EPISODE 41 - Minerals

Transcript

So I don't know about you, but I remember sitting in my micronutrient metabolism class and feeling so lost. I asked my teacher for permission to use a recorder in her class. Thankfully, she said yes because she talked super fast and my hand couldn't write fast enough to keep up with her lecture. I used to have such nice penmanship and I blame college for my chicken scratch now. But this teacher was feisty, tough, ridiculously smart, and very much misunderstood. Everyone was so scared of her class because she was tough. Her class was far from easy. I remember she walked in with a few pieces of paper in her hands. That's it. Nothing else. She didn't use the overhead projector. The whiteboard was never used in her class. She stood in class and talked about metabolism. No pictures, no pathways - just lecture. She never smiled in class. She wouldn't laugh. She was very serious about teaching us the material. As a visual learner, it was so hard for me to follow. I'd listen to her and write frantically on my paper everything she said. I remember when we were learning about iron. Ferric, ferrous, ferritin. Which form was it? How is it stored? Where is it stored? I'd go home and listen to the recording. Still confused and not sure what she said. So I had to create pictures and pathways to make sense of everything. But I really liked this teacher. I would take advantage of her office hours. She was totally different when we were one on one. Not at all like in class. She was still tough. She'd quiz me when I was in her office and to my surprise, I'd get the answers right. Then she'd say, "See? You know it". But that's not what my exams showed, and it certainly wasn't how I felt. I think it also helps when you see someone as a human being. At least it did for me. I'd see her at the gym where I worked out at the time. She had a personal trainer working with her and she'd laugh and smile. I saw a totally different side of her. I'd always go up and talk to her. Crack a joke to get her to smile. I have no idea where she's at now, but I'll never forget her. Not just because she kicked my behind in that metabolism class but because I felt she was really misunderstood and because I learned so many lessons from her.

Intro and Music

Hey there. In this episode, you're going to get a review of minerals. You learned about vitamins and minerals in school because it's important stuff. You're the new nutrition expert, and it doesn't end there. You really have to know your macro and micronutrients as a dietitian. And they're fair game on the RD Exam. I know they aren't easy to remember, and some of the pathways are hard. Even more than that, there's so many of them. But my goal of this episode is to do a review for you, since hearing information can help things stick. It's a way to learn, and one of the reasons I started the podcast. At this stage, though, I know it isn't the first time you're going to learn about minerals. But as part of the review process and to help you with any questions, I wanted to cover it

so you have that listening part of learning. I previously did an episode on vitamins. So if you need a refresher on that, check out episode 21. I thought it was too much to cover vitamins and minerals. in one episode. Your brain shuts off or gets sluggish after a while. I get it because it happens to me and I don't think I'm alone in that. So this episode here is dedicated to minerals. As a reminder, there's major minerals and trace minerals. I'm going to start with the major minerals, which are potassium, magnesium, sodium, phosphorus, and last but not least, calcium.

So let's start with potassium. There's a lot to say about potassium, but I'm going to summarize it. If you work in clinical, you'll get a lot more experience with potassium because it plays a role in a lot of things we do as clinical dietitians. It's a vital mineral in the body. Potassium is an intracellular mineral and it's also an electrolyte because it has a charge. It's positively charged, and the majority of potassium inside the body lives inside the cell. Inside the cell is called intracellular. Potassium plays a role in cell metabolism, transporting glucose into the cell, and protein and glycogen synthesis. It's also involved in the electrical function of the heart.

The balance of potassium inside and outside of the cell is really important. Potassium needs to be monitored when feeding someone who hasn't eaten in a while. Refeeding syndrome is a risk in those people, and one of the signs is a low potassium level. Even a small shift can be life threatening and even fatal. So the levels of intracellular potassium, that's the potassium inside the cell, and the levels of extracellular potassium, which is the levels outside the cell, is really important. The normal level of potassium in the body is 3.5 to 5 meq/L. Keep in mind, if you're listening from another country, the unit of measure might be different. Food sources of potassium are sweet potatoes, potatoes, tomatoes, bananas, beans, orange juice, and prunes. There's a lot of sources of potassium, but those are just some of the foods that are higher in potassium. Elevated potassium levels, which is called hyperkalemia, most often happens when someone has kidney disease. People with kidney disease need to monitor potassium intake because it can't be excreted by the kidneys when they're not functioning properly. So that means potassium needs to be restricted in the diet. Symptoms of hyperkalemia are neuromuscular issues , cardiac arrhythmias, muscle twitching, cramping, and acid based imbalance. Low potassium levels, which is called hypokalemia, is often caused by diuretics, which are given to help remove excess fluid in the body. It's also caused by GI tract losses from diarrhea and vomiting. Symptoms of hypokalemia is lethargy, weakness, cramping, arrhythmias too. Just like with hyperkalemia. When levels are low, potassium can be given to bring the levels back up to a normal range. It can be given in an IV form. If you're working in the hospital, the terminology used would be repleting the electrolytes or replete potassium. That's the terminology we use when we need to give potassium to bring it back to the safe levels. Potassium levels must be taken very seriously. I had a patient one time who had kidney failure and was receiving hemodialysis. They were really busy, so they skipped their hemodialysis that day and decided they would go the next day. Well, the

patient had a massive heart attack because their potassium levels got so high, which threw off the rhythm of the heart. The patient ended up passing away. They had anoxic brain injury, which is when the brain goes too long without oxygen. It was so tragic because this person was so young. Unfortunately, this isn't the first time I'd seen it. It happened so many times. It's just that this patient really stands out to me, I think because this person wasn't even 40 years old. So potassium balance is very important, and maintaining safe potassium levels is essential for safety. So if you work with people who have kidney disease, you know anybody who's getting dialysis, it's so important that they go to their sessions and they don't skip, because potassium is so important in the body but when the levels get thrown off, they can be very dangerous and very detrimental to our health and well being.

Okay, let's move on to sodium. Sodium is a mineral, and it's also an electrolyte, too. It's a cation, which means it has a positive charge. And sodium plays a major role in fluid balance and fluid distribution. Remember how potassium lives primarily in the cell? Well, sodium likes to be predominantly outside the cell in the extracellular fluid. Sodium levels are controlled or regulated by the kidneys and the central nervous system. The normal sodium levels are 135 to 145 meq/L, and the sodium levels should be maintained in this range. But sometimes things can happen. When sodium levels drop, it's called hyponatremia. This is one of the most common electrolyte abnormalities and can lead to hospitalization. I've seen it many times. Symptoms of hyponatremia can range from mild symptoms such as nausea, vomiting, and feeling disoriented to more severe symptoms like confusion, altered mental status, or AMS is the abbreviation we use seizures, coma, respiratory distress, and even death. When I worked in pediatrics, I used to have babies admitted sometimes with hyponatremia. Most of the time it was because the infant formula wasn't being mixed correctly. Many times it was being diluted. It's so important that mixing instructions are followed for that reason. The sodium levels would be corrected, and I'd educate the family on how to mix infant formula according to the manufacturer's instructions. So that's hyponatremia. Hypo meaning low. Hypernatremia, on the other hand, is when sodium levels are elevated. The symptoms are similar, so headaches, dizziness, seizure, and if the levels are too high, it can result in death. The cause of hypernatremia can be fluid loss that exceeds sodium loss, excessive sodium intake, and certain medications like diuretics can throw off the balance. Dietary sources of sodium are processed meats, canned foods, chips, salted pretzels, and fast food. Since sodium homeostasis is controlled by the kidney these when people develop kidney disease, sodium needs to be restricted. Same thing for hypertension and heart disease. A low sodium diet is usually around 2 grams sodium or as low as 1500 milligrams. Here's a side note about salted pretzels. I worked for several years in a pediatric cardiology clinic. Several cardiology patients are on diuretics. Depends on the heart condition but excess fluid puts pressure on the heart. So some of them, depending on what's going on with them, might need diuretics. I'd often hear the doctors telling the patients to eat salted pretzels. I asked one day, Why salted pretzels? And they said, because it's a great source of sodium and it helps

their electrolyte balance. I thought it was so random, but it's true. Most people, especially kids, will eat salted pretzels. And they're crunchy carbs. So that's another thing that's appealing to kids. And it's also a great option. So there you go. That's sodium in a nutshell.

So let's go over magnesium. Magnesium is found in bones, soft tissue, skeletal and heart muscle, and it plays a role in glucose and protein metabolism, fatty acid synthesis, heart rhythm, muscle contraction, nerve impulses, all kinds of things. And it's important for bone structure. The amount in the body is regulated by the GI tract, the kidneys again. Do you see the trend? And bones. Magnesium is absorbed in the jejunum and the ileum. When there's not enough magnesium in the body and the serum magnesium levels drop, it's called hypomagnesemia. Hypo, again, for low. This happens when there's not enough dietary magnesium or when someone develops protein, calorie malnutrition. Also, GI issues that result in malabsorption can contribute to low magnesium levels as well as alcoholism. It can also be caused by certain medications. So that's something else to keep in mind. It makes me think about commercials for medications, where the majority of the commercial is all the side effects. Well, it's amazing how many things can be impacted by medications. And that's why we're here, because drug nutrient interactions are a big deal. Symptoms of hypomagnesemia are muscular weakness, convulsions, seizures, arrhythmias, but it can also include nausea and vomiting, which are pretty vague. A lot of symptoms with these deficiencies are similar to each other. So this is why looking at the patient from a big picture perspective and taking a look at their intake, medications, their biochemical panels, like their labs, and what's going on with them as a whole, really helps you determine what's going on with the patient. It helps you kind of nail down what's going on. On the other hand, the opposite of hypomagnesemia, is hypermagnesemia. And this happens mostly in people who have kidney failure, because, remember, just like with sodium and potassium, and, as you'll learn, with phosphorus, which I'm going to go over next, the levels in the body are regulated and controlled by the kidney. So the kidney determines what needs to be retained and what should be excreted. If the body needs to retain magnesium, the kidneys will decrease excretion, but if the levels are high, the kidneys will remove more. This process, though, can't happen if the kidneys aren't working properly. So something to keep in mind if you're working with a patient who has kidney disease. Signs of toxicity or elevated magnesium levels are flushing, dehydration, drowsiness, and in severe cases, it can lead to cardiac arrest, coma and death. While toxicity and deficiency aren't always related to inadequate or excessive intake, it's important to know foods that are good sources of magnesium. And foods that are rich in magnesium are tofu, green leafy vegetables, whole grains, nuts and seeds. Again, there's other foods, but those are foods that are rich in magnesium.

So let's talk about phosphorus. Phosphorus is an anion, and it's an intracellular anion. Remember, anion means that it has a negative charge. Phosphorus is important for bones and cell membranes. It's also necessary for ATP,

which means it plays a role in glucose metabolism. Phosphorus in the body is controlled by the kidneys. Phos levels are also controlled by absorption in the small intestine and hormonal regulation with regards to bone deposition. So for people with kidney disease, phosphorus is another nutrient that needs to be reduced in the diet. When there's a deficiency in phosphorus, it's called…Can you guess it? Yep. Hypophosphatemia. This can happen if there's not enough phosphorus in the diet. It also happens when someone has vomiting, diarrhea, alcoholism, and malnutrition. Hypophosphatemia also happens when someone who is malnourished receives nutrition, most commonly in the form of parental nutrition. But not always. It can happen with other forms of nutrition too when someone is extremely malnourished. Low phosphorus levels are a potential sign of refeeding syndrome. If someone has low phos levels, they might experience breathing issues, neurological issues like altered mental status and decreased heart function. And if the low phos levels aren't addressed and corrected, it could be deadly. So super important, and especially if you're working with someone who's malnourished and you're giving them nutrition, you have to pay attention to the phosphorus levels. On the other end, hyperphosphatemia happens when there's too much phosphorus or the phosphors are elevated. So it could be seen in people again with kidney failure, because remember, the phos levels are controlled by the kidneys. So if they're not working well, like with the other minerals, then the levels build up and the excess phos isn't being removed from the body. Symptoms include altered mental status or confusion, cardiac arrhythmias, and bone pain. Also, people with kidney failure and high phos levels will sometimes complain of itchiness. One of the things we give patients with kidney failure are phos binders. A common phos binder is calcium, because it binds with phosphorus and it helps control the levels. Foods that contain phosphorus are dairy, beans and lentils, meats, whole grains, seeds and nuts. An easy way to remember if there's phosphorus in a food is this - if the food has protein, it also has phosphorus. So when patients have kidney disease on dialysis and they need more protein, it's harder to limit phos intake because the patient needs enough protein. So it's kind of one of those things that's harder to balance. And working with a physician, a dietitian, the interdisciplinary team, we all come together to come up with a treatment plan to help the patients control their levels as much as possible.

Moving on to calcium. Now. Calcium and phosphorus are friends. They work closely together. They're kind of buddies. Phosphorus is an anion, like I said, which has a negative charge. Calcium, on the other hand, is a cation and has a positive charge. Calcium plays a role in bone health, too. It helps keep bones strong. It also plays a role in nerve and muscle function, cardiac and smooth muscle function, and blood clotting. Most of the calcium in the body is stored in the bones and teeth. And common food sources of calcium are dairy products like yogurt, cheese and milk, fish with bones, almonds, and calcium fortified orange juice. Tofu is also a source of calcium. When calcium levels are low, it's usually not because of inadequate intake of calcium. Low levels are usually because of low magnesium levels, high phosphorus levels, or certain medications. So it's usually something else is going on. Symptoms of low calcium include muscle spasms, muscle cramps, heart arrhythmias. Also, brittle

nails and hair loss are a sign of calcium deficiency. So that's another reason why conducting a thorough nutrition assessment and completing an NFPE or a Nutrition Focused Physical Exam is really important.

So that's your review of the major minerals. These are needed in larger amounts than the trace minerals.

Before I move on to trace minerals, I want to quickly mention refeeding syndrome. These nutrients, these electrolytes, are important to be aware of when feeding someone who's malnourished or has gone a long period of time without food. I have a whole episode dedicated to refeeding syndrome, so if you want to learn more about it, check out episode 18. But I want to make sure I quickly mention it here too. So with refeeding Syndrome, there's an intracellular shift of magnesium, potassium, phosphorus, and glucose. And it happens when glucose is given after a period of starvation. Because of the intracellular shift, it leaves lower levels in the serum and can be devastating if not corrected. Also remember that phosphorus is needed for the production of ATP - Adenosine triphosphate. So phosphorus gets sucked up and used right away, which is also a reason it gets depleted. So when you give the glucose, it quickly takes phosphorus because it's needed in the process of making ATP. When the levels drop to dangerous levels, these nutrients, these electrolytes, need to be repleted and usually in an IV form. So again, if you want to learn more, check out the episode on Refeeding syndrome. It is a condition that happens and it's something to be aware of.

So the trace minerals are iron, zinc, copper, manganese, selenium, chromium, iodine, fluoride, and molybdenum. I know there's a lot. I'm just going to do a review. This is a summary of the minerals, but hopefully by hearing me talk about it, it'll help you for when you go in there and take the exam or if you're already a dietitian and you need a refresher on minerals (I think we all kind of do from time to time), this is a good review and I'm going to be honest, preparing for this episode, I had to do a review of all of these minerals. A lot of them I use regularly, so I'm more familiar with them. But things like molybdenum. I don't do a lot with molybdenum, but I have a great story. So stay with me till the end. And I'll share an important story, a very special patient that I had that had a condition that was related to molybdenum. So stay with me.

Okay, starting with iron. Iron is a component of hemoglobin, which has the function of carrying oxygen throughout the body. I'm always cold, and I've had my levels checked regularly because that can be a symptom of anemia. Iron is important for growing children and babies because it's needed for development. Lots of change in growth happens during pediatrics and adolescents, so adequate iron is really important. The body stores iron in the form of ferritin, and it's stored in the liver, muscles, bone marrow, and spleen. The total amount stored is around 2-4 grams. The needs vary depending on several factors such as age, whether someone is menstruating or not, and certain medical conditions. The way we get iron in the body is from the diet, which is

why you, the dietitian, are so important. This is when you get to use your superpower to help people. There's two different types of iron in food - heme and non heme iron. Heme iron is more readily available and absorbed. About 15% to 35% of ingested heme iron is absorbed. Non-heme iron, on the other hand, needs a little bit more help, kind of like a buddy system, because only about 2 to 20% of ingested non-heme iron is absorbed. So non-heme iron needs help. That's the way I think of it. It kind of needs the buddy system. As a kid, we were never allowed to go anywhere unless we followed the buddy system. We always had to have somebody with us. So I kind of think of non-heme iron as that. And the best buddy for non heme iron is vitamin C. Keep in mind that iron is also best absorbed when it's in the ferrous form. Factors that influence absorption are acidity, vitamin C, like I already mentioned, hydrochloric acid, lactic acid, aspartic, and glutamic acid. These all influence how readily available iron is in the human body. Food iron is in the ferric form, and it's reduced in the stomach to the more absorbable form, which is the ferrous form. Iron must be in its ferric state in order to leave the enterocyte and bind to transferrin. I did a whole episode on anemia, which is such a popular topic, so check out episode 32 if you need a refresher of anemia. But to do a quick summary, iron deficiency leads to microcytic, hypochromic anemia. The mean corpuscular volume drops. Also, with iron deficiency anemia, the hemoglobin concentration is low. Iron deficiency anemia has the following characteristics: small, pale, hypochromic, microcytic cells. If you're asked what the characteristics are of iron deficiency anemia, small, pale, hypochromic microcytic cells would be the right answer. When someone has iron deficiency, they might have tachycardia, which is a fast heart rate. They might experience fatigue, sleepiness, headache, anorexia, and feeling cold. Food sources of iron include meat, seafood, beans, dark leafy, green vegetables, broccoli, peas, bran, and enriched grain foods. Just like some things, such as vitamin C can help increase the absorption of iron, there are some other things I like to call iron thieves that interact with iron and result in decreased absorption. Things like phytic acid found in grains, oxalic acid in spinach, chard, tea and chocolate can all interact with iron and decrease absorption. Also, polyphenols in coffee, tea and cocoa interfere with absorption, and so does calcium, zinc and manganese. Zinc is often recommended in clinical illness and it's a really important nutrient. But when someone taking zinc, you have to keep in mind that it can affect iron absorption. Balance is key. Also, chromium toxicity can contribute to iron deficiency. I have a friend who's a huge tea drinker. She drinks tea all day long. It's one of those things. It's her favorite thing, and she's been like that ever since I've known her for almost 20 years. And so she is somebody who, just like our patients, you have to work with. I knew when she told me that she had iron deficiency and she was anemic that it was because of the amount of tea she drinks. Also her diet is not the best. So with her, telling her to drink less tea, it wasn't going to work, I knew the answer would be no. So I gave her some strategies on maybe how to time her tea consumption, putting her meals at different times and not drinking tea when she's eating foods that are rich in iron and also promoting the consumption of vitamin C foods when she was eating foods that contain iron. So it's just like when you're dealing with your patients and clients and anyone that you'll be working with, you got to kind of figure out where they're willing to budge and where they're not willing to

budge and come up with a plan that can help them hopefully improve their levels. There are iron supplements available on the market like my friend was taking, but they shouldn't be taken without speaking to a healthcare provider because too much iron can be a problem. Iron supplements can have adverse effects such as nausea, gastric discomfort, and constipation, too. Pregnant women are screened for iron deficiency and may be recommended to take an iron supplement, which can be really uncomfortable because pregnancy can cause constipation. So to have to take a supplement that can further cause constipation can be quite undesirable. There are different types of supplements, and some are more easily tolerated than others. Again, this would be something that you'd discuss with the interdisciplinary team. Now, let's talk a little about toxicity. I've had a couple of patients with iron toxicity, which can result from excessive iron intake more than what the body needs. Usually it happens from supplements, but it can happen due to a condition called hemochromatosis, which is a genetic disorder. This condition increases iron stored in the organs, usually in the liver, and it can cause damage to the organs. So it's something to keep an eye on. You might have somebody if you have someone who has iron toxicity, it might be a genetic condition that you're working with. So that's iron in a nutshell. But before I move on, I have a quick story, because there's a lot to cover. So, several years ago, I was seeing a patient who had MUSD or Maple Syrup Urine Disease. He was an adult and someone I'll never forget. He was hilarious and always made me laugh. Every visit I was cracking up. When I was seeing him gummy supplements were fairly new on the market, and none of them contained iron, which in this case was a good thing. My patient came to the clinic, and his mom told him to tell me what he had done. He looked at me and told me his mom was lying to me as he was laughing. The dynamic was always hilarious, and anytime anyone said anything, he would always say, she's lying, or he's lying. Anyways, he told me someone, an unnamed person, forced him to eat the entire bottle of gummy vitamins. I asked him who told him to eat the whole bottle and he said it was his neighbor. The mom was laughing and intercepted the conversation and told him to tell me the truth. I guess he liked to blame the neighbor for everything. And the neighbor was an elderly lady and helped his mom whenever she needed to go somewhere because he always had to have somebody kind of keeping an eye out on him. At the end of the conversation, he sort of admitted that he had made the decision on his own by telling me how much he likes the gummies and he didn't like it when his mom told him he could only have two gummies at a time. So the mom called the doctor right away after she discovered what he had done, and the doctor told her what signs to watch out for and made sure there was no iron in the supplement because that could have been problematic. Which it's true, we need iron, but we don't want too much iron which is why, as dietitians, we want to make sure when you do a dietary recall and you collect a patient's history, you ask about supplements and herbs. People often forget to share this information because it's not a medication, and in their mind, they don't think to share that information. So always make sure you ask about supplements and herbs.

Okay, moving on to zinc. I love zinc. Zinc has a really important role in the human body. Some of the big functions of zinc in the body are wound healing, insulin synthesis, and glucose control, as well as immune function. It might also have antimicrobial and anti-inflammatory properties. And zinc is involved in carbohydrate metabolism. It's excreted by the GI tract, skin and kidneys, and it's needed for enzyme reactions. So it's a really important nutrient. And if you're working with people who have pressure injuries, zinc is a nutrient to pay attention to because they just might need a supplement to help with wound healing. When food containing zinc is consumed, it's hydrolyzed from amino acids by gastric hydrochloric acid or HCl, and enzymes in order for it to be absorbed. Hydrochloric acid is needed to separate the zinc from the amino acids. So if there is a decrease in gastric acidity, it can cause a decrease in zinc absorption. A lot of people take acid reducing medications who have acid reflux. So all of these things have to be looked at and considered. The body is one entire unit, and everything works together. So let's assume there's enough hydrochloric acid where the zinc is removed from the amino acids. Once it's absorbed, which happens primarily in the duodenum and the jejunum, it binds to albumin and is taken to the liver. So albumin levels are also important. Just like with most vitamins and minerals, there are some things that can interfere with zinc absorption. For example, phytic acid and calcium supplements decrease zinc absorption. Large amounts of zinc can compete with copper and iron for absorption. This is why, again, balance is important because an imbalance can disrupt another micronutrient. And if a nutrient is needed in a larger dose, we have to make sure that we're paying attention to the other nutrients that could be impacted by it. Just like with vitamin A, a zinc deficiency can lead to a secondary vitamin A deficiency. So, yeah, homeostasis is always the goal. So the food sources of zinc are seafood, meats, greens, and whole grains. Strict vegans may need a zinc supplementation. Something to keep in mind. If the diet is well balanced, they might be fine, but it is something to pay attention to. There are some people at increased risk of developing zinc deficiency. Like I just mentioned, vegans, but also older adults, people who abuse alcohol, postoperative patients, burn patients, patients who have malabsorptive diseases like Crohn's disease, and also conditions such as renal disease, liver disease, sickle cell anemia and then wound drainage. All of these increase the risk of zinc deficiency. If you end up working in clinical, you'll likely get experience with all these conditions, so zinc will be on your mind. It's hard to diagnose zinc deficiency because the testing is not specific. So you want to give enough supplementation if needed and do a thorough assessment to see how much zinc someone needs. And don't forget to consider any of the conditions I mentioned that will increase the risk of deficiency. And one of the goals is to avoid zinc toxicity because higher levels of zinc may also cause copper deficiency. Pressure injuries, like I mentioned, are a big concern in the hospital setting because people can be immobile and that can lead to pressure injuries. So if someone develops a pressure injury, zinc may need to be considered as part of the nutrition plan. So that's a summary and a review of zinc.

Since I just mentioned copper and I mentioned how high levels of zinc can lead to a copper deficiency, let's move on to copper. Copper has a lot of essential roles in the body. For one, oxidation is a big role. It also plays a role in the maintenance of myelin. It's needed for cholesterol metabolism, glucose metabolism, and formation of melatonin pigment. Isn't it great that we don't have to tell copper in the body what to do? It does all these incredible things on its own when it's available, which is why it needs to be available. And the body has regulatory mechanisms in place to make sure the levels are stable. Copper homeostasis, which remember is the fancy word for balance, is maintained by excretion more than absorption. So the body controls the amount of copper in the body by excreting any excess and then absorbing what is needed. It's absorbed through the intestines and transported with ceruloplasmin in the blood. But it needs a little help, just like zinc does. Remember how zinc needs to be removed from the amino acid in order to be absorbed? Well, hydrochloric acid in the stomach, gastric secretions, and pepsin all help release bound copper so that it can be absorbed. Absorption occurs primarily in the duodenum by either active transport or passive diffusion. When there's a lot of copper available from dietary intake, it's absorbed by passive diffusion because that's the easier way. So I want to go over food sources of copper. It's not as popular as other minerals, but it has its place and it's important. So food sources of copper are liver, cocoa, beans, nuts, whole grains and dried fruit. So what happens to the body when there's not enough copper? People with absorption issues like celiac disease, people recovering from undernutrition, any intestinal surgery, hemodialysis and bariatric surgery are all at increased risk of developing copper deficiency. Also, excessive zinc intake affects copper absorption, like I previously mentioned. And then if someone develops a copper deficiency, it can lead to impaired absorption of iron. It's a domino effect. With copper deficiency, iron can't exit the enterocyte, which causes microcytic, hypochromic copper deficiency anemia. Common symptoms of copper deficiency are hypopigmentation, sensory ataxia, which is when the nerves are affected, neutropenia, increased red blood cell turnover, and heart issues such as abnormal heart rhythm. Just like there's copper deficiency symptoms, copper toxicity is also something to be aware of. Now, in the general healthy population, copper toxicity is rare because the body regulates copper stores by excretion from the liver. So the body maintains the balance. But there are some key things we see and are directly involved in as dietitians when it comes to copper toxicity, and that is with people who have issues with their liver, particularly issues with biliary excretion and cholestasis, because it can cause biliary or liver retention and damage. As dietitians, you can see cholestasis with prolonged parental nutrition. And you'll definitely see this more often in the neonatal population because really tiny babies that are born too early often need parental nutrition. And if there's prolonged need for parental nutrition with an inability to feed the gut, it increases the risk of developing cholestasis because the gut isn't being fed, therefore, everything kind of stays stagnant. The word stagnant and stasis basically have the same meaning. So that's how I remember things not moving. The liver doesn't need to contract or move when the gut isn't being fed. So if that helps you kind of understand cholestasis and stasis and what that means, or stagnant, you can use it. So cholestasis happens et

me do a recap, when the gut isn't being fed. When the gut isn't being fed, nothing really needs to contract and move. So you kind of get this backup and this stagnant not moving system. People with Wilson's disease, which is a genetic disorder, can also develop copper toxicity because copper accumulates in the liver, brain and organs, which can be life threatening. So that's copper.

Let's move on to manganese. Manganese has several roles. It's needed to activate enzymes for urea formation, it neutralizes free radicals, and it plays a role in carbohydrate synthesis. The way it's absorbed is similar to iron in the small intestine, and it also competes with iron for absorption. Any excess manganese is excreted by the liver into the bile, and that's how toxicity is prevented, because excess manganese can cause abnormalities to the central nervous system. Since the liver plays a role in maintaining safe levels, those with liver issues, especially people with cholestasis, like I previously mentioned, are at increased risk of developing manganese toxicity. Long term parental nutrition for more than 30 days or home TPN increases the risk of developing manganese toxicity. So in those cases, manganese is often removed from the TPN bag. Toxicity symptoms include pancreatitis, immune system issues, nephritis, liver damage, reproductive dysfunction, hallucinations, and muscle spasms. Food sources of manganese are nuts, oats, and whole grains. I kind of always remembered those three as, like, the main sources of manganese. And manganese deficiency is rare unless it's totally absent from the diet. So if someone does become deficient in manganese, symptoms include abnormal bone and cartilage formation, poor reproductive performance, congenital abnormalities, growth retardation, and issues with fat and carbohydrate metabolism. So that's a quick rundown of manganese. And like I previously said, cholestasis is a risk factor for those who are on long term parental nutrition, because the gut isn't being used. So we have to be mindful of the nutrients that we're providing in the TPN bag. And in this case, manganese and copper are two that we have to be careful of.

Okay, you're getting there. Let's talk a little about selenium. Selenium is really important because it's an antioxidant, which means it protects against oxidative stress. People who've had trauma or are critically ill in the ICU could benefit from selenium because of its antioxidant properties. It also plays a role in thyroid metabolism. Generally speaking, selenium is absorbed well from food. But the amount of selenium found in food depends on the amount of selenium in the soil. As dietitians, we know that where food comes from and how we grow food makes a difference. And some food sources of selenium are Brazil nuts, fish, organ meats, milk, shellfish, spinach and eggs. When there's not enough selenium in the diet, deficiency can develop. And symptoms of deficiency are hair loss, nausea, vomiting, fatigue and irritability.

So let's move on to talk about iodine. Just like with selenium, the amount of iodine found in food is dependent on the amount of iodine in the soil. The primary source of dietary iodine is in the form of iodized salt, and it's

absorbed in the stomach and the duodenum. Cruciferous vegetables can interfere with iodine uptake by the thyroid gland. These are called goitrogens. Iodine is a component of thyroid hormones, so when iodine is consumed, the majority is taken up by the thyroid. If there's not enough iodine in the diet, a deficiency can develop which can lead to goiter. So that's short and sweet. That's iodine in a nutshell.

Okay, so what's up with chromium? Chromium is needed for growth because it's involved in carbohydrate and lipid metabolism. It's not well absorbed, but once it is, it's transported in the blood with iron. Even though it's not well absorbed, chromium deficiency is rare. If a deficiency does occur, the symptoms are weight loss, hyperglycemia due to the impaired use of glucose and amino acids. And toxicity symptoms, on the other hand, include muscle rhabdomyolysis, renal failure, and liver dysfunction. Food sources are whole grains, egg yolks, legumes, mushrooms and processed meats. All very common foods consumed in the Western diet. If you have someone who's receiving parenteral nutrition, you want to make sure that all the micronutrients and minerals are looked at, including chromium, especially since chromium deficiency can lead to hyperglycemia, which is something we monitor in patients who are receiving parenteral nutrition.

So let's talk a little bit about fluoride. I think of fluoride as a bone mineral. It's how I remember it, because it's an ingredient in toothpaste. It plays a role in hardening tooth enamel, preventing dental carries, or cavities, and it plays a role in bone mineralization. So if there's a deficiency, cavities are often a symptom. Fluoride stimulates osteoblasts, which are bone cells, and it may play a role in reducing osteoporosis. Fluoride absorption takes place in the stomach, and too much fluoride can cause enamel fluorosis, and it can also cause joint pain and stiffness. One of the things we learn from the time we're really little is to not swallow toothpaste. And when kids first learn how to brush their teeth, there's toothpaste that's fluoride free because kids love swallowing toothpaste. Toothpaste is the main source of fluoride, but you also might find fluoride in seaweed. Plus fluoridated water contains fluoride, hence the name. So that's a summary of fluoride.

You made it to the last mineral. And this last one is one of my favorites for a couple of reasons. First of all, I think his kind of a fun one to say - molybdenum. I feel like it's the forgotten mineral. Whenever I talk about molybdenum, even to dietitians, I sometimes get blank stares. We just don't think much about molybdenum, and it's certainly not a mineral that sits at the cool table. Maybe that's why I like it so much. But truthfully, the second reason I love molybdenum is because I had a patient who had a very rare genetic condition that involved molybdenum. So even though it's not a commonly talked about or known mineral, I've seen how important it is to be able to process molybdenum. I'll share a little bit about my patient in a minute, but first I want to review molybdenum. So Molybdenum is a cofactor for metalloenzymes and it's bound to oxygen or sulfur in the body. It's absorbed in the small intestine and it's transported in the body bound to albumin. Just like copper,

homeostasis is controlled by excretion, so if there's too much, the body excretes the excess. It's found in foods such as beans, grains, and nuts. Deficiency is rare, but cases have been seen in long term TPN without supplementation. I've never seen it, but it has been seen in the documentation and the literature. If deficiency happens, the symptoms are altered vision, altered mental status, neurological damage, tachycardia and lethargy. And with toxicity, it can cause gout-like symptoms. There's not a lot to say about molybdenum. That pretty much covers it. So I'm going to go into my story. I had a patient when I worked in pediatrics who had Molybdenum cofactor deficiency, which is a genetic condition, and it's very rare. This patient was not the first person in the family to have this condition, so it had happened to other people in the family. The patient was normal at birth, but soon developed seizures, feeding difficulties, and ultimately ended up with brain dysfunction. My patient was admitted numerous times over the years I worked in pediatrics. They had severe developmental delay, couldn't sit up or speak, and were G-tube dependent. So this patient wasn't able to eat any food. 100% of the patient's nutrition was provided through a feeding tube. Unfortunately, people with this genetic condition don't live past childhood, but my patient lived well into the teen years. The mom was amazing. She was so attentive to her child and she really cared about her child's nutrition. This patient was on a very low calorie diet because they didn't do anything. They were bed-bound and had very low nutrient needs. I remember working with the GI physicians a lot with this patient. Oftentimes the patient would come in with issues with their feeding tube, so that had to be addressed. At the time when the patient was coming into the hospital a lot, I was also the cross cover for the metabolic clinic before I became the full time dietitian in the clinic. So I remember speaking with a geneticist about this case. This condition was so rare, but it always stuck with me because I remember thinking that molybdenum is just not talked about much.

Okay, that was a lot. I know. Try to remember the basics. Tie a story to it if you can, because stories are easier to remember. And I want you to know that I still have to look things up all the time. I say it over and over again. You aren't required to remember every single thing. The exam is an entry level exam. You need to know the basic entry level material. Specializing comes later. I know there's a lot to remember, so try to break it down into pieces that are easier to manage and do your best to understand versus memorize. There's only so much you can memorize. So that's why I try to incorporate some of the mechanisms when I was talking, especially about the electrolytes, because those we work with so frequently. So when you can understand and kind of visualize how these nutrients work in the body, they're easier to remember. So do your best to create pictures in your head, remember stories and think critically. And if you feel like your brain is saturated and you just can't think anymore, take a break. Go for a walk, do something. Just give your brain a break. Sitting there and cramming more information into your brain, it's not going to help. You can afford to take a little bit of time for yourself. You can afford to take that break and just go do something and then come back to studying. You're so close to being able to put RD or RDN, whatever you prefer, behind your name. Envision it. Practice writing it out when you're

bored of studying and you're doodling. I have doodle pages everywhere. Your mindset is a big part of passing the exam, so make sure you're telling yourself positive things. You'll get there. Every minute you spend studying, every minute you spend in your internship rotation, you're getting one step closer. But remember, we all need a break. So make sure you give yourself the time. You deserve it. And remember, there's no limits to achieving the success you so deeply desire. Until next time.

Outro and Music