# TRANSCRIPTIONS OF NARRATIONS FOR EMBRYOLOGY OF THE GUT & MESENTERIES

Embryology of the Gut and Mesenteries, slide 2

This is a median sagittal section of a four week embryo, most of you can probably draw it in your sleep. I made a few modifications from some of the earlier similar slides; I made the heart a little loopier in this one, and I made the aorta a sort of 3 -dimensional structure. The essence of this particular picture, however, is its concentration on naming regions of the gut. The gut is a linear hollow endodermal tube. At this stage in development, it is connected to what is left of the yolk sac by this also hollow tube called the vitelline duct. That short portion of the gut that is connected to the vitelline duct is called the midgut. In front of the midgut, cranial to the midgut, is a much longer foregut, and caudal to the midgut is a much longer hindgut. Emanating from the hindgut is the allantoic diverticulum. The foregut, as you can see, has a part that's in the abdomen and a part that's cranial to the abdomen. You can identify which is which, because the boundary here is this little gray region of the septum transversum, which as you know becomes the central tendon of the abdominal diaphragm. So that part of the foregut which is above the purple region of the septum transversum is the abdominal foregut. Everything cranial to that lies either in the chest, as the part dorsal to the heart does, or even lies in the head and neck region of the body. Anyway, one of the things that I wanted to emphasize in this slide is the fact that coming off the ventral surface of the aorta, the anterior surface, in the midline are three big arteries going to different parts of the abdominal region of the gut. And if you go to the next slide, I will name them and tell you a little more about them.

Embryology of the Gut and Mesenteries, slide 3

One artery goes to the abdominal region of the foregut, and it is called the celiac artery. A second artery goes to the midgut; it is called the superior mesenteric artery, abbreviated here as SMA. And the third artery goes to the hindgut; it's called the inferior mesenteric artery, abbreviated here as IMA. Now, at this stage in development, the gut is a straight hollow tube, but you have either seen, or will see soon, in dissection how convoluted the gut becomes and how many other structures become associated with it, particularly glandular structures. No matter how complex the abdominal portion of the foregut becomes, or how many structures become associated with it, all of the things derived from or associated with the abdominal portion of the foregut will receive their blood supply from the celiac artery. And, similarly, no matter how complicated the midgut becomes, all of the structures derived from or associated with the midgut will receive their arterial supply from the superior mesenteric artery. And by now you will have figured out that no matter how complex the hindgut becomes, everything derived from the hindgut, or associated with, it will receive their blood supply from the inferior mesenteric artery.

Embryology of the Gut and Mesenteries, slide 4

Now I want to take a cross-section through the hindgut region of the embryo (it's one we've seen before) on the next slide.

Embryology of the Gut and Mesenteries, slide 5

This reminds you that caudal to the septum transversum there is a single coelomic cavity called the peritoneal cavity, but that really it is formed of a right coelomic channel and a left coelomic channel, each of which has lost its lateral wall, and that disappearance of the lateral walls of these channels is indicated by the dotted lines, and when that region of the extraembryonic coelom that we have always marked with an asterisk is folded into the embryo, we now have created a single peritoneal cavity because the right and left coelomic channels communicate freely through that incorporated region of the extraembryonic coelom. But now I certainly want to emphasize that once it's been brought into the embryo it's considered intraembryonic coelom.

Embryology of the Gut and Mesenteries, slide 6

Let's take a cross-section of the embryo through a portion of the septum transversum that is caudal to the part that will become the central tendon of the diaphragm. This portion of the septum transversum - the pink part on this drawing - is in the abdominal cavity. The next slide shows what the cross-section will look like.

Embryology of the Gut and Mesenteries, slide 7

This is very similar to a cross-section we looked at when were talking about formation of the diaphragm. But what I want to emphasize here that in this region of the septum transversum caudal to the diaphragm, you still have separate right and left coelomic channels. Those channels don't loose their lateral walls until they are caudal to the septum transversum, and then caudal to the septum transversum you have a single coelomic cavity in the abdomen - the peritoneal cavity. I like to view these coelomic channels that we see on the slide as cranially directed diverticula of the peritoneal cavity - one to the left and one to the right of the midline - that exist only in the region of the septum transversum, and end blindly when they abut the central tendon of the diaphragm.

Embryology of the Gut and Mesenteries, slide 8

From a previous lecture, you will recall how much I like to pretend that I am standing in the coelomic cavity, and can walk around inside of it following different routes. So let's imagine that I or you are standing in the peritoneal cavity ventral to the hindgut. You are in that region of the peritoneal cavity that has been marked with an asterisk in previous slides. And as you are standing there, you're going to look up to your left and you're going to see the original left coelomic channel, and you're going to look to your right, on the right side of the gut you will see the original right coelomic channel. But now you are ventral to the gut, and you are going to walk forward. And as you walk forward, what are you going to encounter? This slide shows what you will encounter. After a while, you will see this big tube dropping down from the gut in front of you. That tube is the vitelline duct, and you have a choice: you can sweep around to the left side of the vitelline duct or you can sweep around to the right side of the vitelline duct, or you can in fact leave the embryo altogether and head out through the umbilical cord to the portion of the extraembryonic coelom that's in the umbilical cord, and work your way into the big extraembryonic coelom not shown on this slide. But I don't want to do that, so let us choose one path - let's walk around the left side of the vitelline duct, and once we get past the vitelline duct, what happens? What do we see? We run into the back surface, the caudal surface, of the septum transversum, and for a moment we think we can't go any further forward at all because everywhere we look there is septum transversum. And then we realize that up to our left is that portion of the original left coelomic channel in the region of the septum transversum that I said I like to view as an anterior diverticulum in the left side of the peritoneal cavity. And if I was a really good jumper, I could jump high and get into that left diverticulum, anteriorly directed diverticulum, of the peritoneal cavity. Or I could walk to my right a bit and if I look up then, I would see the continuation of the right part of the peritoneal cavity, what I have called also a right peritoneal diverticulum. And I could jump high into it. But whether I jump into the left peritoneal diverticulum or the right peritoneal diverticulum, as I continue to walk forward alongside the gut, alongside the abdominal portion of the foregut, I would soon run into a barrier. That barrier would be the pleuroperitoneal membrane. If I was in the left channel, it would the left pleuroperitoneal membrane, if I was in the right side, it would be the right pleuroperitoneal membrane. It makes no difference, my forward progress would be stopped, and as we know, these pleuroperitoneal membranes contribute to the central tendon of the diaphragm.

Embryology of the Gut and Mesenteries, slide 9

We can't spend all our time having fun walking through the coelomic cavity, so let's go back to the median sagittal section and show where we want to take a cross-section through the hindgut.

Embryology of the Gut and Mesenteries, slide 10

Right now, the hindgut seems suspended from the region of the aorta by a thick sheet of mesoderm. But very soon, the right and left sides of the peritoneal cavity are going to approach one another and squeeze that thick sheet of mesoderm into a very thin sheet indeed. And this is shown on the next slide.

Embryology of the Gut and Mesenteries, slide 11

This shows that the mesoderm running between the aorta and the hindgut has now been squeezed into a thin sheet, lined on either side by mesothelium. That mesoderm, between the mesothelial layers, will turn into a connective tissue. And whenever you have a thin sheet of connective tissue with mesothelium on either side of that, it is said to constitute a mesentery. We saw the mesentery of the heart before, we called it the mesocardium, then it disappeared. Now we have the mesentery of the hindgut, in this case, I have labeled it "dorsal mesentery", the "dorsal" is not really necessary, because there is no other mesentery of the hindgut, but you'll see later why I put the word "dorsal" in here. You've probably have already deduced that the portion of the peritoneum that is in contact with the gut is called the visceral peritoneum. But all of the portion of the peritoneum that is not directly in contact with the gut, and also is not part of the mesentery, is called the parietal peritoneum. And that the mesentery connects parietal peritoneum to visceral peritoneum.

Embryology of the Gut and Mesenteries, slide 12
And now, once again, let's take a cross-section through the portion of the septum transversum that's in the abdomen.

Embryology of the Gut and Mesenteries, slide 13
The only difference between this and what was shown a few slides ago is that now I've applied the terms right and left peritoneal diverticula to these portions of the channels that are dorsal to the septum transversum.

Embryology of the Gut and Mesenteries, slide 14
This shows here also, as we saw for the hindgut, the two sides of the peritoneal cavity approach one another and squeeze the mesoderm between the aorta and the gut into a thin sheet, which becomes connective tissue with mesothelium on either side. Now we have a dorsal mesentery running between the aorta and the foregut, and in fact an identical event occurs in the region of the midgut, so that in fact throughout the entire length of the abdominal gut, a thin dorsal mesentery extending between the aorta and the gut is created.

Embryology of the Gut and Mesenteries, slide 15
The rest of this lecture is going to be devoted to separate considerations of what happens to the foregut, midgut, and hindgut. I want to do foregut now, so let me blow up this view of the foregut so it occupies the whole screen.

Embryology of the Gut and Mesenteries, slide 16
This shows things you are familiar with. I point out the portion of the septum transversum that will become a part of the diaphragm is colored grey, and all of the rest of the septum transversum, which lies ventral to the abdominal foregut and will not become a part of the diaphragm, is shown in a dark pink. The dorsal mesentery, which we now know runs the entire length of the abdominal gut, is shown in a light pink. Nothing else requires explanation.

Embryology of the Gut and Mesenteries, slide 17
And the first change we are going to notice in the foregut is that, near its back end, a finger-like, hollow endodermal diverticulum grows dorsally into the dorsal mesentery, and even further caudally, just before the foregut actually joins the midgut, a second endodermal finger-like diverticulum grows ventrally into that portion of the septum transversum which is not contributing to the diaphragm. These diverticula are labeled here. The dorsal midline diverticulum is called the dorsal pancreatic diverticulum. The ventral diverticulum is called the hepatopancreatic diverticulum. The names give you big clues as to what these things will contribute to. You don't put the word pancreatic into the name of something unless it's going to contribute to the pancreas and you don't put the word hepatopancreatic into the name of something unless it's going to contribute to the liver, which is the ‘hepar’, and the pancreas.

Embryology of the Gut and Mesenteries, slide 18
This shows the situation a little later in time. I haven't done anything with the dorsal pancreatic diverticulum, although I'm sure it's getting bigger, because I want to focus on what's happening with this ventral midline diverticulum of the foregut. It grows a little bit, and then it, itself, divides into two - a bigger one, which I have labeled here the hepatocystic diverticulum (cystic refers to the gallbladder so we know that this is going to be associated with the liver and gallbladder); and a smaller, more caudal branch, which really hugs the back surface of the septum transversum. That branch is called the ventral pancreatic diverticulum, and is the part of the hepatopancreatic diverticulum that contributes to the pancreas.

Embryology of the Gut and Mesenteries, slide 19
Here we are a little later in time. I've shown the dorsal pancreatic diverticulum as somewhat larger. What I really want to show here is that the hepatocystic diverticulum grows in length a bit, and then it bifurcates into two. One of these is called the cystic diverticulum, that's the part that hugs the back surface of the septum transversum, and the

larger, more cranially directed branch is called the hepatic diverticulum. I remind you, these are all hollow endodermal tubes. In the next slide, I'll say a little bit about what some of these become.

Embryology of the Gut and Mesenteries, slide 20

I've already mentioned that the pancreatic diverticula become the pancreas, and we'll go into that in some depth later. But let's take a look at what happens to the hepatocystic part of this system. The hepatic diverticulum is going to branch many times, and then, after so doing, there will be a tremendous proliferation of the endodermal lining to become a solid organ which is the liver. Now all of the tubes that led up to that solid organ become the bile ducts which are draining bile from the liver, and they eventually all converge on a single big bile duct draining the liver, which is called the common hepatic duct. That was the stem of the hepatic diverticulum. The cystic diverticulum does not branch; it stays a single tube with a sac at the end of it - that sac is the gallbladder. The stem of the cystic diverticulum becomes the cystic duct, which drains the gallbladder. And the cystic duct and common hepatic duct meet one another in what was the stem of the hepatocystic diverticulum, but in the developed organism is called the common bile duct. And the common bile duct travels down, and is joined by the duct of the ventral pancreas to form what was the stem of the entire hepatocystic diverticulum. This stem is considered in the developed organism the end of the common bile duct. So we have the common bile duct receiving bile from the liver, bile that had been stored in the gall bladder, and the secretions of the ventral pancreas, and emptying into the foregut.

Embryology of the Gut and Mesenteries, slide 21

Now I'd like to imagine that I could take an impossible cross-section. One that went through the dorsal pancreatic diverticulum and foregut, and then came out the hepatopancreatic diverticulum, and followed the hepatocystic diverticulum, and then went out the hepatic branch of the hepatocystic diverticulum through the developing liver, and then turned ventrally and went out through the septum transversum and the abdominal wall. Now clearly this can not be done in real life (no-one could take a cross-section like this), but if you could it would look like what we see on the next slide.

Embryology of the Gut and Mesenteries, slide 22

Here is that cross-section. It shows the dorsal pancreatic diverticulum extending into the dorsal mesentery of the foregut. And it shows this fake hepatic diverticulum coming out of the ventral aspect of the foregut. But, what it also shows, and what I really want to emphasize with this slide, is that the right and left peritoneal diverticula, which were on either side of the foregut dorsal to the septum transversum, start to expand ventrally. We know of one other instance where coelomic channels expand ventrally. The pleural sacs do, in order to accommodate the growing lungs. There are no growing lungs here, I don't know why these right and left peritoneal diverticula expand ventrally. Maybe they're trying to emulate their cousins in the chest, but it doesn't make any difference why they do it. And as they do it, they start to squeeze the mesoderm of the septum transversum into, or toward, the median sagittal plane.

Embryology of the Gut and Mesenteries, slide 23

And now we see the completion of this process, and all of the mesoderm of the septum transversum caudal to the diaphragm has been squeezed into the median sagittal plane. This ventral expansion of the two peritoneal diverticula occurs simultaneously with the development and growth of the hepatic diverticulum. But people have chosen (for reasons which elude me) to pretend that they happen at different times. If you go to the next slide, you'll see what happens if you pretend that the ventral expansion of the two peritoneal diverticula occurs, and is completed before, the hepatopancreatic diverticulum arises.

Embryology of the Gut and Mesenteries, slide 24

If this expansion of the two peritoneal diverticula ventrally had indeed occurred before any of the foregut diverticula arose, then you would have created what's labeled here: a ventral mesentery of the foregut - a thin sheet of connective tissue with mesothelium on either side. This connective tissue would have been derived from septum transversum that had been squeezed between the ventrally expanding peritoneal diverticula. Most books like to refer to there being a ventral mesentery of the foregut, and they say that the hepatocystic diverticulum grows into that ventral mesentery.  The truth of the matter is that the hepatocystic diverticulum grows into the septum transversum, and a ventral mesentery is created simultaneously by the expansion of the peritoneal diverticula.

<u>Embryology of the Gut and Mesenteries, slide 25</u>

Here I have capitulated to what most people like to do.  Now I have shown, truthfully, a dorsal pancreatic diverticulum growing into a dorsal mesentery and, falsely, a hepatic diverticulum growing into a preexisting ventral mesentery. Having done that, we can in fact give names to separate parts of this ventral mesentery.  They will exist ultimately.  The portion of the ventral mesentery between the developing liver and the foregut is called the lesser omentum.  The portion of the ventral mesentery between the developing liver and the anterior (or ventral) body wall is called the falciform ligament.  The connective tissue of both of these regions of the ventral mesentery, that is the lesser omentum and falciform ligament, is derived from the septum transversum mesoderm. You can also see that some mesoderm of the septum transversum is in contact with and surrounds the developing liver, and it becomes a connective tissue we will give a name to later.

<u>Embryology of the Gut and Mesenteries, slide 26</u>

Now I've shown this just a little further along in development. Remember this is a fake cross- section; you could not take a real cross-section that goes through both the dorsal pancreatic diverticulum and then through the hepatic diverticulum all by itself.  But anyway, giving me that leeway, I've shown that the endoderm of the dorsal pancreatic diverticulum has proliferated and will form a solid organ that will drain by a duct into the foregut, and I've shown the liver endoderm having proliferated to form a solid organ. We know that it will drain by a duct which at first is called the common hepatic duct, and later in its course the common bile duct, and we see that the common bile duct runs in the lesser omentum to get to the foregut.

<u>Embryology of the Gut and Mesenteries, slide 27</u>

And now back to a median sagittal section of this region.  By this time the liver has really grown quite large, and indeed the septum transversum has been squeezed into a ventral mesentery.  And we are going to start to give names to parts of it, but first I want to focus in, or draw your attention to, what has happened to the foregut itself, because prior to this time, the abdominal portion of the foregut was a straight tube, and now we see that it has developed two curvatures.  The cranial portion of the abdominal foregut has developed a curvature that is convex dorsally.  And the caudal portion of the abdominal foregut has developed a curvature that is convex ventrally.  This occurs by differential growth of the dorsal and ventral surfaces of the gut tube, but regardless, that portion that is convex dorsally can now be identified as the future stomach.  And that part that is convex ventrally will become part of the duodenum.  The stomach is said to have a greater curvature, which is the dorsal curve which has the larger radius, and a lesser curvature, which is the ventral curve of the stomach which has a smaller radius.  And we could say that the duodenum has a greater curvature, which would be the larger radius ventral surface, and a lesser curvature which is the smaller radius dorsal surface.  And now we could say that the dorsal pancreatic diverticulum is indeed a midline diverticulum of the lesser curvature of the duodenum, and that the hepatopancreatic diverticulum is a midline diverticulum of the greater curvature of the duodenum, and it occurs immediately cranial to the junction of the foregut and the midgut.  And although we will talk about it later, the midgut forms part of the duodenum as well, that part immediately caudal to the hepatopancreatic diverticulum. Now that we can identify the stomach and duodenum, we can start to give names to regions of the dorsal mesentery.  The portion of the dorsal mesentery that goes to the greater curvature of the stomach is called the mesogastrium.  The portion of the dorsal mesentery that goes to the lesser curvature of the duodenum is called the mesoduodenum.  And the dorsal pancreas, we now must say, is a structure growing into the mesoduodenum.  And we can also give names to different regions or portions of the ventral mesentery.  The lesser omentum runs from the gut to the liver.  The part of the lesser omentum that runs from the lesser curvature of the stomach to the liver is called the hepatogastric ligament.  The part of the lesser omentum that runs from the greater curvature of the duodenum to the liver is called the hepatoduodenal ligament.  These are just regions of a single, thin sheet of connective tissue with mesothelium on either side, otherwise nothing demarcates them.  The common bile duct runs in the free caudal edge of the hepatoduodenal ligament.  You will see that in dissection.  And also we see the falciform ligament, which is that portion of the ventral mesentery between the liver and the anterior abdominal wall.   And finally, this picture shows two other things.  One, not terribly important, that the ventral pancreas is getting bigger.  And one very important, and that is, that as the liver grows it actually contacts the undersurface of the abdominal diaphragm.  And that happens as the ventral mesentery is being created, so that the contact of the liver with the undersurface of the abdominal diaphragm prevents the two peritoneal diverticula from approaching one another cranial to the liver. So in fact there is no ventral mesentery formed cranial to the liver. This region of the liver that contacts the undersurface of the diaphragm (you'll see in dissection) is called the bare area of the liver.

Embryology of the Gut and Mesenteries, slide 28
And now let's take a real cross-section: one that goes through the stomach, hepatogastric ligament, developing liver, and falciform ligament.

Embryology of the Gut and Mesenteries, slide 29
Here is that cross-section labeled in ways you could have predicted. I want to point out a few things, and that is that the portion of the septum transversum mesoderm that envelopes the liver turns into a connective tissue, which is the connective tissue capsule of the liver, which is called Glisson's capsule, and then it [the connective tissue capsule] is surrounded by mesothelium. We can now name all the things that the septum transversum gives rise to. It gives rise to the major portion of the central tendon of the diaphragm, and then caudal to that, it gives rise to the lesser omentum, to Glisson's capsule, and to the falciform ligament. And this picture also shows one other thing. It shows that the growth of the liver occurs predominantly to the right side of the midline and so the right peritoneal diverticulum is getting squeezed into a smaller space than is the left peritoneal diverticulum.

Embryology of the Gut and Mesenteries, slide 30
And now I want to take one of these fake cross-sections (not as bad as the one we did previously). This one will go through the dorsal pancreatic diverticulum, through the duodenum, and it will jog forward a little so it can continue down through the very stem of the hepatopancreatic diverticulum. And then it jogs out along the ventral pancreatic portion of that diverticulum. Then it enters the portion of the peritoneal cavity that is in front of the vitelline duct and behind the septum transversum, and then finally goes out through the anterior abdominal wall.

Embryology of the Gut and Mesenteries, slide 31
This is that cross-section labeled. But I do want to remind you that you could never have a real cross-section that could go through both the origin of the dorsal pancreatic diverticulum and the origin of the hepatopancreatic diverticulum, of which the ventral pancreas is a part, because those two diverticula arise at different cranial/caudal levels.

Embryology of the Gut and Mesenteries, slide 32
As all of these things are happening, the gut is undergoing a rotation, a rotation around a craniocaudal axis. If you could stand at the front end of the embryo and look down towards the gut, or in this portrayal, if you were on the left side of the computer screen looking in the plane of the computer screen, you would see the foregut undergo what appeared to you to be a clockwise rotation. In other words, the greater curvature of the stomach would move out in front of the plane of the computer screen, which would be towards the left of the embryo, and the greater curvature of the duodenum would move behind the plane of the computer screen towards the right of the embryo. Now, I'd like to take a cross-section through our stomach and liver after the foregut has undergone this sort of rotation.

Embryology of the Gut and Mesenteries, slide 33
Things are now considerably more complicated. Some things you should notice: the stomach is now horizontally disposed, really, and its greater curvature faces to the left. The hepatogastric ligament, originally a median sagittal structure, is also horizontally disposed, running from right to left between the lesser curvature of the stomach and the liver. For some reason that only our Creator knows, the falciform ligament has not participated in this rotation, so it still is a median sagittal structure running between the liver and anterior abdominal wall. The right peritoneal diverticulum is now a very odd shaped structure. Much of it lies posterior to the stomach and hepatogastric ligament, though some of it still lies to the right side of the liver and falciform ligament. And the left peritoneal diverticulum is equally odd-shaped. The mesogastrium still runs from its origin, ventral to the aorta, out to the greater curvature of the stomach, but now it has to loop to the left side in order to get there. And we also see something interesting has happened: lymphoid tissue has accumulated between the left and right mesothelial layers

of the mesogastrium. It's actually accumulated in the connective tissue of the mesogastrium. And as it accumulates, it bulges out the left layer of the mesogastrium, and forms a structure that we will identify as the spleen. And I've also shown the kidneys having migrated up from their origin in the pelvis. And finally, I've gotten rid of the posterior cardinal veins and replaced them with the inferior vena cava which is to the right of the aorta, because that is eventually what does happen.

Embryology of the Gut and Mesenteries, slide 34
And we should take a cross-section through the pancreatic diverticula with the intervening duodenum, realizing that the duodenum has rotated behind the plane of the computer screen, towards the right side of the embryo.

Embryology of the Gut and Mesenteries, slide 35
What I show here is a cross-section early in the rotation of the duodenum towards the right side of the embryo. And I want you to also notice a subtle change in the attachment site of the hepatopancreatic diverticulum, or the beginning of the common bile duct, identified here because it is receiving the duct of the ventral pancreas. That attachment site has moved ever so slightly towards the posterior surface of the duodenum. It used to be exactly opposite the origin of the dorsal pancreatic diverticulum; it used to be precisely on the greater curvature of the duodenum. But now it has moved ever so slightly closer to the origin of the dorsal pancreatic diverticulum.

Embryology of the Gut and Mesenteries, slide 36
This shows the cross-section after the duodenum has progressed further in its rotation toward the right side of the embryo, and also after the site of origin of the hepatopancreatic diverticulum (which we know is where the common bile duct empties) has moved further along the back surface of the duodenum to become somewhat closer to the site of origin of the dorsal pancreatic diverticulum.

Embryology of the Gut and Mesenteries, slide 37
Now we've carried this rotation to its completion, and the greater curvature of the duodenum faces to the left side of the computer screen as you are looking at it - that's the right side of the embryo. But notice now that the opening of the common bile duct into the duodenum is rather close to the opening of the dorsal pancreatic duct, or the dorsal pancreatic diverticulum. But I will remind you that these two things - the common bile duct opening into the duodenum and the dorsal pancreatic duct opening into the duodenum - are in different craniocaudal planes, that we could not catch them in the same cross-section because the dorsal pancreas arose more cranially than did the hepatopancreatic diverticulum.

Embryology of the Gut and Mesenteries, slide 38
This is a very elegantly drawn picture of what it would look like if you could actually dissect the embryo at this stage, open it up and look at what these organs how they're positioned in the body. We see the stomach has moved to the left side, and it has a big bulgy greater curvature off to the left. We see the liver has grown mainly on the right side, and occupies the right part of the abdomen. We see the duodenum has swept to the right side. We see the dorsal pancreas coming off of the lesser curvature of the duodenum; that hasn't changed, that's where it started and that's where it is now still. But we see that the common bile duct, shown here in green (and remember the common bile duct is really the beginning of the hepatopancreatic diverticulum and then the hepatocystic component of that diverticulum), we see that the opening of the common bile duct into the duodenum has shifted onto the posteromedial surface of the duodenum. And notice that the ventral pancreas has taken up a position posterior to the duct of the dorsal pancreas, and that the common bile duct, after it gives off its branch to the ventral pancreas, takes up a position posterior to the glandular tissue of the ventral pancreas, and then the common bile duct continues posterior to the duodenum and then up towards the gallbladder and liver. When this narration is over, go back to the previous slide and you'll see I drew a little green circle posterior to the ventral pancreas. That is meant to be the portion of the common bile duct which now, due to all of these positional changes and rotations, has ended up posterior to the ventral pancreas.

Embryology of the Gut and Mesenteries, slide 39
This truly is a beautiful drawing, close-up of the duodenum and ventral and dorsal pancreata. The dorsal pancreas is a glandular structure with a duct system. It secretes its enzymes into those ducts, and those ducts converge to

form a single dorsal pancreatic duct that empties into the lesser curvature of the duodenum. That was the original site of the dorsal pancreatic diverticulum. The ventral pancreas is a glandular structure with its own duct system. These ducts converge on a single ventral pancreatic duct. That duct joins the distal end of the common bile duct, which then enters the dorsomedial aspect of the duodenum a little bit further distally than did the duct of the dorsal pancreas. We know that the ventral pancreatic duct had to join the distal end of the common bile duct because they are in fact both products of the single hepatopancreatic diverticulum. We see that a bit of the ventral pancreas is posterior to the dorsal pancreatic duct and that, proximal to receiving the duct of the ventral pancreas, the common bile duct actually lies posterior to the glandular tissue of the ventral pancreas, and then further proximally it lies posterior to the duodenum.

Embryology of the Gut and Mesenteries, slide 40

This is an attempt to show you what the mesenteries would look like after all of these rotational changes. The solid, and partially translucent, orange structure is the lesser omentum. It's labeled here. I did not label the hepatogastric portion, which runs from the lesser curvature of the stomach to the liver. Nor did I label its hepatoduodenal portion, which runs from the greater curvature of the duodenum to the liver. You can see, however, that the common bile duct lies in the free edge of the hepatoduodenal portion of the lesser omentum - in the free edge of the hepatoduodenal ligament. That used to be a caudal edge. Now, because of the rotations, the free edge of the lesser omentum faces to the embryo right side. So, the common bile duct runs in the right free edge of the hepatoduodenal ligament. I've also tried to draw in the mesogastrium here, which has grown tremendously in length. I drew it as sort of loopy orange lines. It has its same origin over the ventral aspect of the aorta that's called the root of the mesentery. The root of the mesentery is where it joins the parietal peritoneum. At any rate, the mesogastrium sweeps from its dorsal midline root to join the visceral peritoneum of the stomach along its greater curvature. Now we see that the greater curvature of the stomach, at this point, can be viewed as a having a leftward facing portion - that's near the top of the stomach - and having an inferiorly facing portion, near the bottom of the stomach. And the mesogastrium has grown very long it sweeps from its root way to the left, and then loops back again to join the leftward facing portion of the greater curvature of the stomach. And it also sweeps from its root way inferiorly, and loops back again to join the inferiorly facing portion of the greater curvature of the stomach. And that part of the mesogastrium that joins the leftward facing portion of the greater curvature, I have labeled the upper mesogastrium. And that portion of the mesogastrium that joins the inferiorly facing part of the greater curvature of the stomach, I have labeled as lower mesogastrium. These are simply different regions of one continuous mesenteric sheet.

Embryology of the Gut and Mesenteries, slide 41

This is the same cross-section through the liver and stomach after rotation of the foregut that we saw previously, but I've put in some arrows here to indicate some changes that are going to occur in the peritoneum. The visceral peritoneum over the posterior surface of the liver is going to contact the parietal peritoneum on the anterior surface of the inferior vena cava. The two mesothelial layers will fuse and then disappear. And the posterior surface of the upper mesogastrium, that was originally the left surface, will contact the parietal peritoneum over the kidney, and again the mesothelial layers will fuse here and disappear. And the next slide shows you what things will look like after these peritoneal fusions.

Embryology of the Gut and Mesenteries, slide 42

As you can see, after these peritoneal fusions, the inferior vena cava becomes embedded in a groove on the posterior surface of the liver - it's called the caval fossa; you'll see it in dissection. And the root of the upper mesogastrium has shifted. It used to be a midline root positioned ventral to the aorta. Now it is shifted way to the left, and has a location over the kidney. We can also see that as a result of the inferior vena cava taking up a position embedded in the posterior surface of the liver, that a portion of the original right peritoneal diverticulum is separated from the rest of it. The separate portion lies posterior to the stomach and hepatogastric ligament. And that's separated from the part that lies to the right of and to the front of the liver, which I've still kept the letter "R" in. That part now lying posterior to the stomach and hepatogastric ligament is called the lesser sac of the peritoneal cavity. The remainder of the right peritoneal diverticulum (with the "R's" in it), the left peritoneal diverticulum, and all of the rest of the peritoneal cavity which was never separated into parts, is said to constitute the greater sac of the peritoneal cavity. Finally, after the change in the root of the upper mesogastrium, we start to give names to this portion of the mesentery. The part of the upper mesogastrium that runs from its root over the left kidney to the spleen is called the lienorenal ligament, 'lieno' refers to spleen, 'renal' to kidney. And the part of the upper mesogastrium that runs from the spleen to the stomach is called gastrosplenic ligament.

Embryology of the Gut and Mesenteries, slide 43
And the process of fusions between visceral peritoneum and parietal peritoneum, or mesentery and parietal peritoneum, are not confined to this liver/stomach region. But if we look down at our duodenum and pancreas, we see that the visceral peritoneum over the posterior aspect of the ventral pancreas contacts the parietal peritoneum of the posterior body wall. We see that the mesoduodenum contacts parietal peritoneum of the posterior body wall. And we will see that the visceral peritoneum over the posterior surface of the dorsal pancreas will contact the mesoduodenum. The next slide just reinforces this by showing you these things closer together.

Embryology of the Gut and Mesenteries, slide 44
Here we just see contact being made between visceral peritoneum over the back of the duodenum and ventral pancreas with parietal peritoneum, contact of mesoduodenum with parietal peritoneum, and contact of visceral peritoneum over the posterior surface of the dorsal pancreas with mesoduodenum.

Embryology of the Gut and Mesenteries, slide 45
It seems that I've carried the illustration of this process to an extreme, because now I just show fusion of the mesothelial layers that have contacted one another.

Embryology of the Gut and Mesenteries, slide 46
This proves I have carried things to an extreme, because now I'm just showing dissolution of the mesothelial layers that have contacted one another.

Embryology of the Gut and Mesenteries, slide 47
And this shows the final stage in which all of the contacting mesothelial layers have disintegrated completely, and we can see that the duodenum, ventral pancreas, and dorsal pancreas except for its tail (its tip) are now retroperitoneal structures. And the visceral peritoneum that covered the anterior surfaces of the duodenum and the pancreata is now said to constitute parietal peritoneum because it's now the peritoneum of the posterior abdominal wall. When any structure that had a mesentery loses that mesentery and becomes retroperitoneal, it is said to be secondarily retroperitoneal. That phrase simply means "I once had a mesentery, now I lost it, now I am retroperitoneal." There is such a thing as being primarily retroperitoneal - that means you formed in the retroperitoneum from the very git go, you never had a mesentery. But that's not true of the duodenum and pancreas. Most of the duodenum, all of the ventral pancreas, and most of the dorsal pancreas become secondarily retroperitoneal structures. The only part of the pancreas that still has a mesentery, if you will, is the tail of the pancreas, and it runs in the root of the lienorenal ligament.

Embryology of the Gut and Mesenteries, slide 48
And this is an attempt to show you what an actual dissection would look like after these fusions. First, the lesser omentum is still in a solid orange color. That lesser omentum, as you know, is comprised of the hepatogastric and hepatoduodenal ligaments. And previously, when I talked about a region of the right peritoneal diverticulum being sequestered behind the hepatogastric ligament and the stomach, and I called it the lesser sac, I seemed to indicate that it was completely isolated in every way from the remainder of the right peritoneal diverticulum, which became a part of the greater sac. But, in fact, now I can say that there is one place where the lesser sac and greater sac are in continuity, and that is posterior to the free edge of the hepatoduodenal ligament. There is a little opening between the lesser sac and greater sac, which is called the Foramen of Winslow, or the epiploic foramen, because the common bile duct does not become retroperitoneal. That is the only normal means of communication, or opening, between greater sac and lesser sac, posterior to the free edge of the hepatoduodenal ligament. Now if we change our focus and look what's happened to the mesogastrium. I spoke previously of its fusion - the upper mesogastrium fusion to the parietal peritoneum. And now this illustrates that the line of fusion takes place obliquely. It starts cranially in the midline and sweeps downward and to the left, and so you have an oblique root of the upper mesogastrium. And after the duodenum and pancreas become secondarily retroperitoneal, the root of the lower mesogastrium runs a straight horizontal course, starting at the left kidney and passing across the inferior

border of the pancreas. I want to emphasize that the original root of the mesogastrium, like the root of all of the mesentery, was a midline structure ventral to the aorta. But that has entirely changed. It starts ventral to the aorta, just below the diaphragm, but it sweeps downward and to the left until it reaches the anterior surface of the kidney, and then it sweeps straight across to the right along the inferior border of the pancreas. So the mesogastrial root is very different now than it was at the beginning.

Embryology of the Gut and Mesenteries, slide 49
And now let's take a median sagittal section after the duodenum and pancreas have become secondarily retroperitoneal, and the root of the mesogastrium has changed in the way I described.

Embryology of the Gut and Mesenteries, slide 50
Here is that median sagittal section. You might have been able to figure out what it would go through. I want to point out obviously that it goes through the stomach and the hepatogastric ligament, and it goes through the lower mesogastrium. We see the root of the lower mesogastrium, having been transected as it runs along the inferior border of the pancreas. We see the pancreas and duodenum, here retroperitoneal. We see the lower mesogastrium sweep down from its root, down into the abdominal cavity and then make a turn and come back up to join the greater curvature of the stomach. I have given a name to the part of the lower mesogastrium that sweeps down from its root - I've called that the posterior sheet of the lower mesogastrium, and I've given a name to the part that sweeps back up again to join the greater curvature of the stomach - I've called it the anterior sheet of the mesogastrium. Also, I want to point out that the portion of the peritoneal cavity that is posterior to the stomach and the hepatogastric ligament is the lesser sac of the peritoneal cavity. And now we can see that a bit of this space does extend up posterior to the liver - that's called the superior recess of the lesser sac. And quite a bit of it extends down between the anterior and posterior sheets of the lower mesogastrium, and that's called the inferior recess of the lesser sac. These letters "gs" refer to the greater sac of the peritoneal cavity, which is everything that isn't the lesser sac.

Embryology of the Gut and Mesenteries, slide 51
Now I want to complete consideration of development of the pancreas. This is a slide we saw before. I just remind you now that at this stage in development, the entire ventral pancreas and most of the dorsal pancreas all but its tip are secondarily retroperitoneal, as is the part of the duodenum that I've shown here. The only part of the duodenum that still retains a mesentery is its very beginning, as you'll see in dissection. Once the different parts of the pancreas become retroperitoneal, they fuse to one another, and the product is shown in the next slide.

Embryology of the Gut and Mesenteries, slide 52
In this slide the ventral pancreas is shown fused to the dorsal pancreas, and the slide highlights the fusion that occurs between the ducts of these two structures. A cross-bridge forms between the duct of the ventral pancreas and the duct of the dorsal pancreas, and after that communication forms, most of the secretion of the dorsal pancreas follows a route indicated by this gray line. It comes down the duct of the dorsal pancreas, goes across the communication, enters the duct of the ventral pancreas, and is carried by it to the very termination of the common bile duct. The new duct created by the communication between the original dorsal duct and original ventral duct is called the main pancreatic duct of Wirsung, and it's indicated in gray as I said before. The terminal part of the original dorsal duct is called the accessory pancreatic duct of Santorini. Sometimes it persists as a small duct that receives some of the secretions of the original dorsal pancreas. Sometimes it completely degenerates. It's opening into the duodenum is obviously lost in those circumstances, and all of the dorsal pancreatic secretions would then flow into the main pancreatic duct.

Embryology of the Gut and Mesenteries, slide 53
And now I want to give names to parts of the definitive pancreas that are formed from the dorsal and ventral pancreatic diverticula. The head of the adult (or definitive) pancreas is entirely formed by the ventral pancreatic diverticulum, and the uncinate process of the head of the pancreas is that little bit of the head which does not make direct fusion contact with the dorsal pancreatic diverticulum. The neck of the pancreas is the zone of fusion between ventral and dorsal pancreas. The body and tail of the adult pancreas are the representatives of the dorsal

pancreatic diverticulum - the tail being that part which extends into the lienorenal ligament and did not become entirely retroperitoneal.

Embryology of the Gut and Mesenteries, slide 54
I suggest you take a rest before we go on to consider the midgut and hindgut, but if you are not tired, move right ahead.

Embryology of the Gut and Mesenteries, slide 55
Here's a median sagittal section taken before all those changes in the foregut that were just described have taken place. But now we are going to concentrate on the midgut. The most amazing thing about the midgut really is that it is so small at this stage of development. It is just that region of the gut to which the vitelline duct is attached. I remind you that the vitelline duct passes through the umbilical cord, and within the umbilical cord is a remnant of the yolk sac. And I also remind you that the superior mesenteric artery is the vessel coming off the ventral surface of the aorta that supplies the midgut now, and will supply all of the structures derived from the midgut throughout development and life. The most astounding thing about midgut development is that this little tiny structure grows so very big. It grows so tremendously in length that it actually cannot fit within the fetal abdominal cavity. And there is only one place for it to go, and that is into the umbilical cord. Now when a structure that is supposed to be in a body cavity passes through the body wall, that is said to be a hernia. And this is therefore a herniation of the midgut into the umbilical cord. It is something that is supposed to occur; it's normal, so it is called a physiological umbilical hernia of the midgut, as opposed to an abnormal hernia. And it occurs during the 7th week of development, when the midgut has grown so extensively that it cannot any longer be accommodated in the fetal abdominal cavity.

Embryology of the Gut and Mesenteries, slide 56
Here is a picture of the early stage of that physiological umbilical hernia. The midgut has grown so extensively that it loops down into the umbilical cord, and in fact it is called the midgut loop. I have also included in this picture the termination of the foregut. I have not included septum transversum and all those other things associated with the foregut, but you know they're there. And I have included the very beginning of the hindgut as well. And I have separated the termination of the foregut from the midgut by a green dotted line, and I have separated the termination of the midgut from the beginning of the hindgut by a green dotted line. And regarding the boundary between foregut and the midgut, let me state that it occurs immediately caudal to the origin of the hepatopancreatic diverticulum, the beginning of which is indicated here. Now you know that the hepatopancreatic diverticulum and the dorsal pancreatic diverticulum arise from the duodenum, which I have labeled her. But the duodenum also has a portion arising from the midgut, and that is the part of the duodenum that is caudal to the hepatopancreatic diverticulum, caudal to the common bile duct opening in an adult, and is also part of the midgut that does not herniate, but stays in the abdominal cavity. Now if a part of the duodenum derives from the midgut, it must be supplied by the superior mesenteric artery with its blood. And if a part of the duodenum arises from the foregut, that part must be supplied by the celiac artery by blood. And you will see when you learn the distribution of arteries to the duodenum, that some come from the celiac and some come from the superior mesenteric. The hepatopancreatic diverticulum is right at the boundary virtually between the midgut and the foregut. The pancreas usually gets its main blood supply from the celiac, but it also gets branches from superior mesenteric. The liver is usually supplied entirely by the celiac artery, but you know in some people, probably, this diverticulum arises 50 microns further caudally than in other people, and maybe that accounts for the fact that in about 25% of people, a very major hepatic artery arises from the superior mesenteric, and this has considerable importance clinically as well. Now let's get back to the midgut itself. As I said, it forms a loop into the umbilical cord. The portion nearest to the foregut is called the cranial limb of the midgut loop, as labeled here. The portion that runs from the attachment site of the vitelline duct back up to the hindgut is called the caudal limb of the midgut loop. The superior mesenteric artery has had to grow very long. It attaches to the midgut opposite the site of the origin of the vitelline duct. Of course, on its way to this site, it is giving off side branches to the cranial and caudal limbs of the loop, those aren't illustrated here. And the dorsal mesentery has had to grow very considerably. Before the midgut grew so much, the dorsal mesentery had a root which was very short, and just ventral to the aorta at the site where the superior mesenteric artery arose. That root hasn't changed in length at all, but from that very short root in the

vicinity of the origin of the SMA, now this mesentery has to fan out very dramatically to reach the entire cranial and caudal limbs of the midgut loop.

Embryology of the Gut and Mesenteries, slide 57

While the midgut is in the umbilical cord it continues its growth in length. The cranial limb, and the bend in the loop itself, grow far more in length than does the caudal limb. The diameter of the cranial limb and the bend does not grow as dramatically as the diameter of the caudal limb. And the cranial limb, as a result of its growth, develops a number of twists and turns and folds, and it will become the jejunum and ileum of the small intestine of the adult. The vitelline duct is attached to what will become part of the distal ileum of the adult. The caudal limb, which grows more in diameter but not nearly so much in length, is marked by an expansion where it begins, and that expansion can be identified as the future cecum of the ascending colon. The rest of the caudal limb of the midgut loop is destined to become the ascending and transverse colons, which allows you to deduce that the hindgut is destined to become of the descending and sigmoid colons.

Embryology of the Gut and Mesenteries, slide 58

In addition to growing in such a way that we can identify what will become the jejunum and ileum, and what will become the ascending and transverse colons, the midgut loop undergoes a rotation while it is within the umbilical cord. If you lay on the floor and look up at the bottom edge of your computer screen, this rotation would be such as to occur in a counter- or anti-clockwise direction (I've drawn an arrow here to indicate that direction). It means that the caudal limb of the midgut loop will sweep out in front of the computer screen and the cranial limb of the midgut loop will sweep behind the plane of the computer screen. The axis of this rotation is essentially the superior mesenteric artery.

Embryology of the Gut and Mesenteries, slide 59

Here is the way the midgut loop looks after the rotation has occurred. The caudal limb of the midgut loop actually lies cranial to the cranial limb of the midgut loop. We don't change the names of the loops, but their positions have changed 180 degrees with respect to one another. The mesentery, which still has a very confined root anterior to the origin of the superior mesenteric artery, has fanned out very dramatically as the limbs of the midgut loop have grown in length. And then, as the rotation of the midgut loop occurs, the mesentery twists around, and I tried to show that by this very high quality drawing.

Embryology of the Gut and Mesenteries, slide 60

What this big arrow means is that, some time during the 10th week of development, after all of these changes have occurred in the midgut loop, the abdominal cavity has grown sufficiently large that there is now room within it for the midgut. And the midgut does return from the umbilical cord back into the abdominal cavity. The first parts of the midgut loop to return is the part of the cranial limb nearest the duodenum and the part of the caudal limb nearest the hindgut, and those things move into the upper left quadrant of the abdomen. And the last part to return is the part to which the vitelline duct attaches (which is the distal ileum) and also the cecum nearby. And those parts move in to the lower right quadrant of the abdominal cavity. Everything intervening sort of fills up the space between upper left and lower right quadrants of the cavity.

Embryology of the Gut and Mesenteries, slide 61

Here is our front view of what it would look like after the midgut loop has returned. As you see, the part of the cranial limb nearest the duodenum and the part of the caudal limb nearest the hindgut are in the upper left quadrant, and the cecum and the distal ileum are in the lower right quadrant, and I show the superior mesenteric artery running down to the ileum opposite the site of origin of the vitelline duct. I chopped off the vitelline duct, it runs up through the belly button into the umbilical cord to meet the remnant of the yolk sac. Eventually the vitelline duct and yolk sac completely degenerate. If they don't, you can read about what happens in the handout. When the midgut loop returns to the abdominal cavity, it pushes most of the hindgut to the left side, and that portion which is so pushed becomes the descending colon. The very caudal end of the hindgut stays where it was and connects to the rectum. And connecting the descending colon and the rectum is the sigmoid colon region of the hindgut. You'll note that the caudal limb of the midgut loop is still pretty straight and runs an oblique course from the upper left quadrant to the lower right quadrant. I've called it the oblique colon because at this stage it has not yet differentiated itself into ascending and transverse colons, but go to the next slide and it will.

Embryology of the Gut and Mesenteries, slide 62
And now we show the midgut loop having formed an ascending and transverse colon by growth of the "oblique colon", and this was really made possible by continued growth of the abdominal cavity. It seems that the liver has grown smaller in comparison, but in fact the abdominal cavity has simply grown so large that the liver doesn't take up nearly as much space as it used to.

Embryology of the Gut and Mesenteries, slide 63
This shows the mesentery both of the midgut and of the hindgut. The midgut mesentery originally had a very short root located in the vicinity of the superior mesenteric artery origin. That root has grown very little, but the mesentery itself has fanned out tremendously to reach the jejunum and ileum region of the midgut loop, to reach the cecum, ascending colon and transverse colon region of the midgut loop, and I've illustrated here how much this mesentery fans out to reach the extensive portion of the bowel it goes to, from a very narrow or short region of origin. Hindgut mesentery is different. The hindgut hasn't grown very long. The hindgut mesentery still maintains a midline root along the anterior aspect of the aorta - most of which we can not see actually, because it is hidden by the midgut loop and its mesentery, but I think you can appreciate that the hindgut mesentery essentially runs straight across from its origin to reach the hindgut.

Embryology of the Gut and Mesenteries, slide 64
Here is a transverse section of our fetus through the region of the hindgut. All I wanted to show by this section is something I said before, and that is, as the midgut loop returns into the abdominal cavity, it pushes that portion of the hindgut destined to become the descending colon towards the left side.

Embryology of the Gut and Mesenteries, slide 65
Here we see that the portion of the hindgut destined to become the descending colon has been pushed so far to the left that the visceral peritoneum on the posterior surface of the descending colon contacts the parietal peritoneum of the posterior abdominal wall, and that the mesentery of the descending colon will contact the parietal peritoneum of the posterior abdominal wall. And almost certainly, you have deduced that the mesothelial layers of visceral peritoneum and mesentery will merge with the mesothelial layers of the parietal peritoneum. Then these mesothelial cells will degenerate, and we will complete the process by which the descending colon becomes secondarily retroperitoneal. I show this in the next few slides. Why don't you just look at them until we come to the end of this process of retroperitonealization of the descending colon.

Embryology of the Gut and Mesenteries, slide 66-67
No narration.

Embryology of the Gut and Mesenteries, slide 68
Now the descending colon is secondarily retroperitoneal. Why secondarily? As you know, it had a mesentery, it lost a mesentery. And as was the case for the duodenum and pancreas, when this happens, the visceral peritoneum on the anterior surface of the bowel, in this particular case descending colon, plus the anterior sheet of its mesentery, take on all the histological characteristics of parietal peritoneum, and are simply referred to now as part of the parietal peritoneum.

Embryology of the Gut and Mesenteries, slide 69
This shows in front view what happens to the dorsal mesentery of the hindgut. A large rectangular patch going to the descending colon has disappeared. And this gives a sharp root, horizontal root, to half of the mesentery of the transverse colon, and it also gives a more or less horizontal root (it curves a bit) to a mesentery for the sigmoid colon, because the sigmoid colon does not become retroperitoneal.

Embryology of the Gut and Mesenteries, slide 70
And then the ascending colon becomes secondarily retroperitoneal, and loses a triangular patch of its mesentery, which merges with parietal peritoneum. When that triangular patch of the ascending colon's mesentery disappears, it extends the horizontal root of the transverse colon. The transverse mesocolon - that's the name given to the mesentery of the transverse colon - now has a long horizontal root extending all the way from the left side to the

right side. And the second effect of losing this triangular patch of the mesentery of the ascending colon is that the root of the small intestine mesentery changes. You know that had been a part of the mesentery of the midgut, and therefore it had a root located in a short region ventral to the origin of the superior mesenteric artery. But when the ascending colon becomes secondarily retroperitoneal, so does the superior mesenteric artery. And the root of the mesentery of the small intestine now extends the whole length of this secondarily retroperitoneal superior mesenteric artery. You know that originally, the root of the dorsal mesentery of all of the abdominal gut ran in the midline, ventral to the aorta. That has essentially all been changed. The root of the upper mesogastrium follows an oblique course downward and to the left. The root of the lower mesogastrium follows a horizontal course along the lower border of the pancreas. The ascending colon has completely lost its mesentery. The root of the transverse mesocolon runs horizontally from the right side of the embryo to the left side. The root of the mesentery of the small intestine starts more or less in the midline, near the origin of the superior mesenteric artery, but it runs a curvilinear course downward and to the right, to end up in the right lower quadrant. The descending colon has lost its mesentery. And the sigmoid mesocolon has a curved, more or less horizontal root, down near the pelvis. I reiterate - almost nothing of the original midline root of the abdominal gut remains.

Embryology of the Gut and Mesenteries, slide 71
In the slide that follows I'm going to show a median sagittal section; it's going to leave out a lot of stuff, because I want to focus in on the transverse colon and the transverse mesocolon, and its relationship to the stomach and lower mesogastrium.

Embryology of the Gut and Mesenteries, slide 72
This differs from slide 50 only in that it contains the transverse colon, with the transverse mesocolon caught in section. It shows the lower mesogastrium - I've only labeled the anterior sheet, but the posterior sheet is there as well, and as you know the lower mesogastrium has a horizontal root that runs along the inferior edge of the pancreas, and the transverse mesocolon also has a horizontal root that parallels, and lies immediately caudal to, the root of the lower mesogastrium. We've caught the root of the transverse mesocolon and the root of the lower mesogastrium in our median sagittal section here.

Embryology of the Gut and Mesenteries, slide 73
Well the proximity of the transverse mesocolon to the lower mesogastrium posterior sheet brings these two into contact, and as you will have guessed, the mesothelium on the anterior surface of the transverse mesocolon fuses to the mesothelium on the posterior surface of the posterior sheet of the lower mesogastrium, and the next slide will show you what you must have figured out will happen.

Embryology of the Gut and Mesenteries, slide 74
You were right, the fused mesothelial layers dissolve and bring about a merger of the transverse mesocolon with the upper portion of the posterior sheet of the lower mesogastrium, and that's shown in the next slide.

Embryology of the Gut and Mesenteries, slide 75
Once this fusion is complete, the resulting structure keeps the name transverse mesocolon, and we completely ignore the fact that it has any contribution from the upper part of the lower mesogastrium. Although the root of the transverse mesocolon is wider from side to side than is the pancreas, where the two overlap, the root of the transverse mesocolon does run along the inferior border of the body of the pancreas.

Embryology of the Gut and Mesenteries, slide 76
After creation of the definitive transverse mesocolon occurs, the anterior sheet of the lower mesogastrium contacts the posterior sheet of the lower mesogastrium in the region inferior to the transverse colon. And you can well anticipate what's going to happen. It's shown in the next slide.

Embryology of the Gut and Mesenteries, slide 77
The lower part of the anterior layer of the lower mesogastrium has fused to all that remains of the posterior layer of the lower mesogastrium and formed a single mesenteric sheet, which descends from the transverse colon. This fusion has obliterated much of the inferior recess of the lesser sac. It still exists, but it exists as a smaller region

superior to the transverse colon. We can start giving some additional names to these definitive mesenteric structures. That portion of the anterior sheet of the lower mesogastrium which runs from the greater curvature of the stomach down to the transverse colon is called the gastrocolic ligament. The portion of the fused anterior and posterior layers of the lower mesogastrium that drops down from the transverse colon is called the apron of the greater omentum. The greater omentum is the name given to a sheet formed of the gastrocolic ligament and this thing called the apron of the greater omentum. Its mesentery has a lot of fat and so it looks like there is this fat filled sheet dropping down from the greater curvature of the stomach - it's called the greater omentum. The fat in the greater omentum is usually so extensive that you actually cannot see the transverse colon which is stuck to its backside. And so if you want to see the transverse colon you have to lift up the apron of the greater omentum and then you can see the transverse colon from below or from behind actually. And this is also the only way to see the transverse mesocolon.

<u>Embryology of the Gut and Mesenteries, slide 78</u>
No narration.