>> It's November 14, 2016. This is lecture 24 – a brand new unit, our final unit, which kicks off with the system that you learned about a long time ago. Kids are always interested in where food goes and where poop comes from and that's what this system is all about. It's pretty simple. It starts at your mouth. It ends at your anus. It's a continuous tube with certain highlights – anatomical, physiological highlights – along the way. Today we're going to run through this system. Ooh, that's a bad choice of words. But, at least, we're going to go through this system from beginning to end, and Wednesday we'll come back and revisit some of the things that we more or less breezed by. So our focus, naturally, is on the anatomy of the system And before we go there let's comment on the obvious act and that is to physically and chemically digest what we call food and – much more important – absorb that, absorb those nutrients into either the circulatory or the lymphatic system. In fact, if you had a choice – if I had a choice, I wouldn't call this the digestive system. I'd call it the absorptive system because that's really the payoff. Digestion makes absorption possible but the real benefit of this system is in the nutrient absorption that occurs along its path. So let's jump in, just as food jumps in. And the mouth is where most people traditionally place food. You can shove it up other places but it works best in this site. The lining of the mouth is interesting. You should know that it's epithelium. What kind? Stratified, squamous epithelium. This is easy to confirm. You can take a toothpick. You can scrape off some of the cells lining your cheek. And of course you've seen this already in lab. So it's lined with stratified, squamous epithelium. The teeth are interesting and cosmetically important. Everybody has to have straight teeth. Everybody has to have white teeth. You know, so a lot of attention there. But how many do you have? Well, at least when you're born you had none, and when you die you have none sometimes. But at least as you get into your first year or two, 28 teeth are not showing up. Only what? Only 20. These are the first teeth. These are the so-called baby teeth. The proper term is deciduous, deciduous meaning destined to fall out. And you recall putting those under your pillow and getting some sort of reward from the tooth fairy which, of course, we all believe in. So, never mind those. They're history. And they've been replaced by 28 more or less permanent teeth. Wait a minute. It says here what? Thirty-two. Now, those four beyond 28 are what are called the third molars. The common name for those? Wisdom teeth. And you may or may not have those. Many of us don't have a mouth which is big enough to accommodate them. So if you're like me, you had your wisdom teeth removed because there simply wasn't room for them. They became impacted and therefore were taken out. But anyway, 32 possible so-called permanent teeth. They're permanent if you keep them healthy. Now, this slide doesn't seem to be resembling anything, but actually these are bristles of a toothbrush and this is that filmy stuff that develops overnight and between meals. It's called plaque. And this is where bacteria grow, and of course if bacteria get a foothold they dissolve the enamel of your teeth and create cavities. I bet some of you don't even have a cavity because you're a good brusher of your teeth, but of course many of us have cavities that have been filled by a dentist. But cavities, of course, are tooth decay caused by

oral bacteria. So what do the teeth do? They are organs of mastication. They make chewing possible. They are divisible into various descriptions and names. They are pretty capable. Have you ever bit your tongue or bit your cheek? You know how powerful and deadly they can be. After all, they can chew up a tough piece of steak. There is no reason they couldn't do damage to your cheek or tongue as they sometimes do. The teeth. Now, the tongue is an interesting organ. And here – whoa, this is an amazing tongue. You think that might have been Photoshopped? I don't know. I'm thinking yes. But this one looks a little more credible. And you wonder how that could fit in the mouth. But, never mind. The tongue is a muscle – not a single muscle, actually six muscles, all of which are skeletal muscles, most of which are innervated by what cranial nerve? What cranial nerve controls the tongue and therefore makes speech possible? The hypoglossal. So the tongue is designed, of course, to make speech possible, the creation of words, also assists in mastication. That means chewing. It helps move the food around. And it's an amazing organ because it stays out of the way of the teeth usually. And then finally, the tongue will help to move food backwards so that it can be swallowed. And not the least of its functions also is that it contains chemo receptors for taste as well as temperature. So the tongue is a pretty amazing organ, one which is attached to the hyoid in part, also the mandible. So it's a skeletal muscle, actually six skeletal muscles which are capable of quite a bit of movement – that is, different movements, as you know. Yet, it is restrained. It is held, at least on its underside, by a membrane that you can see you right after class if you want to go to the restroom. Lift your tongue up and you will see this kind of membrane running up the middle. Maybe you've noticed it. And you can feel it. You can photo it if you want. You know, a selfie of your own what? A lingual – what is it? Lingual frenulum. The word "frenulum" means "a bridal." This function is to restrain. That means hold and restrict the movement of the tongue. Sometimes the lingual frenulum is too short and that makes movements of the tongue too restrained. In fact, there's a name for that which you've heard, I bet. It's called being tongue tied. Ever heard that expression? Tongue tied. Actually it's a case where the lingual frenulum is too short and therefore limits the ability of it to move and therefore may make some speech patterns of someone difficult. The tongue. And, of course, secreting into the mouth there are salivary glands. These are not endo. These are exocrine. That means they have ducts which lead into the interior of the mouth. There are six of these, actually three pairs, and their function is to secrete saliva not just occasionally but 24-7. Saliva is always being secreted to one degree or another. Its function is not just to keep your mouth wet but to also liquefy the food that we eat to lubricate that food to make swallowing less painful. And at the same time when it liquefies food it makes it suitable for tasting. In other words you cannot taste dry food. Is it has to be moistened. It has to be liquefied. And sometimes that's achieved with the drink that we eat but it can also be achieved by saliva. So saliva has many functions. And finally it also contains an enzyme, an enzyme that initiates. That means get started the process of carbohydrate digestion. The name of that enzyme is amylase but its action here is pretty brief, meaning food doesn't

spend that much time in the mouth. So the action of this enzyme is limited to those brief moments where we're actually chewing food. What's the word for chewing? It's up on the board. It's mastication. Some people don't believe in mastication. They just shove food in there and swallow it immediately. I'm just joking. But again, you can take your time or you can spend some time with mastication. The salivary glands are as follows. The largest, which sits on top of the masseter muscle, is called the parotid. The word "parotid" means "cheek" because that refers to its location. It has a duct which comes across the masseter muscle, and that duct enters the mouth where? Just lateral to the upper second molar. This duct is subject to infection. It's subject to blockage. And either of those conditions would cause this gland to get very large, as it too may be infected or otherwise backed up. What do you call that condition where there's an infection of the parotid gland? Well, it's called parotiditus but it goes by the "M-word" which you may have heard: mumps. Mumps, a bacterial disease – an infection, really, of the parotid salivary glands. Under the mandible, bilaterally, tucked right up against the digastric, the second of three pairs. These are called the submandibular glands. Their duct enters along both sides of the lingual frenulum under the tongue. And speaking of the time, the third set is the – what is it? Sublingual, literally meaning "under the tongue," and this also deposits its secretion to the floor of the mouth. This has happened to you, I'm sure. You're talking in a very animated and enthusiastic way and somebody in front of you gets sprayed with your saliva. No? Never happened to you? OK. But it happens. Trust me. And that's because, after all, if you lift your tongue up, the saliva will come flying out of there. And so that's why nobody sits, actually, in this area as a rule. Now, all of these are innervated by the autonomic nervous system and sympathetic actually inhibits these. Parasympathetic actually excites these. And that's consistent with that catchphrase that we gave the parasympathetic system. Remember sympathetic was fight or flight. Parasympathetic was feed and breathe. And certainly eating is synonymous with feeding. So there you are. Sympathetic tends to inhibit. Parasympathetic tends to excite. So let's move beyond of the mouth, just as food would. And the next hurdle, if you will, is the structure which dangles midline just at the entrance of the oral pharynx. And the oral pharynx can be two words or one. Nevertheless it is a passageway where air moves and also food moves. Strategically, it's located right behind the uvula. This is the uvula which is just a fleshy structure that dangles midline and is part of the soft palate. At night, especially in people who air breathe – that is, mouth breathe – this can vibrate and this creates noise which can be heard over the neighborhood. This is called snoring. So the movement of the uvula can be cause for marital strife. There you go. Now, guarding also the entrance to the oral pharynx, you know, are these large structures that are part of the lymphatic system. You know them already as the tonsils. Which ones? These are the palatine tonsils. The lingual tonsils – very small. I guess you could reference them here. They're a bit out of focus. They don't normally produce any problems. Remember though, the tonsils are there to remove or guard the entrance, that is remove bacteria which might be contaminating the airway or the food supply coming through

here. The irony of that is the tonsils sometimes become infected themselves, yes? And that's called tonsillitis which is painful, especially for children, and it makes eating, even breathing, somewhat difficult. So let's go down the esophagus now, which is the food tube, of course. The esophagus not only conducts food but also liquids of all kinds, even air. Air goes down the esophagus unavoidably. It's located posterior to the trachea and is essentially a muscular tube which is at its beginning skeletal muscle but the final two-thirds is what? Smooth muscle. So you probably experience something like this. Let's say you have an ice cube in your mouth and accidentally you swallow it. Oh no! And you try to sort of return it. After a certain point you can't. In other words, you have control over the proximal one-third because that's what? Skeletal muscle. But once it gets into the smooth muscle, forget it. It's on its way down. And the name of this process wherever it occurs is peristalsis, the wavic movement of material. And it takes about 30 seconds for food to get from your mouth down into your stomach. And this is not, incidentally, gravity dependent. Can you stand on your head and take a bite of something and have that stuff go up to your stomach? Yes, because it's not gravity that brings it down. It's the wavic contraction of the smooth muscle. And so that is interesting. And that tube is pretty straight because some people can stick swords down there. Please don't do this at home. But this is, of course, a stunt called sword-swallowing and you've seen it demonstrated. Google it if you haven't. It's fun to watch. Now, the lining of the esophagus is essentially a continuation of the mouth. So once again, it's made of what? Stratified, squamous epithelium. The design of this, then, is mainly to provide a protective barrier and not so much to allow for absorption. There isn't much absorption going on for two reasons. One, the material hasn't been properly digested. And the other obvious one is that food doesn't spend that much time in the esophagus so there is little opportunity for that process to occur. What it does do, though, is it initiates peristalsis which continues in and beyond the stomach and beyond the rest of the G.I. tract. So let's go to the stomach. We know the stomach is not in the thoracic cavity. It's in the abdominal cavity. It's just below the diaphragm. It's located in the upper left quadrant, and despite its reputation, it's not really a digestive organ. What I mean is not much digestion takes place there. And so its primary function is not to digest but to store food so that we can pig out and engorge ourselves and then go about our day. The stomach is small, that is it can be small, and then it can stretch tremendously. It's often described as a kind of J-shaped organ. The inlet, of course, is at the esophagus and the exit marks the beginning of the small intestine called the duodenum. So here we see there must be some kind of guardian of this entrance, and the name of that sphincter which marks the entry into the stomach is called the what? Lower esophageal sphincter. It used to be called the cardiac sphincter – and still is – but the word cardiac sphincter made no sense because cardiac sphincter suggests the heart. And even though the heart is just above here, the word had no real significance so we're trying to get rid of it. We're going to call it what? Lower esophageal sphincter. Here it is. Obviously its function is to control the entry of food into the stomach but, more importantly, it prevents food from going back up into the what?

>> Esophagus.

>> Esophagus. And not only food but the acid which is secreted within and therefore found in the stomach. We don't want that acid to wash up into the esophagus. In fact, you know that's not welcome. There's a name for that that everybody uses even though it's totally wrong: heartburn. Two reasons it's wrong: the heart's not involved and there is no burning going on here, actual burning. So the proper term for this is what?

>> Acid reflux.

>> Acid reflux. There you go. It goes by the acronym GERD – G-E-R-D. We'll refer to that in a moment. Gastroesophageal reflux disease. Basically due to a weak sphincter. What sphincter? [Inaudible student reply] Lower esophageal sphincter. Babies typically have a very weak lower esophageal sphincter. So what are they doing all the time? Nevermind crying and peeing and pooping but they're also what? They're spitting up on you all the time. So don't blame them. It's just their what? Their lower esophageal sphincter. The exit – also marked by a sphincter. That's called the pyloric sphincter. The word "pylorus" means gate – G-A-T-E – because this is really the gateway into the small intestine. Its function is to control the emptying of the stomach because we don't want food to move out of the stomach too soon. That is, we want to give the duodenum an opportunity to do its thing before we just run new material in there. Now, this is an interesting histological cross-section – actually, a long section – through this area right here. So you notice an abrupt transition right about here? what is the histology to the left of this line? That looks to be stratified squamous. Over here it looks like simple columnar. So in short, this is the esophagus and this is the stomach – abrupt change in histology. So the stomach for the most part is simple columnar in our epithelium but it's hardly smooth. The interior of the stomach is rippled. That is, it's folded into pleats and the name of those pleats are rugae. The word "rugae" means a fold, F-O-L-D. So just like taking a piece of paper and pleating it into an accordion-like design would be to create or simulate the rugae. If that's not clear, here's an illustration, an actual photo of a stomach. So to be clear, this is what?

>> Esophagus.

>> Esophagus. And the sphincter here would be the? Lower esophageal. At this end would be the pyloric. Now we section it open. We see these folds. They are especially prominent in an empty stomach. And the name of these internal folds of the mucosa rugae. This is typical of any organ which is capable of huge expansion. And the stomach normally is about a liter in terms of its volume but it can stretch to four liters. I find this hard to believe but that's what I've read [laughing]. But then again, I get confirmation of that when I go to a buffet. I see people, you know, with plates of food. I'm not kidding. They're like this. And look around and it's gone, so you know when into their tummy. So, yeah, the stomach is capable of huge, huge ability to contract. Indeed, this illustration shows two outlines, one in red, the other in black. And

the red outline is an empty stomach. The black outline is a full stomach. And so were just reminding you of the obvious fact that the stomach is – what is its function? It's a food storage organ. And some people store a huge amount of food in there. I guess they're thinking they're never going to eat again. So, that's just sort of the plan. Or it's just a value thing. If it's a free buffet, they just really want to get their money's worth. I'm not sure. So inside the stomach there are also glands, exocrine glands, which produce the acid we've alluded to, and those cells are called gastric glands, producing gastric juice more or less all the time but especially after a meal. This juice, if you want to call it, is HCl. What's that?

>> Hydrochloric acid.

>> Hydrochloric acid plus at least one notable enzyme called pepsin, both of which are involved in protein digestion. Proteins are difficult to digest so the stomach gets a head start. In other words, it makes the job of the small intestines easier because food spends about four hours in the stomach and at least the protein gets some digestion at that time. Here's a very good photo of the stomach. MM stands for mucous membrane but RU must stand for rugae. Now when you get a chance – you will in the lab – take a scalpel and cut your cat's stomach open and then scrape out all the stuff in there. And there's going to be some disgusting things, but just throw that all out. You know, it's going to be furballs and birds' beaks and all sorts of fun stuff, probably some worms in there too. Sorry to disgust. But once you get that all out, you'll see what? You'll see the rugae especially if the stomach is empty, less so when the stomach is full, which goes to the function of this which we've bypassed up till now. What is the function of these rugae?

[Inaudible Student Comment]

It allows expansion and so we find rugae in the vagina. We find rugae in the gallbladder. All, again, designed to allow for expansion. So the stomach – an interesting organ. Here is a barium study. In other words an x-ray study. And this must be what? Number one. Hmm. [Student reply] Esophagus. This, then, is the stomach. And down here at eight we see a narrowed outlet. That must be the pyloric sphincter. Now, many of us have a weak lower esophageal sphincter, therefore we are prone to what? G-E-R-D: gastroesophageal reflux disease. And some people say, "Well, don't worry about it. Just swallow some Tums or some Rolaids." But actually, over a lifetime, over years this acid can do damage to the esophagus and actually promote cancer, esophageal cancer. So, is attention to GERD important? Should you ignore it or do something about it? Do something about it. In fact, here's a surgical device recently introduced. It's actually a ring of ball bearings which are magnetized and this is placed on the outside of the esophagus right here by a surgical team. And what's that going to do? Well, basically it creates or reinforces what? Hmm. It creates the lower esophageal reflux. So this is a surgical attempt to deal with this GERD, gastroesophageal reflux disease, which sooner or later will lead to cancer of the esophagus. And you don't want to have cancer of the esophagus because, of

course, the esophagus is going to be destroyed and/or surgically removed which makes life a bit problematic. This is inside the stomach looking not at the lower esophageal but looking at this sphincter which is the pyloric sphincter. You can see that it's open and, of course, now food can pass out. Any time the mucous membrane along the G.I. tract is eroded, then it can cause bleeding and pain and discomfort and the common name for that is up here, I'm sure. New word. Where is it? Ulcers. And ulcers can happen in any location. They can happen in the esophagus. They can happen in the mouth. They can happen in the stomach. But if they occur in the stomach then they are called gastric ulcers. It used to be thought years ago that ulcers were caused by nervousness or stress, and now we know that that can aggravate ulcers but the real cause is a bacteria called H. pylori. But when you take microbiology you'll learn all about it. This is the inside of the stomach and this is apparently is a – ooh! It looks like a U-word. What? A?

>> Ulcer.

>> Ulcer. This is in the duodenum now looking back at the sphincter which we've mentioned. The sphincter which marks the entry into the duodenum is the? Pyloric sphincter. And that's the closed appearance of the pyloric sphincter. This is more or less an outward view of everything that we're dealing with here. This is the stomach. I want to mention, and certainly you can see, that the stomach is protected by the lower ribs. Many people think their stomach is down here. It's actually tucked up pretty well and therefore guarded to some extent by the ribs, as you can see. This is a strange photo. You're wondering what this is all about. It's just a butt, but –

["Ewww" From Student]

This is a person, obviously, and what has been done here is remove the entire G.I. tract and place it alongside with the actual dimensions preserved. So starting here, what do you think that is? Hmm.

>> It's a tongue.

>> Tongue. This must be the? Esophagus. This must be the? Stomach. The next portion, then, which is rather lengthy is the small intestine. Small intestine is 19 feet. So I don't know. That looks like four and four and four, and then four more would be 16, right? So you can imagine 19 feet, and that makes it anything but small. Why is it called small? Not because of its length. It's actually rather lengthy. But small in what? Diameter. So let's get into it because this is the most important functional part of your digestive system. It's where most digestion occurs and it's where 98% of the absorption occurs. So, naturally, it is the most valuable part of your G.I. tract. It has three segments which are somewhat ill-defined – the first 10 inches known as the duodenum. In fact, the word "duodenum" means "10 fingers." In other words, if you place your hands side-by-side, that's about as long as the what? Ten inches, more or less. And then following that is a segment called the jejunum. The word "jejunum" means "empty" and that's a misnomer because it's not empty. But

why was it called that? Really, the same explanation for arteries. Are arteries empty? No. But after death they are empty. So the jejunum is not empty but after death it empties out, and so this was a mistake. That is, it's a misnomer. But nevertheless it's the name. And the final segment – that is the distal-most segment which is maybe 10 feet – is the iliem. So, putting this all together, one foot more or less the duodenum, eight feet more or less the jejunum, and then 10 feet more or less is the iliem. These are not numbers you want to memorize. What you do want to understand is that the jejunum and the iliem are anchored to, supported by, surrounded by what's called the mesentery, the mesentery proper. You've seen it already in your cat because essentially it holds the small intestine in place. Notice what's not included. What part of the small intestine is not supported by the mesentery? It's the duodenum. In fact, it's retroperitoneal meaning it's behind the peritoneum, an idea that you'll have to think about and use illustrations to really confirm. So the small intestine. It is, then, where most of the digestion and most of the absorption occurs. Here we can see a segment of the small intestine enlarged. And if you could run your finger on the inside of the small intestine, it's certainly not as smooth as this whiteboard. In fact, it is rippled – rippled not with rugae but with permanent folds. They are referred to as plicae circulares. Plicae circulares – circular folds, permanent folds of the small intestine. These are not designed to allow expansion but they are designed to do what? Increase surface area. Why is that so important? Remember the function of this portion of the G.I. tract is the A-word. What?

[Inaudible Student Reply]

And more surface area, better absorption. It's simply that idea. The plicae circulares, then, are like hills and valleys. Hills and valleys. And mounted on these plicae are microscopic projections which further increase the surface area. And these are called villi, V-I double L-I. That's plural. What's the singular version of that word? Villus. These are vascular projections which sit on top of and are found at the surface of plicae circulares. So if you'd like an analogy, the plicae are like hills and what? Valleys. The villi are like trees which are situated on that. And the combined function of both of these is to increase surface area and therefore make possible make more efficient what process? [Inaudible student reply] Absorption. Now this is just what it looks like. It's an ordinary terrycloth towel, right? Is a terrycloth towel famous for something?

>> Absorption.

>> Absorption.

>> Ah, for absorption, right? And you might say, "Well, yeah, I get that but what's the way that it's able to do that?" If you look closely at a terrycloth towel – and we can do it right – see that at its very very intimate level it's just a bunch of threads and loops made out of cotton thread, right? So from a distance the towel doesn't look that impressive but when you get right down to it you see that these are multiplying the surface area. These loops are analogous to the V-word.

What's the V-word? Villi – having the function, then, of increasing surface area. So with that, we need to build a notion, that is diagram this anatomy. And here are the villi which are further magnified to the right. And at the base of the villi there are secretory cells which produce and add enzymes along the way. These are called intestinal glands. So without being very artistic, I could make a couple of villi. These are three villi. And at the base of each would be these glands that are epithelial exocrine glands. Those are called intestinal glands. The villi themselves are made of simple columnar in our epithelium. And also periodically there are these cells that you recall: goblet cells. What do goblet cells do? [Inaudible student reply] Now, mucus has a totally different function here. In the respiratory system mucus was designed to provide a sticky surface that would trap dust and airborne particles. There is no dust down here. So the function of mucus is totally different. It's designed to coat – C-O-A-T – and seal – S-E-A-L – and to protect the epithelial cells from their very own active digestion. In other words, without these goblet cells you wouldn't make any mucus and therefore you have the U-word. What's that?

>> Ulcers.

>> Ulcers. So there's a certain significance to these goblet cells. Now the lining, that is the cross-sectional anatomy of the small intestine, is divisible into four layers. And just as with vessels, these are called jackets. The Latin word for jacket is tunic. So how many tunics are there in an artery? Three. How many here? Four. The inside one is called the tunica mucosa which is an MM. MM stands for mucous membrane. This is mainly, as we said, simple columnar in our epithelial. No cilia but there are goblet cells. And at the surface these cells, then, are single-rowed. So I don't have time to do this except to show a few. The surface is simple columnar epithelium. How many cells deep is that? One. So, deep to that is a zone or layer referred to as the lamina propria. Lamina means layer. Propria refers to connective tissue, and this is the underlying connective tissue which is just deep to this simple columnar epithelium. So it's this area right here where I have an X drawn for now. The lamina propria contains blood capillaries but also a lymphatic capillary which we gave name to just last week. That was named for the word "milk," you might recall. And these lymph capillaries at this location – there it is. The L-word. What? Lacteals surrounded by blood capillaries which basically fill up this area inside each villi, the layer known as the lamina propria. Somewhat deep to that, at least at the base of each villus, there's a little smooth muscle. That's referred to as the muscularis mucosa which contracts and therefore tends to cause these to move slightly, that is to move back and forth which helps in mixing and overall improves the process of digestion. Now, deep to this layer – that is, the layer we described as the tunica mucosa. Deep to that, which is right in here, is the second layer called the tunica what? Submucosa because it is sub mucosum. Basically it's filled with loose connective tissue – in other words, areolar – and it's in this area where we have longitudinal blood vessels and lymphatics, and by that I mean arteries and veins which are running more or less longitudinally down the axis. And so this is kind of analogous to the subterranean streets of

Lancaster or any city. If you drive down the street, do you know there's stuff underground there? There is. There is what? There's sewer lines. There's gas lines. There's electrical lines. There's telephone lines. This is like that. It's called the what? Sub mucosa. And that's where you'll find the bigger vessels as well as nerves and the larger lymph vessels. Deep to that as we approach the surface, the outside surface, is the third layer called the tunica muscularis. This is smooth muscle but it has two layers – that is, one layer which is going like this circularly and one which is going this way which is longitudinally. So the innermost is circular. The outer is longitudinal. The circular layer is designed to bring about mixing. That means local constriction and therefore mixes food up with enzymes and emulsifiers and so forth. It's a longitudinal layer that contracts in a wavic fashion and therefore makes the P word possible.

["Peristalsis" From Multiple Students]

Peristalsis. Longitudinal layer contributes to G.I. peristalsis. The circular layer, more or less local mixing, local contraction. Finally, on the outside – the outside surface which we would see as we look inside and actually touch an intestinal segment. That's part of the peritoneum. It's called the tunica serosa which is simple squamous. Actually, it's the visceral layer of the peritoneum and as such is also known as the visceral peritoneum. It's also continuous with the mesentery which supports and anchors. And you'll see that. You'll touch that. You'll get a better sense of that in lab. So here we are. How many layers?

>> Four.

>> A, B, C, D. And this next illustration, which you have, pretty much lines up and demarks these layers. A – A is called the what?

[Inaudible Student Reply]

Tunica mucosa which features the plicae circularis as well as these projections which are called villi. With that observation you can see that the interior of the small intestine is very much like shack carpeting. It's very much like a terrycloth towel designed to increase surface area therefore maximize absorption. Being is the tunica submucosa. C is the tunica muscularis. And D is the tunica serosa, the outer layer. So let's leave behind the small intestine and, obviously, move into the large intestine. This, incidentally, is a cross-section through the small intestine which is easy to confirm or guess because "VI" stands for what? Villi. And one big distinction between the large intestine and the small intestine is that the large intestine has no villi. It's not really intended for absorption. It is only involved in the absorption of water, some vitamins, and some electrolytes, but certainly not anything substantial in terms of nutrients. With that said, can you live without a large intestine? Yes. And so the function of the large intestine is mainly storage and removal of what? Removal of water, vitamins, and electrolytes. The proximal colon, that is the initiating segment of the colon, is called the cecum. The word "cecum" means pouch. You saw this early in the semester with your rat. The distal end of the small intestine, recall, is the iliem. So there is a sphincter which marks the end of the small and the

beginning of the large. That sphincter is marked here and identified. It's called the ileocecal sphincter. Its function is to prevent material in the large intestine from backing up into the small intestine. That might not at first seem important but here's the story. There's a lot of bacteria in your large intestine. There are no bacteria in your small intestine. So what's the important function of the ileocecal sphincter? It prevents bacteria from moving up into your iliem where it would cause some grave consequences. In short, it's okay to have bacteria in your large intestine but not in the small. So the cecum which is kind of a pouch – indeed, the word means pouch – features an interesting structure which has some familiarity. It's called the vermiform appendix. Now, most of you know it just as one: the appendix. It's actually a dead-ended tube. The word "vermiform" means like a worm, W-O-R-M, because it is wormlike. And it's legendary, of course, because bacteria sometimes can lodge in here and then an infection gets going. And what you call an infected appendix?

["Appendicitis" From Students]

Appendicitis. This is not a joke. It certainly painful. And can an appendicitis episode be lethal? It can be because if that ruptures what's going to be scattered out throughout your entire abdominal cavity is all sorts of nasty feces and cause peritonitis and death. So, appendix inflammation needs to be addressed surgically, of course. It looks like we're running out of time, but let's at least finish this remark here. The cecum transitions upward. That is, it changes to a segment that moves up the right side. That's called the ascending colon. Then it transverse – that is, it runs from right over to left where it's called the transverse colon. Then it goes down the left side. It changes name now, then called the descending colon. And then it enters into an S-shaped loop which at the end is called the sigmoid. The word "sigmoid" is Greek for the letter S. The sigmoid, as we'll get to – because not today. We're running out of time. But it leads into the rectum, which everybody has heard at least that word. The word "rectum" is Latin for what? We've used it more than once. Rectus abdominis. Rectus femoris. The rectum is called that because it's straight. It's the last 6 inches. So the sigmoid leads to the rectum. But as we finish this for today, let's make it clear that the large intestines do not have any villi. They are essentially flatter on the interior and are made of simple columnar epithelium without villi. The outside of the large intestine, though, is interesting because it has characteristic buttons of fat. I called them buttons because they look like buttons from a shirt. But this is just a glop of adipose which is referred to as epiploic appendages, also called omental appendages, which are external, fat-filled bodies. Look for those in the cadaver. However, most important, or at least most characteristic of the large intestine is not its size but the fact that there are stripes of smooth muscle that run alongside the outer layer of the large intestine. Let me get an illustration here. And creates the very noticeable bulges and pouches which are characteristic of the large intestine. So this is the large intestine and these yellow things are what? The? [Inaudible student reply] And then here you can see a stripe of smooth muscle, better seen here. And there are three of these running parallel resembling or reminiscent of an elastic,

a piece of elastic in let's say a swimming suit or a pair of trousers, right? And what does elastic in that kind of garment due to the fabric? Doesn't it cause the fabric to sort of bunch up? And these bunches or bulges are called haustra which is a Latin term for drawer, D-R-A-W-E-R, a drawer. And this is where feces are essentially compacted. That means water is removed so that we don't waste a lot of water as we defecate on a daily basis. This is a standard x-ray of the large intestine filled with contrast material. So quite obviously this would be what? Hmm. I guess not obvious. That's the what? That would be the?

>> Ascending.

>> Ascending colon. And this is probably the?

["Transverse" In Unison From Students]

And this must be the? [Inaudible student replies] And then this must be the? And this must be the final homestretch: the rectum, which we'll talk about our next visit. We'll finish this up and move on. So sorry to keep you a little late. But we did make it. [Sigh] We made it to the rectum.