

Acland's DVD Atlas of Human Anatomy

Transcript for Volume 6

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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 posterolateral 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 tendineae 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 pericardium 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 surface 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. They're 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. 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 getting 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 jejunum-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 jejunum-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 against 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 mesogastrium 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 jejunum-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 jejunum-ileum. To see all of the duodenum, we'll remove the mesentery, and the jejunum-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 pancreas, 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 absorption 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 absorptive 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 ileocecal 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 arrangement, 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 jejunum-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 teniae 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 through 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 greater omentum that clings to its anterior surface. The omentum isn't the 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 behind 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 uncinata 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 system 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 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 we'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 uncinata 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 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 jejunum-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 jejunum-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 jejunum-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 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 supplied 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 tortuous. 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. Here, 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 urethral 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

In this section we'll look at the reproductive organs, first in the male, then in the female. 00.00

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 spermatazoa 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 bulbospongiosus muscle surrounds the bulb, and also the proximal corpus spongiosum. The bulbospongiosus 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 through 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 bulbospongiosus 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 childbearing 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 symphysis, 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, here's 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 laparoscopic 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-spongiosus 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 bulbospongiosus 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 through 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 ischiopubic 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