, the mesovarium. The medial pole of the ovary is attached to the uterus by this cord, the ligament of the ovary, also called the proper ligament of the ovary.

24.50

The ovarian blood vessels cross the pelvic brim here, and pass beneath the peritoneum to reach the lateral pole of the ovary. They create this peritoneal fold, the suspensory ligament of the ovary, also called the infundibulo-pelvic ligament. It forms the highest part of the broad ligament complex.

25.14

The upper aspect of the broad ligament is tented forward by the cord-like round ligament, which passes laterally, then forward to pass through the inguinal canal.

25.26

We've been seeing the reproductive organs of individuals who had lived a long time. In a younger adult, the ovaries and the uterus are much more substantial, as we can see in this view of the female pelvic organs made during a laparascopic procedure on an individual of childbearing age.

25.46

Here our view is reversed: this is anterior, this is posterior. Here's the uterus, here are the uterine tubes, hanging backwards, here are the round ligaments. Here we're looking down into the recto-uterine pouch. Here's the right broad ligament, with the round ligament running within it. Here's the right ovary, hanging on its mesovarium. When we pick up the ampulla of the uterine tube with forceps we can see the fimbria, the ovary, and the suspensory ligament of the ovary.

26.26

Now that we've seen the internal aspects of the female reproductive system, we'll move on to look at the external genital structures.

26.35

The female genital and urinary openings are concealed, and protected by the labia majora, which we're seeing here from directly below. To see more, we'll separate the labia majora, and hold them apart with sutures. Between the labia majora are these two smaller folds, the labia minora.

26.54

Concealed just in front of the point where the labia minora meet is the head of the clitoris, which is the female analog of the penis. We'll see more of it shortly.

27.07

The labia minora surround the entrance to this space, the vestibule of the vagina. In front, the urethra opens into the vestibule at the external urethral meatus. Opening into the vestibule from above, is the vagina.

27.28

To see the erectile and muscular structures of the female perineum we'll look at a dissection in which all the skin and subcutaneous fat of the perineum have been removed.

27.41

The ischio-pubic rami are here, the ischial tuberosities are here. The pubic symphysis is here. Here are the dry bones seen from the same angle, with the pubic symphysis, the ischial tuberosities, and the ischio-pubic rami.

28.05

On each side the adductor muscles of the thigh, arise from the edges of the ischio-pubic rami. Here are the edges of the labia minora.

28.16

Within each of the labia minora there's a thin almost tubular sheet of muscle, the bulbo-spongiousus muscle. The most posterior fibers of bulbo-spongiosus meet with the most anterior fibers of the external anal sphincter muscle at a meeting point of muscles known as the perineal body.

28.33

The bulbospongious muscles are attached to the underside of this transverse partition the perineal membrane, which we'll see shortly. In addition, on each side a slender muscle runs parallel to the ischio-pubic ramus: it's the ischio-cavernosus muscle. The two bulbospongiosus muscles surround a mass of erectile tissue, the bulb of the vestibule. To see it we'll remove the bulbospongiosus muscles.

29.05

Here's the bulb of the vestibule. It's in two halves, which are joined together here, as we'll see. Buried within the ischio-cavernosus muscles, which we've also removed here, are two separate erectile bodies, the crura of the clitoris, which we'll see shortly.

29.23

To see all of the bulb of the vestibule, we'll remove the lining of the vestibule here. All this is the bulb of the vestibule. Its mid-line portion lies between the clitoris and the external urethral meatus. Directly behind the bulb on each side is the greater vestibular gland, which produces a watery secretion that lubricates the vaginal opening.

29.51

The perineal membrane lies directly above the bulb of the vestibule: we'll remove the bulb to see it. Here's the perineal membrane: it's a flat partition of fibromuscular tissue that bridges the space between the ischio-pubic rami.

30.09

The vestibule of the vagina, and the urethra pass though the perineal membrane. The posterior margin of the pubic symphysis is here, just in front of the urethra. Back here, above and behind the perineal membrane, we're looking into the ischio-rectal fossae, from which the fat has been removed.

30.32

This is the underside of the levator ani muscle. To see it better we'll remove the perineal membrane. Here's the right side of the levator ani, here's the left side. The levator ani is the principal component of the pelvic diaphragm, the sling of muscle that holds up the rectum, and also the vagina.

30.58

Lastly in our view from below we'll take a further look at the clitoris. To see it we'll look at a dissection in which the structures that surround it have been removed.

31.10

Here's the clitoris. The clitoris consists of two crura, which unite to form the body. The crura and body of the clitoris are formed of erectile tissue. The crura, like the crura of the penis, are attached along the undersides of the ischiopoubic rami.

31.31

The body of the clitoris is curved, and points downwards. It ends at the glans, just in front of the point where the labia minora come together. The glans of the clitoris is richly endowed with sensory nerve endings.

31.46

Looking from below, we've already seen the opening of the vagina. To see more of the vagina we'll look at an isolated specimen that's been divided close to the midline. The adjoining bladder, which we've removed, was here.

32.04

Here's the vaginal vestibule, here's the urethra, opening at the external urethral meatus. The lining of the vagina is marked by numerous small transverse folds called rugae.

32.18

The upper end of the vagina is closed off by the cervix of the uterus, which projects down into it. Here's the same specimen with the vagina intact, and with the bladder in place. This is the urethra, surrounded by the external urethral sphincter muscle.

32.36

This fringe of muscle that's attached around the urethra and the vaginal vestibule is the cut edge of the pelvic diaphragm. Here's the pelvic diaphragm again, in a more complete dissection. The muscle sling that forms the pelvic diaphragm is more fully described in Volume 3 of this atlas. Now, lets review what we've seen of the female reproductive system.

33.00

REVIEW

Here are the ovaries, and the uterine tubes, each with its isthmus, ampulla, and infundibulum, and the fimbriae.

33.19

Here's the uterus, with its fundus, body, and cervix. Here's the broad ligament, the round ligament, infundibulo-pelvic ligament, mesovarium, and mesosalpinx. Here's the recto-uterine recess, here's the vesico-uterine recess.

33 40

Here are the labia majora, the labia minora, the external urethral meatus, the bulb of the vestibule, the greater vestibular gland, and the perineal membrane. Here's the vaginal vestibule, here's the vaginal opening, here's the vagina. Here's the head of the clitoris, and here are the body, and crura of the clitoris.

34.10

That brings us to the end of this section, the end of this Tape on the internal organs and reproductive system, and the end of the Video Atlas of Human Anatomy.

34.29

END OF VOLUME 6