>> Steve Langjahr: February 8, 2017, this is our second lecture in anatomy. Our first lecture was all about language, vocabulary, anatomical jargon. Now we're going to get down to some actual anatomical issues. And you know that we as homo sapiens are made of trillions, yeah, over 75 trillion cells. As incredible as that number is there are really only about 260 different kinds of cells which even that is pretty impressive. So today we're going to talk about basic cell structure and function. Knowing that cells are very different, that is they specialize, but at the same time they have certain things in common. So our introduction here will be a kind of common, average, typical, garden variety cell, at least a human cell. And there are many elaborate, wonderful, colorful illustrations such as this. Yours is black and white, but you can embellish it as you'd like. And these depict the typical anatomy of a cell. Cells, remember, are the fundamental basis for our life. And their health, their success determines our health and success as well. So let's investigate using an imaginary microscope because, of course, cells are not visible to our naked eye. What defines the cell? What outlines, encloses, isolates a cell? Cell membrane. Now, some of you might confuse or otherwise call this the cell wall. You know from biology that humans don't have cell walls. What sort of organisms do? Plants. And none of you are plants. So we don't call it a cell wall, it's a cell membrane. Very difficult to see even with the microscopes we have in lab. And, in fact, it's invisible in most of our ordinary microscopes. It's semipermeable meaning it selects what gets in what gets out. And that's sort of attests to its function. It's a gatekeeper. It decides what is acquired, what is eliminated. It's made of fat, made of phospholipid. So we say it's a bimolecular layer of fat. But it's function is right here and fairly obvious. It controls, it dictates, it decides the transport of molecules into or out of the cell. It also isolates the cell from others. And naturally inadvertently defines the cell, the cell membrane. Inside the cell, inside the cell membrane we have a soup, S-O-U-P, which is, of course, better known, more properly known as cytosol. You may also know it's called cytoplasm, and it's water based. In other words basically an aqueous solution, but rather fortified with a number of solutes. That is it contains organic molecules such as proteins, fats, complex carbohydrates, simple carbohydrates, and a plethora of electrolytes and inorganic salts. So it's quite a complicated recipe. But it is by nature the environment in which things happen, the cytosol. It forms the molecular or cellular environment for reactions within a cell. Now, as we go through this description of a cell it's necessary or at least useful for you to have a physical rather than just a verbal notion of what these things are. So it wouldn't be unreasonable for you to draw these things. So I'm going to do it for you just to prove it's not so hard. What did I just draw? Cell membrane, all right? Now, you might argue it's supposed to have two layers. We described it as bimolecular, but I don't have a fine enough marker to show that. So cell membrane. Notice that sometimes the cell membrane is invaginated, that is it has ridges and valleys. And in some cases it's not nearly then as smooth as we depicted in this single example. The most dominant organelle, and incidentally the word organelle means little organ, an organelle is anything that's more or less common, that is typical and permanent and has or carries out a particular

function. Now, certainly and obviously all cells have to have a cell membrane. But surprisingly not all cells have a nucleus. And many cells have more than one nucleus. So even though we've come to expect the nucleus as the dominant, perhaps required organelle, it's not actually found in all cells. Does anybody know a cell that doesn't have a nucleus? Red blood cells, yeah, interesting. But, anyway, the word nucleus means nut, N-U-T, because the first folks to examine a cell thought it looked like a kernel or a little nut inside. We describe it as being spheroid which means like a sphere. It's not a circle and it's not a dot. I get irritated at that because on an exam invariably a student will say a nucleus it's the dot in the center of the cell. Well, first of all it's not a dot. And second of all it's not in the center of the cell necessarily. So it's a membrane bound organelle that has two porous membranes much like the construction of the cell membrane itself. And we know that it holds the genetic material which you know or should know now is called chromatin. What's chromatin? Chromatin is basically the affiliation of DNA, DXE, ribose and nucleic acid and protein. Chromatin is said to be dispersed, that means spread out and very thready. In fact, when you look into a microscope will you see the nucleus more often than not? Yes. Will you see the chromatin? No, because it's what? It's dispersed and thready until when? When does this chromatin become noticeably different, even photographable? Well, during cell division. And here that chromatin starts to fold and wind into protein spools and becomes now quite dense, quite photographable. And, therefore, in that state is described is chromosomes. Chromosomes are not visible all the time, only when a cell is preparing to divide. What are chromosomes but condensed and coiled chromatin. So let's look at a few illustrations, none of them particularly better than others. Here's your typical mug shot, cell membrane. What's this organelle here as well as here? Must be the nucleus. Notice it has holes in it which allow for the entry and exit of some of the products produced by the nucleus. And in many but not all nuclei there will be another mass, a mass known as the nucleolus which literally means little nucleus. Rounded masses of not DNA but what? RNA, ribonucleic acid which are found in the nucleus itself. So let's build on our artistic work here. What organelle has been shown here so far? Cell membrane, okay. Now nucleus. Now nucleolus. Hey, so if you can draw three circles you're in pretty good shape. Now, this is an actual photograph, not a drawing of a cell. And the outer membrane is pretty easy to spot. And this organelle would appear to be what? The nucleus. The cell membrane as we said is hard to see. And, in fact, the best photograph ever made of the cell membrane is this right here. It's not with a light microscope but an electron microscope. And as bad as it is it's the best that we have. And at least you can see that it lives up to this description. A cell membrane is what? Bimolecular layer, two layers. This is another electron micrograph. NU stands for nucleus. And how many layers to the membrane around a nucleus? Two. So IM stands for inner membrane, OM stands for outer membrane. And NP stands for nuclear pores which allow materials to move in and especially out of the nucleus. This diagram is probably familiar from textbooks. You know that DNA is this iconic molecule that has this double helix shape. And in that form DNA is invisible. Because when it's dispersed and thready it's known only as chromatin. But during when? During cell division it gets wound very tightly onto protein spools called, called histones which then create the visible and recognizable chromosomes. But, again, these can only be seen, only photographed when a cell is preparing the divide. Good. Moving onto other organelles, and we're only going to do a handful of others, number three on our countdown endoplasmic reticulum. A lot of syllables there. Endo meaning within, plasmic referring to the cytoplasm, and reticulum means to reticulate. That means to be twisted back and forth and back and forth. So that describes actually much about this organelle. Endoplasmic reticulum, a double what? Double layered, wavy channels which in many instances connect what with what? Nucleus to the cell membrane. So could you add or illustrate the endoplasmic reticulum using just these descriptions? Yeah, it's not hard. Are we done? No, that's wavy but that's not two layers, that's one, right? So we have to kind of do that. Basic structure then of the ER, we call it ER, obviously an acronym for endoplasmic reticulum. They come in two forms, smooth ER and rough ER. Let's go to rough. Rough ER are so called because they are dotted or studded with masses of RNA, specifically organelles in their own right called ribosomes. Rough ER then contain and are attached to many ribosomes. And the function of rough ER is to synthesize, that means to make and store what? Protein, protein that might be exported as an enzyme or as a hormone to the environment outside the cell. But what if these ribosomes were missing? That is what do you call the endoplasmic reticulum without ribosomes? We call it smooth, smooth ER. And these are involved in the synthesis of carbohydrates and fats. So that's the basic distinction. Here's an illustration from a book. These are apparently ER, and these nodules on here, these masses of RNA are called what? Ribosomes. So is this rough or smooth? That's rough ER, and that's involved in the synthesis of protein. Now, these are actual photographs, and maybe not too outstanding from where you're seated. But, again, a photo of rough ER. So without dwelling on this, ER stands for what? They come in two forms, rough which synthesizes what? Protein. The smooth synthesize fats and complex carbohydrates. The next organelle, number four, referred to at Golgi or Golgi complex, sometimes called Golgi apparatus. Now, Golgi as you can see is capitalized. But beyond that it's the name of a person. And, guess what, his name was Golgi. So this is a eponym, and eponym is a name given in honor of somebody. And as such it means nothing to us. In other words, there's nothing about this description that is very descriptive. So instead we'll translate. The Golgi are flattened stacks of membranous sacs. I know that sounds like Dr. Seuss, but the words are good. Flattened, uh-huh, stacked, uh-huh, membranous sacs. And this is a rendition from a book, a textbook, a drawing of the Golgi complex. They look a little bit I suppose like the ER, but they're somewhat isolated. That is solitary, not connected to the cell membrane or necessarily the nucleus. And as you can see their function is here and that's important. The function is not to produce proteins but what? Secrete proteins, that is actually export them to the outside usually. And those proteins may serve many functions including chemical messaging in the form of hormones. So incidentally now as we go through these organelles you want to have a description of the organelle, you want to have an understanding of its function, and also be able to diagram it which is, well, not too hard. So we've done the ER. How would we draw the Golgi? Well, we'd have to draw something like this, flattened what? Flattened, stacked, membranous sacs. And notice in this indication there are little vesicles which are pinched off here which actually allow for the containment of protein which then will be exported, secreted to the outside. This is an actual photograph so it's not a drawing at all. And even though it's not labeled does it seem to fit the description. Does this appear to be flattened and stacked membranous stacks? Yeah. Golgi complex. And yet here's another one. It looks kind of abstract, but another highly magnified view of the Golgi complex. It says here also that these organelles may form lysosomes. So later in the course, that is on an exam, if I ask you where lysosomes come from you say, well, they are derived from the Golgi. Good. So where do we go next? Well, the mitochondria. Mito means thready, chondro refers to a body. So literally mitochondria translates to thready body. Now, from biology or your general knowledge you know that these are often described or look a bit like peanuts. Don't say that on the exam, but they do look like that. They're kind of rod shaped. They are membrane bound. In fact they have two membranes, and inner membrane and a outer membrane. The inner membrane is folded, that is wrinkled and pleated and creates a lot of internal shelving called cristae. The metaphor or analogy which is often equated to mitochondria is that they are what? Hmm, powerhouses. Please don't say that on an exam. Because that's just an analogy. They don't generate electricity. Why do we call them powerhouses? They don't even make energy. In fact, you probably know from basic physics that energy is never created or destroyed. So maybe this description of powerhouses is a bit of an exaggeration. What do the mitochondria do? They take glucose, sugar, and they react it with O2, what's that? Oxygen. And in the presence of H2O and by complex metabolic events they generate this energy currency that you've learned from biology, the ubiquitous energy currency. The dollar bill of life is what? The ATP. So they do make ATP, and they do so by breaking down what? Breaking down glucose. Byproducts of this are unimportant but notable. What byproducts occur? CO2 and water, and these end up in the air that we exhale. So it's hard to overestimate the importance of mitochondria. And let's be clear, most cells have hundreds of mitochondria. Many have thousands, even tens of thousands of mitochondria. And what do you suppose would dictate the number of mitochondria? Why would this cell have many more than that cell? Hmm, probably because it has a greater demand for ATP. So just as an example skin cell versus liver cell, hmm, which do you imagine would have more mitochondria? Liver cell. You have a sense that liver cells do more than skin cells. And so that's a fair and obvious guess. Mitochondria. Here's yet another photo. Again, they kind of look like peanuts, but please don't say that on the exam. What would you say on the exam? Well, they are what? They're rod shaped, membrane bound. And so how would you draw that? Could you do so? Well, first of all we have to be realistic to scale. In other words, you can't make a mitochondria look like that as much as it might be nice. Because that clearly is bigger than the what? So all right, let's be realistic. Mitochondria looking a bit like that. And we have to have the inner shelves in there. So you can do it, you can practice and you should. It's not that had. Mitochondria. There are some cells that have no mitochondria, and that would seem odd because you'd wonder how they could produce any ATP. And it's somewhat paradoxical, but the red blood cell what did we say about that earlier? It was notable because it had no nucleus. It also has no mitochondria. And we're a bit disappointed because we have this great grand notion of red blood cells. But actually you probably also know that red blood cells really only do one simple thing, and that's what? They carry oxygen. They don't use oxygen, they what? They carry oxygen. In fact, if they had mitochondria then they'd use the oxygen that they're supposed to be carrying. So you can see that that would be self-defeating. Number 6, lysosomes mentioned only briefly above. Lyso means to break, some a word for body. So literally the word lysosome, body breaking, it's kind of obscure. These are sacs, membraned vesicles, membrane bound [inaudible] usually which contain digestive enzymes that are typically involved in cleaning up messes inside the cell. That is they digest, they neutralize, they kill and destroy bacteria which might have been acquired through a process called phagocytosis. So, of course, lysosomes are important in those cells involved in defense. And what's the legendary cell that you know defends your body from infection? White blood cells. So lysosomes not found in red blood cells but found naturally and plentifully in white blood cells. So essentially they detoxify and destroy bacteria. They also remove and clean up debris of all kinds, even damaged and dismantled organelles. So lysosomes have that function. To look at them under the microscope they're not very imposing. Here we see a couple of lysosomes labeled, and here are Golgi. You probably would recognize those without any labeling. So when it comes to a drawing of lysosomes you're pretty well home free. In other words what would a lysosome look like in a diagram? Draw a chocolate chip cookie and you're done. I know that seems simplistic, but there's not much more to say about lysosomes. Our last organelle which, again, not found in every cell but important in those that they are found, microtubules. Self-explanatory really. Two words there, micro what? So what's that mean? Micro? Small. Tubule. So I have to laugh because on the exam I ask what's a microtubule and a student said small tubes. Well, thanks. That's what the name says. But what can we say beyond that? They are straight, bundled and what?

>> Hollow.

>> Steve Langjahr: Much more descriptive. In fact, if I say to you straight, hollow and bundled what vision do you have? Something obviously that's straight, hollow and bundled. But here's a good thing that comes to mind. What are these? And are they straight? Are the hollowed? Are the bundled? Microtubules. And even though we haven't yet mentioned the function, it's almost implied or at least intuitively clear why are they hollow? Hmm, something's going to go down there you think. And so it's not a shock to find that these are involved as internal transport channels within the cell. In some settings they also provide support that is rigidity, kind of like an internal skeleton. And in

some context, that is in some cells, they form cilia and or mitotic spindles which pull the chromosomes apart. So there are lots of functions of microtubules. And here are two quick sketches of them seen at different angles. So if you're going to do microtubules you don't want to just do that. You probably want to show that they are what? They're bundled just like a bunch of soda straws taped together. A reasonable rendition. Here's yet another photo. Not very impressive of lysosomes. And even if this weren't labeled you'd probably guess that that's, well, that's what microtubules look like. And here's an even better photo of microtubules. Really astounding and, of course, magnified at what factor? I don't know if you can see this, magnified at 145,000 times. Don't expect to see that in the lab because we don't have a microscope that can touch that. But it has been photographed, incredible as it seems. So there's your rundown, one, two, three, four, five, six and seven. Be sure you have a visual notion of what these organelles look like, a verbal description that you can compose and describe the appearance of these organelles. And finally the F word, what do you have to know? The function of them. Now let's move on. Because we said at the outset that there are 260 different kinds of cells. And they differ in their morphology. The word morphology meaning their shape. And so there is a very clean, a very clear, a very obvious connection between morphology and function. And that goes to anything in your life or experience. What do we call that thing there? A chair. Does its shape have anything to do with its function? Yeah. Is it designed to do what it does? So the same ideas apply here. The shape of a cell is not accidental but rather intimately determining and limiting what the cell will do. So the shape and the anatomical characteristics of a cell determine the functions that that cell can perform. We could go on and on with examples, but two are quite enough. Sperm cells, do sperm cells look like this one which we sort of imagined and drew here? No. What do sperm cells do? What's their claim to fame? They move and eventually they stick their nose in something, they penetrate. Is this cell designed for moving? I don't think so. Would it penetrate much? No. So clearly the sperm cell looks like a little tadpole, and it's exquisitely designed for exactly what it does, motility and penetration. Is has a flagella which allows it to move, and it has a very nice conical cell membrane which allows it to penetrate the cell membrane of an ovum. In fact, here is the surface of an ovum, and these appear to be what they are. What are these? These are sperm cells. Does morphology determine the function? Yeah, pretty clear. Next ciliated epithelial cells. Cilia are those hairlike appendages that often form at the surface of special epithelial cells. And we find these along the airways. What's going through the airways? Obviously air. Is that air always clean? No. And so the function of the cilia as you know is to move and, therefore, take this debris, this dust, this dirt and essentially push it much like a broom will push dust through or across the floor. The function then is to remove airborne debris. And are these cells pretty well designed to do that? Would a sperm cell do that very well? No. Would this cell do that very well? No. So I think you get it that the design of a cell is no accident and varies according to the function because the morphology determines the function. Ciliated epithelial cells then designed to remove, sweep along airborne debris. Now, with that said let's leave cells and get a little more complex. We know that cells are the sort of foundation for the human body. But things start to get complex once we have aggregates of cells. And so let's talk about the levels of structural sophistication, structural organization in the human body. And we start actually at the subcellular level. Because we already said cells are made up of organelles, and organelles are made up of molecules. So even more simple than a cell are biochemical levels of life. That is chemical molecular level of biology. In short molecules make up what? Cells. And the cells as they aggregate and specialize, many similar cells working together for a common function or purpose produce the next level of complexity called what? Tissues. Tissues form the histological level of life. And many different tissues, many different tissues cooperate to form something more complex, something called a organ. That's the organ level of organization. Many different organs work together to create an even more complex task to execute more complex functions. And so many different organs form systems. And the systemic level is finally completed because all of your systems for you, the organism. So let's be clear. We're going from simple here at number one to complex here at number five. To recap molecules make up cells. Cells make up tissues. Tissues make up organs. Organs make up systems. Systems make up you. So if we talk about molecules like DNA those form organelles which form cells which form tissues, then recognizable organs. This appears to be what? Stomach which is part of what system? Digestive system, which is one of many systems that make up you. And so clearly in this course we'll be studying systems, yes? And when we study a system we're going to study the what? The organs that make it up and the tissues that make it up and even the cells. So as we move into actual organ systems we'll be looking at individual organs by name, tissues that make up those organs, cells that make up those. So actually for the rest of today and beginning – and throughout next week we're going to be looking at tissues as a foundation for our understanding of organs. So let's define it. We've already said, although it was simplistic, that tissues are made up of what? Cells. And that is too simplistic. So what actually is a tissue but a group of, let's read this, group of what? Functionally related cells and their what?

>> Intercellular material.

>> Steve Langjahr: Good. So with that said let's imagine a kitchen countertop. You with me? Tile. And what's that stuff between the tile called? Grout, all right. so the tile are the cells, and the grout is what? The intercellular material. So as we'll learn a tissue is not just a bunch of cells. Many times the cells are not that important. What's important is the stuff outside the cells which in this sense is called intercellular material. Inter as a prefix, inter means what? Not to be confused with intra which means within. So that's a working definition for a tissue. And here's the good news. There are only four categories of human tissue. Wow, that sounds great. Here's the bad news. There are many subtypes in each of those four. But at least there are four basic kinds of tissue. And we'll run down them now and spend more time on Monday. And, indeed, the entire labs, all of the labs next week will be devoted to actual hands on study

of tissues. But to remind you how many tissue categories are there?

>> Four.

>> Steve Langjahr: Number one, epithelium, epi means upon, upon or above. Thelium refers to the tissue, epithelium. These cells have the following distinction. They are closely joined just like pieces of a jigsaw puzzle, like your knuckles laced together such as this. And if you interpret that closely joined would there be, therefore, any intercellular material? No. It's like having a countertop with tile but now what? No grout. So that's the distinction. These cells are very tightly packed, and there is then no intercellular material. That is a clue to their function. Because when something is locked together like that it clearly provides a better seal, S-E-A-L, and these are often designed to form barriers, to form membranes. Epithelial tissue then is classified by the type of cell that is the shape and appearance of the cell and also the degree of layering, whether there's one layer, two layer or whatever. Some of the words that are used to describe shape are squamous, cuboidal and columnar. I think those are intuitive. Squamous is a word for flat or scaley. Cuboidal what's that? Cube shaped. Columnar? So you got it. And words for stratification or the lack of it are simple, stratified and transitional. Simple means one cell deep. Stratified is like this where there are many, many, many, many layers. So as we look down to this floor there are floor tiles here. Are there any tiles underneath you think? Probably not. So this would be squamous. What kind? Simple squamous. If there were ten layers of tile then it would be stratified squamous. And then, of course, cells don't have to be squamous at all. There are, of course, these. What do these look like? They're kind of boxy. Those would be? So tell me if there's one layer of these, and there appear to be, what's the full description? Is it epithelium? Yes. It is cuboidal? Yes. Is it stratified? No. So what are the three words that describe this tissue? Simple, cuboidal, epithelium, all three words. And as if you need another example here's yet another picture. These cells are tall and skinny so they're not cuboidal? They're probably what? And they're one cell deep. So, once again, three words. Simple, columnar, epithelium. Good. Transitional is a funny word which simply means that these cells sometimes are layered, sometimes not. That is they transition or change as the organ that they make up stretches. In fact, you'll learn this in lab, transitional epithelium is exclusively found in the urinary system, especially and mainly the bladder. What do you know the bladder does? Yes, it fills with urine, but does it stretch? Does it contract? So the cells obviously have to think out or pile up as the organ fills or empties with urine. Question Dorothy [assumed spelling]?

[Inaudible Audience Question]

You would expect that, but the uterus even though it expands it doesn't do it that quickly. I mean the uterus gets big over nine months, whereas the bladder gets big over nine minutes, right? So there's the thought that that would be transitional there, but it's actually limited to the urinary system. Good question. How many categories of tissue? This is number two, connective. This is the monstrosity category because there's so many different types. What makes this tissue distinct is this. The cells are not tightly packed but they're what? Here's the word, isolated. And if they're isolated obviously there's stuff outside the cell. And the stuff outside the cell intercellular material. From now on we're going to call it what it is, it's matrix. So we don't call it grout. We call it what? Matrix. So you've probably seen, this is an example, you've probably seen a Jell-O salad, right? I know this is bizarre. But a Jell-O salad with fruit cocktail in it, get that idea? So the fruit are the cells. The Jell-O is the m word, what? And what determines the nature of that desert is not the fruit but rather the Jell-O, the matrix. So I'm trying to emphasize that what matters here not the cells but rather the matrix. And so the physical nature of the matrix determines the physical properties of the tissue. And what do we mean physical properties? What's the physical property of this thing? It's hard, all right. What's the physical property of this? It's soft and flexible. So physical properties means what it feels like if you handle it. And that varies quite a bit from rigid to elastic to gooey or all sorts of descriptions. And so the categories here tend to reflect the different properties of the matrix. First we have something called loose connective tissue. Loose connective tissue you're going to see, that is you will see in the lab when you dissect the skin off of the rat. And even if you've never done that yet you've all taken skin off of a raw piece of chicken, right? So that filmy stuff under the skin is loose connective tissue. Pretty much self-explanatory. Next we have dense connective tissue. The word dense is obviously the opposite of loose, and it means hard or at least more compact. So this tissue tends to be firmer, more firm and is especially infiltrated with a lot of protein called collagen. Dense connective tissues tend to be, therefore, very strong. And they form some of the strongest things in your body. These things that cross over to your wrist that feel like cords those are called tendons. They're made of what? Dense connective tissue. Are they strong? You bet. Are they rigid? No, but they are very strong by virtue of the matrix. Then we have cartilage. Lots of cartilages, we'll learn them by name. Cartilage in your ear, cartilage in your nose, cartilage at the end of joints. Cartilage tends to be rubbery, also very, very forgiving. That means if you change its shape, guess what, it will resume that shape. The word I'm thinking of is resilient. Ever heard the word resilient? Resilient. And so that is what you'd expect for something that's supporting such things as the ear and so on. The hardest of connective tissue is hard because of the matrix that it contains and this is bone. What makes bone matrix hard is not the collagen, not the protein, but the inorganic salts. What are the inorganic salts that we know bones contains? C word, calcium and phosphorous. So it's the calcium that gives bone its very dense and hard and rigid characteristics. Finally, and maybe unexpectedly we have vascular connective tissue. Vascular is a word for blood or blood vessels. And you might not think that blood is tissue but it is. In fact, it's what kind of tissue? It's connective tissue because is blood made of isolated active cells imbedded in some kind of substance? Yeah. So blood is a liquid connective tissue. And the matrix that is there is called plasma, the liquid portion of that connective tissue. Three categories – I should say four categories. Here's our third one, muscle tissue. We like to think that most of your body is what? Muscle tissue. Not always the case. Muscle tissue is characterized by this ability, this capacity. Muscle tissue, muscle cells can do what? Contract. That's all they do. They don't expand. They just what? They contract and relax. But they don't push out, they only pull in. Quite amazing. These cells are long and skinny and tend to be called fibers. They come in three forms that you'll learn about in lab. But quickly we can unfold them. Skeletal muscle is called that because why? This is muscle that attaches to and moves the skeleton. Next category is smooth muscle. This doesn't attach to or move the skeleton. It's found around hollow organs such as the digestive organs designed to squeeze and move things along. Sometimes smooth muscle is called visceral muscle. And then there's the rather rare type of muscle but no less important, it's called cardiac muscle. Where do you find cardiac muscle? In fact it is the heart. Some students say cardiac muscle is around the heart. No, cardiac muscle what? Is the heart. And you don't find it anywhere else. It's function is quite obvious, pumping blood. Finally, finishing today the category which is you could argue the most precious and allowing you to do what you're doing now and that's thinking and contemplating and planning and fantasizing or whatever you're doing, nervous tissue. What makes us different from your garden variety slug. These cells are long, wiry, often with stellate cell bodies, the word stellate meaning like a star. Nerve tissue is easy to spot for these reasons. The wiry description is a good one because these cells have very long extensions. Maybe you know already the terms axons and dendrites. Maybe you know about sensory nerves versus motor nerves. But without getting too into it yet we can say simply that nerve cells are categorized by their function, function such as sensation, function such as movement, function such as interpretation of events. And basically those cells that do any of that are called neurons. Neurons are capable of generating electrical signals which are the basis for communication and processing of all sorts of information. Interestingly, though, there are cells that are also part of nerve tissue that don't generate impulses. These are those that insulate, insulate especially axons. These are called neuroglia. The word glia means glue. And the understanding of this is not really difficult, especially if you compare a nerve to a wire which carries electricity. Are there wires in here that are carrying electricity? Are they touching each other or are they kept apart by some other means, insulated. And so neuroglia are like electric insulation. They support and provide that kind of isolation for the neurons. No less important than the neurons because if you strip away the neuroglia the neurons are going to short circuit and you have a terrible mess on your hands. So that brings us to the end of lecture two. We're going to elaborate naturally again on Monday. And you'll have a couple of labs next week so you'll become experts in histology. Have a great weekend, and we'll see you back next week. Valentines' Day next week. Just let me shut this off. I'll be right with you.