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Okay, folks, I wore a red shirt today in commemoration of blood. So let's talk about blood today a bunch of functions, some of which we'll get in this chapter, many of which we're going to talk about later on this semester. And actually, some of which we talked about last semester. So let's just get into it. And I'm going to start by talking about how these core puzzles are produced. Now, what's the core puzzle you guys already know red blood cells, white blood cells, and platelets. There's some things that you don't have to know. And one of them is, you know, I don't care about what happens during gestation I care about, you know, once we're been born and how we're making our red blood cells at that particular point in time in our platelets, we're not going to do white blood cells when it comes to their production, just red blood cells, and platelets. And when it comes to the production of all of these, it's going to happen in the red bone marrow. Thank you guys knew that. And so here's a picture of something called Hamato, polices, hemo polices. Those are just fancy words for the production of red blood cells, white blood cells, and platelets. And it's happening as far as we're concerned. In the red bone marrow. We start with a stem cell. So what we see here up on the screen, pretty much the entire white screen is your red bone marrow. And in that bone marrow, we have all these cells right here. It all starts right here with the stem cell, the stem cells called hemo cytoplasm, and then a hemo Seidel blast is going to divide, it's going to differentiate into what we call daughter cells. There's two daughter cells that I need you to know, the pro erythroblast which is circled here and the mega carrier blast, which is circled here, the other three, and I'll show you, you're not going to have to know that. So again, we're going to concentrate on the production of red blood cells, and the production of platelets, not the white blood cells. So going back to that picture, the two daughter cells, pro erythroblasts, and mega carrier blast came from this one stem cell, then what happens? Well, when it comes to red blood cells, we're looking at about another 25 to 30 steps that are going to occur. A few of them are shown here on the screen, I couldn't care less about those steps. All I need you to know is this, we have this stem cell, it gives rise to this daughter cell the probe or throw blast, and then eventually we're going to get a mature red blood cell. Something else I need you to know is that we need a hormone in order for this to occur. And that hormone is called erythropoietin. And I've abbreviated it EPO on the screen, we obviously talked about a whole bunch of hormones, in the beginning of the semester, that was maybe 20% 30% of the hormones that are in your body. Here's two more that I need you to know. One of which is produced by your kidney. So your kidneys produce EPO, it's released into the blood, it's targeted as the bone marrow. It's targeted, specifically the pro erythroblast. When that hormone binds to the EPO receptors of the pro withdrawal blast, pro withdrawal blast is told, let's go. And eventually that cell is going to be a red blood cell. So I need you to know that please. On the other side, we have the production of platelets here, we need a hormone in order for that to occur as well. And that hormone is made. As far as you're concerned, the liver is called thrombopoietin. I abbreviated that TPO in the picture, its target this daughter cell the mega

carrier blasts, once TPL binds to those receptors, eventually we're going to get a mega carrier site. And then what happens is, is that the megakaryocyte breaks apart. And it gives us our platelets. And this is something that you've already been told platelets are not cells, they're pieces of cells, specifically the megakaryocyte easy way to remember that think about megakaryocyte as a cookie, take the cookie and just smash it on the ground, the crumbs are the platelets are just pieces of that megakaryocyte. Now once we thought that platelets were cells, because boy do they act like cells, and you're gonna see it in this chapter, how cell like they are, but they're simply not cells. So again, don't have to worry about the red or the white blood cells, just the red blood cells over here in the platelets before we move forward, and we're going to come back to this picture a couple of times during the next two and a half lectures as we get through the blood. Want to do a little clinical stuff here.

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EPO a real focal point, we naturally make it but we can give it to our patients as well in certain conditions. I have to hear up on the screen to that are in your notes us for those that have kidney failure. That should make perfect sense going back to the picture. What produces this hormone the kidneys do, your kidneys are failing. If the kidneys don't make the EPO. You're not making red blood cells again, be clear on this without that hormone, you're not making red blood cells. Alright, so with kidney failure, you may have to give your your patient EPO so that that patient can make red blood cells like the patient needs to make red blood cells Another instance where you might have to give a patient a POS those that are going through chemotherapy, why don't we get chemotherapy, once the patient has, has cancer chemotherapeutic drugs are not magic bullets, they don't go and they just destroy cancer cells. chemotherapeutic drugs destroy fast dividing cells, like cancer cells, what there are other cells in your body that divide quickly, some of which are in the red bone marrow that are going to affect the production of these red blood cells. And so chemotherapeutic drugs are going to destroy the cells, including the red blood cells themselves. And so now you need to give your patient EPO in order for that patient to make more red blood cells. So two clinical instances where this particular hormone can be used as a treatment option. That's that. Speaking of red blood cells, let's talk about this. I know you guys already did. Red blood cells are these basically they're just balloons full of hemoglobin molecules. You guys know, they don't have any organelles. At one time they did we clearly see that in the picture. These cells have I mean, you can see the the nucleus plain as day eventually that nucleus and all the other organelles are extruded from the cell. They're not needed. What a red blood cell does is extrude all of those organelles so that that red blood cell has lots of room for the protein, hemoglobin, a red blood cell is a balloon full of hemoglobin molecules. So let's talk about those hemoglobin molecules. 250 million hemoglobin molecules are in one red blood cells. So I'm going to draw a hemoglobin molecule here, I'm just going to draw a square with four squares inside of that square. So this is haemoglobin. And then what I'm going to do is I'm going to partition it like so. And then what I'm going to do is put alpha one there, alpha two, beta one. And beta two, those are subunits. Let me put up above here, hemoglobin, I'm going to abbreviate it HB. So that protein there is actually four proteins that came together to make a bigger protein. What kind of structure is that remind me quaternary structure remember that from the very first lecture of last semester, these are subunits. So tertiary structure right here, tertiary structure, tertiary structure, tertiary structure, they all came together to make a quaternary structure. So hemoglobin is actually four proteins that came together to make the one big protein. Now when it comes to the structure of hemoglobin, that's not all hemoglobin is it's not just one big protein. It's got another very important structure. I'm going to draw that over here to the side, and I'm going to put it on the hemoglobin molecule, I'm going to draw a circle. That circle is a heme. And right in the middle of that heme is a molecule iron. You need iron to make hemoglobin, because you need iron to form heme. Each of these particular teams is on a sub unit. And so this isn't exactly the way it is, but it's going to be for

our purposes. There's a heme on that sub unit. There's a Hema net sub unit. And so we have four teams. And on those teams is where oxygen is going to buy. So I'm going to put my oxygen molecules here, the pen is doing some weird things tonight. We're gonna talk more about binding oxygen to hemoglobin when we get to the respiratory system. But for right now, this is going to be good enough for us just to know what these structures are. There's something else in your notes, not the alpha and the beta sub units. But in your notes, you'll see that there's a there's a gamma sub unit with fetal hemoglobin, we can't we don't have time to get into fetal hemoglobin, we're just going to do adult hemoglobin, which has the alpha and the beta sub units, alpha one, alpha two, beta one, beta two, we're going to come back to those sub units again, when we talk about anemia toward the end of the lecture today. So we're not even close to being done with hemoglobin right now. Now,

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when it comes to these red blood cells, look how many we're making every stinking, so not a year, not a month, not a week, not a day, every single second, we're making two and a half million red blood cells. That means in the time it took me to say that we all made 10 million red blood cells. So two and a half million a second. Now it takes a while for the red blood cells to mature because there are many steps I said there's about 25 to 30 steps by the time that red blood cell is a mature red blood cell but there's an awful lot of this going on within the red bone marrow obviously two and a half million per second. Now you might be thinking to yourself, for making two and a half million red blood cells every second Why isn't our blood jello? The reason our blood isn't that thick is because well, we're destroying two and a half million red blood cells every second as well. And that way, we keep the concentration of red blood cells fairly constant. Going back to the death of the red blood cells, the depth of the red blood cells that stated here, destruction of red blood cells are the same number that a destroyed is the same number that we're producing. Red blood cells don't last very long, three, four months, that's not very long for a cell in the body. And the reason it doesn't last very long is because it doesn't have a nucleus, it doesn't have any way to repair itself. Those red blood cells go through a lot they're circulating in the blood, you're squeezing your way through these little itty bitty capillaries are shear stress on the walls. And they're going to wear out fairly quickly. And so that's one of the reasons that they get destroyed. So phobias, the main reason that they get destroyed so quickly. And that's what we're going to concentrate on until the break the destruction of red blood cells. And what an important concept that is. And when we talk about the destruction of red blood cells, we're going to concentrate on the hemoglobin molecule, because again, there's so stinking many of them within the red blood cell itself. And what we're really going to concentrate on in this story that we're going to take, or we're going to tell is the heme molecule, the catabolism of this molecule right here now, we will certainly be metabolizing the protein into amino acids. Not a terribly sexy, exciting story at all. But the heme story, that one's fun, and the heme story. It's an entire page notes. It's that right there. So what we're about to draw is going to be a big picture, we're going to draw that. That's the destruction of the red blood cell. And we're going to concentrate on the heme molecules of the hemoglobin. That's what we're going to do. And so we need to draw a number of structures in this picture. Now, the picture that I'm going to draw is not going to be anatomically correct, not even close. So the first thing I'm going to draw on this picture is a macrophage. Something else I want to add, as I as I draw this is that I want you to understand that the destruction of these red blood cells, is occurring mainly in the spleen in the liver. So this macrophage that I'm drawing up on the screen right now, that macrophages in the spleen, it's in the liver, it's in the circulatory system of those particular organs. And that's where this destruction is going to occur. The macrophage is going to eat these worn out red blood cells because they don't belong there. And as they do, they're going to metabolize the the hemoglobin. And as we're going to concentrate on. Now, what I'm going to do here is I'm going to draw three red tubes coming off the macrophage, this is where it's not even close to being anatomically correct. Those are blood vessels, blood vessels do not

come off of a macrophage, the macrophage is actually within the blood vessels. The reason I'm drawing it the way I am, you'll see, it's just to clarify the story. But understand that these macrophages are within these particular tubes that I'm drawing, right now, we got to draw another tube here. And then another tube on this side. And those are all separate blood vessels, but they are blood vessels within either the liver, or the spleen. Now what we have to do is we're going to draw the liver. So we're going to assume that this is happening in the liver, and it does. But I'm going to draw the liver separate from the macrophage, even though the macrophages in the liver, you're going to see why. And so this is going to be the liver. And again, not even close to anatomically correct, because certainly a macrophage is not as big as the liver. But it's going to look like it on this screen. And I'll label it as such. So that's the liver.

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And then we have to draw another structure down here. That's a duct, you guys know what a duct is, is just a tube. The duct that I'm drawing there is actually not anatomically correct, either. There's more tubing, you'll learn about it when we get to the digestive system secret will teach you all about it. Speaking of the digestive system, this is the digestive tract down here, specifically the small intestine, but we're just going to call it the digestive tract. That's good enough. So digestive tract, we're still not done. We have to draw another blood vessel. Again, this is not anatomically correct. And this blood vessel we're going to draw coming off of the liver. Again, not really the way it happens, but that's okay. And then we're going to draw one more structure and is going to be the kidneys. And so this is going to represent the kidneys and I'll label it as such. So now we have all the structures in place that's going to help us with this story in the story. catabolism of the red blood cell. And so we're going to start with the heme. We're going to concentrate on the heme. So I'm just going to write the word heme here. So this macrophage just ate a red blood cell. There's a whole bunch of games there, because well, there's 250 million hemoglobin molecules per red blood cell. So there's literally a billion heme molecules in that one red blood cell, what's going to happen to this heme molecule, it's gonna get metabolized going to get broken apart. And it's going to become three different things. And what are the three different things that he was going to become, this is what he was going to become when you catabolism it, one of the things we're going to get is carbon monoxide, we produce carbon monoxide naturally in our body. Certainly, given that iron is right in the middle of that he molecule iron is going to be one of the other things that we get, we'll put the two plus they're never going to get a third molecule is called Billy Vir, then I'm going to write that right there. And that's where the story is really going to kick off from that point, although we will throw a little bit more into the story when it comes to carbon monoxide. So what's going to happen to carbon monoxide, well, there's a blood vessel there, that carbon monoxide is going to end up in the blood. And as soon as it's in the blood, hemoglobin is going to grab it, you're not going to have this gas just floating around in the blood. Hemoglobin loves carbon monoxide. And it just grabs it has a high high affinity for it. About 1% of your hemoglobin molecules have a carbon monoxide molecule attached to it. And when carbon monoxide is attached to hemoglobin, hemoglobin has a special name is called carboxy. Hemoglobin and I'll write that here. So carboxyhemoglobin is hemoglobin with a carbon monoxide attached to it hemo globin. And again, we're looking at roughly 1% Unless of course you smoke, and it's about five to 10%. And we start to run into some issues that we'll talk about when we get to the respiratory system. What happens to the iron, the iron is also going to be released into the blood. It's going to be carried by a molecule, I don't really care about it. And then it's going to go to a number of places, one of which is the liver. A lot of iron is stored in your liver. If you want to get iron in your diet, you can eat some liver, and it'll get stored here. And it's stored here as ferritin. So I'm going to write the word ferrets in here. ferritin is the storage form of iron. So that's stored iron. And that's all we're gonna say about that. Now, let's go back to our third molecule, Billy vierten Billy Viridian is going to be converted into another molecule called Billy Rubin. And so I'm going to put that here. So this is going

to be Billy Rubin. Now there's two kinds of Billy Rubin the Billy Rubin that is formed from Billy veered it is called indirect Billy Rubin. There's also direct Billy Rubin. Indirect Billy Rubin. This Billy Rubin. Let's talk a little bit about I'm going to put it up here. So indirect Billy Rubin is the one that's formed from Billy Bearden. I'm going to abbreviate it I'd be indirect bilirubin. It's fat soluble. It's toxic. Now, I talked about toxicity in the past when I told you anything is toxic in the body at high enough levels, even water. But if you say that a molecule is toxic, the level doesn't

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have to go up that much. Like ammonia, for example, from last semester with protein metabolism was converted into urea. If you remember something that's less toxic. One of the things that's important to know about indirect bilirubin is it cannot be excreted. Now, what is excrete me excrete means getting rid of it from the body. There's number of ways to get rid of things from the body, you can excrete it in your feces, you can excreted in your urine. We can't do that. So we have now produced a molecule that is toxic that we can get rid of. That sounds terrible. Fortunately, we've devised a way to turn this molecule into something that we can excrete. That's not as toxic and that's direct bilirubin, which we're going to talk about. So I'm going to put direct bilirubin here. And I'll abbreviate that DB because I'll have to use the abbreviation timer to just because I don't have a Ryan room to write the entire word. Same thing with indirect. This is water soluble not as toxic and can be excreted. And so that's where this story is going to go. I'm going to tell you how we take indirect bilirubin and turn it into direct bilirubin. That's what I'm going to show you one other thing I need to mention, indirect really riveted, I'm going to show you where this is in your notes. It's on that page. It's kind of toward the bottom of the page. You see this? Indirect Billy Rubin could also be called free Billy Rubin. indirectly. RUBIN can also be called unconjugated bilirubin, I can use those terms interchangeably. Direct Billy Rubin is also known as conjugated Billy Rubin. You'll see why by the way when we use these words, conjugated and unconjugated, when we get to the story are further along in the story, I should say. So let's go back to our story. How are we going to turn indirectly Ruben into direct Billy router I'm going to show you So Billy Rubin, indirect Billy Rubin, which I am now going to abbreviate IB gets dumped into the blood. It's fat soluble, can't float all by itself needs to be carried by something. And what's going to carry it is a protein, a protein that you're familiar with albumin. So albumin is going to grab indirect bilirubin. And what albumin is going to do is it's going to carry it's going to carry it to the liver, it'll carry it to the spleen to let because the liver is up here on the screen. We're going to concentrate on the liver. So now what's going to happen is is that indirect bilirubin, it's going to end up in a liver cell through receptor mediated endocytosis. I don't know if you remember that from last semester, chapter three, about two weeks into the semester. I'm going to write out indirect bilirubin. Now because I have the room. You don't have to know it's receptor mediated endocytosis. By the way, I just thought I'd throw that out there. Just to show you how smart you guys are. Because we learned it last semester. So we have indirect bilirubin is now in this liver cell. What's the liver cell going to do? It's going to attach one molecule to indirect bilirubin. And that is just one chemical reaction is going to attach what's called glucuronic acid. It's going to attach this molecule glucuronic acid that's all one reaction to in direct bilirubin. That's called conjugation. When you conjugate a molecule, all you're doing is chemical reaction when you add something to it, that's all. So that is a conjugate conjugated bilirubin now, indirect bilirubin is unconjugated. Direct bilirubin, which is what we're going to get is now also considered conjugated really ruin. It's just indirect plus glucuronic acid. That's all. So what did we just do? We turned a toxic molecule into a non toxic molecule by adding one thing to it in the liver. And that way, now we can get rid of it. Now we can excrete it. And how are we going to excrete it? I'm going to show you. So the direct bilirubin is going to be added to a fluid that the liver produces called bile. We're going to talk about bile when we get to

the digestive system. We're not going to talk about it right now. So all I really need you to know is is that direct bilirubin is going to make its way to the digestive tract. And most of it is going to go in that direction. So I'm going to put the word most here.

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And it's how's it going to get there through these tubes that lets you see what's going to teach you all about. And so now we have direct bilirubin in the digestive tract where we can excrete it. And it's going to be excreted because it's going to be added to your feces. Now, something I haven't told you yet. Billy Rubin is yellow. But when this Billy Rubin goes to the digestive tract, a couple of things happen to it that I'm not going to talk about. It gets turned into a couple of other molecules, one of which is brown. It's called Circleville. And the reason your feces are brown is because we add Billy Rubin to if you don't add Billy Rubin to your feces, your feces will be the color of these walls pale. They would not be brown that's going to be empty. point when we talk about jaundice, you'll see I have the word most here, I don't have the word all here. That means it's got to go someplace else. This isn't exactly the way that it happens. But this is the way that we're going to learn some, and I'm going to put the word some here of that Billy Rubin is going to end up in the blood. It's going to make its way to the kidneys. So I'm going to put direct Billy Rubin here and then direct to the Rubin here. And I just told you, oh, and by the way, direct bilirubin is water soluble, so albumin does not have to carry it. albumin has to carry indirect bilirubin because it is a fat soluble molecule. That's why you do not see me attaching this to an albumin molecule. Make sure you remember that please. Direct bilirubin is down your kidneys. So what are the kidneys going to do to it? It's added to your urine. I told you that Billy Rubin is yellow. That's why your urine is yellow. If you don't have bilirubin to your urine will be clear as water. Unless you're dehydrated, it can be certainly darker for that. But do remember that Billy Rubin turns or causes your urine to be yellow. Another important point when we get to jaundice. So what did we just do? We got rid of bilirubin from the body. We excreted it in our feces, we excreted it in our urine. We turned it into something that was toxic into something that is non toxic. And we got rid of it. What you see here up on this page is every single one of those words right there. Yes. So my question is indirect Billy Rubin? Direct bilirubin Is that correct? Correct. Through glucose uronic acid. Look, you're on a cat that the liver cell just adds glucuronic acid to it. That's all it does. It just sticks them both together. The indirect and the direct indirect bilirubin and glucuronic acid together get one chemical reaction. Correct. You're welcome. Are we good with this? Yes. Well, I've been talking Oh, not anywhere near long enough. Now what you'll see southern notes, bruises. It was kind of fun to talk about. There's so much in blood that we're not going to talk about bruises. If you want me to talk about bruises with you personally over email or my office. I'm more than happy. But it won't be on the exam. will be on the exam no with John. So now let's talk about jaundice. What's jaundice? Jaundice is just yellowing of the skin the conjunctiva which is the why to your eyes. Mucous membranes. Why would that happen? Elevated levels of bilirubin? Well, what kind? indirect or direct? It doesn't matter. Both of the molecules are yellow. And so if somebody is jaundice, that is a sign that their level of bilirubin is high. And then you got to figure out well, why. And there's three kinds actually before that. I don't know why this is crossed out. It shouldn't be. We're doing this. Let me show you the picture. This picture right here. This is especially true in infants kind of true in adults, but much more true in infants. We see these numbers one through five here. It should be first, second, third, fourth, fifth, really, the numbers are showing progressively the spread of jaundice in the body. In the beginning stages of jaundice or somebody is jaundice. Pretty much the conjunct of is that's what gets yellow first. And then kind of the face the head area. Yes.

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I'll be honest with you. I don't know. I really don't. But but it does. Yeah, I really I really don't know the answer to that question. Okay, but again, it's more so in infants, not so much in adults, okay, but it can still follow this in adults as well. So this is a pattern that I'd like you to know. So starts here, then as the level of bilirubin goes up even more than the Trump starts to get more yellow, it doesn't mean that it goes away in the face and the conjunctiva it's still there. It's just spreading, then below the waist, then it'll get into the limbs, and then the hands and the feet. Again, at this point, the entire body is jaundice. And so especially so for an infant if that infant has jaundice, hands and feet, the level of bilirubin in the infant's body is very, very high at that point. So please don't listen. And when it goes away, it progresses in the opposite direction. The last thing that will not be jaundice would be the head area and the conjunctiva. All right. Now, when it comes to jaundice, there's three kinds free panic panic posts. Pet, otherwise known as obstructive. What's the paddock mean? Liver well what's right in the center of this picture? The liver. A pre hepatic jaundice means something happened before the liver that caused the jaundice. Apparently jaundice is something going on with liver postmatic A name I hate I like obstructive a lot better. We can't get the the bilirubin into the digestive tract. That's our issue. So what we're going to do now is that we're going to compare and contrast prePac hepatic post defatting, we're going to see what level what type of bilirubin is high, and what the feces in the urine look like with each of those, based on our knowledge now, of how we progress from indirect to direct, and all the steps in between before and after. So we're going to make three columns, then these three columns are going to contain three fatik, hepatic and obstructive jaundice, so pre padding and that will be their hepatic dead center. And then obstructed, otherwise known as post hepatic. So we're going to talk about the causes first. So what's the cause of a pre hepatic Jon's? cause destruction of too many red blood cells. That's our problem. So destruction have too many red blood cells, more than two and a half million per second. Now, why would this happen? I give you two examples. One of which hemolytic disease anytime you see the word lysis lytic it means we're destroying something. hemolytic disease is by definition, a disease where well, we destroy too many red blood cells. I'm going to give you two examples of hemolytic diseases later on in the lecture. And then the last lecture that I give about blood, I'm going to give you a third one. Another instance where you have too many red blood cells being destroyed is a newborn. Well, what is it about newborns? It doesn't mean every newborn is going to get you on this by the way. But it's not that uncommon. When we are developing an MA R hematocrit is incredibly high. You guys know what an adequate is right? red blood cell concentration talked about this with lecture Seaver. And as an adult, it can range anywhere from 35 to 50%, depending on whether you're female or a male, but let's just say 40%, because it's a nice round number. So let's just say I have adequate as an adult is 40%. In mom, the fetus, it's 80%. Most of the Blood is red blood cells in a fetus. And there's reasons for this that we're not going to get into. As soon as that baby is born. There's obviously twice as many red blood cells that can be destroyed and are being destroyed. And eventually, that baby is no longer going to have an 80% Dramatic rate, it's going to be closer to 40%. It's going to take a while months and months and months. But you're going to have a lot of red blood cells to destroy because they have so many red blood cells. And that's the reason and we'll talk about a little bit more the treatment if they're even needs to be one when it comes to jaundice and infants and that kind of thing. So we have too many red blood cells being destroyed. Well, why would that cause jaundice? Well, let's go back to the picture. Too many red blood cells being destroyed means there's a heck of a lot of heme molecules, which means there's going to be more millet Billy Bearden, which means it's going to be more indirect bilirubin, which means it's going to be more indirect bilirubin in the blood. It'll also mean that the liver is going to have more indirect bilirubin to conjugate and to direct bilirubin, which means there's going to be more direct bilirubin in the blood, and then it circulates and it gets into the conjunctiva on your skin and

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your in your mucous membranes. So what causes jaundice with the pre hepatic jaundice? So what causes the jaundice the jaundice is caused by and it's especially indirect. That's when it's going to be much, much higher. There's a rate limiting step when it comes to the liver conjugating bilirubin it'll still go up the direct will still go up. But it's really the indirect that's causing the John is Pope we're going to include the direct but I'm only going to put one arrow there might not even go up one arrow but we're going to put one arrow there.

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There's a jaundice now, one of the things if the liver is conjugating more indirect to direct Do you think that we're going to get more direct into your feces? Yes

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or no? Of course we are. Do you think we're going to have more direct going into your yard? Of course we are. Darker feces How much darker depends on how severe the gentleman says, depends on how high the level of bilirubin is. Darker feces? Darker urine. Now can urine be darker for other reasons can feces be darker for other reasons, of course. But if you have a jaundice individual and you see darker urine, you see darker feces. It's probably pre hepatic. Alright, so what's in another way? Again, assessing your patient, looking at the feces, looking at the urine. A paddock now what's our what's our issue here? What's the cause? cause liver has difficulty conjugating conjugating bilirubin what the liver is having difficulty doing is turning indirect bilirubin into direct bilirubin. Why? Well, there's a number of things that can be going on and I have a few listed in your notes. One of which hepatitis. You guys know what hepatitis is. The virus, hepatitis A, B, C, I think they're all the way up to freakin K or L or something like that. It's a virus that attacks the liver, you attack the liver, you compromise the liver, the cells don't work as well. Hepatitis can lead to scarring of the liver, which is called cirrhosis. Cirrhosis can be caused by a bunch of different reasons anybody know what the leading cause of cirrhosis is? Alcoholism takes some time to develop. But alcoholism alcohol needs to be metabolized by the liver and eventually the liver just gets damaged and become scarred so there have cirrhosis? Again cirrhosis can happen for a bunch of different reasons hepatitis can lead to is not treated properly. Another one? Do I have another one? Maybe that's something I need to do I have another one in the notes. Oh yeah, I do preterm baby, preterm baby. Now it could still be a new a newborn that comes to normal term like 39 weeks. But typically we're going to see this with a preterm baby. Now why would that be preterm baby is born too early, just organs might not have developed, one of which is a liver. If the liver is not developed properly, well, can't conjugate very well. And so now we have an increase in bilirubin and what kind? Let's figure that one out. So what's going to cause the Jonas? Well, let's think about this one. Go back to our picture. We have a liver that does not conjugate very well. And there's severity to this. It can be mild, moderate or severe. If the liver is not conjugating, do you think that we're going to build up the indirect? Of course we are because we can't convert it. And so now indirect bilirubin is going to build up in the blood build up and the blood build up and the blood build up in the blood because it has nowhere to go Can't excrete it. And so now what? Increase in indirect what's going to happen to our end or I'm sorry, our direct bilirubin will that go up or down the direct? It's going to go down. So now you're not going to have as much direct bilirubin in your feces, pale feces. Your urine light urine light colored urine, clear urine. How clear depends on how severe it is. So you see a jaundice patient pale feces, light colored urine. It's probably hepatic. All right. Now let's go to obstructive also known as post hepatic. The reason I don't like post a panic is because I didn't draw this anatomically correct. But some of these tubes are actually within the liver itself. And that after the liver, which is what post means, I like obstructive better. You're obstructing the tubes. You're not allowing the bilirubin to get into the digestive tract. So

the way that I have written down here I just have one duct is much more vast than that. We just can't get it here. We don't have any problems with destroying too many red blood cells. That's not our problem. We have a nice healthy liver. That's not our problem. Our problem is getting this bilirubin, the direct bilirubin into the digestive tract.

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So let's write that down. What's the cause? difficulty getting direct bilirubin to the digestive tract There is some obstruction which is why it's called obstructive jaundice which is why I like the name a lot better than post a pet. Now what can cause this? Well, lots of things and I have a few examples in the notes. I believe gall stones is the first one you guys are going to see gall stones later on this semester. Siefert has a jar and they literally looked like stones in there as hard as rocks by the way, so gall stones can clog up the tubing tumor get big old cancer clogging up the tubing. pancreatitis. What does the pancreas have to do with any of this? Well, it'll make more sense when we get to the digestive system. But the pancreas has tubes that come to the same point as these tubes that the pancreas is inflamed, it can screw up the tubes coming from the pancreas and then clog up these tubes. More later, Siebert will show the show you the anatomy. So we have a number of things that can obstruct the delivery of the bilirubin directly ruin to the digestive tract. So now let's think about this one. What's gonna cause our jaundice? Well, we're not going to have again, any issues conjugating indirectly Ruben, we're not going to have too much indirect really ruin because we're not destroying too many red blood cells. But we can't get the direct bilirubin to the digestive tract is there somewhere else that can go? It sure can. It can go to the kidneys. And in order for it to get to the kidneys, we need to dump it into the blood. So because all that direct bilirubin cannot be delivered to the digestive tract, we will instead deliver it to the kidneys. We will have high levels of direct bilirubin causing our jaundice. Now I asked you this, what color will the feces be? They're gonna be pale. Why? Because we can't get the direct bilirubin to the digestive tract. What color is our urine going to be? Should it be dark? By the way if this is severe enough, and I kid you not with an obstructive jaundice, that urine could look like Coca Cola and I kid you not. That's how dark it can get if it's severe enough. Alright, so I say dark it doesn't mean well I'm a little dehydrated in my urine looks little bit dark today. It could be what the hell is that? Dark if it's severe enough. So pre hepatic, hepatic obstructive should make sense based on this picture. That's why I went into this in such detail. So that we can truly understand not just memorize I could have sat here and said, well with pre diabetic Giannis, you have high levels of that. You learn zero. This paired with this you'll learn all kinds of stuff so when you learn this you learn John is when you learn jhanas you learn this, they go well together. Need a break yet we do let's take a break. Okay, folks, let us finish up. So we went over all those different types of jaundice. Now let's talk about treatment. Now certainly, when it comes to treatment, you need to figure out what type of jaundice it is. So that you can direct your treatment at you know if it's gall stones, or a tumor, or somebody has cirrhosis, hepatitis, so forth, and so forth, and so forth. So certainly, addressing the underlying issue is incredibly important. What I'm talking about here as well, when it comes to treatment is trying to diminish the level of bilirubin. So kind of bailing the water out of the ship, or the boat. Okay, plugging the hole is the underlying issue, but in the meantime, we can still get rid of some of the excess bilirubin. How can we do that? We can use what's called Photo therapy. There are a special lights out there that have blue and green wavelength, but you don't necessarily need a billy light. All you need is light that has green and blue wavelengths in it. That would be the lights in this room. That wouldn't be the sun. It's any light that we can visibly see. But again, we have these specialized lights that can be used. And what happens is this. These blue and green wavelengths, if they can penetrate the skin will literally break down the bilirubin and then the level of bilirubin goes down. It can only be done in infants, though. And the reason is this. An infant skin is really really thin.

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That's not happening in adults. It's not even happening in a three or four or five year old the skin is too thick. The light will not penetrate deeply enough to destroy the Billy Rubin. So again, only infants. Now does that mean that people who are older than an F that are screwed at their levels of Billy ruiner I know because we can do what are called exchange transfusions, and extreme chance for using a simple, you're going to remove some of their blood that has high bilirubin in it, I'm going to give them a blood transfusion of normal blood that doesn't have high levels of bilirubin in it. So take out bad blood put in good blood exchange transfusion. And again, that's what you can do for somebody older than an infant. And certainly you can do exchange transfusions in infants as well. So both of these are going to work with infants only exchange transfusion is going to be work or is going to work in somebody who's older than an infant. So please know those All right. Now, and sometimes Genesis goes away by itself. Most kids who are born with jaundice, it just goes away. It might freak out. Some parents like why the hell's my baby all yellow, it's probably okay. It'll just kind of go away. And most times, the baby gets taken home, mom and dad can just, you know, make sure that the baby is exposed as much as possible to, to like, and it'll just go away, probably usually within a couple of weeks. But sometimes it doesn't. And you need extra measures. And sometimes they'll give mom and dad or Billy light just to make mom and dad feel better. And sometimes the baby needs it, especially at the level of Billy Reubens, really hot. And there's a danger of developing was called Kernicterus. connectors that just really ruin toxicity, mainly in the brain. This is almost exclusively seen in infants. Why is that? The reason is because the infants blood brain barrier is not very tight yet. You guys know what the blood brain barrier is, like your secret taught you the blood brain barrier last semester, the blood brain barrier is a very, very tight barrier, the brain is going to let anything at that done belong and won't let anything out that should stay in the brain. It's much easier for the bilirubin levels to build up into the brain if that barrier is not tight, and it's not tight in infant. Now, rare in adults, it can't happen in adults, but only if the brain barrier is compromised for whatever reason. Like chemotherapy, for example, could compromise the blood brain barrier and cause something like this to happen. Let me ask you this really quick. Bring something up. Chemotherapy, tell me which one of these John, this is somebody who's a chemotherapeutic or getting chemotherapeutic drugs might develop? Pre padding, right? We're destroying lots of red blood cells with that chemotherapeutic drug, we talked about it already. And then you'd have to give me peel, right? So you can get a pre hepatic jaundice with that. That's not the only thing that can compromise the blood brain barrier. There are other things that can happen. But that's certainly one of them, and kind of put that stuff together. Going back to our treatment, warning signs, and again, this is an infant's lethargic muscle rigidity that just have that just has to do with what's going on in the brain and the damage to the brain cells themselves. You're lethargic, those brain cells are hyperpolarizing that as many action potentials are being generated, they become lethargic muscle rigidity, what's that all about? upper motor neurons being damaged, causing an increase in muscle tone. Remember that from last semester. Second to the last lecture of last note was the last lecture of last semester, I think that we talked about that high pitched cry, why it hurts, babies can't talk, they'll tell you a lot of times what's going on by crying. What can happen with this worst case scenario is death. Certainly a bunch of bad things as well, because again, we're damaging the brain. So what must be done, you need to address the underlying issue. And you can be guaranteed that both of these are going on with that child to lower the level of bilirubin in that child. Absolutely. All right. Let me ask you this really quick. Let's go back to our picture here. Of these three, are there any that you could see that would be worse when it comes to Billy Ruben than maybe others? Given what you know about indirect and direct? Which one would you think would be the least scary when it comes to bilirubin levels? Obstructive why? Because it's direct indirect is not as toxic. The ones were indirect as high,

causing the jaundice or the more dangerous ones. Now I don't want you to sit there and think well, Doctor are tumors aren't dangerous. Of course they're dangerous. pancreatitis is a dangerous Of course, it's dangerous.

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I'm just talking about the bilirubin level itself and its effects. So again, it's the indirect one. That's the toxic one. That's the one that's more dangerous. And so keep that in mind, please. Now, let's change gears really quickly with this. I know you already went over this with lecture seabird. I want you to know that as well on my exam, it'll be a vomit question. Just spit it back at me. What the heck is a normal homematic And then male and female hemoglobin concentration there are normal ranges a little bit higher in males and has to do with evolution, we're not going to get into it. Just know the numbers very straightforward. Again, I know you need to know with Lex receivers as well. So that's that. Speaking of hemoglobin still, let's talk about anemia, by definition is a deficiency of hemoglobin. That's what it is one of the main jobs of hemoglobin, it's not its only job, but its main job is to carry oxygen. And where is it carrying oxygen to the cells of the body so that the cells of the body can make ATP? Well, if you have less Sima globin, you can't carry as much oxygen in the blood. You can't carry as much oxygen to the blood, you're not going to get as much oxygen to the cells, which means cells are going to fail to produce as much ATP. So then signs and symptoms 50. All these signs and symptoms revolve around a decreased oxygen carrying capacity of the blood, because there's not as much chemicals. So fatigue, that's a no brainer. Shortness of breath upon exertion. When I say exertion, it can be something as simple as walking. It depends on how severe the anemia is. And by the way, it doesn't matter what kind of anemia you have, we're going to go over I don't know, five or six different kinds. There's more than that. But we're going to go over about a half a dozen, the symptoms, the signs are going to be all the same. Because it's a decrease in hemoglobin concentration. That's our issue. malaise means the patient doesn't feel that great, paler, pale skin, why the hell would their skin get pale? Our skin color is obviously due to melanin. We learned that last semester, but it's also due to our blood. If your blood has less oxygen in it, less hemoglobin in it, it's not going to be as red. And so the skin will appear more pale, paler, paler, pale skin, same thing. Are there other things? Yes, but these are the ones that I'd like you to know. And when it comes to anemia, let's talk about the different kinds. And so we're going to put together here, three different columns, just like we did with pre fatik panic and post panic, or obstructive has nothing to do with it. But I kind of divided these anemias into different categories, a nutrient deficient anemia, so some nutrient is deficient causing the anemia. We have bone marrow damage otherwise known as a player Asia plays your damage, same thing. And then genetic. You're born with it. So a mutation of some genes. So let's talk about the nutrient deficiency anemia is the most common cause of anemia is iron deficiency. So what's our nutrient deficiency iron? That's a no brainer. We know that we need iron to make hemoglobin because well, heme has iron as part of the structure. If you don't have heme, you don't have functional hemoglobin. And so iron deficiency. What do we need to know about iron deficiency? Well, one of the things is, how do you know somebody has iron deficiency, you take their blood, you do blood work, you determine the level of iron in your blood very, very easy. And when it comes to iron deficiency, how can you fix it? Get more iron in your diet. There's iron pills, there's iron shots, there's all kinds of ways to do it eat some liver, we know that the liver stores iron in the form of ferritin. That's why liver is a very good source of iron. Meat is the best source of iron red meat, especially as the best source of iron. It doesn't mean people who are vegetarians vegan can't get iron in their diet. They certainly can and many vegetables out there with iron in it, spinach being one of them. So there are many ways to increase the iron levels in somebody's blood and body if they have an iron deficiency anemia, and it's the most common again, of all the anemias. So very, very

straightforward. Next one on the list is a BT 12 deficiency, otherwise known as CO Ballymun. I'll just put B 12. There oops. Now, when it comes to b 12, it can certainly be a deficiency because of not getting enough of it in your diet.

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But it can also be caused by a lack of what's called intrinsic factor and that's in your notes. I'll point to it as I talk. So intrinsic factor, commonly due to a lack of this particular protein made by your stomach. This protein made by your stomach is vital to absorb the B 12 from your gut. So you're ingesting B 12 Either in pills, or animal products by the way. There is no non animal product that has been 12 minutes. So for those of you that are vegan, those of you who are vegetarian, you are not getting any B 12 in your diet. The normal way there is no vegetable on the planet that has B 12 in it. It's only in meat And it's only in dairy products. But last foods are fortified with B 12. You ever see that on packages fortified with this fortified with vitamin D fortified with would be 12, the company is adding it to it. And that's the only way you're going to get it unless you take a pill. Regardless of how you getting it, it's in your gut doesn't do you any good in your gut, you got to absorb it into your blood, and you can't absorb it into your blood. Without this protein I'm going to show you later on when you get to the digestive system, how that happens. So if you don't have that protein, you can eat 10 pounds of meat, it's not going to make one bit of difference, it's not going to get absorbed. And there are some people who simply do not make this protein. So supplementing that to help them changing their diet and then to help them. So are they screwed? No, they can take shots at B 12. Unfortunately, B 12, a water soluble vitamin, it's one of the few water soluble vitamins that are stored in the liver stores it about a month's worth. So you'd have to take a shot about once a month, it's cheap, about five bucks somewhere in there. And you can just take it yourself to the shots that are prescribed by a physician. All right. Again, it could be due to an intake deficiency, especially if you're vegetarian or vegan, and you don't understand that you're not getting B 12 in your diet. It can become dangerous, although it takes a long time for B 12 levels to become low. A couple of years or so. How do you diagnose this blood work? Just like with the I take blood you measured Level A B 12? How do you fix it get more B 12 in the body shots, food bills, whatever. The last one here is B nine, also known as full eight. So B nine, you can get this in all kinds of foods, even vegetarians, vegans can get it in your diet. Oh, here's another thing I haven't mentioned. Iron is pretty straightforward. You need it. What about B nine and B 12. Because I don't see B nine and B 12. Here that's a beta subunit. That's not vitamin B of any kind right there. That's beta. So what is it about being on B 12 deficiency that causes anemia, I'm going to show you how to go to this picture right here. So we have all these steps here that are needed to give us a immature red blood cell. From probe or through glass all the way down to here there's about 25 Steps give or take. V 12, and B nine are necessary for the maturation process that's occurring during these steps to give us a mature red blood cell. And without those vitamins, that's not happening. That's why you need B nine and B 12. Enough of it in your diet. Okay. So anyway, going back to that. So how do you diagnose it? Once again, blood work. Just measure it. What if it's low? Just get long been on your diet? Lots of foods have been identified. Alright, very straightforward. Now, let's say that somebody is anemic. You test their blood, iron levels are fine. Well, the levels of fine B 12 levels are fine. Well, what is it? Well, it could be a plastic anemia. So let's put that in our list here. aplastic anemia aplastic anemia is an anemia that develops because the bone marrow has been damaged. A pleasure again, damage. Now why would this happen? Most often your immune system gets stupid. And it eats the bone marrow. When it starts to eat bone marrow ceton stem cells and the pro roofwise A screw and all that stuff up. It's screwing Humana police's up and diminishing the number of red blood cells that are going to be produced. And so it can also be due to some drugs, I say drugs, their medications that are prescribed that can cause damage to the bone marrow. But again, most often it's your immune system just getting stupid. How was you diagnosed this blood work? I'm

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going to do it. Unfortunately for this person, you're going to have to do a bone marrow biopsy, which is a very unpleasant thing. And so you do the bone marrow biopsy, you look at it underneath the microscope and you look to see, well, you're not going to do it. Well, you might do it if you have the right kind of position someday. Is you just going to look at the bone marrow and look to see how's it look? So look damaged if it looks damaged. aplastic anemia? How do you treat this? Well, there's a couple of ways it can be treated. One is immunosuppressive drugs. Well, what's that got to do with anything? When you have an autoimmune disease? Your immune system is too active, it's overactive. So you want to suppress the immune system. Can you give me a type of drug that we learned about a couple of weeks ago that could be prescribed to this person?

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Think cortisol, right? corticosteroid, like prednisone, for example. There are lots of other ones out there that depress the immune system.

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But one of which we learned when we were talking about cortisol right So that could be something that's given bone marrow transplants a possible cure possible cure why? Let's say you get a bone marrow transplant, it takes fine, the body still has that crazy immune system doesn't mean that the immune system isn't going to attack the bone marrow again. So it's a possible cure, but it's certainly worth a shot. All right. So that's a plastic anemia. Now. Let's talk about some genetic conditions. Thalassemia being the first. And so now we're going to go back to the picture of our hemoglobin molecule. There's two kinds of phallus Siemian. There's Alpha thalassemia. And there's beta thalassemia, alpha and beta. And so what happens here is this. So we have this hemoglobin molecule, we know it's a protein. And we know that it's made up of these individual subunits, which themselves have proteins. Well, how did the gamma globin molecule get here, the cell had to make it right. There had to be genes for the Alpha one Alpha two beta one beta two subunits, correct genes. 20 of the 30,000 are recipes for protein. We remember you remember that for the last semester. Lecture number two later, and maybe lecture number three, I don't I don't remember. So we have to have genes for each of these subunits. Well, if the gene is screwed up, when you transcribe that gene and make the mRNA, the mRNA is screwed up. If the mRNA is screwed up, when you translate it, what the protein is going to be screwed up. And now you have a screwed up, hemoglobin molecule. And some people with Dallas EMIA have screwed up Alpha genes, and some people have screwed up beta genes, which is why we have alpha thalassemia, beta thalassemia, mild, moderate severe forms of this. Almost every year, I've had a student come up to me and tell me that he or she has Dallas Senia. Fortunately for them, it's been a mild form of it. And they haven't had to do anything when it comes to treatment. They say every once in a while I have a bad day. But if they had a more moderate or severe form of thalassemia, what kind of treatment options would they have? Most often, they would just get a lot of blood transfusions, though, then you can run into some risk where your iron levels get too high. Well, nevermind, nevermind. Nevermind. Here's something else. Look at this hemolytic anemia, would you see that? I told you I was going to tell you about two different hemolytic diseases, or this is one of them. fallacy, Mia, you increase the risk of destroying too many red blood cells because the red blood cells are just compromised with this particular condition if it's again, moderate

to severe. And so what I'm going to do here now is this is a hemolytic disease. Oh, and by the way, how do you diagnose it genetic testing bloodwork, I'm going to do it. Looking at bone marrow under a microscope, I'm going to do it, you need to do a genetic test to figure out is the gene all screwed up. And again, blood transfusions, that's one way to tackle it. Bone Marrow Transplant once again, a possible cure doesn't mean it's going to actually happen. So that's Dallas Siemian. Then we have the last one here, sickle cell anemia. And so let's write that one down here. So sickle cell anemia. With this one, we also have subunit issues. But for this one, it's not alpha or beta. It's just beta. Now, the mutation is different than it is with beta thalassemia. similar but different. With fallacy me you don't get any sickly. with sickle cell anemia, you will get sickling of the red blood cells, I'm going to show you a picture of a sickled red blood cell, a number of them. And so let's go back here, we have a beta issue. And by the way, this is also hemolytic. So obviously, people with these genetic conditions have an increased risk of pre hepatic, John's because these are hemolytic diseases here. Now, let's go to sickle cell anemia back over here. I'll show you picture up. Now we know what red blood cells are supposed to look like. Nice, beautiful, round red blood cells.

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Well, those don't look beautiful in round. These, all of these cells up here on the screen are red blood cells gone wrong. And a few of them you can really see the sickling. So this used to be a nice round red blood cell. Now it has sickle. Now, this does not mean that if you have sickle cell anemia that you're walking around with your red blood cells that look like this. This happens during what's called sickle cell crisis. When something triggers the red blood cells, which are nice, round and red. To do this, what kinds of things can trigger the red blood cells to all of a sudden start to sickle like this? A number of things, I'm going to show them to you. factors that increase the risk of sickle cell crisis. Hypoxia, which is a low level of oxygen, low pH and the blood acidosis. Severe dehydration is another one infection, something as simple as a cold virus flu virus, certainly COVID. I'm sure people who had sickle cell who have sickle cell anemia, were a bit more scared of COVID than let's say, maybe some other people are because it could cause them to go into a sickle cell crisis. I want to make sure that you understand something here is that these things do not cause sickle cell anemia. Sickle cell anemia is caused by a genetic mutation. These things that I have outlined here, increase the risk of the red blood cells sickling. If you don't have sickle cell anemia, you can be as hypoxic as you want. Dehydrated as you want, get all the viruses and pathogens in your body, your cells are not going to secure your red blood cells are not going to signal it and going to happen. Because you don't have the mutation for it to happen. And what's the big problem here vaso occlusive crisis, let me show you what that looks like. So this is going to be a capillary, we now know what that is. And as you well know, red blood cells marched through these capillaries, one at a time. That's how small these and actually those capillaries are actually in diameter, smaller than red blood cells that kind of got to squeeze through right? Thankfully, the red blood cells are flexible. But that's one of the things that causes damage to the red blood cells shear stress to the walls and wears them out quickly.

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But some of these red blood cells might get stuck. So there's a sickle cell. That was a red blood cell. Well, now what? Well, blood flow was going in this direction. It sure as hell isn't anymore. And so what do we get?

1:07:04

ischemia. You can't get the blood to where it needs to go, which are the cells of the body to deliver nutrients to deliver oxygen, what's going to happen to yourselves. We're going to die, tissues are going to die, organs are going to die depends on how severe it is and how fast it is. But it's something that can certainly happen. And so this is vaso occlusive crisis, we put that in there. So vaso occlusive, basal blood vessel occlusive, it's being occluded. And it definitely is a crisis can lead to death. Now, there are ways to tackle this. We're not going to get into it. Alright, I think I used to have it in the notes. Do I have hydroxyurea in the notes? I do still. Okay, you actually might have an older version. It doesn't matter. We're not gonna Don't Don't worry about it. Oh, yeah. We're just gonna say blood transfusions. That's good enough for us. All right. Again, another hemolytic anemia. Okay, so last thing we're going to talk about before we're done tonight, we're going to go the complete opposite direction. We're gonna go Polly site Demian. Now, yeah. Yeah, yeah. Yeah. If you have any new notes just cross it out. Because the older Okay, yeah, we're always making the notes better on the lab manual better. Okay, so let's talk about polycythemia. Now, it's just an increased concentration of red blood cells. Now, it might sound fantastic, but many of the things that cause an increase in red blood cell concentration are far from fantastic. So let's talk about it. So polysafe Demian, increase increased red blood cell concentrate, so high hematocrit, it's going to be higher than 50% in the male, higher and 45% of female. And so let's talk about those things that can cause polysafe Demian. The one main thing that we're going to concentrate on is hypoxia, which is something that I just mentioned with sickle cell anemia, and sickle cell crisis, low oxygen levels. Now, if you have less oxygen in your blood, it means you don't have the ability to carry quite as much oxygen to your cells. And so the body will respond to that acclimate to that in a negative feedback manner, and increase the concentration of red blood cells, which means you have more hemoglobin, so you have more workers to carry, what oxygen is there, to your cells. Now, why would your Why would your body be hypoxic? Well, I have a few examples in the notes, one of which is cardiovascular disease. I think you could probably figure out why that would be. We're certainly going to talk more about that when we get to the heart and circulation next week sometime pulmonary diseases, emphysema, chronic bronchitis, interstitial lung disease, all these things that we'll talk about when we get to the respiratory system. Smoking, I believe is another one that I have. And then this last one I won't put yet, but certainly these first three things are bad. And so you might think to yourself, well, somebody who has pulmonary disease has a higher red blood cell concentration good for them, no, it's not good for them. The body is desperately trying to get the red blood cell concentration up so that they can, the body can desperately get even remotely close to getting the amount of oxygen needed to get it to ourselves. So this is not a good thing. This one not so bad. Being at high altitude, something we'll talk about when we get to the respiratory system. So I'll give you an example Denver, Colorado is a mile above sea level. That's why it's called the Mile High City, Dayton, Ohio is at sea level, Denver is literally one mile higher than Dayton is. And the higher you get an elevation, the less oxygen that you have available to breathe. I will explain to you when we get to the respiratory system as to why that is. But if you have less oxygen to breathe in the air, your body will acclimate to that in a negative feedback way, and start to produce more red blood cells. So people in Denver have higher magic rates than we do. The numbers that are quoted that we have quoted for you, our numbers at sea level, and those are the numbers are going to be quoted in your books, for example, because sea level is normal, so to speak. And the higher you go in elevation, the lower and lower your oxygen levels are, and the higher and higher your medic rate is now how much higher a few percentage points. It's not that great, but it's still higher. So high altitude, more on that later. So what's going on here? So regardless of which of these four is happening, what it does is, is that it stimulates the kidneys to increase the amount of EPO

1:12:00

released. And when the kidneys do that, or EPO goes through the bone marrow binds to the pro

erythroblasts and you get an increase in red blood cells. That's all. Now, are these the only things No, I'm gonna give you a couple of others. Another one is defect. So let's go over here. Number one, hypoxia number two, increasing EPO release in the kidneys. Number three, we get an increase in red blood cells. Is there another number one? There is not it's ranked one but another number one isn't something separate from hypoxia, sure. Defective hemoglobin will cause or EPO to be released in the kidneys. If we have defective hemoglobin, we're not carrying enough oxygen to ourselves. kidneys don't know the difference between defective hemoglobin in low oxygen levels. So they'll just start to pump out a lot more EPO. What does this mean? This means that you can be anemic and polysafe Mnemic. At the same time. If you have defective hemoglobin because you heat the hemoglobin that's going to be produced might just be defective, because it's going to be defective for a reason to begin with. So it might be something wrong with the production of the hemoglobin like somebody has style Senia for example, with defective hemoglobin because the alpha or beta subunits are all screwed up. That's one another one I can give you that's in the notes is cancer. So cancer can cause an increase. Now it has nothing to do with EPO unless it's a cancer of the kidneys that's causing too much EPO. Certainly it can be that. But I'm just going to give you something completely separate. And so I'll just put this over here, cancer, and there's a specific cancer called polysafe anemia. I know it's not in the notes, but I'm just going to write it here. Anyway, poly site de Mia Vera might have heard that, that is a specific cancer that causes too many red blood cells to be produced. And if it's not treated, the person doesn't have more than a few years to live. Fortunately, we got a lot smarter. There's some drugs that can be given to a patient they can live 20 more years with this particular condition once it's diagnosed, but a cancer causing too many red blood cells to be produced. One other thing that can cause polycythemia is blood doping. And what's blood doping, literally infusing not infusing transfusing. Red blood cells, somebody just has a transfusion or red blood cells. It's common with athletes, endurance athletes, especially cyclists. Lance Armstrong was doing this. He was also taking shots of EPO or red blood cells for us. to yourself, certainly an endurance athlete is going to have a great advantage if they have a higher red blood cell concentration can you this will be the last thing we talk about. Tell me a way that somebody and this is cheating by the way, you can't do that. In sports competitions, you can't do that. But is there a way an athlete can train to increase his or her red blood cell concentration without cheating Tony? Go to high altitude. A lot of athletes do that. Go to Denver, go to Pikes Peak go into the mountains train. So if you guys wanted to run the, the airforce marathon, you wanted advantage. Go to Denver for a few months doesn't take that long, by the way. takes about two to three weeks for your chromatic crit to be about the same as somebody in Denver. You come back to Dayton, your America would be high for about another week. And you'd have a decided advantage. All right. Okay, we're done. When we come back on Thursday, we will continue our discussion. Sir

Blood PM 2-10-22

Thu, 2/17 8:55AM 1:06:37

SUMMARY KEYWORDS

platelets, blood vessel, called, factor, clotting, thrombin, blood, thrombus, bleeding, activated, white blood cells, platelet plug, clot, vitamin k, bruises, blood vessel wall, produced, pathway, von willebrand factor, blood clots

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00:02

Shall we begin? So the last lecture we spent more or less, most of that time talking about red blood cells. Let's talk about white blood cells and platelets. Tonight, we're going to start with white blood cells, I'm not going to spend a whole lot of time on them, when I do need you to know is what their normal range is anywhere 5000 to 9000. So if you take blood from a patient, and you do a complete blood count, otherwise known as a CBC, this is one of the things that they're going to measure. And it's going to be the number of white blood cells. And so I need you to know that normal range. And so let's talk about when the ranges are out. Or I'm sorry, when the ranges are outside of what the normal ranges and that would be number one leukopenia, low white blood cell capital, certainly, it's going to be less than 5000 5000 is low normal. Why would this happen? Well, this is something that we're familiar with bone marrow a pleasure, let me remind you. Last lecture, we talked about bone marrow aplasia, but we were talking about anemia. When you damage the bone marrow, you could compromise the production of the core puzzles and water core puzzles, red blood cells, white blood cells, platelets, so with bone marrow aplasia going back to it. Where did it go? Did it just disappeared? Really? Okay, well, we talked about it in the last lecture. And again, we're talking about a decrease in red blood cell concentration with bone marrow plays. And now we're talking about a decrease in white blood cell count with a bone marrow a pleasure. Another reason you can have a low white blood cell count leukopenia is AIDS. AIDS is a condition where the virus attacks white blood cells, that will diminish white blood cell count. And so because of that immune system is severely compromised. With people who have AIDS. Let's go the other direction leukocytosis. Here we have a white, white blood cell count above 10,000. What would cause this? Well, what's one of the main reasons we have white blood cells? What do they do? They fight infection. So if you have some pathogen in the body, you're gonna make more white blood cells to fight whatever the pathogen is, inflammation can cause an elevation and white blood cell count, certainly cancer can. Let's talk about a specific cancer leukemia, which is a cancer of any one of the five different white blood cells that you have. Something that can happen with leukemia is is that when the white blood cells go up and count, you can start to crowd out other core fossils, like your red blood cells and your platelets. So you can actually develop anemia. Because of the Leukemia, you can also decrease your platelet count, that's called thrombocytopenia. We'll talk about that in a little bit when we actually get to the platelet. One thing I want to mention as well is is that this is the most common cancer in kids. And a lot of times when people hear the word leukemia, their minds go to kids, it is the most prevalent cancer in kids. But way more adults get leukemia than kids do. In the notes 10 times as many adults get leukemia than kids get leukemia, just a couple of stats I'd like you to know. And that's really all we're going to talk about when it comes to white blood cells. Now, let's go to thrombocytes. Platelets, we need to know what the normal count is, once again between 150 and 400,000 is going to be our normal

count. Now let's talk about what the count is low. Let's talk about what the count is high. thrombocytopenia, I just mentioned it and I just mentioned it when I was talking about leukemia, leukemia, again, cancer of a white blood cell, it can crowd out the other core puzzles, one of which is the platelets, you can develop a thrombocytopenia. So that's one reason and other one is your immune system can just get stupid. Lupus is an autoimmune disease where you can have a decrease in white blood cell concentration, because once again, the immune system is attacking things in the body, it should not and then there's our bone marrow aplasia. Again, I can't put it on the screen because for whatever reason, this computer took it away from me. But bone marrow pleasure damage to the bone marrow, white blood cells are producing the bone marrow or I'm sorry, platelets are producing that bone marrow. It could drop your book or your your platelet count. What kind of things would we see with thrombocytopenia? Typically, it's asymptomatic. People don't even know they have it. And a lot of times when thrombocytopenia is revealed, is revealed because something else was being tested. They did the blood work, and they found that somebody has a low platelet count.

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But that person didn't know it because they weren't no signs and symptoms of it. If somebody does have signs and symptoms, what could be seen bruising. Now what I have over here, and why would that be well? No more when we actually get into platelets and to see how important they are, when it comes to the process of stopping your bleeding, we are bleeding all the time you are bleeding right now. I'm bleeding right now. But what's happening continuously is and bleeding, it just damaged blood vessels. That's what's happening. We're repairing and constantly. And playlists play a key role in stopping bleeding. And we're going to see that when we get to hemostasis in just a little bit. So because of that, we're not going to see bruising, unless, of course, we hit something very, very hard, then we'll certainly bruise but just our day to day activities would cause bruising, if platelets weren't working properly, or we didn't have enough of them. So being my hand on this table right now, I'd been to kind of hard, I'm not gonna bruise why.

05:54

Because I'm going to start bleeding just fine. Because I don't have a platelet problem in my body, I don't have a coagulation problem in my body. But if I had a low platelet count, if I had thrombocytopenia, I can be guaranteed that my hand would be very bruised after this particular lecture. And there's different kinds of bruises. And it's based on their size. And that's what you see in the notes here, particularly I purpura and ecchymosis, I'm going to show you pictures of him, and it's actually in the same picture. And once again, it's all based on size, the sizes in your notes. And so particular itty bitty bruises. And typically they're in clustered same thing with pyrifera, they're clustered, the size of particular would be more or less the size of the tip of your pen or your pencil. So if you take a pen, and you just did this to your skin, that would be the size of particularly, if you turn your pen or your pencil over to the other side, maybe the size of an eraser of a normal pencil, that would be about the size of the pure pure ecchymosis. We're bigger than that. And we can get to, again, a bigger bruise, that would be ecchymosis. So if you can know what those are and what the size ranges are for each of those, that would be great. And to know that it could be a sign that somebody has a low platelet count. What else could you have? Well, just bleeding in general. And if you get if you get a platelet count less than 50,000, well, then now things can become a bit more problematic. Where you can have more severe bleeding. What do you treat it with? You give people platelets that have low platelet count, you get plates, you might think why don't you just give them

TPO? Because it doesn't work? Why doesn't it work? I don't know, I don't think anybody knows. But TPO just simply does not work. It's not used clinically, which is why when we saw TPL, I didn't talk about its clinical use. There are no clinical uses for TPO. And to remind you what TPO is TPO is what the liver produces. That's the hormone. It targets the mega carrier blasts, again, not used clinically. So that's thrombocytopenia. Let's go the other direction, let's talk about a high platelet count. Once again, typically, asymptomatic people don't know they have it. And typically, when it's determined that they have thrived thrombocytosis is by accident, something else. They were looking for something else or maybe just even routine blood work. If there are problems with thrombocytosis, it could be that the platelets are going to clump together. So we'll get what's called a blood clot fancy word for this thrombus. We're going to talk about that in detail in just a little bit. What would cause this? Most often it's TPO over sensitivity. What what does that mean? Well, this hormone produced by the liver targets these cells, well there has to be a TPO receptor. Sometimes these mega carrier blasts are just simply oversensitive to the hormone itself. The over multiplying too many megakaryocytes too many platelets, you can also have a cancer that causes an increase in platelet production. How do you treat that? anticoagulants a lot of people call them blood thinners? I don't like the word blood thinner because blood thinners do not thin your blood that's not at all what they do. And we're going to get the blood thinners anticoagulants today. So that's that for that right now, that's going to lead beautifully into how do you stop bleeding. It's called hemostasis. So let's talk about hemostasis. We have these three mechanisms here. The first one we're not going to spend much time on is called vascular spasm otherwise known as vasospasm. So anytime you damage cut a blood vessel, there's going to be this reflexive response to the blood vessel, the blood vessel is going to constrict a smooth muscle wrapped around it. It's going to contract and it's going to constrict. There's two reasons that that happens. Number one, if you have a tube that's this big, versus a tube that's this big, you're going to have much less blood in it right? So that's going to limit bleeding. So the blood vessels constrict to death. bleeding, we have a cut blood vessel, we're losing blood. The other reason it happens, it's in the hopes of taking the two cut ends, and bringing them together to completely stop the bleeding. If you constrict the blood vessels, now, that's not going to work in most blood vessels in your body, it's not going to work in any artery in your body. Because the pressure is too high. It's not going to work in any big blood vessels in the body, like veins are just too stinking big. It could work in small blood vessels with low pressures and what blood vessels would those be venules, very small venules. Maybe capillaries is where vasospasm will work to where the two ends can meet and actually close up wherever the cut is, depending on how big the cut is, of course. So that's the premise behind vasospasm. And it's going to happen regardless, I said it doesn't work in arteries, it doesn't mean it's not happening in arteries. It is happening in arteries. And when I say it doesn't work, it doesn't work to close. Whatever gap there is, if there's a cut, it certainly works to limit the blood flow to limit the bleeding that's occurred. So that's vasospasm, we're going to assume that it didn't work. And so now we're going to go to our platelets. So now we're going to see just how important platelets are. And platelets are very important in the platelet plug reaction. And also it's blood coagulation, otherwise known as clotting. And so let's get into this now. So what we're going to do is we're going to see how important platelets are initially as a platelet, but we're going to draw that right there. So I'm going to draw a blood vessel on the screen. And we're going to go through all the steps involved in this story. And this story is a story of the platelet plug. And so we're going to assume that the blood vessel has been cut, although the blood vessel doesn't have to be cut. And that's going to be a very important point, we're going to mention in just a second here. So I'm going to draw a blood vessel, I'm going to draw this blood vessel differently than I've drawn blood vessels in the past, what I'm going to do is I'm going to have walls in this blood vessel, whereas before I just did that, that's now how I'm going to draw the blood vessel, this time is still going to be a tube. But the tube is now going to have a wall. So it's like it's going to be a sagittal cut of the blood vessel. So that that

12:19

12:19

is the wall of the blood vessel, not the whole blood vessel. This is the wall of the blood vessel as well. So the blood is flowing in here. This is where the blood is. Right here. Bless you. Now I'm going to cut this blood vessel. So it's damaged right there, it's damaged. Right, so that's where the cut is. Again, that's the wall. And so that wall has wood in it a lot of connective tissue, you guys know this smooth muscle cells. And so there's our damage. And so that's going to be step number one. Now something I need to mention here. Okay, so right there, we have a cut, or damaged, or inflamed blood vessel. What that means is that you don't have to cut it for this to happen. I'm going to show you a pretty picture of what we're about to draw. To give you an example. This picture right here is a pretty picture of what we're about to draw. And in this particular picture, here's our blood vessel wall right here. This is where the blood is flowing, this blood vessel is not cut, this person is not bleeding, right now, in order for this person to bleed, we need to cut all the way through the wall all the way through the smooth muscle, then the blood would escape. This is a damaged blood vessel. We don't even have to damage it, we just need to inflame it. And that's going to be a very important point when we talked about blood clots. And so that's why I put these three things here, but in the picture, it's cut. So now what's going to happen. So step number one we've cut, we've damaged we've inflamed the blood vessel. Number two, the endothelial cells, you guys know what the endothelial cells are, right? Those are the cells that line the walls are going to produce a protein and that protein is called von Willebrand factor. I'm going to make it blue. So this is von Willebrand factor, I will label it VDF is what I'm going to call it. And so this is number two. So von Willebrand factor produced by the endothelial cells in response to this cuts that's occurred. That's gonna be number two. Now, what's so important about this protein, I want you to think of it as double sided tape. It stick now it's not literally sticky, but it's good visualization is going to stick to the wall, the blood vessel is going to be sticky on the other side, so that platelets can stick to the wall much, much better. Now playlists can stick to this blood vessel wall without von Willebrand factor, but it's much tougher for them to stick to the wall, they don't stick as hard. Now it's going to be step number three. So to this site, platelets are going to aggregate, we're going to make the platelets a different color, they're going to be green. So the platelets are going to stick to the von Willebrand factor, which is stuck to the wall. And so number three, I'll just put it over here, platelets. And I'm going to put the word stick. Stick to blood vessel wall, specifically, the von Willebrand factor, then what once those platelets adhere to something stick to something, they're going to be activated. And when they get activated, they release stuff. And so what are they going to release, let me make that three a better three. They're going to release four things that I want you to be aware of. Two of which I want you to be very aware of. And those four things are calcium, serotonin, a DP, and thromboxane. So these green things are platelets. So I'll just no can't do that. Because I need an arrow to go up from that point. We know that those are platelets, I'll just label it. That's a platelet. And that's a platelet. And by the way, these platelets have this irregular shape to them when they're floating around. Which is why I've given them kind of an irregular shape as they stick into von Willebrand factor, but that's going to change. So number four, these platelets are going to release for things. So platelets release calcium. Serotonin, this is the same serotonin that we talked about last semester that is a neurotransmitter.

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It's also a signaling mechanism when it comes to platelets, seratonin, a DP. And thromboxane. By the way, that's the same a DP that we turn into a TP it has another job, actually, ATP is also a neurotransmitter. I just didn't tell you that last semester. So these four things are going to be released by those platelets. Why? Because they themselves have been activated. The two that I really want you to pay attention to are ADP and thromboxane. So why are the platelets releasing this and they're releasing this in this general vicinity over here, I just didn't put it in this general vicinity because I just don't have the room to write all those words. Right here in between these two platelets.

There are other platelets in the neighborhood and those other platelets are going to bind ATP and thromboxane because they have a DP receptors and they have thromboxane receptors. They also have serotonin receptors, we're not going to get into the serotonin story just ATP Anthro boxing. So step number five and do realize it step number five is happening with a cut is I just don't have again room to write it there activates other platelets and when those other platelets are activated, they are going to release ATP thromboxane, calcium and serotonin so we'll make that number six. So number six, the activated platelets which were just activated by the original platelets that are stuck to the ball Willebrand factor activated platelets, the ones from number five, activate other platelets by releasing seratonin, calcium, ADP and from boxing. And it continues on until we have enough platelets in a positive feedback manner. Now, when these platelets are activated, the ones that are activated by the initial ones that are stuck to von Willebrand factors, the ones that five and the ones that six they change their shape. I told you that they have an irregular shape when they're kind of floating around. And I drew these too to have more or less than a regular shape. They're not going to look like that when they get activated. What are they going to look like? They're going to look like little stars. They're going to grow these projections, they're going to look like this. That's what the platelets are going to look like now Why these projections, these little arms and these little legs are going to stick to each other? No, are they going to literally stick to each other they are not. But it's a good visual to have. And so that's going to lead us to number seven. Although before we get to number seven, I want to add one more thing to this page. And that is, the thromboxane has another function. And I'm just going to kind of put that over here to the side thromboxane. And I'm going to put the word also thromboxane. Also, because it has another function, and that is to activate other platelets. thromboxane also causes vasoconstriction. This is separate from vasospasm. Why do you think the thromboxane does that? To limit bleeding, we're going to basal constrict the blood vessel more. And so it limits blood loss. If you make the tube smaller, you're going to lose less blood. We actually learned that last semester, we learned at Starbucks and causes vasoconstriction. It was in the first lecture. If you recall, if you don't, it's okay. But if you're curious, look under your notes under Ecosa noise, it'll be there. So let's continue our story. So we're going to draw this again, except we're not going to put all these steps in here, we're just going to draw a little bit of the picture, we're gonna go to step number seven. So step number seven is going to be on the next page, we're going to draw that blood vessel that cut blood vessel, same one, it's cut right there. It's cut right there. We're gonna put von Willebrand factor in the picture, we're going to put our original platelets in the picture. But now what we're going to do is, is that we're going to add the platelets that are starred, because that's where they're going, they're going to plug the hole, it is a platelet plug. That's why it's called a platelet plug. So let's put a whole bunch of these little platelets sticking to each other

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until we have enough of them to plug the hole. So they're all joining their little arms and their little legs together. So that we start to stop the bleeding. And so number seven, platelet plug is formed. But we're not done. Because something else has already started to happen as the platelets were doing their thing. And actually the platelets are involved in the next part of this story. And I'm going to give you the punch line. The punch line is this, what's the next thing that's going to happen with the platelets are going to be stuck there, plugging the hole and then we're going to put a mesh on top of the platelets, we're going to put a mesh on top of the platelets and that mesh is made up of another protein. And that mesh is called a fibrin clot. I'm going to show you a pretty picture of the mesh. So we're going to go back to our PowerPoint. Again, here's a look at the platelets are all hold hands. So again, this is a prettier picture of what I just drew. These are the initial platelet stuff to von Willebrand factor, we have one Willebrand factor, these little black little lines, that's for Willebrand factor. This is what we're going to see this is the mesh, the orange stuff fibrillin is this filamentous protein. And it's sticky. Notice these are red blood cells in here, they got stuck there, think of this as a

spiderweb. It's sitting right on top of the platelet plug, we just don't see the platelets in the picture because the mesh is so vast. So I'm going to show you how we make this orange mushy stuff, how this happens. That's the next part of this story. And that's called coagulation. So again, initially, we had vasospasm. Then we just talked about the platelet plug. Now we get to talk about coagulation. And that's the production of the fibrin clot. So let's talk about that now. So when that blood vessel is cut, the platelets are going to do their thing. And this stuff is also going to start to begin to happen. So this doesn't happen after the platelet plug has been formed. It's happening while the platelet plug is being formed. And there's two pathways. Yes.

24:40

So you said the platelets you know, join like, you know, joined together. Is that what you said?

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The fibrillin is already starting to happen. It just hasn't formed quite yet. As it's happening yet. They're happening at the same time. Thank you. You're welcome, sir. So now what are we going to do? Yes. So there's two initiating mechanisms once extremely can one's intrinsic. Extrinsic means outside of intrinsic means within. And so we have these two separate pathways that are going to be initiated, that's going to eventually give us this fibrin clot. And so in, there's a bunch of stuff already crossed off, I actually already put it on pilot as to what you don't have to know in this chapter. It's already on pilot. So the stuff that you see crossed off some pilot already. So let's talk about this. So again, we have two pathways to mechanisms that are going to be initiated again, once that blood vessel is either damaged, inflamed or cut, we have a cut blood vessel in this case. So we're going to have the intrinsic mechanism. And again, this is coagulation. And so we have an intrinsic mechanism. And we have an extrinsic mechanism. And you'll see why they're called each in just a second. Now I can use the word pathway, and I'm going to in parentheses just put pathway above it because it is a pathway there's going to be a reaction which leads to another which leads to another which leads to another. And over here on this side, we're going to put the extrinsic mechanism or pathway. And so our blood vessel has been cut, and these are going to be initiated now, floating in the blood is a protein. And this protein has a name, it's called Hagerman factor. And this protein just floats around minds its own business in the blood until is it until it is exposed to something foreign. So if we look at a blood vessel, and let's look at the pretty picture of the blood vessel, this one right here, let's imagine that we don't have this damage here. The inner lining of these blood vessels is made of what endothelial cells, hey, demand factor, this protein that's in your blood should only see endothelial factor, or I'm sorry, endothelial cells, that it's familiar with that that's its friend. But now we've cut the damage. We've inflamed the blood vessel. Now what is taken, in fact, you're going to be exposed to connected tissue in the wall, smooth muscle cells in the wall. that's foreign to Hagerman factor, one factor doesn't know what the hell that is, because that's normally being covered up by these endothelial cells. So it's going to be exposed to this foreign stuff. And that's going to activate Hagerman factor is going to stimulate Hagan factor. And because Hagerman factor is already in the blood intrinsic to the blood. That's the start of the intrinsic mechanism. So Hagerman factor is activated when exposed to blood vessel wall. Because that blood vessel wall has stuff in it it's not familiar with, Hey, give it a factor is going to be a knitter is going to be stimulated, if it's exposed to anything foreign. If you bled on this on your on your desk right now, your bloods gonna clot. Why? Because whatever the hell your deaths are made of, is something that Hagerman factor is not familiar with. So it will initiate the intrinsic mechanism. It won't initiate the extrinsic mechanism. But you only need one of these mechanisms, only one of these pathways to make blood clot and that's the point

I'm going to come back to in just a second. So that's the extrinsic mechanism, then there's going to be you know, some other things going on that we're not going to concern ourselves with. While that's going on, the extrinsic mechanism is going to be initiated as well. And so something from outside the blood is going to be produced is called thromboplastin. So I'm going to write that here thromboplastin. is produced and released. So it needs to be produced produced and released by the damaged tissue, what tissue tissue or the blood vessel, damaged tissue

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actually put released into the blood released into the blood by the damaged tissue. And the damaged tissue is tissue with a blood vessel. So thromboplastin was not in the blood to begin with, where it was thrombo class and thromboplastin was here is going to end up in the blood, because it's going to be released into the blood it has to be, because we need the clotting mechanism to occur. And so that's why they call it the extrinsic mechanism. It's faster by the way, this takes about, I don't know, 30 ish seconds. This takes about a little while, but two, three times as long but 90 ish seconds somewhere in there. But they're happening at the same time. And they're all going to come to the same common point. Each of these pathways, each of these mechanisms, is going to produce an enzyme called prothrombin. Ace. One or the other can do it. But both of them doing it at the same time will just make more prothrombin x. And so we're going to call the extrinsic mechanism and the intrinsic mechanism. Number one, we're going to call the or call prothrombin, Ace production. Number two, and it's going to go back to another point that I was starting with Hagerman factor, if you expose a human factor to anything foreign, this intrinsic pathway will be initiated and we will have prothrombin x. And so if you take blood from a patient, that blood is going to go into a little glass vial is glass. A friend of a Hagan factor is familiar with glass? Do you have any glass in your blood? Hopefully you don't. So Hagerman factor is going to be activated by that glass fine. Now you're going to have clotted blood in that glass file, you're going to send it to the lab and the lab is going to throw it away. Because the lab can't do a damn thing with clotted blood. But the blood doesn't clot in the little glass vial when you put blood into it from your patient. Because they treat the glass was something that doesn't allow the clotting mechanism to occur. And most often, that's Heparin, and we're going to see heparin later on in the lecture. All right. So anyway, let's move our story on. So we have an intrinsic pathway, we have an extrinsic pathway. And then we have a common pathway. And it's called the common pathway because both the intrinsic and the intrinsic extrinsic mechanism come to this common point. And that's prothrombin. So Tor prothrombin AST is going to be part of the common pathway. So now let's do coagulation. But now we have the common pathway. So coagulation is continuing on. So now we're going to be at step three, and specifically, the common pathway, or the common mechanism. And so let the story begin, there's going to be this protein present in the blood already made by your liver, it's called thrombin. But at this particular point, thrombin is going to be in its inactive form. And thrombin in its inactive form is called prothrombin. So it's inactive, we need to activate it, we have to activate it because we need to make the orange meshi stuff, we need to make fibric. So we have all these steps that are going to allow us to do that. And so prothrombin is going to be activated, it's going to be activated, you guessed it by prothrombin ace, the enzyme that was produced here by the intrinsic and extrinsic mechanisms, pathways. And what are we going to get in the end we're going to get active thrombin antithrombin is called well thrombin. Good because thrombin has a very important job. And that's what's happening here. This does this job which allows this to do its job which allows this to do its job. It's like a little assembly line. Everything is dependent on the other thing that happens before it. So now what so now we have thrombin because well, let me just write it down. Here's our fibric the messy stuff that's going to be on top of the platelets, we're finally going to make it but at this particular point in time, it's in active and inactive fibrillin is called

Full Brynna gin. So I'm going to put inactive underneath it. And what's going to activate fibrillin thrombin is the thrombin that was produced over here by prothrombin x. And so now we have fibric which is active. Prom is going to do another job for us. And that is we have another factor here.

34:46

If you don't know Roman numerals, learn them because you're going to need them for this exam. That's a 13 This is something else that's already in the blood and it's inactive form. We need to activate factor 30 We're going to activate factor 13, for us is also thrombin. We think, Well, we already have the messy stuff, what the hell else do we need, we need to protect the messy stuff, we need to protect the fibrillin. Because there are things that want to break it down in factor 13 isn't going to let that happen. Factor 13, which is now active, is going to stabilize the fibric protects it from being broken down. Now we have our messy stuff, you know what I did one, two and three, I changed my mind. Gonna do A, B and C, and D, you'll see why they be this over here, prothrombin ace, that's going to be C thrombin doing its thing is going to be d well, so now we're gonna go back over here fibrillin clock clot D. And now, we stopped bleeding. So that's how you do it. All right. What else. So if you look in the notes, there's a whole bunch of stuff that you don't have to know, there are a bunch of other factors that you don't have to know. Same thing over here, common pathway a bunch of factors that you don't have to know, like thrombin is factor two, I don't even need you to know that. I just need you to know what I've put up on the screen when I drew what I drew with intrinsic extrinsic, and the common pathway. Now, we're not done, we have a blood vessel, there's a cut, we need to repair it, we just can't leave it like that. We want the blood vessel to be what it was before we've damaged in flame that cutting. The platelets aren't doing their job and aren't done doing their job. By the way, the platelets are also involved with coagulation. I just not specifically told you that. But they are. Now what's gonna happen is this. So we have all these platelets, they're stuck to each side of the wall and there's platelets all in between, they've all joined little hands and feet. Now what the platelets are going to do is that they're going to contract like muscle cells. And they're going to pull these two walls closer together, it's going to make it easier to repair the wall, you're not going to have as much material to the platelets are going to release something very similar to growth hormone is called platelet derived growth factor. It works just like growth hormone. And we know a growth hormone isn't what it does it repairs tissue. This is going to repair the tissue, platelet derived growth factor. So we're going to pull the walls together, we're going to release this growth hormone like substance. And eventually that blood vessel wall is going to be repaired to platelets at one time. Do we think that they were cells? That's why they're called thrombo sites site is a cell. And then we studied them more when we found out they're not cells. But can you see how we were fooled into thinking they were cells? What do they do? They release ATP serotonin from boxing. Right? And cow calcium. They turn into little stars, they can track like muscle cells, they release something that's like growth hormone. Hell, I would think it was a cell to if I was studying this particular cell, because it acts just like a bunch of different cells in the body. It has an incredibly important job when it comes to hemostasis not only hemostasis but to repair the blood vessel wall itself. It can't happen without platelets. So now do you see why it's so easy to bleed and get bruises if you have a low platelet count? Particularly Pierre Pierre ecchymosis, bigger bruises, bleeding gums, internal bleeding with low platelet counts, because this doesn't happen that well without platelets. And then when we have repaired the blood vessel wall, and by the way, it's called clot retraction. So what I was just talking about with platelets is this right here, and all that. Then when the blood vessel walls repaired, do we need all this stuff? Of course we don't. So we're going to get rid of it. And there's one enzyme that'll do that. And it's called plasma. Plasma is gonna digest that fibric boom, it's all gone. And we have a beautiful blood vessel wall again. Yep.

39:41

They do all this stuff. What is it about? That makes them nuts? Well, they don't have a nucleus. They I mean, they just don't have the organelle they just they just don't have the machinery that a cell would have. But they have enough to do the things that they do. They have myosin and act like they have all remnants of stuff but it's like taking a car and kind of ripping it apart but just leaving enough of the card that do that's that's the dominant nevermind forget about the car analogy. I'll stick with what I just talked about earlier, okay? It's got enough stuff to do sell stuff, but not enough stuff to be called to sell. Okay? It's more anatomy that anything that really physiologically because physiologically these things behave just like sales all right? Yes sir.

40:29

So once once the deputy or like five virgin becomes five likely 13 become you know that once that happens

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like the the messy stuff is February as the messy stuff. Yeah, like how does the like the broken part like you know, come together like the platelets contract they contract like a muscle cell. And they're all joining hands and it's just gonna pull the blood vessel walls closer together.

41:07

Once they pull it together, then

41:09

then they they're they're releasing something like growth hormone and then the repair process begins. In the blood vessel wall gets repaired, the ones that muscle wall gets repaired, not the muscle wall, the entire wall is closer together. If you had like too big if you had this area of a I don't know erode in this area of a road and you just have you have way more road to build. But if you can bring the two areas closer together, there's less road to build to bring the two areas together. That's why the blood vessel walls are coming closer together. It's easier to repair. Putting in a concrete or something. Yeah, it'd be less concrete to put in to the room. It's closer together. Alright guys, let's take a break. Here we go. So now what? Well, what we just talked about normal. Let's talk about some abnormal stuff. So what if you don't clot properly? Well, then you're said to have a bleeding disorder. And so let's talk about some bleeding disorder, one of which is hemophilia. Now there's a bunch of stuff crossed off here, three kinds of hemophilia. I urge you to know what causes each and by the way, you're born with this as a genetic condition. Hemophilia A, B and C a is the most prevalent by far. And with haemophilia A, we have a deficiency of factor eight. Well, what's factor eight, it doesn't matter. If we look at this picture, you see a whole bunch of factors, there's 13 of them one through 13. You don't have to know them specifically. But what I do need you to know is that with haemophilia, you're deficient in one of them and if you're deficient in just one of the 13 You're not going to clock properly because they're all dependent on each other because it's this pathway that occurs. So haemophilia a, I want to get you need to know your Roman numerals. So that is an eight

haemophilia B, that's a nine. haemophilia C very rare. That's an 11. That's all you need enough, and that A is the most prevalent of the bunch. What other bleeding disorders do we have? Von Willebrand disease something else that you're born with? While Willebrand factor is a protein. And so we have this genetic mutation of the protein that encodes one Willebrand factor, you know, you have one Willebrand disease, and by the way, factor eight as well is going to be deficient. Don't have to know any of the other stuff. Vitamin K deficiency don't mix us up with potassium, by the way, two completely different things. Vitamin K is necessary for the liver to produce. And by the way, the liver makes most of the factors. And again, there's 13 of them, not all 13. But most of the 13, the liver produces them. And the liver needs vitamin K in order to produce four of them. 279 and 10. A very easy way to remember that is two plus five is seven, two, or two plus seven is nine. So 279. And then the number after nine is 10. I need you to know those four, please. All right. Now why would you be deficient in vitamin K? About half of the vitamin K in your body is produced by the bacteria in your gut that bacteria is called flora. It's considered good bacteria. Why is it considered good bacteria? Because it does good stuff for us. And one of the good things that the flora do is produce vitamin K. So it produces it in the gut, and then we absorb it into the blood, and then it goes to the liver and other places and the liver uses the vitamin K to make again to seven nine and 10.

44:55

If you have extensive antibiotic treat with an antibody additives that said to be broad spectrum, a broad spectrum antibiotic is an antibiotic that will kill kill many different kinds of bacteria. Let's say that a patient is on it for 345 weeks, and even longer with some conditions, that antibiotic is going to kill all the bacteria in the body, including the good bacteria in your gut. And if you have less bacteria in your gut, you're going to have less vitamin K. And so you can be at risk at a bleeding disorder because of that your patient could be so you got to be very careful with that. So what can you do for your patient? Well tell him to eat foods that have naturally high levels of this good bacteria like yogurt, cabbage, for example, probiotics can replenish the the bad bacteria, the good bacteria, I should say, in the gut, you can also give them vitamin K, D, Vitamin D pills, you can take vitamin K shots. But you have to be kind of careful with this thing. So extensive antibiotic treatment, not getting enough vitamin K in your diet, that's that would certainly limit vitamin K in your body. Again, as I said, about half of the vitamin K in your body comes from the gut bacteria producing it, well, where's the other half come from our diet. What else? Well, maybe you do get enough in your diet. But if you don't absorb it from the gut, it's gonna go right through you. And so some people have some conditions where you don't absorb very well, Crohn's disease, that is an example of that. We'll talk a little bit more about when we get to the digestive system. And then newborns, every newborn who was born in a clinical setting is going to get a vitamin K shot. Why? Because they don't have extensive Flora yet. They don't have that bacteria in their gut, it's gonna take them about a month to get enough bacteria to produce enough vitamin K. And so that vitamin K shot that they get is going to last them about a month. Now, if they don't get the vitamin K shot, I mean, they're going to die. But they're at increased risk of bleeding. And the big, big risk is the big scary one is a brain bleed, that could certainly cause a lot of problems. And so again, you're going to get that vitamin K shot. And it's standard nowadays. So vitamin K deficiency can cause a bleeding disorder, what treatment Do you have, again, replace the last vitamin K in any way that you can? Something else that can cause excessive bleeding, lack of coagulation, liver disease, why? Well, I mentioned it about five minutes ago, your liver produces most of the factors most of the 13. The other thing the liver does for us is what produces this beautiful hormone. That picture went TPO, which is going to give us platelets. So liver disease, you could have low TPL, which means you could have low platelet count. So those are bleeding disorders, again, you bleed too much you don't clot very well, let's go the other direction. What if you clot too much? What can happen that? Well, some bad things as well. Formation of a thrombus. So let's draw this. So this is too much clotting now. So what I'm going to do over here is I'm

going to draw a blood vessel. And in this blood vessel, we're going to clot, and we know that the platelets were green, so I'll use green here. And we know that the fibrillin I put as a black meshi shape. So there's a blood clot a fancy word for it is a thrombus that's not supposed to be there. So this is extra clotting. So that in and of itself is not a good thing. Because I think we can clearly see that, well we're starting to plug up the blood vessels. Not a good thing. Something else that's bad that can occur. Little pieces of this can break off. And so now we have this thing here. So we have a piece of it. Now you might think to yourself, that's fantastic. Now it's smaller. No, it's not fantastic. This can be life threatening. This can be very dangerous. Why is that? I'm going to show you. So I'm going to draw that blood vessel again. I'm gonna draw it over here to the right. So here's that same blood vessel. Now I know you guys haven't gone through circulation yet. So I'm going to give you a quick and dirty circulations a story here. On by the way, this is called an embolus. an embolus is a piece of a thrombus that has been dislodged from the thrombus. So here's our ambulance right here.

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And it's in this blood vessel and most often is going to be happening in veins.

50:00

tell you why in a little bit. Now we need to put a couple of other things in this story. This is going to be the lungs. Now I'll label it lungs. This thick, I need to tell you what this is.

50:19

That's a pretty damn handsome looking heart, if I do say so myself, look at that. So that's the heart. So a little blood flow lecture here in about two minutes. So this is a vein. Your veins take blood back to the heart. And we're going to assume that this is the systemic circulation. And so this dotted line is going to be the venous system. You'll go over this in detail. With Seaver Did you already go over with CVID? Or no? Okay, so then, you know all this stuff. So right atrium, right ventricle? pulmonary trunk, right. pulmonary arteries, right. Now label the pulmonary arteries. And I'm going to draw blood vessels again, again, the line, the dotted lines, the side lines, those are blood vessels. I just didn't draw them all fancy. So this pulmonary artery why is this blood going to the lungs? To get what? Oxygen right pulmonary artery as deoxygenated blood? Well, you know that arteries branch into smaller and smaller and smaller blood vessels. Can you see where a problem is going to happen? Now. This thrombus is following blood flow here, it's going along with the blood it's floating around in the blood. And right now at this point in his nice big old vein. It's not causing any problems. But nice little itty bitty arterioles is going to cause a humongous problem. It's going to clog them up. Anybody know what that's called when it's in a pulmonary artery? pulmonary embolus. So now we have a pulmonary embolus. The condition is called pulmonary embolism. Does that sound dangerous? Yeah, that's life threatening. It clogs enough of the pulmonary arteries up, you're not going to oxygenate your blood. And you're going to die. Now doesn't mean you're going to, but it can kill you quickly. If it's not that bad, people can walk around with this for days, they're just going to feel like crap, all of a sudden they go to the doc they'll do studies and they'll say Oh, you got pulmonary embolism. And they got to clean it up. We'll talk about how we do that just a little bit. So let's abbreviate this Pe by the way. Let's go back to the other side. Again, most often this happens in a vein. And we call it deep vein. We're talking about the thrombus right now, thrombosis otherwise known as d v. T. Whenever you see DVT, whenever we talk about DVT. It is coupled to PE, always why? Because of what I'm

showing you on the right hand side. A deep vein thrombosis is dangerous because it can cause a pulmonary embolism. And this thrombus can be in your ankle. And how long does it take for it to circulate from the heart to the lungs? About a minute, you can sit there completely fine. And then the next minute you're gasping for air because you're not oxygenating your blood. So again, potentially very, very, very, very dangerous, not something you ever want to mess with. Now, what is it about veins, especially by the way, in your legs? We'll talk about why in a little bit. So we're overclocking right now. Now, why would somebody overclocked? Well, let's talk about some reasons. So now let's go back to the notes. So what we just do, there's this except I put a little bit more detail into so what would cause it typically a lot of inflammation. If you remember, when we started this whole discussion about hemostasis in the platelet book, cut damaged, inflamed blood vessels. You don't have to cut the blood vessel. You just have to inflame it. If you inflame it, this starts, this starts. This starts and ends.

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You're getting that just by inflaming the blood vessel walls. Now why would Somebody's have extra inflammation. While we've talked about a number of things over the last couple of semesters, one of which we talked about just a couple of weeks ago. Diabetes, if you remember, did we not? We're talking about diabetes mellitus that is not incipit. As we talked about, why is it so bad? Why is high levels of glucose so bad? It inflames your blood vessels. And I told you at the time, it leads to cardiovascular disease. This is cardiovascular disease. Blood clots are diabetes is one of the leading causes of cardiovascular disease. People don't put the two together, but they're absolutely linked together because of the inflammation that they cause. For that it causes I should say, so lots and lots of inflammation. Another condition here disseminated intravascular coagulation, otherwise known as DIC, this one's a really bad one. You get a lot of clotting, and you get so much stinking clotting. If it's severe enough, you use the platelets up, you use your factors up. Now, what do you have left to stop the bleeding? Nothing. So now what are you gonna do? Are you gonna bleed? With DIC? You have massive bleeding. And you have massive clotting. Very, very dangerous condition. In the clinical world, some people call DIC D death. I is see coming. That is coming. I'm not joking. It doesn't mean that you're going to die if you get DIC but your chances of living aren't fantastic. Especially if you have other bad things going on. Like sepsis, for example. COVID for I'm sure that COVID caused a lot of DIC and caused people unfortunately to pass away because of all the inflammation that occurs from it. So anyway, lots of inflammation, know what DIC is, again, lots of clotting, a lot of bleeding at same time. What else can cause us excess aquatic stasis? What stasis Yes. relationship with COVID. And yeah, there is. Absolutely there's also why people die from people did die from COVID From thrombus. Yeah, they did. Yeah. Thank you all. So what is stasis? stasis, by definition is slowed flow of a fluid, and the fluid we're talking about is blood. If blood is flowing slower, it's easier for platelets to start to stick together. It's easy for coagulation factors to start to get activated. Where we commonly see slowed blood flow is in the legs. Why would that be? Where's the blood gonna go to the heart, or the legs below the heart, it's working against gravity. Plus in the venous and we're talking venous return, pressure in your veins is very, very low. It's like 10 times less than what it is an artery. So the pressure is low to begin with. harder to get the blood up when the pressure is low like that. It's going up against gravity. That's why you need valves, right? You guys learned about the valves in the veins. And so you have stasis in the legs. So let's go back to this especially in the legs, why? stasis? Why? stasis? That's what all right. congestive heart failure is something else that I have. That's when the heart isn't pumping properly, and pump the heart doesn't pump properly, bloods not going to flow that well. Slow blood flow. Now we have risk factors. So this increases your risk of developing blood clots. The first one is being overweight, so overweight and obesity. So what is it about being overweight and obese, that increases your risk of developing blood clots. You have increased inflammation in the body. There are many studies that show it is

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increased inflammation, increased blood clots, plus your fat tissue is not just there to store fat. Your fat tissue is active. metabolically, your fat cells produce hormones and release hormones. And some of the hormones that they're releasing, they're just dysregulated when you're overweight, and it causes additional inflammation. So being overweight, obese, big risk factor in increasing blood clot formation. Pregnancy. What's it what is it about pregnancy? I have two things. Number one, when the baby is old enough and during gestation is going to start to just press on things. Causing stasis, increases risk of blood clots and estrogen, high levels of estrogen increase the risk of developing blood clots, it has to do with the effects of estrogen on the liver and producing the coagulation factors don't worry about. So increased estrogen increases your risk of developing blood clots. That includes supplemental estrogen, estrogen you would take in as a shot. Birth control pills, a patch for birth control. That would be supplemental aka estrogen. estrogen therapy during menopause, for example, especially supplemental estrogen. So if we had to compare the risk factors between natural estrogen going up during pregnancy, and supplemental estrogen, like in pill form, for example, supplemental estrogen is worse when it comes to increasing your risk of developing blood clots. If anybody in here is on birth control, and you have estrogen in your birth control pills, go look on the box, it tells you right there on the box, you are now at an increased risk of developing blood clots. It's right on the birth control box. All right. Smoking, is there any stinking thing worse for you than smoking? It increases inflammation in the body. If you're on birth control, and you're smoking, very, very dangerous. Okay. So again, these are risk factors for again, excessive clotting. Now, most people don't have a clotting problem. Why? Well, number one, they don't have a lot of inflammation in the body. Number two, we produce things that naturally diminish clotting when it's not supposed to happen, that I have three things here up on the screen in your notes. This is something that we produce naturally anti thrombin. Now I don't need you to know all these different factors that it is inhibiting. Don't worry about it. But do know that anti thrombin is something that diminishes too much clotting. It doesn't stop it but it doesn't allow overclocking to occur. Same thing with heparin. We make it naturally it activates anti thrombin and then we have prostate cycling. This works more on the platelets and doesn't let them clump as much. So three things that we make naturally that diminish over clotting. But certainly there are people out there that clot too much. And so what can we do for them. anticoagulants otherwise known as blood thinners? I hate the word blood thinner because anticoagulants do not thin your blood. Not even close. So I don't even know why the hell they call them blood thinners. But they do heparin. We make it naturally. But we can give it to people who overclock. And how does it work? Well, it was said on the previous page activates anti thrombin. What else? Coumadin, warfarin, same exact thing, just different names for the same thing has been around for 5060 years. How does Coumadin work? It competes with vitamin K. So it diminishes what factors to seven, nine and 10. Again, you need to know that

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Eliquis and Xarelto along with Pradaxa are the new anticoagulants on the blog. They're supposedly better because they're not as broad as Coumadin and Warfarin are when it comes to what the effect. So they're only affecting one factor. And so side effects are supposed to be a little bit lower. They're actually supposed to work a little bit better. They haven't been around that long, maybe 567 years. How do they work? They Eliquis Xarelto both inhibit factor 10. What's the factor 10? It doesn't matter. You don't have to know what it is. All right, for Daksa inhibits thrombin you actually do know what that is. And then we have a couple over here that are going to work more on the platelets. Plavix blocks, ADP receptors. And so why is that so important? Well, let's go back to this picture right here.

This is the pretty picture. Or we can go back to my ugly picture as well. So ADP is something that we need to activate a platelet and there needs to be an ADP receptor that binds the ADP. Now turn the platelets into stars so that they can stick together. Well, what Plavix does is it blocks the ATP receptors. So Plavix is a watch of the ATP receptor starts with the name an antagonist and then we have aspirin. It's not an antagonist any receptor for what aspirin will do is it blocks we learned about costs, right? Cox one and Cox two earlier on in the semester when we're talking about prostaglandins. And so, aspirin inhibits one of the cycle oxygen aces which then inhibits thromboxane. This thromboxane we need throat boxing to activate platelets so it doesn't allow over activation of platelets. That's how that's how aspirin works. Now what? So know these in general what if somebody has a PE, you suspect them of having a p given their signs and symptoms, their history and are gasping for air or somebody's having a heart attack? And you suspect that it might be a blood clot that's causing a heart attack, or stroke or what have you? What can you do for them? You can bust the clot. How do you do that? A couple of things that can be given stricto kinase will bust the heart bust apart, it's clot. Tissue plasminogen activator will bust apart o'clock. And how do they do that? It activates plasma that we already see. plasmin remind you? You saw plasmon right here, which is something that's produced naturally in the body to break apart the fibrin clot, when we no longer need the fibrin clot. When the blood vessel wall has been repaired, well, we can still take advantage of this particular enzyme and that's what plasmin is in emergency situation when again, you suspect that a clot is causing the problem that your particular patient has. All right. Okay. Now what? I wasn't planning on doing blood typing yet tonight. You want to go where you want me to keep talking? That's a dumb question. All right, I'll see you guys on Tuesday.

Blood PM 2-15-22

Thu, 2/17 8:57AM 53:24

SUMMARY KEYWORDS

antigen, blood, antibodies, red blood cells, genotype, negative, genes, mom, positive, transfusions, baby, immune system, type, plasma, type o blood, cells, anti, recipient, attack, big

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So tonight, what we're going to do is we're going to finish up the blood chapter and then we're going to get right into the heart chapter. Exam number two, when is it? So we from tonight, and that's going to just be over the blood chapter is going to be 40 questions, you'll have an hour to complete that exam, which is a ton of time for 40 questions, I'll send an email, giving you all the details of that. So with that, let us start sorry, let us finish this chapter, we're gonna talk about blood typing, there's about 30 different ways to type your blood, the ABO system and the RA system. That's typically what what we see in clinical settings. So somebody asks you what your blood type is, you might say on B negative, the B is part of the ABO system, the negative the positive is part of the RH system. And so let us investigate that further. So we see all this stuff in the notes, abo system and some facts about it. And then the RH system and some facts about it. We're going to talk about it by looking at a couple of charts here. So here, what we have are a bunch of red blood cells. And here we have some antibodies. And down here we have genes, your blood type is dictated by your red blood cells, and specifically which antigens are in the membranes of those red blood cells. And once an adage, if you don't know what an antigen is, antigen is just something that can activate your immune system, that's all an antigen is, and just could be all kinds of different things. And so we have these antigens within the membranes of your red blood cell you are born with these, by the way, mom and dad are going to dictate which antigens you have in your red blood cells. It's dictated by genes, which is why I'm going to talk a little bit about jeans today. So here's a red blood cell, and it has the A antigen, and they made it circles. Here is a red blood cell and it has the B antigen, they made a triangles. If you have Type A B blood, you have both of those antigens in the membrane. If you don't have either of those antigens in the membranes of your red blood cells, well, then you have type O blood when it comes to the plasma, so though again, those are red blood cells. In your plasma, you may or may not have these antibodies that are specific for those antigens. If you have type A blood, you have antibodies that are going to attack the B antigen. And that's fine, because you don't have the B antigen in your red blood cells. And to remind you what is an antibody, an antibody is something that is produced by your immune system, its protein, and its job is to attack a specific antigen. So anti B attacks, antigen v. And again, anti B antibodies are found naturally in the plasma of people with type A blood. People with type B blood have anti a antibodies in their plasma, which is perfectly fine because people with Type B blood don't have the antigen. So that's again, not a big deal. If you have Type A B blood, you better not have either of those antibodies, because if you do, the antibodies are going to attack the blood, the red blood cells and we're going to talk about what happens when we have an antibody attacking an antigen, specifically these red blood cells. If you have type O blood, because you don't have either of those antigens, it's okay to have both of the antibodies in your

plasma. And you do and that's something that I need you to know. So what we see here in this little picture is a lot of these words over here minus the genotype stuff. Now what we can do is let's just talk about the positive and the negative is called the RH system.

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Here we have another antigen, it's antigen do it by the way, why is it called antigen A and antigen being an antigen D because the people that discovered it wanted to use the letters of the alphabet, that's all antigen D, if you have that present, and by the way, this is something I drew obviously, it's not as pretty as that. That's a red blood cell. That's a red blood cell. This red blood cell has the D antigen in it because it does this person has positive blood. If you don't have the D antigen, in the membranes of your red blood cells, you have negative blood. Most people have positive blood but 85% of the population has positive blood. Most people in this room have positive blood. What kind of antibodies do we have against the D antigen? We don't. We do not make anti D naturally. Can we make antibody? Yes, we can. I'm going to give you two examples of when that will happen. But nationally, the only antibodies we make against these types of antigens are the anti B's and the anti aids and again, this is all dictated by what mom and dad gave to you which antigens you're going to have. And then as a result, what antibodies you're going to have in your plasma. Now let's talk about genotype. C to do this, just to make it perfectly clear. So we'll have Type A. Let's do this up what type eight here at the top. So it's going to be type A blood, we'll do positive and negative in just a second. So again, your blood type is dictated by mom and dad. So I'm going to put mom here. And I'm going to put dad over here, mom, dictates your genotype your jeans. Well, because they're Oh site as part of who you were one time. And that sperm is part of who you were at one time. Each of those gametes has what half, but the genes correct. We know that haploid versus diploid, these are haploid cells, half of the genes are in this old side, half of the genes that are in this Oh side. So if you're type a, let's say that this O site that got fertilized by this particular sperm had the aging in it. And let's say that that sperm had the aging in it. Well, what are we going to get as a result, both of those jeans, if you have both a jeans, you're going to be typing. Let's say that mom's Oh, site, they got fertilized. Another one had an A in it, but dad's had an O. Now we have to genotype a oh, that's still type it. And then this will be thorough, let's say the Oh site had a no, in the sperm had an A, it's still going to be a. So there you go. There's type egg, we'll just be thorough, we'll do type B, really quick. Story is going to be the same mom and dad. Oh, saying sperm BB is going to give us that genotype. Bo, gives us that genotype. Bo, once again, that genotype we'll do a B and we'll do a B and O on the same page. Because there's only one possibility for each mom, here's dad, mom's Oh site might have had an A dad's had to be or mom's had to be and dad had the A in both cases, when those genes get together because well, sperm fertilize the egg. We have both of those genes, that baby's going to have Type A B blood type O there's only one possibility. And that is mom and dad both had to have an O gene within each of the gametes. And that's the only genotype possible for Type O blood. Now, you might be asking yourself, why is it that if there's an O that we don't have Type O if we have the other gene, either A or B. The reason for that is is that A is dominant, B is dominant, and always recessive. These are things that you probably learned in Junior High in high school, but we'll just go over it again. A and B genes are dominant. If you have a dominant gene, it's going to be expressed.

08:23

dominant genes are expressed phenotypically remember that Phenotype Genotype probably learned about it when it came to plants, for example, in your biology class. phenotype is the appearance of something, genotype for the genes that dictate what the appearance is going to be. So why is a

flower green? Because if it's a genotype, the green flower, that's its phenotype or how many petals it has, why do you have blue eyes or brown eyes or green eyes or hazel eyes? Why are you? Why is your hair the color it is? Why do you look the way that you do? Mom and Dad's jeans gave you those phenotypes. The phenotype of blood, blood typing is the blood type. That's the phenotype, Type A B A B O positive, negative. That's the phenotype, the genotype. Those are the genes. And again, if you have an A or a B gene, you're going to express those antigens in the red blood cells. And I made that perfectly clear. If you have an A, you're going to be a you're going to have the a gene, or I'm sorry, the A antigen, not the Oh, because the A dominates the, the B dominates the A B if you have an a gene. If you have a B gene, you're going to express those antigens because once again, the A and the B are dominant. Now, oh is recessive. The only way you're going to express a recessive gene is if Have both of them. So, both recessive genes needed for two recessive genes needed. And we put that two instead of both two recessive genes needed to be expressed, which is why the only way you are going to have type O blood is if you have both. Oh, from dad and Ofra. Mom, it's the only way it's going to happen. So far, so good. Now when, yes. When two O's, for example, possessive, they're still expressed, they will be expressed only if both of them are present in the big Latina. Typically, the phenotype would be type Oh, yeah, that's the phenotype. Now, when it comes to positive and negative, we have the D antigen now. So let's talk about the D antigen and genotype with the D antigen. So, positive versus negative blood type. And so how is this going to work? Well with positive blood, and again, we'll go mom and dad again. So mom in the designation here is a capital D in a lower script D. So mom could have a big D and dad have a little D, which is recessive, the big D is dominant. Or Mom could have the little D and dad have the big D, or they both can have big DS, but what we're going to get in the end is Big D, little D, or big D, big D, that's all going to be positive blood. So all of those are positive. If we talk about negative, there's only one possibility because the little D, that's going to be the recessive gene. And so little D, little D, that's going to be negative blood. And so once again, recessive and dominant, the big D is the dominant gene, the little D is the recessive gene. So big D is dominant. Little D is the recessive gene. So you need both of them to be negative. Now, how do I want you to know this stuff when it comes to Gino types, which are leading to again phenotypically the blood type? We'll do an example here. I'm going to show you how mom can have a positive blood, dad have B positive blood that they can make a baby. That's O negative. I'm going to show you that. So if mom has Type A can mom's genotype could it be this? Is that type a yes or no? Of course it is.

13:07

Is that positive? Of course it is. That's be positive, is it not? Yes. All right, mom and dad are gonna have a baby. In moms Oh site that gets fertilized. So moms Oh, sites can either have an A or an O gene. It can have both. And moms Oh site can either have a big deer a little gene in it can't have both. So they gotta have one of each. Dad sperm can either have a B gene in it or an O gene? Yeah, Bo. And dad sperm can either have a big D in it for a little DNA can have both. So let's say that mom's o site as an O. Let's say dad sperm has an O. Let's say mom's Oh site had the little D and dad's sperm. Had the little D is that OH negative? Of course it is. If you want to do Punnett squares, do Punnett squares. I think it's a waste of time. I think it's easy just to pick one of the two. That's all. If mom is this genotype in dad is that genotype. They can have a baby with any blood type. Right? That baby can be OH negative or positive. That baby can be oh a negative or a positive. Be negative be positive. A B negative. A B positive. I'll prove it to you. Well, we already established that the baby can be Oh, two O's, right one from mom, one from dad. Mom can give a big D dad can get the big D or it could be Oh Big D little D so they're both a positive right? A negative mom can give the A dad gives a no. Both give a little D that's a negative. Mom gives her a the sperm has an O in it. Both have a big D, or one has a big D, one has a little D, that's a positive, mom can give an O dad can give his B. Both of them give little DS, Bo, big D, big D, or b Oh, big D, little D, mon gives an A. So the OSI could have

had an A, the spring could have had a B, oh, say little D, spring little D, A, B, big D, big D, or A, B, big D, little D, they can make babies with any blood type. If this is their genotype, now, that doesn't mean that if mom is a positive a dad is be positive that they can necessarily make babies with any blood type. Why is that? Because this might not be their genotype. Their genotype might be this instead. So if mom is a positive, in dad is be positive? Could mom be this? Can dad be this? Are those both a positive and be positive? Of course they are. How many different blood types can this baby be? One and one only. Mom only has an eight to give. Right? She's got two eight genes as part of her genetic code. So her Oh side is going to have an A can't have anything else. Dad can only give a B because that's all he has to give.

16:34

The old sites gonna have a big D. In the springs gonna have a big D, what blood type is that?

16:41

Say be positive depends on the genotype. On the exam, if I give a particular blood type for mom, and a particular blood type for dad, and let's say it's a positive for mom and be positive for Dad, I want you to assume that we have these blood types with recessive genes in it, that's what I want you to assume. So if it's a I want you to assume it's a Oh, it's B, I want you to assume it's B. If it's positive, I want you to assume it's big D, little D, that's how I want you to assumption to be unless I tell you otherwise. So if I say if mom has a positive blood, baby has B positive blood give me all the possibilities that baby can be? That might be a question on the exam. And you have to assume that these are the genotype unless I tell you, if mom is a big D, big D and dad is big, BB Big D, big D, tell me all the possibilities. I might tell you what the genotype is. And if I do you obviously have to use that genotype in the question because that's what I gave you. But if I don't give you the genotype, you assume that we have these recessive genes within the genotype. That should be your assumption, because if you don't, you're screwed when it comes to answering the question properly, those kinds of questions. Yes. And so when it comes to practicing these kinds of things, just kind of randomly pick the blood types. And I might give you mom and baby you give me dad, or I might give you Dad and baby, you give me Mom, you got to figure it out the exact same way. And so just randomly pick these blood types for two of the three people. And then candidate. And it could be that when you randomly pick them, it might work or might not work. If we reverse these, let's say mom is a negative instead of a positive, and Dad is being negative instead of B positive. And Baby is O positive. Let's do the genotype here. Again, let's just we have to do the recessives. If I don't tell you otherwise. So that's o net or that's a negative, right? That's been negative, right? And oh positive is either that or that? Correct? Is that possible? Okay, so you just randomly pick something. That's not possible. But it's good that you recognize it. Like if mom is a negative and dad is being negative and the baby is all positive? Well, this is what happened. Because that's not daddy. The only way you can make a positive baby is that at least one of the parents have to have positive blood. If you have both parents with negative blood, it is impossible to have a baby with positive blood. Impossible. I'm not judging Mommy, I'm just stating a fact here. That's all I'm doing. So you can just have scattered on a piece of paper, all these blood types, close your eyes, hit your pencil on it, close your eyes that your pencil on another one and see if it's possible. And if it's possible, do all the types of blood types. That's the way I would study this fairly straightforward, just take one gene of each and put them together. Again, if you want to do Punnett squares do Punnett squares, if that if that makes it easier for you or if it's more comfortable for you. So anyway, I drew a little picture here myself showing what an a negative through, you know, all positive red blood cells are going to look like, I tried to match the

antigen and what it looked like in the original picture that's much prettier than mine, the antigen was round in the in the BMG was triangle. And then over here, this is a chart that you have in your notes, that summarizes everything in this chart to give you every possible blood type with the ABO system, RH system, I give you every possible genotype, I tell you exactly what antibodies are going to be in the plasma of these particular individuals. So that summarizes everything right there.

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So use it. What else that right there, I don't need you to know the specific percentages, because these percentages will change a little bit from year to year. But for the most part, from year to year, the percent of people without positive blood, there's going to be the most prevalent people. Whereas a B negative blood is the most rare of blood. So all I need you to know here is how they're ranked. That's all this will be a very straightforward question on the exam, there's really no critical thinking going on in this particular material right here. Just know the rank Oh positive and a positive and be positive and OH negative and only just the write down a lot. Just this is straight memorization right here. So if you could know that, please, that would be fantastic. What else do we need to know about blood typing, we need to know how to match blood types. When we transfuse blood, or cells or plasma into a patient. And so there, it's going to be very, very important. So we just got done talking about genes when now we're going to be talking about the antigens, and the antibodies and how important it is to know where these specific antigens are and where the antibodies are, what we can make them what we can't mix. Now, when it comes to transfusions, there's three kinds of transfusions that we're going to be covering wholesale transfusions, so let's put transfusions right here at the top of the page. So when you transfuse, you're going to be adding something to the patient. And so we can have whole blood transfusions. You can have cell transfusions, and you can have plasma transfusions. And so what do we need to worry about when it comes to all of these. So when I say cell, I'm talking about red blood cell. And so let's put over here as well. red blood cell, which has the antigen, of course. And then the plasma, which of course, has the antibody, or maybe it doesn't depends on the blood side. So if you're giving whole blood means you're given everything, you're given the cells and you're given the plasma. So what do you need to worry about? Well, you need to worry about what antigen is in that blood type. And what antibodies are in that blood type. If you're giving a cell transfusion, and you could just give red blood cells, you don't have to give whole blood. What do you have to worry about there? Well, of course, the antigen on the red blood cell, do you have to worry about the plasma? No, because there is no plasma? If you're giving plasma, what do you have to worry about? Well, you don't have to worry about the antigen in the plasma, because there is no antigen because there's no red blood cells in it. It's just the plasma. You have to worry about the antibody and the plasma that you are giving to a patient. And so now what we're going to do is that we're going to go over some examples of transfusions. And so we're gonna start with whole blood, and that's what we're going to spend our most time on. What you have to be careful of, is when you transfuse not to cause agglutination, or you want to try to avoid it at all costs, and so once agglutination Well, let's go back to our picture over here when it comes to antibody the job of an antibody is to attack antigens. And specific antibodies have specific antigens that they attack. Anti B attacks the B antigen Anti A attacks the antigen. Did I mention that there are no antibodies that I say that? Okay, good. So, that's the job of an engine. So we don't want to combine them. Sometimes we have to though. Ideally, you want to give somebody their own blood type, somebody has been negative, you want to give them be negative. But sometimes that's not possible because there's blood shortages all the time. And so because of blood shortages, even in hospitals, I'm not even talking about like in war, when people are in the fields fighting, where you know, you don't have a med unit following along with a whole bunch of blood. So they might have to be given the wrong kind of blood. But if they don't, they're probably going to bleed to death. So it's better to give them blood

as opposed to just letting them die. So sometimes it has to happen again, even in hospital settings. But again, ideally, you want to be able to give the person the same exact blood cells plasma that they that they have.

25:34

The reason is, is because if you start to combine the wrong types of blood, and cells in plasma, you get what's called agglutination. And that's because of an in compatibility between the antigens and the antibodies. And so what does agglutination look like? Well, what's going to happen is red blood cells are going to get clumped together, because the antibodies are going to attack the antigens within the bunk within the the membrane of the red blood cell. And then it's going to lead to hemolysis. That means red blood cells are gonna pop and die. consequences could be what, basically, from nothing to death. Those are the consequences. Now, death is rare. When it comes to no consequences at all, that would be rare too. But it could be something as simple as the person just has itchy skin. That could be something that occurs if you give them the wrong blood type to you cause ischemia, for example, because of mass clumping of the blood cells. Let me show you what it looks like. It's kind of a cartoon picture, but it gives you an idea. Here's an compatibility problem. Antibodies attacking these red blood cells. Now the red blood cells are clumped, and boom, so we have, so obviously, it's not ideal. So let's go through a couple of examples where agglutination is going to occur. And we're going to do whole blood transfusion. So we're going to start here. Again, donor blood should be the same type as the recipient. But that's not going to happen in these examples, these two examples that I'm going to give you now. So let us take let's go type O. So let's go to B type O blood. And we are going to and this is going to be me redraw that a little bit higher, this blood is going to be the donor blood. This blood is going to be the bag of blood that you get out of the refrigerator in the hospital. This is blood that was donated by somebody very kind that donated their blood. And so this is the donor blood. And we're going to give it to somebody a patient that has type A blood. So this is going to be what we call the recipient blood. This is going to be the blood of the patient, the patient is going to receive the type O blood. So let's talk about what's in type O blood. So I'm going to draw a red blood cell here. So there's our red blood cell, what's in the membrane, we're not going to do positive and negative right now we're just going to separate them out. What's in the membrane of type O blood A or B antigens? Which one? Neither. That's why it's type O blood type of blood. We don't have a antigen, we don't have the B antigen. That's why we call it type O right? Type O, neither A nor B antigen. What antibodies do we have? Yeah, both of them. So we have anti A, and we have anti B. And so let's draw those strong and green, I guess. And when you draw an antibody and make it look like the letter y, because well that's kind of what they look like. Let me be consistent with the shape. I think that's Anti A. And we have anti B, so we have them both. Now what about the person with type A blood, so let's draw their red blood cell. So their red blood cell is going to have obviously the H antigen in it. And the A antigen is a circle. Let me be consistent. I want to draw it the same way I had it here. So I made it blue. So let me make it blue here as well. So there's our E antigen. You know, I'm going to make the antibodies black. And I want to make them green because I had something else that was green. So Anti A and anti B. So Anti A and anti B those are antibodies. And so what antibodies do we have in type A blood? Anti B, right? I'm gonna draw some anti B's over here. Now something else to keep in mind. Antibodies do not attack do not attack antibodies, antibodies attack antigens, just make sure that we keep that in mind. So, this blood is going to be given to that blood is agglutination going to occur yes or no?

30:23

Yes.

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Because once again, that is the A antigen, right. And we have anti a over here. So, Anti A is going to end up in this person circulation, and we are going to attack. So, anti a donor blood we'll agglutinate. A red blood cells, that's what's gonna happen, we're gonna get an agglutination reaction. Now what we're going to do is we're going to reverse, we're going to have type A blood, we're going to give to somebody with type O blood. And I'm going to show you how this is worse. This actually the way that's drawn up, it's really not that bad. This person might not feel much of anything. But this next person could be much more severe, we're going to reverse it. So we're going to go type A blood.

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And this is going to be the donor blood is going to be given to type O blood. And this is going to be the recipient blood the patient blood.

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And so we're going to go through our little wriggle room, we're going to talk about what's aware. So our type A blood, of course, has the B or I'm sorry, the E antigen. And that blood also has anti B it'll be here with typo, the red blood cells have nothing. And we have both antibodies over here in this person's blood. So there's our Anti A. And here's our antibody. And so are we going to get agglutination? Yes, again, this blood is going to be donated to that recipient. And what's waiting in type old blood circulation is anti A, it's going to attack these red blood cells that are going to be introduced into that circulation. So in this particular case, and Ta is going to attack the red blood cells that are now all of a sudden in this person circulation, whereas before they certainly weren't. And so in this particular case, anti a attack a red blood cells from donor blood. And this is worse. Why? Worse as compared to the example that I gave you initially? The reason that this is worse? And so here's the reason why is it worse? Oops. The reason is this. What's doing the attacking are the antibodies from the recipient. Let me put recipient over here by the way, so I'm going to erase that put recipient and we're going to make sure that we're 100%, clear here, recipient patient Anti A agglutinate. A red blood cells from donor. I just wanted to put the word recipient in there just to make sure that we're clear here. So why is it why is this worse? The reason is this is because these antibodies here in the recipient are part of the immune system at that particular individual. Why is because we have activated not that it wasn't already activated, but it's a good word. It's a nice visual word activated the immune response the immune system

34:40

of the recipient. I'm going to show you that that's not the case in the original.

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These are the antibodies that did the attacking and those antibodies are once again in the recipient. What did the attacking here? Did this antibody do the attacking? No. It was an antibody that was introduced into this person circulation From the donor. So we're not activating the the the immune

introduced into this person circulation From the donor. So we're not activating the the the immune response in this person's blood at all. We don't want to do that we don't want an overactive immune system, bad things can happen because of that. This is going to cause an agglutination reaction that is worse. And so here we had the potential where things can just go south, doesn't mean it's going to, but of these two, this one's worse. And so what you don't want to do is activate the immune system of the recipient of the patient. So if somebody has type O blood, they have both those antibodies. So if you give them type A blood type B, blood type A B blood, you're activating their immune system, the only blood that you can give them where that's not going to happen, is more type O blood. If somebody has type A blood, you don't want to activate those antibodies. So what don't you give them? You don't give Mo? Or you don't give him I should say type B, you don't give him type AB? Oh, it's okay. Because that's not going to activate the immune system. Because there's nothing to attack these red. But what are these red blood cells? Nothing. So there's nothing that these red blood cells are going to have that will activate that person's immune system. So typo was completely fine, not completely fine, still gonna cause agglutination. But it's not going to activate the immune system. So please keep that in mind. Now what? So that's whole blood. But again, don't have to just give hold blood transfusions, we can give cell transfusions. And when it comes to cell transfusions, we're just talking about the red blood cell. So we're going to give these red blood cells to a recipient to a patient. And so certainly what you have to worry about is the antigen on the red blood cell. And so when it comes to the cells, let's just do this really quick. So cell transfusion. When I say cell, again, I'm talking about red blood cells. So a cells Well, the antigen what blood type as the Anti A. So A cells do not give to do not give to what blood type? B, B has anti A, right? Correct. So type B blood. So a type B recipient.

37:46

Anybody else? That's going to have again, anti B. Oh, correct. Does an O have anti B? Yes. So do not give a sales to somebody with type B blood? Don't give it to somebody? What type of like, can you give it to a B?

38:08

Yeah, what's it what everybody's to say B hat? Nada? Nothing. So you can give it to them? The cells do not give to Taipei. Yeah. Typo again. Yep. What about a B cells? Who can you give a B cells to do not give to

38:39

anybody except somebody who has a B blood, that's the only blood that you can give them to? Type B has anti A, right? Type A has anti B. And type O has both of those antibodies. So do not give a B cells to type A, type B or type O can't? Because auntie a is present in those in those blood types. What about O cells? Given anybody you can give Oh sales anybody? What because what antigens do Oh sells that. Now again, we're not taking into account positive and negative we're going to talk about that. I'll just put can be given anyone can be given to all blood types. All right, yes. And we can do the same thing for plasma. And I'll make you do it. So universal cell donor, typo negative. There's a negative I got a little bit more complete in the notes. I'm going to tell you the difference between the negative and the positive and who can get what who can't get what when it comes to positive and negative blood. But if you have OH negative cells, let's go back up to the pretty picture I drew there's so negative What does Negative have nothing, no antigens whatsoever. In this particular picture, I do

the ABO and the RH system. And I show you the red blood cells in which the antigens are going to have, you can get this red blood cell to anybody because it doesn't matter what antibodies they have, there's nothing to attack. And when it comes to donor cells, here's my donor cells. Right here, universal recipient would be A B positive blood if you have a B positive blood. And again, I'll talk about the A and the B, or I'm sorry, the the positive and the negative A B, no antibodies. Right? No antibodies, nothing to attack anybody. So if you have type A B blood, you can get cells from everybody. Positive and negative. Again, it's a slightly different story, we'll get to the positive and the negative story in just a little bit. And we can do the same little chart once again, for plasma. So we can go through that. And so where's my plasma right here, universal plasma donor. Of course, a B, what antibodies is a B half. None then have any antibodies. So if you give that plasmid, somebody, those antibodies can attack anything Correct. Universal plasma recipient, what blood type can get plasma from anybody? Type O, because the red blood cells don't have any antigens on. So if you have type O blood, your red blood cells are absent of antigen. Nothing can attack them. You can get plasma from somebody that gave blood that had type a type B, it doesn't matter. Because there's nothing to attack. All right, let's take a break. When we come back, we'll get into the positive and the negative. And I'm going to give you an example of another hemolytic anemia. Folks, all right, so let's finish this up. And we're gonna finish it off by talking about now, positive negative blood and some agglutination problems there. So I'm going to make a couple of statements here. Number one,

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negative blood, or cells can be given to a recipient a patient. With positive blood, that's 100%. Fine. That's not to cause any problems whatsoever. Negative can be given to positive.

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But not the other way around positive blood or cells cannot be given to a recipient with negative blood. And why? Well, the reason is this. Again, we don't make antibody naturally Correct. Doesn't matter. If you have positive blood or negative blood, there are no anti D antibodies in your body naturally. But we can make them. And the only way that that's going to happen is this. So if we go back to our little pretty picture over here, and this one, we can do this one, because we have the DNS, you know the page. So if somebody has positive blood, they have these DNS, that's just keep it simple, we'll just go here, somebody has positive blood, they have these damages. And that's floating around in their circulation. Their immune system is familiar with that antigen. And because it's familiar with it, the immune system isn't going to respond to it. That's how the immune system responds, by the way, it responds to foreign things. It responds to foreign antigens. So a virus, for example, has antigens on it that are foreign. And so the immune system attacks, if you have positive blood, you don't have something foreign within the circulation, because the circulation the immune system, I should say is familiar with it. But if you have negative blood, you have red blood cells that are floating around with no D antigen on them and the immune system is not familiar with that D engine whatsoever. And so now, all of a sudden, if you introduced these red blood cells into somebody with negative blood, the immune system is going to respond create antibody, and now we have antibody we have an immune response. So, why because the D antigen is foreign to the immune system of a recipient with negative blood, their immune system has never in its life, seen that antigen. And the job of the immune system is to destroy foreign antigens. That's how it works. When you give an organ transplant, for example, you need to have a match. What does that mean? It means that the organ that you're giving that patient has to have the anthracene antigens of the patient, if not, the organ is going to get rejected. Well, what does that mean? It means the immune

system destroy the Oregon that's why you just can't give anybody a heart, or liver or a lung, it has to match. And this is the reason because the immune system responds to foreign things. Alright, so damages for the immune system of a recipient with negative blood. And TD

45:59

will therefore be produced in the recipient. Now, really, at that particular point time, it's not the biggest deals.

46:15

But if you give that person positive blood again, it's going to be right, because that entity is going to be sitting there waiting for another antigen D. And it's going to attack it. That's the issue. Last but not least, give you another example of where we can have a problem with the D antigen, and antibody to condition called erythroblastosis fetalis. This happens in the womb. This is the scenario and it's the only scenario. Mom has negative blood if mom has positive blood, this cannot happen. So here's our scenario with the visceral blastocyst. I'm just gonna abbreviate it E F. E, F. So the scenario is this mom has negative blood doesn't matter what kind aibee aibee pilot doesn't matter AB negative B negative or negative doesn't matter. And dad has positive blood so a dad has negative blood a mom has negative blood this can't happen. It has to be mom's negative dad as positive and first baby let's learn how to spell baby. First baby has positive blood if that baby has negative blood, this isn't going to happen. So this is the scenario and certainly can a baby B have positive blood if mom is negative and dad is positive Of course. Now at this particular point in time we don't have a problem here's where the problem can arise so here's where the story is going to begin. So with this scenario right here if you during the birthing process so if during birthing which can get very bloody whether it's a vaginal birth or a C section we have blood involved here. Moms bleeding baby can be bleeding if during birthing babies baby's positive blood gets into mom's negative circulation what's going to happen mom produces anti D right? At this point is it a problem for that baby yes or no? No babies outside of mom right now baby couldn't care less what's going inside a mom circulation it's not going to affect baby whatsoever. Candidate it affect the next baby if the baby's positive. Yes. So at this point, we don't have a problem.

49:04

If the second baby has positive blood mom's Auntie D will agglutinate. Babies baby number two that is second baby babies. D because they're positive d red blood cells.

49:41

This could cause big problems to the baby. It can cause miscarriage and a number of other things that we're not going to get into what would need to be done here? Oh by the way, this can be prevented. I have it in the notes mom during the pregnancy can be given medication. It's not a vacation. It's a shot called Rogan. And what Rogan does is it suppresses the immune system from making antibody. That's its job. Michelle will be given a couple of times during pregnancy and things should be okay. Now let's say that things start to get a little out of hand for the baby that's in the womb, what can they do? They can do exchange transfusions. They can do it through the umbilical

cord. And that's pretty much the course of action that they would do. And by the way, something else that I need to mention, let me see if it's here. This is a hemolytic anemia. So I told you all else right there. So unbolt. Remember the hemolytic anemias. Let me remind you remember this. And then we went over here when we talked about the different anemias Thalassemia hemolytic Seimone, sickle cell hemolytic, which can lead to what? A pre Hispanic jaundice correct. And I told you at the time, I was going to give you two I was going to give you a third one. Well, now is that time I'm giving you the third hemolytic anemia. Can this baby become jaundice? Yeah, can this baby's bilirubin levels begin to get a little out of hand? Yeah, what could this baby developed starts with the cake Kernicterus remember that? This connector is dangerous, it sure as hell is. And so this can become an emergency situation. A lot of times with this, they will deliver the baby early, like in the early 30s. Normal gestation is around what 3839 weeks, they might have to deliver this baby in about 32 ish weeks, but they got to get the hell out of there. To treat it properly. Can you do exchange transfusions through the umbilical cord? You can't? Is it that is that ideal? It's not ideal. It's better to have the BB in hand and do the exchange transfusions that way. So know the scenario. Know what can happen as a result of the scenario. Something else I don't know if this is in your notes, I have it here in red. This could also occur if the female already has the antibody. So let's say that this female has negative blood and she asked to and she was given positive blood she could have made and she could have produced antibody well before the pregnancy. So that's the possibility. So the first baby could have been in danger. Not the way that I drew it up here, but certainly this baby could have been in danger. If this female this this mom was given positive blood before the pregnancy even happened. Okay, so that's what this is all about right there. Okay, could also occur if a woman already has antibody prior to the first pregnancy? All right, yes.

52:42

When do people actually figure out that this issue for the second pregnancy they get blood testing?

52:47

If mom has negative blood? We're gonna give a real game. Yeah. Even if Dad is negative because you know. You never know. All right. So yeah, typically mom with negative blood just gets Rogin. Okay. All right. That's that for that chapter. And so that's it for exam number two, it's over for this the material. So what I'm going to do here really quickly