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