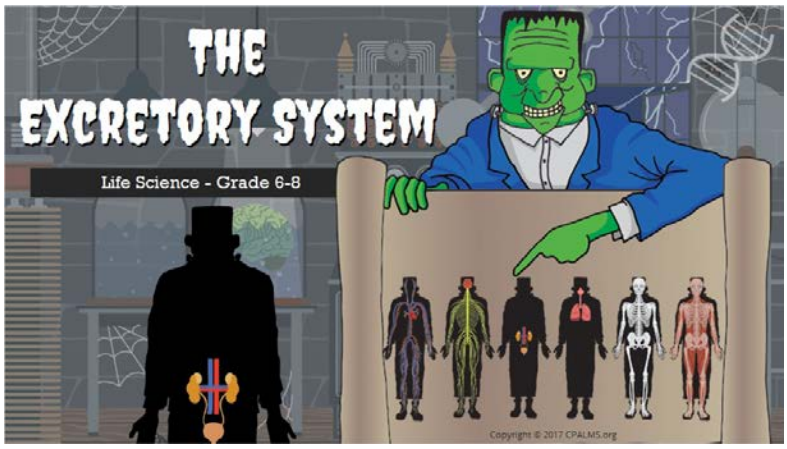
The Excretory System

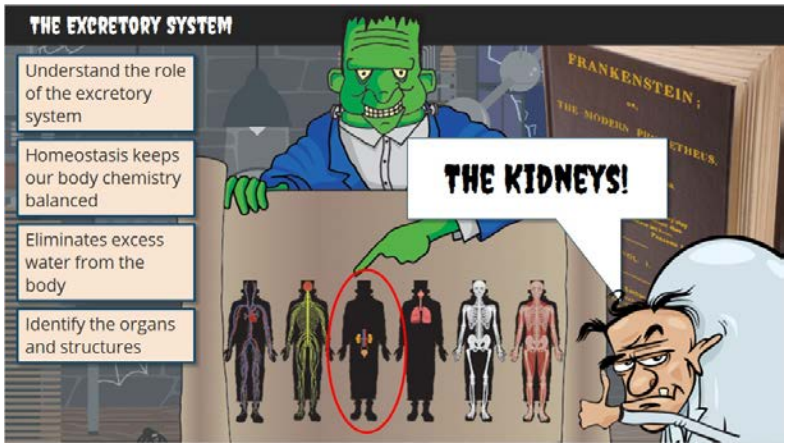
1.1 Welcome



Notes:

Welcome to "The Excretory System," part six of the human body systems series, an interactive science tutorial for middle school students.

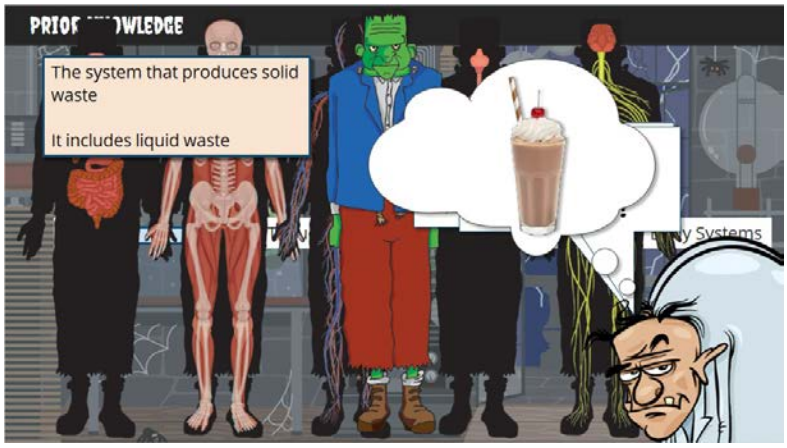
1.2 The Excretory System



Notes:

The excretory system is the sixth body system we are exploring in this series. By the end of this tutorial, you will understand the role of the excretory system in maintaining homeostasis by keeping our body chemistry balanced. This system eliminates excess water through a very complex pair of organs that you might take for granted - the kidneys - through the regulation of urine formation. You will be able to learn and identify the organs and structures that enable the system to function. As you learn, you earn, body systems that is, that are helping to complete the Frankenstein monster from Mary Shelley's book from 1818! Igor and Dr. Frankenstein are depending on you. Off you go!

1.3 Prior Knowledge

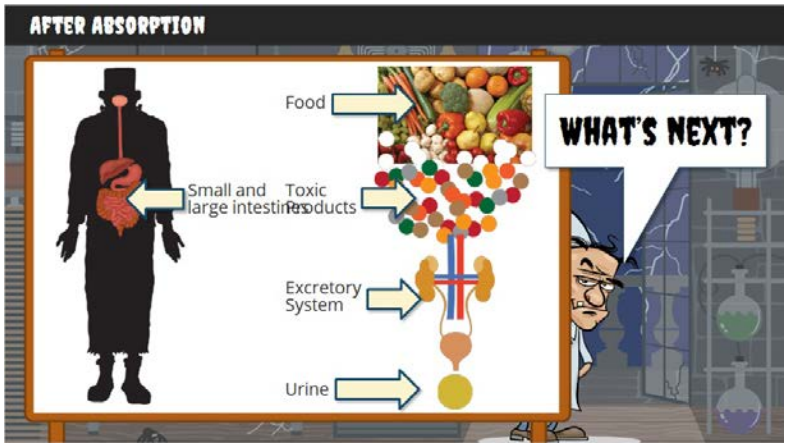


Notes:

As before, we need to review a few things before we jump into new material. Keep in mind that cells multiply and become specialized as tissues and organs form. Organs are associated with specific body systems such as those you've learned previously: the nervous, respiratory, circulatory, musculoskeletal systems and most recently, the digestive system. Remember also, that we have been talking about this term homeostasis. This is really important if we need all organs and systems to work together. This is our body's way of regulating systems to keep everything running smoothly or in balance even though things outside aren't.

I'm not sure what you're planning on feeding Frankenstein but whatever you end up choosing, you now have another problem. What goes in, must come out! This now applies to the part of the system that produces solid waste but it also includes liquid waste! All of the body systems function in a coordinated way, and the excretory system is no exception.

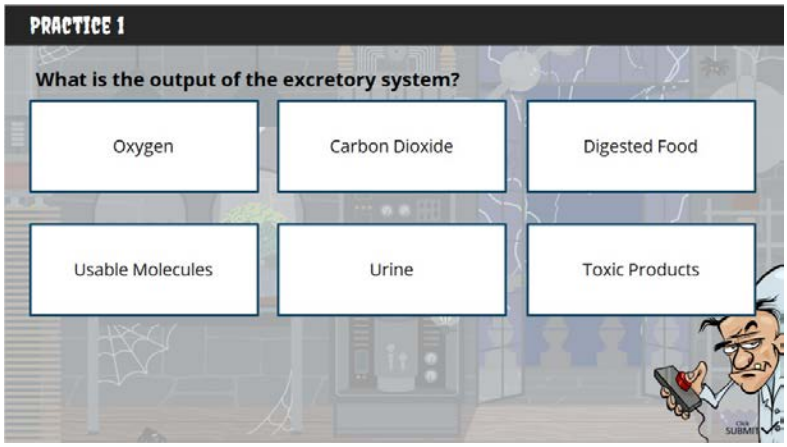
1.4 After Absorption



Notes:

We previously learned how food is digested and nutrients absorbed from the small and large intestines into our blood stream. What's next? Obviously food is vital to providing nutrients; - and who doesn't enjoy good food? But nonetheless, toxic products are generated as food is broken down to usable molecules. The excretory system is designed to remove chemical waste as it maintains a balance of water in the body. The output is the liquid waste you remove when you go to the bathroom, we call this urine.

1.5 Practice 1



Notes:

The excretory system is a critical part of our health. We will learned a great deal about the system in this tutorial, but for now, can you select the best answer to the question: What is the output of the excretory system?

Correct	Choice
NO	Oxygen
NO	Carbon Dioxide
NO	Digested Food
NO	Usable Molecules
YES	Urine
NO	Toxic Products

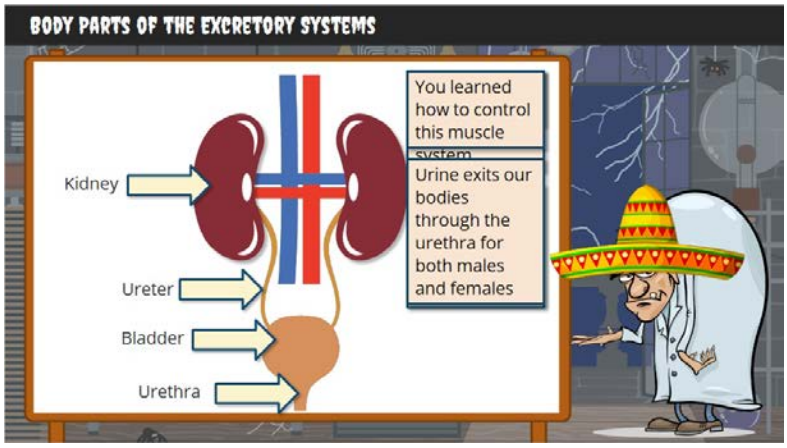
Feedback when correct:

Excellent! I'm glad you know what the final output of the excretory system is. Igor will be very happy that you're off to a great start.

Feedback when incorrect:

The correct – and best answer – is urine. However, urine contains water and toxic products from digested food. Usable molecules and filtered blood are returned to the body after the toxic products and some of the water is removed and excreted as urine.

1.6 Body Parts of the Excretory Systems

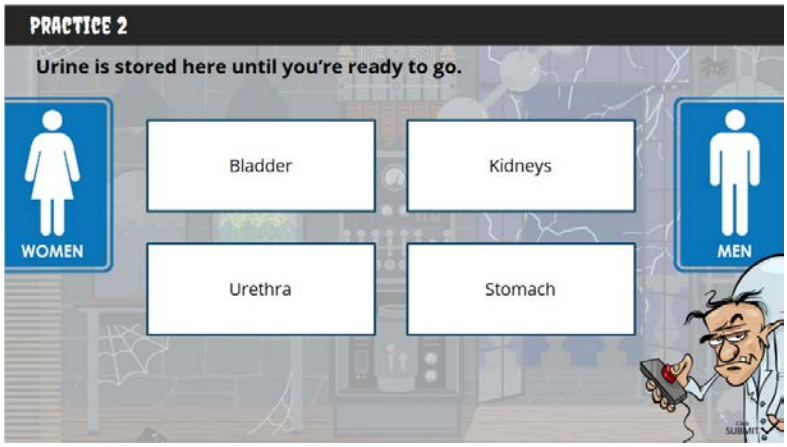


Notes:

Our kidneys are in the shape of kidney beans - those beans commonly used in chili - only our kidneys are of course larger. Your kidneys are about the size of your fist. You have a pair of kidneys, but you really only need one. It is very fortunate we were given an extra just in case! Kidneys are the primary organ of the excretory system and they work 24/7 to filter toxic wastes from our bloodstream, producing urine.

Urine drains into the bladder from the ureters, the tubules that exit the kidneys. Here in the bladder, urine is stored until the muscle around the bladder contracts and forces the urine out. When you became potty trained many years ago, you learned how to control this muscle. Finally then, urine exits our bodies through the urethra for both males and females. We definitely need this system for our creature!

1.7 Practice 2

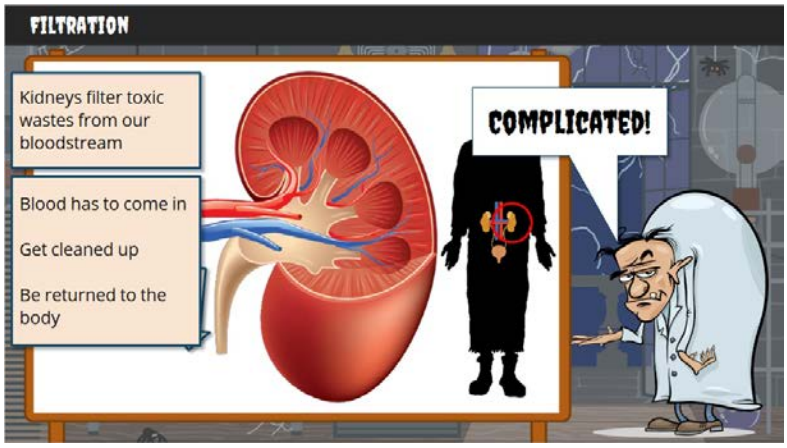


Notes:

When you have to go, you have to go! But until you're ready and have access to a bathroom, what organ is responsible for storing your urine? Select the correct answer from this list.

Correct	Choice	Feedback
YES	Bladder	That's right! The bladder is the organ below your kidneys that stores your urine until you can go to the bathroom.
NO	Kidneys	You're right that the kidneys are important in the urinary system but that's not where urine is stored. The kidneys are where urine is formed by removing excess water and waste from blood. Try again!
NO	Stomach	The stomach is part of the digestive system. It doesn't play a role in the urinary system. Try again!
NO	Urethra	You're right that the urethra is important in the urinary system but that's not where urine is stored. The urethra is the tube where the urine exits the body. Try again!

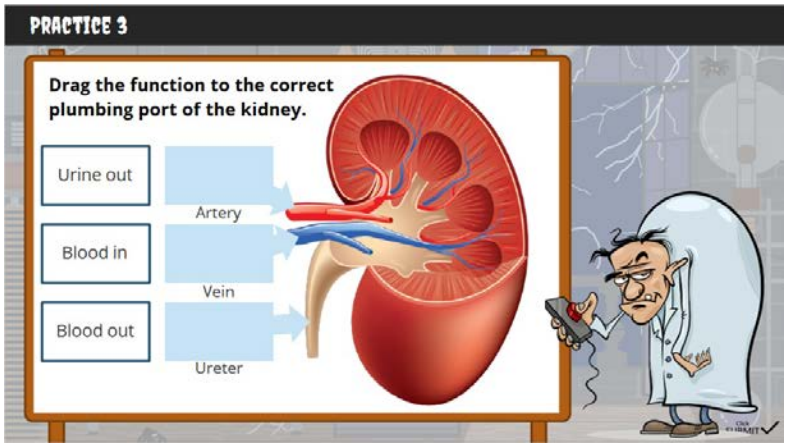
1.8 Filtration



Notes:

Let's open up a kidney and see what's going on inside. That looks very complicated! We mentioned earlier that the kidneys filter toxic wastes from our bloodstream. This means that blood has to come in, get cleaned up, and be returned to the body. We have three tubes that help accomplish this: blood comes in through an artery and leaves through a vein. The tube that carries urine out of the kidney is the ureter.

1.9 Practice 3



Notes:

The kidney is kind of like a plumbing system with three in-or-out ports. Blood comes in and out removing waste products in between. Drag the correct function to the name of each plumbing port.

Function	Plumbing port
Blood in	Artery
Urine out	Ureter
Blood out	Vein

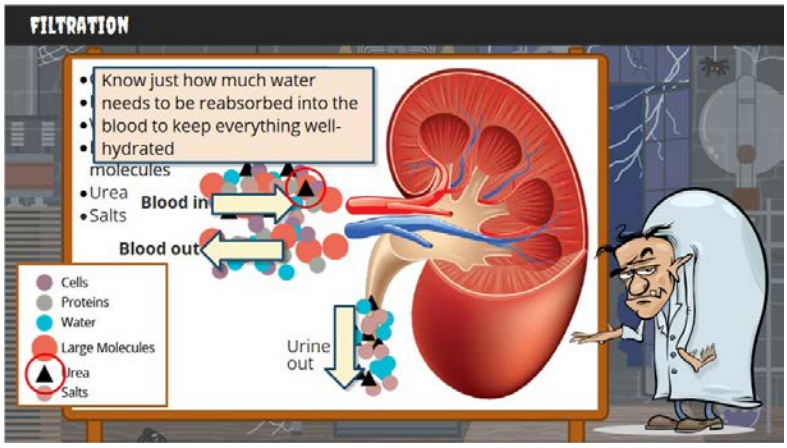
Feedback when correct:

Yep, the artery brings blood into the kidney while the vein returns blood back to the body; urine is collected and removed through the ureter

Feedback when incorrect:

Let's take a look at the correct answers – blood comes into the kidney through the artery and back out through the kidney vein; the ureter brings the urine from the kidney and transports it to the bladder for storage.

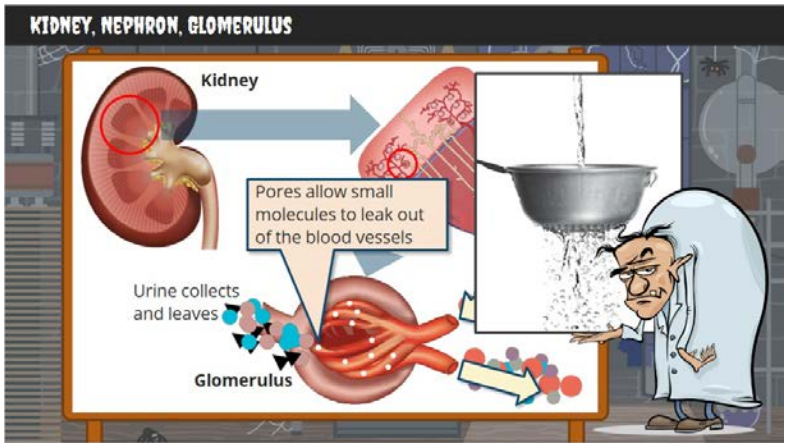
1.10 Filtration



Notes:

Now, the blood that enters the kidneys contains red blood cells, salts, nutrients, and typically lots of water. Large components like cells and big molecules flow in and out of the kidney blood supply. These are not removed from the blood, whereas smaller molecules like water, salt, amino acids, glucose, and toxic waste are filtered out. But wait, some of those are good things that we don't want to lose through our urine! Turns out the kidney has a system to re-capture those important nutrients in urine, while getting rid of waste like urea, a breakdown product of protein. Urea is shown here as a black triangle. The filtered blood returns to the body without this waste molecule and without excess water. The kidneys are programmed to know just how much water needs to be reabsorbed into the blood to keep everything well-hydrated. This is an important function that helps maintain an internal balance of the chemicals and water in your body. This is an important aspect of homeostasis.

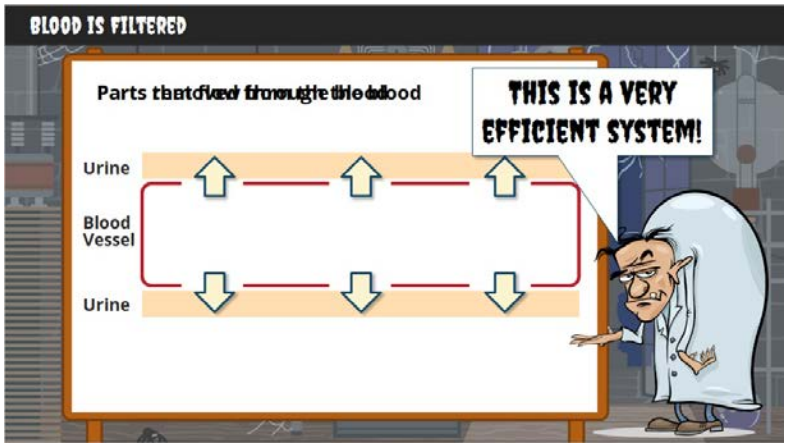
1.11 Kidney, Nephron, Glomerulus



Notes:

I know you're wondering - wow, how does the kidney actually do all of that?! We have to take a look at the smaller structures within the kidney to understand this. The kidney is organized into these triangular-shaped sections where the urine collects. These are the nephrons. And inside each nephron are small blood vessels or capillaries that form a dense ball where filtration takes place. This ball of capillaries is called the glomerulus**.** You know how a colander lets you drain water from cooked pasta? - the kidney uses the same mechanism - because inside the glomerulus are tiny holes in the blood capillaries that let water and other small molecules escape. These collect into urine.

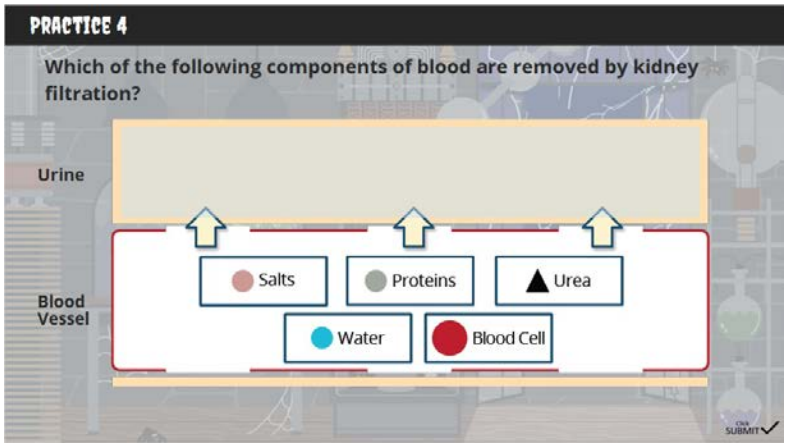
1.12 Blood is Filtered



Notes:

Let's zoom in on a blood vessel in the kidney. Here we see all of the parts that flow through the blood; water, urea, salt, blood cells and other proteins. What will get removed from the blood? Excess water, salts and urea are removed from the blood. Whatever is removed will end up in the urine, which your body will eventually get rid of when you go to the bathroom. This is a very efficient system.

1.13 Practice 4



Notes:

Which of the following components of blood are removed during kidney filtration? Drag those that leave the capillaries in the glomerulus to the urine sites.

Blood Vessel	Urine
Blood Cell	Not Applicable
Proteins	Not Applicable
Salts	Urine
Urea	Urine
Water	Urine

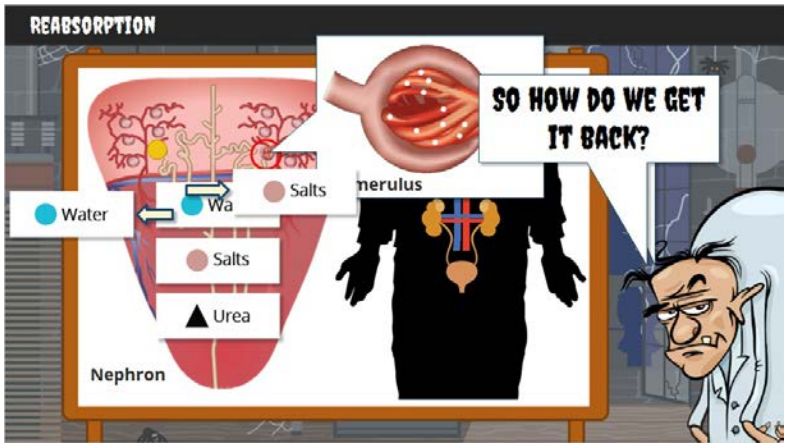
Feedback when correct:

Yep, you got it! Small components of blood can flow out of the holes of the blood vessels in the glomerulus where as larger components are not removed.

Feedback when incorrect:

Sorry, it's only the small components in blood that can flow out of the holes of the blood vessels in the glomerulus: this is water, urea, and small molecules like salt. Larger components such as blood cells and proteins are not removed.

1.14 Reabsorption



Notes:

We mentioned that a lot of material gets filtered out of blood in the kidney that Frankenstein needs to hold onto. So how do we get it back? The incredible human body has taken care of this for us, of course! In the last section we learned how water, some salts, and urea waste are removed from the blood in the glomerulus of the kidney. Before that, urine leaves the kidney, there is a long path where the molecules travel inside the nephron before they exit through the ureter. Along this path, the tubules within the nephron re-capture water and salts. It's here that there is re-uptake of what came out earlier. Cool, huh!

1.15 Excess Water Removal

Notes:

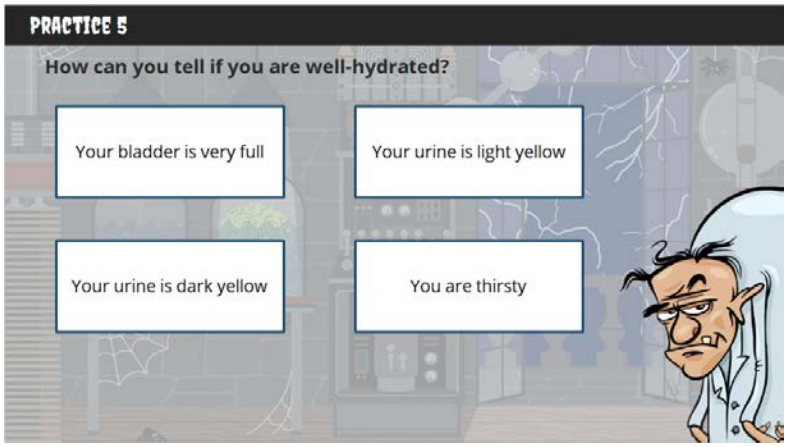
Our body has developed overlapping systems to handle waste products. Excess water is removed through sweat, tears, and some is eliminated as feces following digestion. Our respiratory system also is involved. We breathe out water vapor, which we can only see when it's really cold outside. So while the kidneys perform the bulk of the job of internal water management, other systems also play a role. Remember we also breathe out another waste product of digestion and respiration - carbon dioxide. It's exhaled as a gas.

1.16 Hydration

Notes:

So now, when we refer to the excretory system think about water. Your body regulates itself and determines how much water you need for your cells. If you need more, you feel thirsty and drink something. The water is carried by your blood. If you have excess water it is filtered through your kidneys and transported to your bladder. If you aren't thirsty to get rid of water you can go to the bathroom to urinate. Your body regulates your water this way. One way you can tell how well hydrated (or whether your body has enough water) is to look at the color of your urine. If it is light yellow you are well hydrated. If your urine is a really dark yellow, that may mean you need to drink more water.

1.17 Practice 5

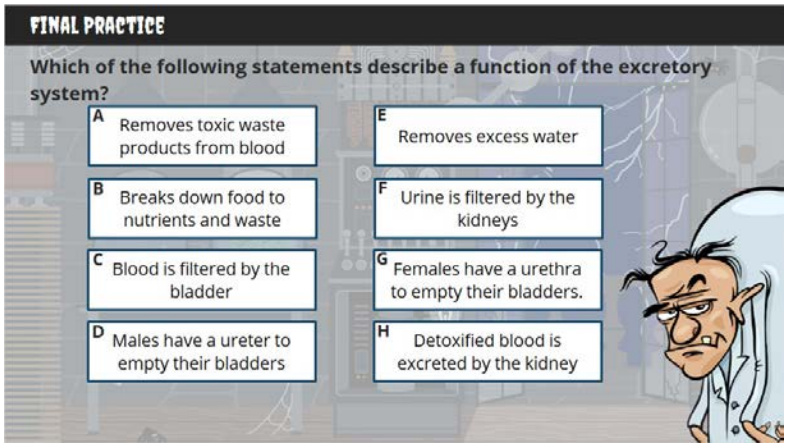


Notes:

Cloe reminded us that drinking enough water keeps us well-hydrated, an important health tip. What is one way that you can tell if you are well-hydrated?

Correct	Choice	Feedback
NO	Your bladder is very full	You're right that sometimes when you're very well-hydrated, your bladder will feel full. But a full bladder just means it's full of urine. It doesn't tell you whether you are well-hydrated or not.
YES	Your urine is light yellow	That's right! When you are well-hydrated, your urine is light yellow.
NO	Your urine is dark yellow	Dark yellow urine is a sign you need to drink more water and become hydrated!
NO	You are thirsty	Being thirsty is a sign that you need water, but what is a better way?

1.18 Final Practice



Notes:

The excretory system is a critical part of our health you've learned here. You definitely want to earn this body system for your creature! So let's go through a final question to make sure you've really got this one. Which of the following statements describe a function of the excretory system?

Correct	Choice
YES	Removes toxic waste products from blood
YES	Removes excess water
NO	Which of the following statements describe a function of the excretory system?
NO	Breaks down food to nutrients and waste
NO	Urine is filtered by the kidneys
NO	Blood is filtered by the bladder
YES	Females have a urethra to empty their bladders.
NO	Males have a ureter to empty their bladders
NO	Detoxified blood is excreted by the kidney

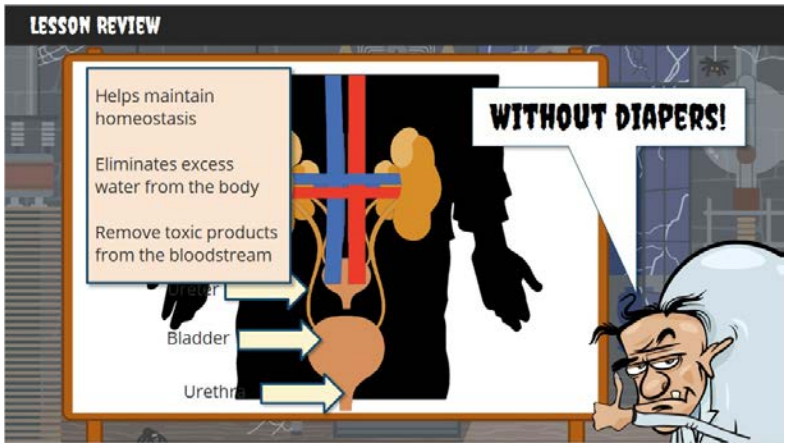
Feedback when correct:

Excellent! I'm glad you know so much about your excretory system. The correct answers are: removes toxic wastes products as it removes excess water. Also you remember that females empty their bladder through the urethra – and males do the same! Wonderful, now, Igor is waiting for you.

Feedback when incorrect:

Let's go through the wrong answers. Answer B is incorrect because food is broken down by the digestive system, not the excretory system. C. is incorrect because blood is filtered by the kidney, not the bladder. Answer D is incorrect because males have a urethra in which they empty their bladders, just like females. F is incorrect because the kidney filters blood creating urine. H is incorrect because blood is not excreted. Detoxified blood is returned to the body after filtration by the kidney. Now let's go over the correct answers. The excretory system removes toxic wastes products as it removes excess water. Also you remember that females empty their bladder through the urethra – and males do the same! Wonderful, now, Igor is waiting for you.

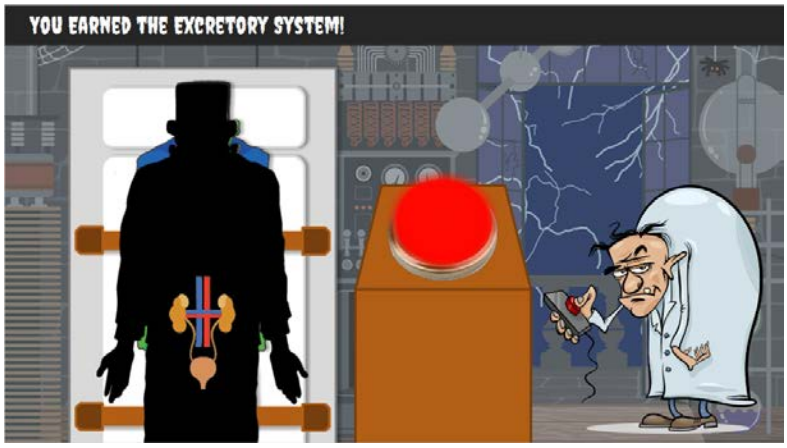
1.19 Lesson Review



Notes:

We are almost there - making Frankenstein presentable to the world - without diapers! Let's review what we've learned about the excretory system. First we know that it is really important to overall homeostasis, specifically by eliminating excess water in our body. Through the production of urine and the body structures that allow us to excrete it, the excretory system helps eliminate toxic waste products from the breakdown of foods and other components in our blood system. Let's remind ourselves of these specialized structures that make up the this system. The primary organs are two kidneys on either side of your back, the ureter than drains the kidneys of urine into the bladder where it is stored, and then the urethra where you can finally pee it out! Ahhh!

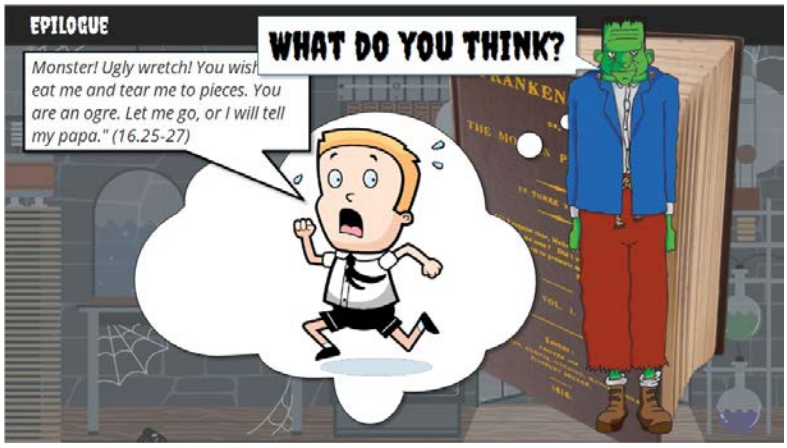
1.20 You Earned the Excretory System!



Notes:

Congratulations for doing such a great job on the excretory system tasks! Now push the red button to add the excretory system to your growing creature. Let's not think too much about this creature needing to pee!

1.21 Epilogue

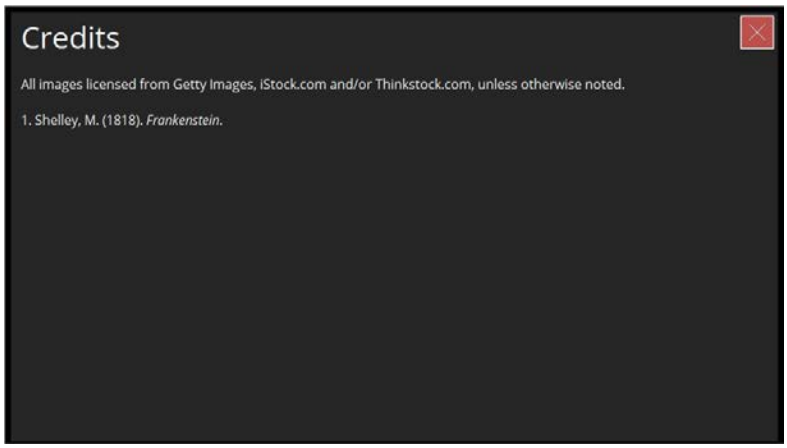


Notes:

At the end of the previous tutorial, we read the following passage from Mary Shelley's novel where she describes a meeting of a boy and Dr. Frankenstein's creature: *"Monster! Ugly wretch! You wish to eat me and tear me to pieces. You are an ogre. Let me go, or I will tell my papa." (16.25-27)*

Through your efforts, you've created a robust creature that you should be proud of. I think you've thought of everything! He is kind of scary-looking still but I don't think he is a monster at all - what do you think?

Credits (Slide Layer)



Notes:

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1. Shelley, M. (1818). *Frankenstein*.