



Rat Anatomy Workbook

ACCOMPANIES 3D RAT ANATOMY APP BY BIOSPHERA



Animal Welfare Institute

AWI wishes to thank Elisabeth Ormandy for granting us permission to use and share these lesson plans in the hopes that more classrooms can replace once-living specimens with alternatives. This content was generated outside of AWI and we do not warrant the accuracy or timeliness of any information contained in this version. Please refer to your school district's requirements to ensure alignment with the relevant standards.

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Learning Objectives

- Explain how key **anatomical features** help rats in their natural environments
- Describe the major **body systems** of rats and their major organs
- Explain the function of each major **organ**
- Explain how the major body systems in rats **work together** to create whole functioning organisms
- Identify key **similarities and differences** between rats and humans

Introduction to the Rat



In this lab, we will be taking a look at several body systems in the rat. Rats are **mammals**, just like humans. Keep this in mind as you explore the various organs that make up rats bodies!

The body systems we will explore are:

Digestive

Musculoskeletal

Respiratory

Circulatory

Urinary

Endocrine

Nervous and Sensory

Getting To Know 3D Rat Anatomy

BY BIOSPHERA

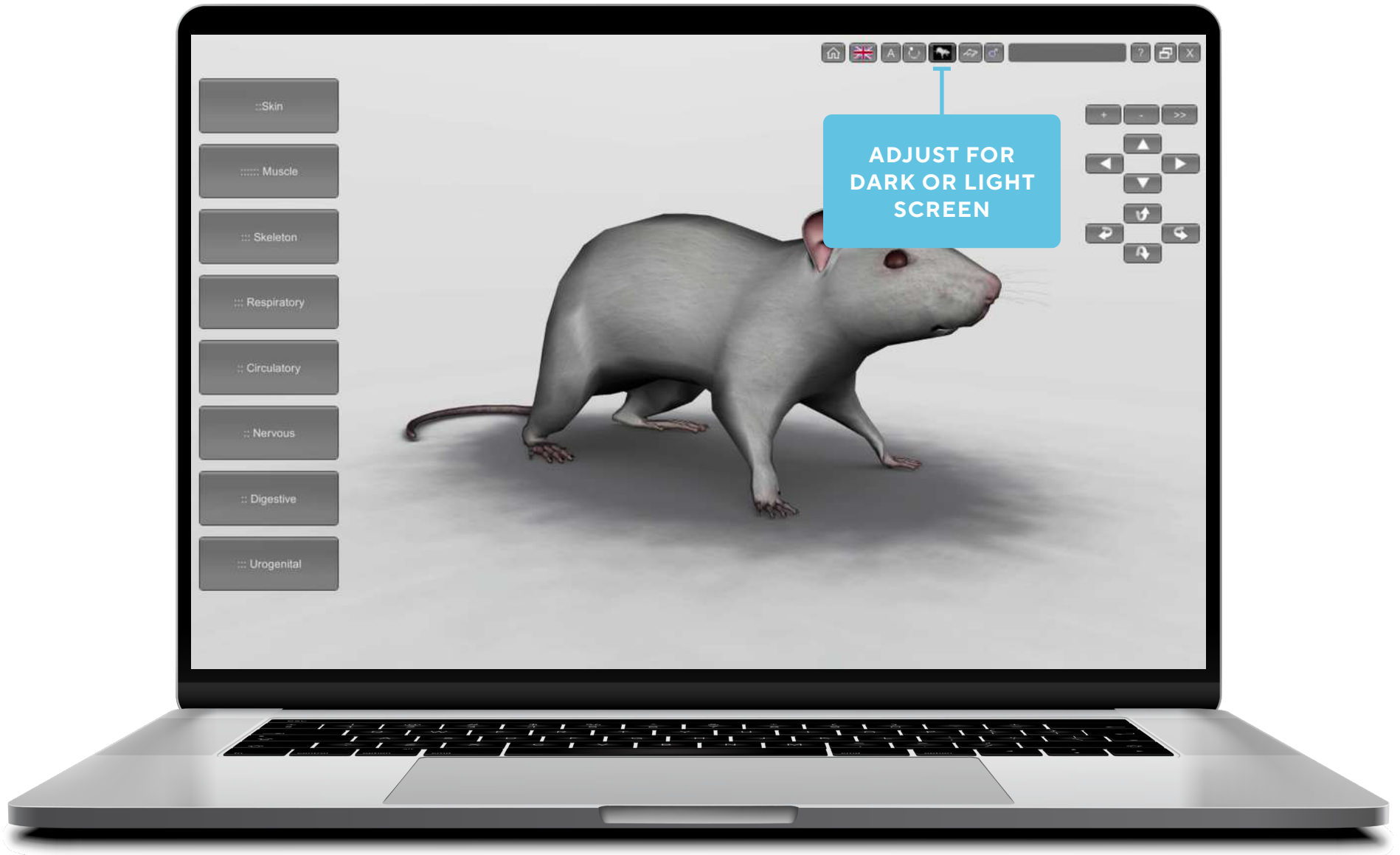
The app is available for iPads, Android tablets, and desktop: biosphera.com



Lets get comfortable with the app!

Take a few minutes to explore the app. Press buttons, move the model around, and touch/hold the organs... see what happens!

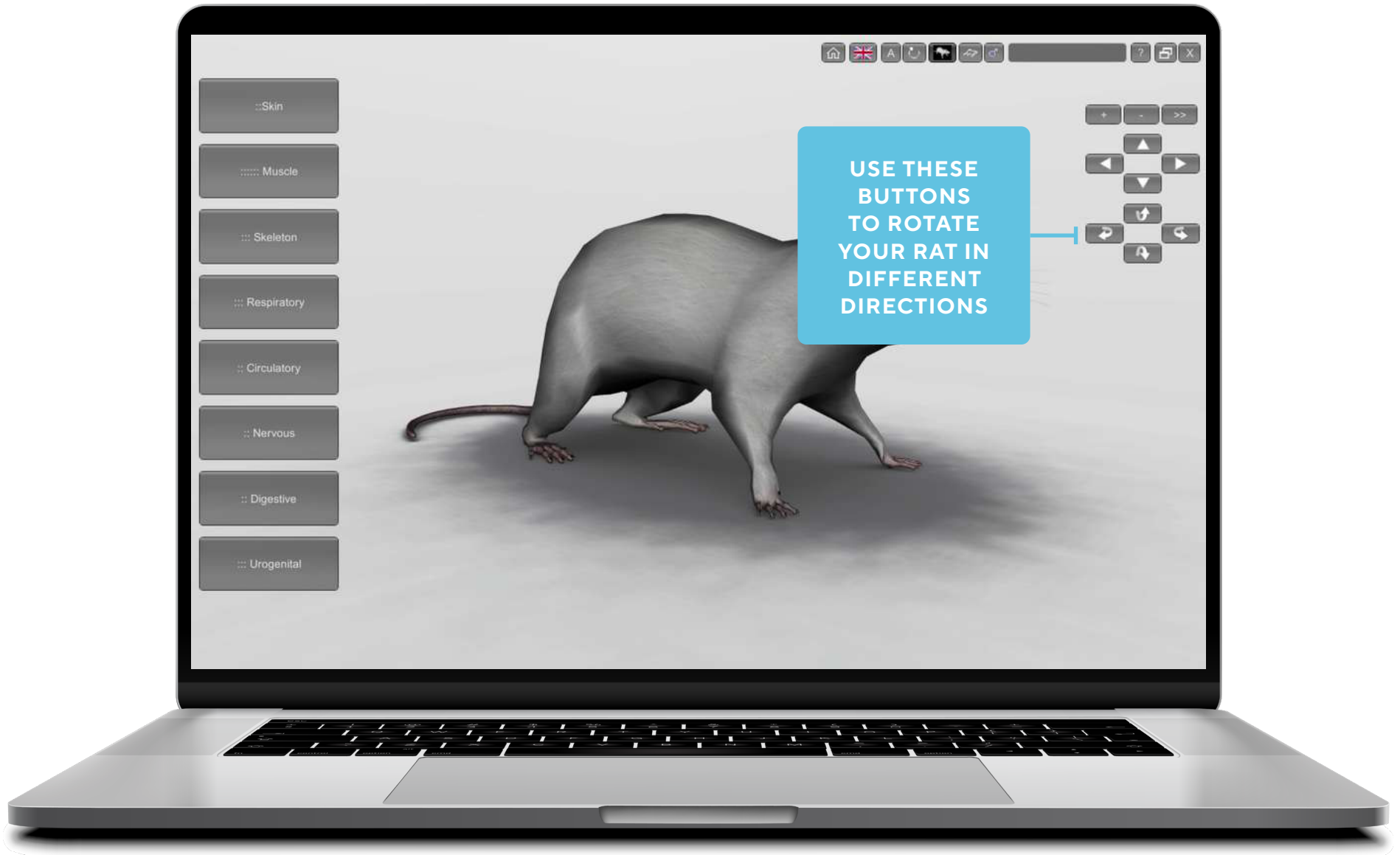


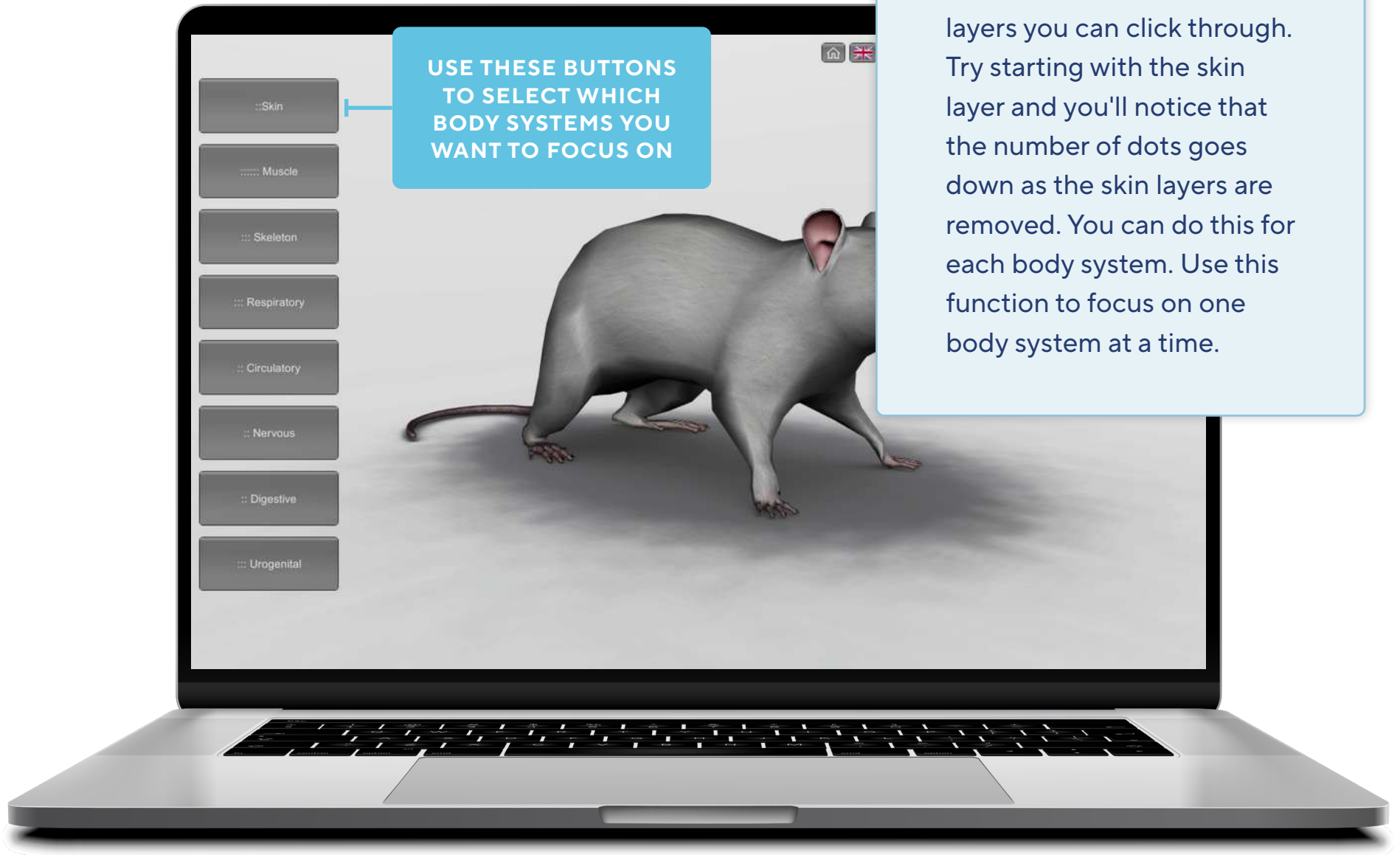










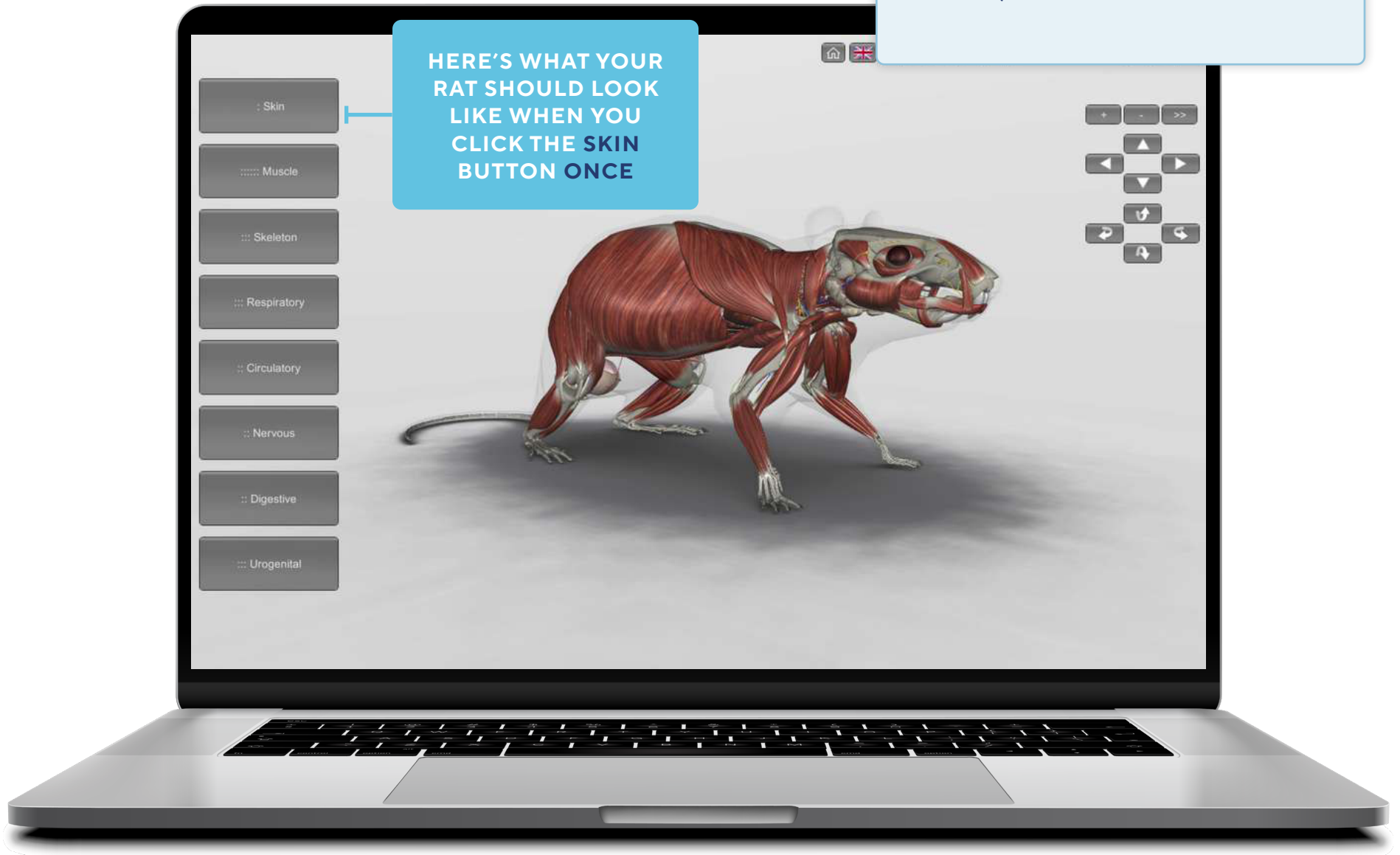


**USE THESE BUTTONS
TO SELECT WHICH
BODY SYSTEMS YOU
WANT TO FOCUS ON**

Each grey body system button displays small dots to indicate the number of layers you can click through. Try starting with the skin layer and you'll notice that the number of dots goes down as the skin layers are removed. You can do this for each body system. Use this function to focus on one body system at a time.

Notice how the **skin** button now only has one set of dots, instead of two.

HERE'S WHAT YOUR RAT SHOULD LOOK LIKE WHEN YOU CLICK THE SKIN BUTTON ONCE



Some Terms To Know

Posterior	Back	Anterior	Front
Superior	Above	Inferior	Below
Caudal	Toward the bottom or tail	Cranial	Toward the top of the head
Proximal	Toward the trunk (abdomen)	Distal	Away from the trunk (abdomen)
Lateral	Away from the midline	Medial	Toward the midline
Dorsal	Back	Ventral	Front
Superficial	Closer to the surface of the body	Deep	Further from the surface of the body
Internal	On the inside	External	On the outside

One More Thing!

When you see a “system button” noted in this workbook like this:



:: Skeleton



:: Respiratory

Make sure your app has the same buttons and layers showing.



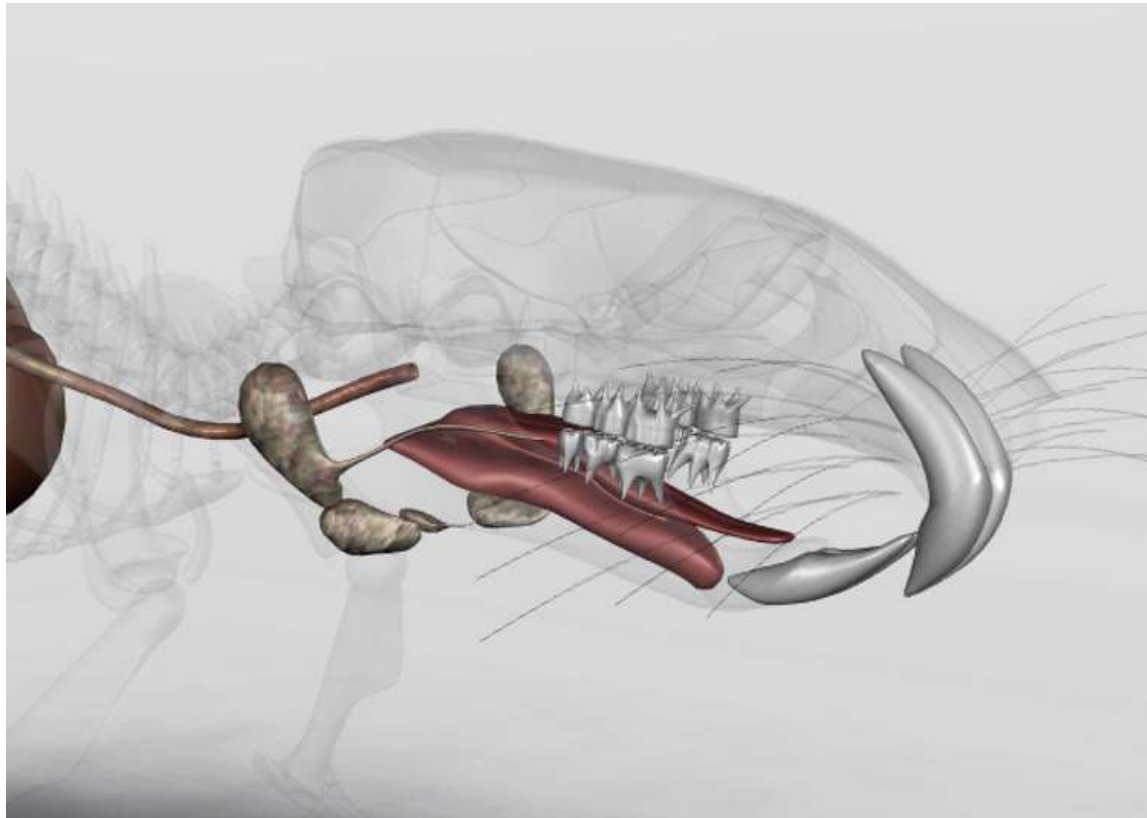
DIGESTIVE SYSTEM

TURN OFF ALL OTHER BODY SYSTEMS AND FOCUS ON THESE:

: Skeleton

:: Digestive

Digestive System: External Anatomy



Rotate your rat and zoom in so that the head is visible.

Hover your pointer over the **teeth** to show the labels.

Can you label the image?

Teeth



Molars: Teeth furthest back in mammalian jaw. Usually adapted for grinding and tearing food.

Incisors: Forward-most teeth in mammalian jaw. Usually adapted for obtaining food by cutting or cropping.

Many mammals have evolved highly specialized type of teeth.

BASED ON THIS COMBINATION OF TEETH, WHAT DO YOU THINK ARE THE DIETARY HABITS OF A RAT?



Carnivore



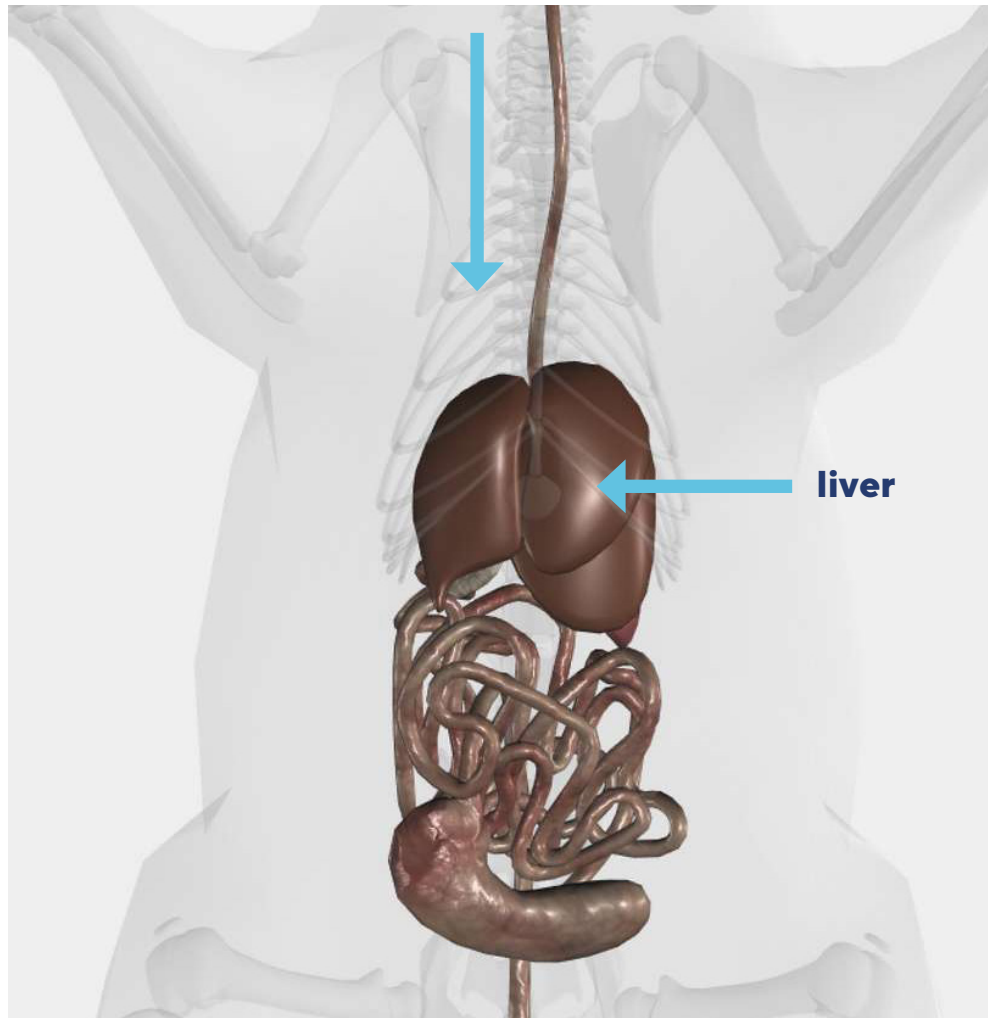
Omnivore



Herbivore

Normal diet consists of a variety of plant and animal material

Food travels down esophagus towards stomach.



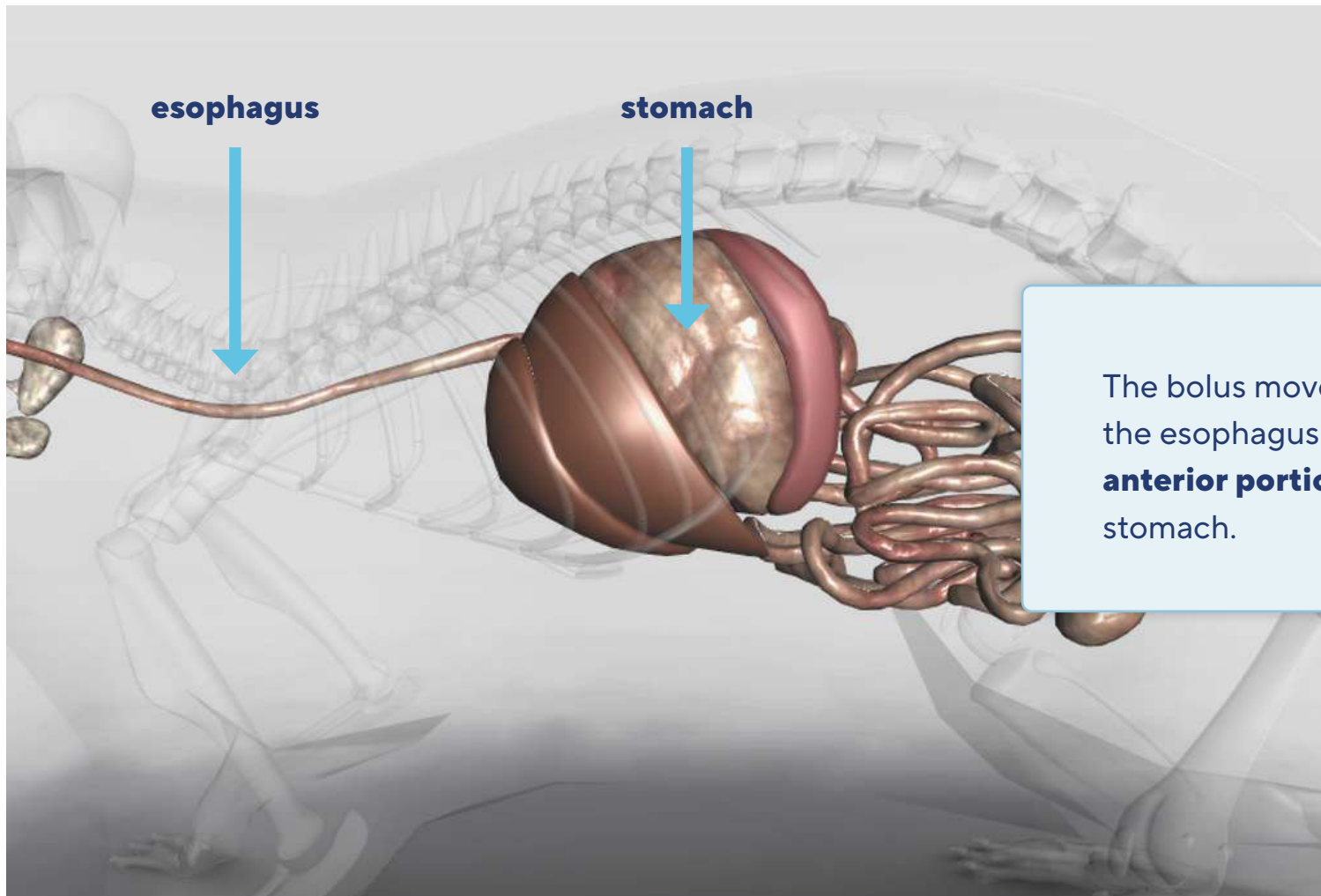
Rotate your rat so you are looking at the **ventral** view (put your rat on their back), zoom in as needed.

After mechanical and chemical digestion in the mouth, the chewed food (called a **bolus**) is swallowed.

The bolus then enters the **esophagus**. Muscle contractions called **peristalsis** push food along towards the stomach.

← HEAD

TAIL →

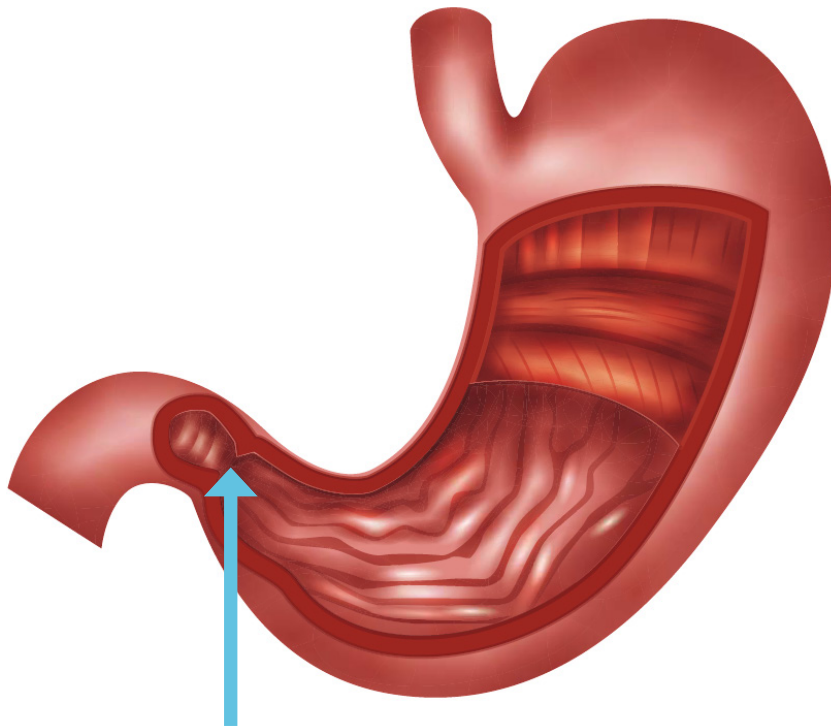


esophagus

stomach

The bolus moves through the esophagus to the **anterior portion** of the stomach.

Stomach



Location: dorsal and posterior to the liver

Structure: muscular organ

Function: muscular organ that continues the chemical and mechanical digestion that started in the mouth

Pyloric Sphincter: Valve between the stomach and duodenum (first part of small intestine)



The food travels to the **small intestines** from the **stomach** through the **pyloric sphincter**.

Find the small intestine on your rat.

Can you label it on the image?

Small Intestine

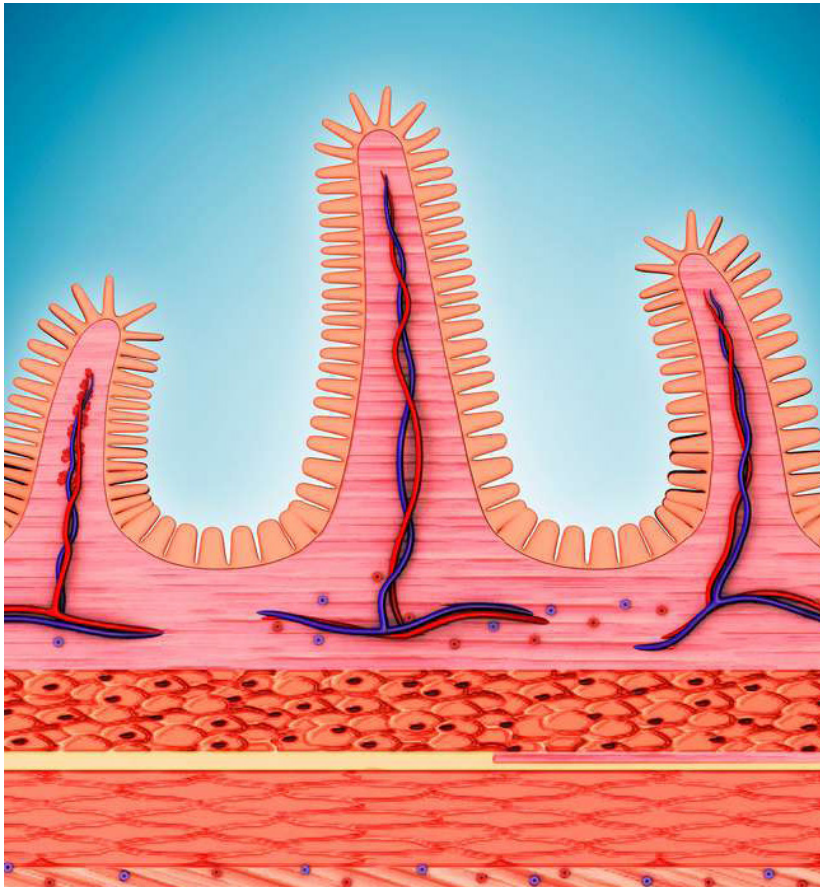


Location: slender coiled tube, starting at the **stomach**, and connects to the **large intestine** at the **caecum**

Structure: consists of **duodenum, jejunum,** and **ileum**, supported and wrapped by a membrane of **mesentery**

Function: receives food from stomach and completes **digestion** started earlier—most food **absorption** and **chemical** digestion occurs here

Intestinal Villi

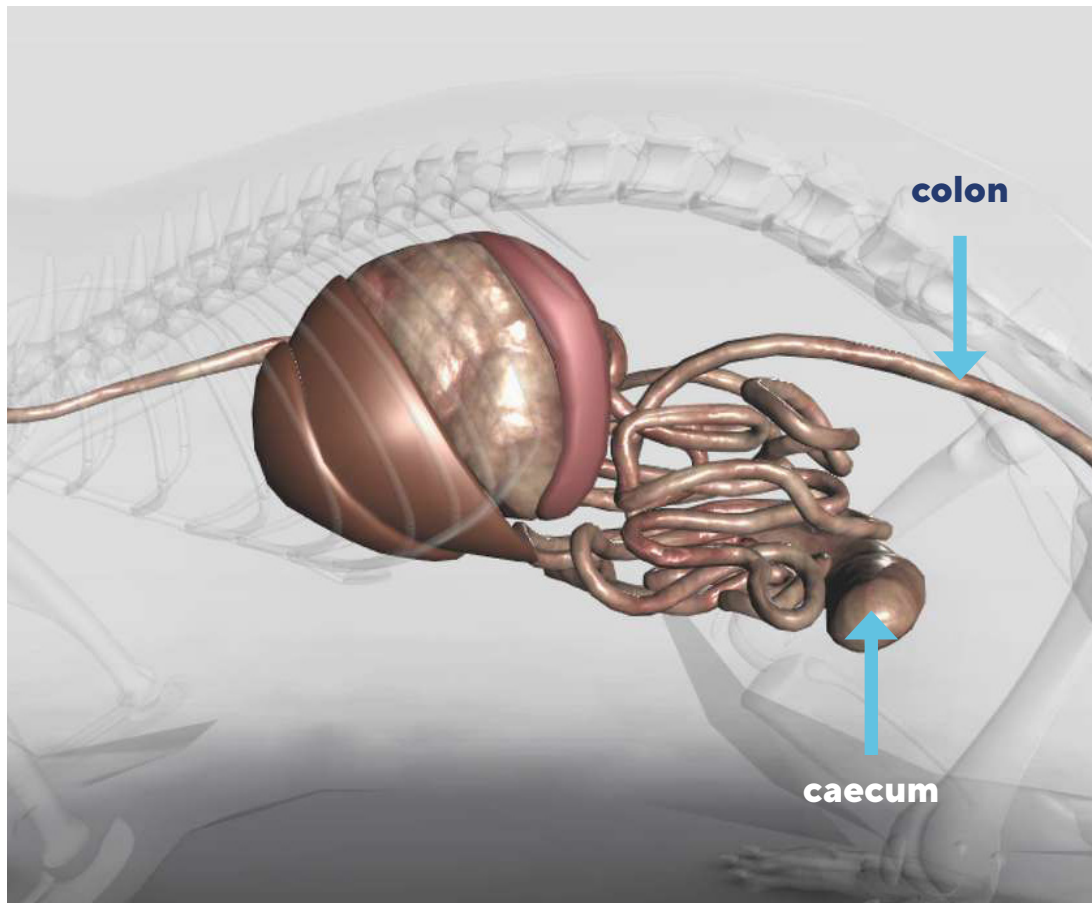


What lines the internal surface of the small intestine and what is its function?

Villi: Increase absorptive surface of the small intestine; higher surface area means more area for absorption

** You won't see villi on the 3D Rat Anatomy app, but they are there!*

Large Intestine



The **large intestine** (also known as **colon**) starts at the **caecum** and connects to the **rectum**.

Rotate your rat as needed to explore the **caecum** and **large intestine** (colon).

Large Intestine

Structure: consists of descending **colon** and **rectum**

Muscular contractions in large intestine initiate defecation

Function: storage of undigested materials that have passed through the small intestine

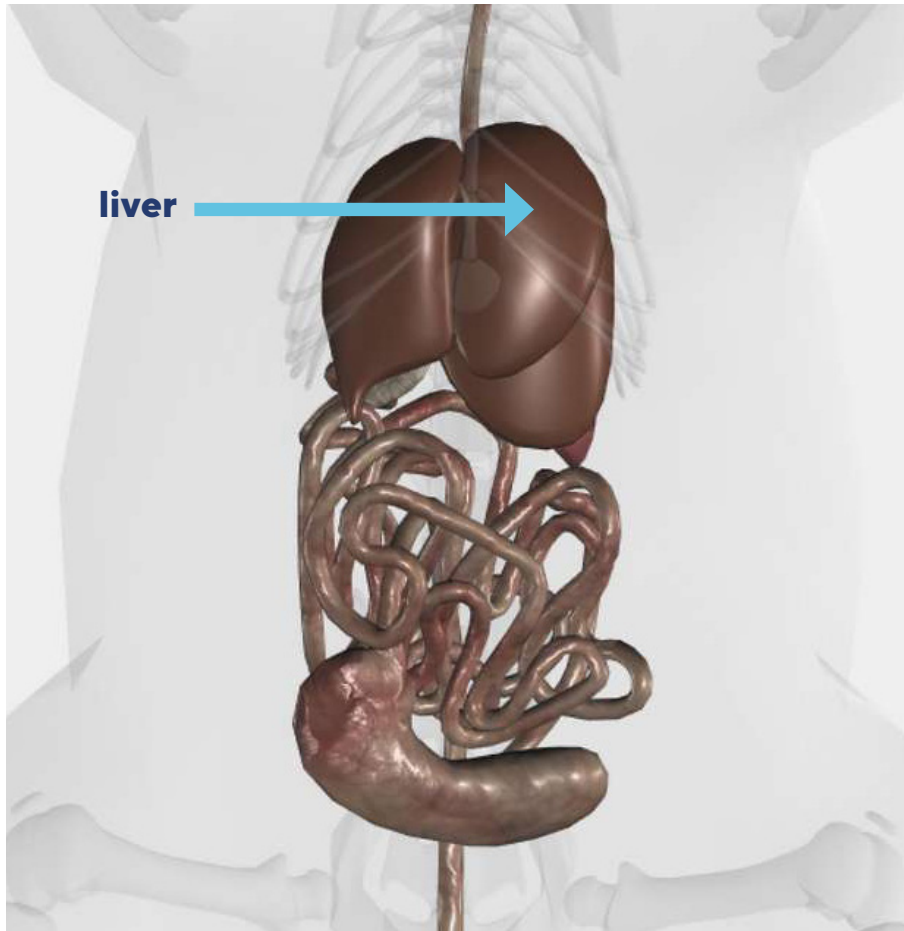
Reabsorbs water from food

Caecum: contains microorganisms which help breakdown plant material not digested by enzymes in small intestine.

WHY WOULD SOME CARNIVORES HAVE A VERY SMALL OR SOMETIMES NON-EXISTENT CAECUM?

1. Some animals do not consume plant matter, so the caecum is unnecessary.
2. The caecum of herbivores is much larger than the caecum of omnivores. Herbivores consume more cellulose and water, making a larger caecum necessary for effective digestion.

Liver

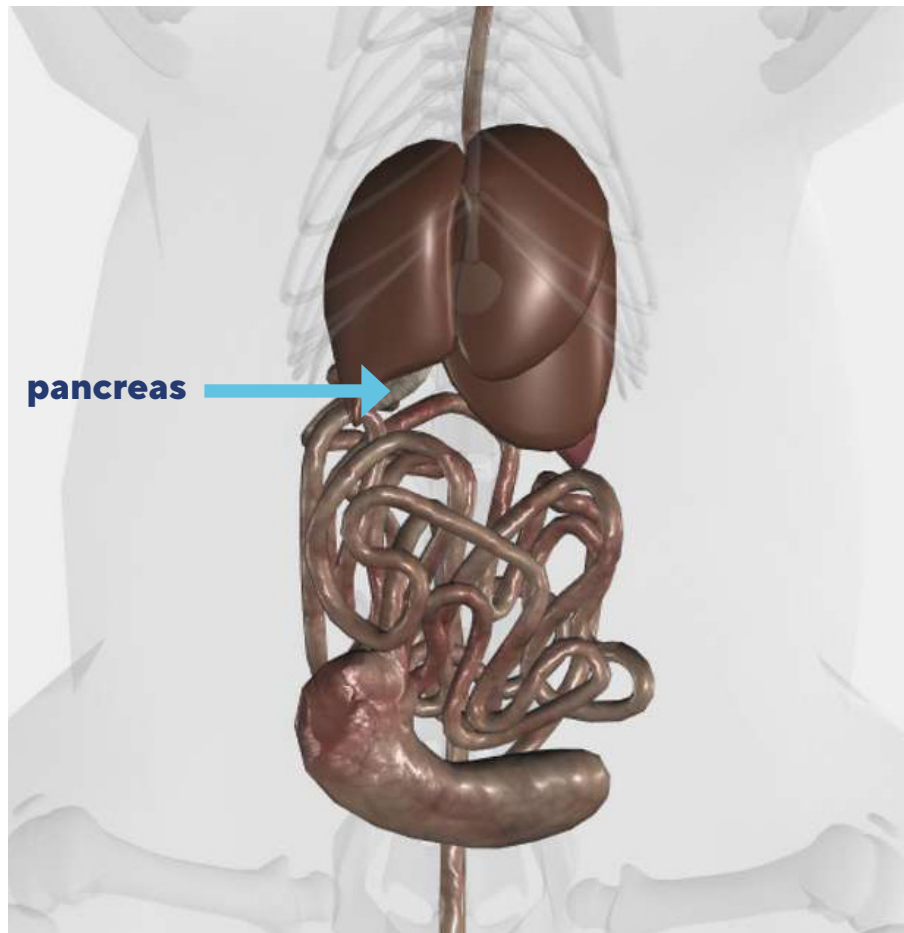


Location: ventral and anterior to the **stomach**

Structure: dark red/brown wedge-shaped organ with **four lobes**

Function: multipurpose organ
Produces bile, removes toxins, stores carbs, and regulates blood sugar levels.

Pancreas



Location: dorsal to **stomach**, wrapped in the **duodenum**

Structure: flattened gland found in between stomach and small intestine

Function: produces two major secretions (1) **digestive enzymes**—responsible for breakdown of fats, carbs, and proteins; (2) **insulin**—a hormone which allows cells to absorb glucose

Common Bile Duct

Location: connects liver to upper portion of small intestine, also known as the duodenum

Structure: small, tube-like

Function: carries bile from the liver into the duodenum—bile is needed to break down fats

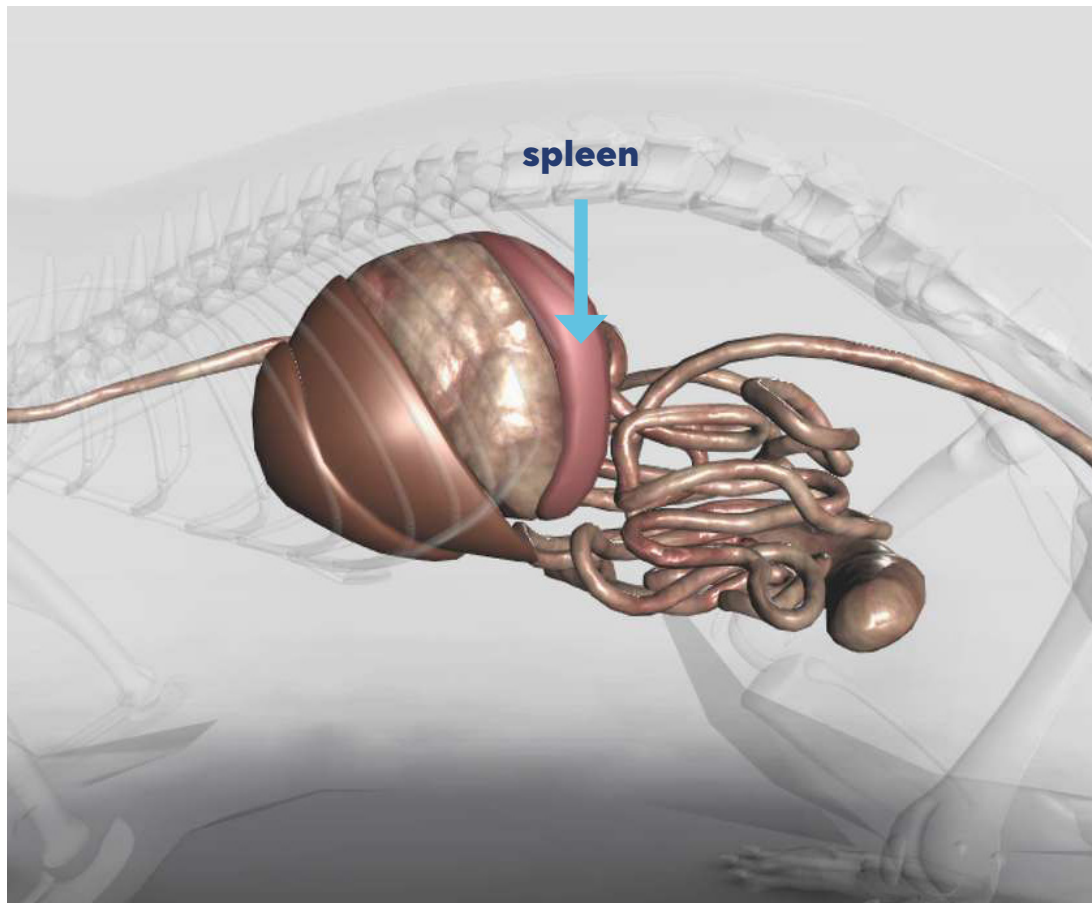
HUMANS HAVE A GALL BLADDER, WHICH CONCENTRATES BILE. WHAT ARE SOME REASONS YOU THINK THIS STRUCTURE IS ABSENT IN RATS?

There are many hypotheses.

One of the more popular ones is that herbivores and other animals who eat low concentrations of fat, or forage continuously (ex. rats), don't need one.

Another is that their liver might be able to concentrate higher levels of fats.

Spleen



Finally, let us locate the **spleen**. It is an elongated, red, organ found on the left side of the rat's body.

It's **not part** of the digestive system, however it is nestled in with the digestive organs.

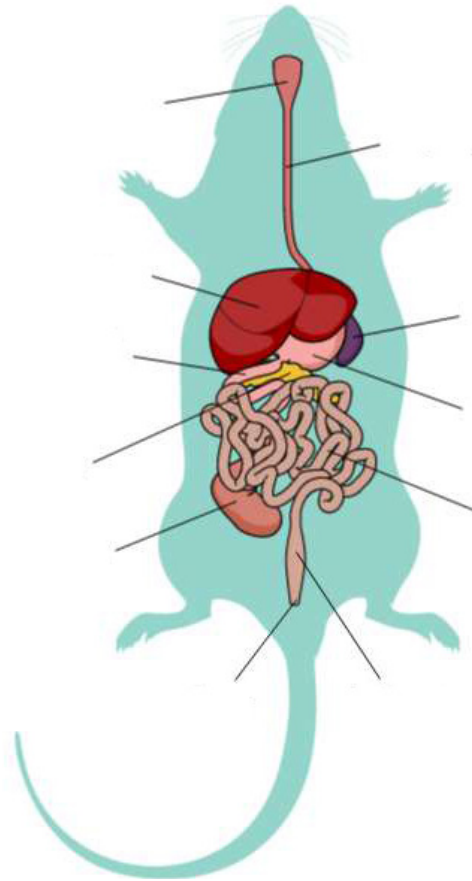
The spleen removes old blood cells and breaks them down.

REVIEW BREAK

With your group, trace the path of food through the digestive system. Name all the different structures the food passes through from the moment a rat takes a bite, to the moment it poops! Choose one person to explain it to the class.

QUIZ!

Label the rat digestive system diagram below.





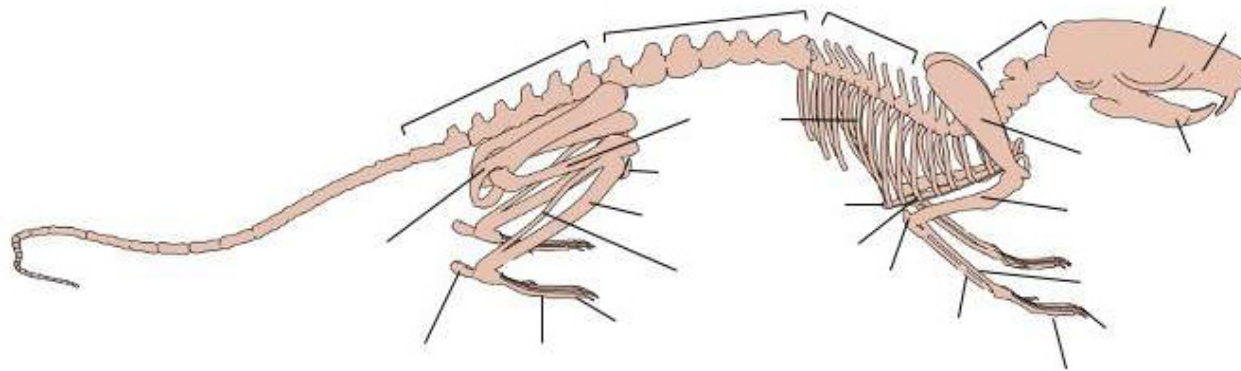
MUSCULOSKELETAL SYSTEM

TURN OFF ALL OTHER BODY SYSTEMS AND FOCUS ON THE SKELETON:

:: Skeleton

Bones

Use your 3D Rat Anatomy app to label all the bones on this rat skeleton.

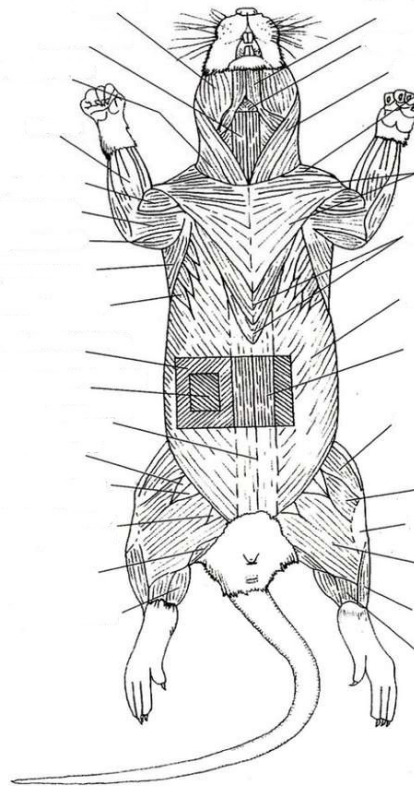


TURN OFF ALL OTHER BODY SYSTEMS AND FOCUS ON THE SKELETON:

☰ Muscles

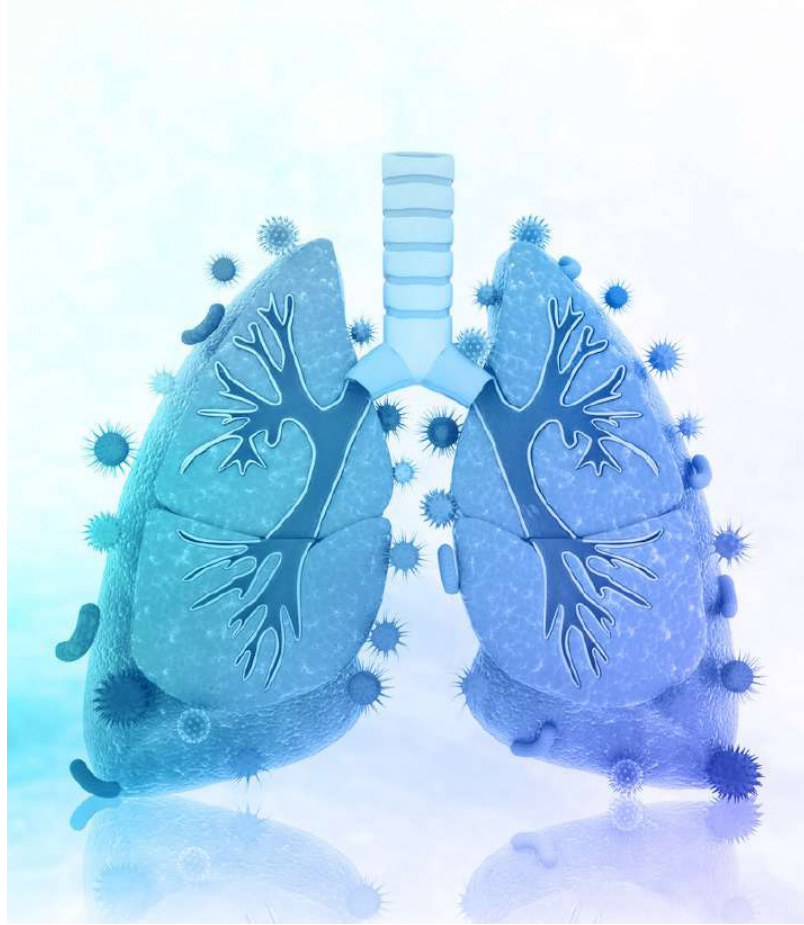
Muscles

Use your 3D Rat Anatomy app to label the muscles on the image. Feel free to peel back deeper layers and explore deeper muscles in the app!



REVIEW BREAK

With your group write down the names of three major muscles and three major bones in the musculoskeletal system of the rat.



RESPIRATORY SYSTEM

TURN OFF ALL OTHER BODY SYSTEMS AND FOCUS ON THESE:

: Skeleton

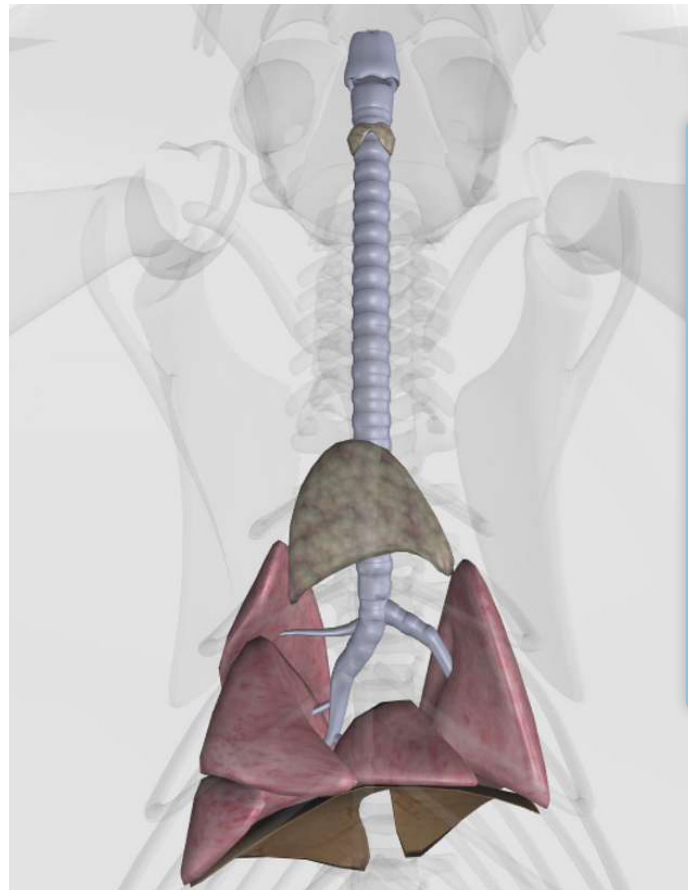
:: Respiratory

Lungs and Trachea

Location: chest cavity

Structure: large, spongy expandable organ

Function: the **site of gas exchange** between the respiratory and circulatory systems



Locate the **trachea** and **lungs**

Locate the **bronchi** and/or **bronchial tree**

Can you label them on the image?

DO YOU NOTICE A DIFFERENCE BETWEEN EACH LUNG?

1. The heart is located on the left side of the body.
2. Most animals have fewer lung lobes (including humans) on the left side of the body to make room for the heart.

WHY WOULD THE TRACHEA BE LINKED WITH CARTILAGE RINGS?

1. To prevent it from collapsing as the animal inhales

Trachea

air travels down the **trachea**, moves into each lung through the divided branches of the **bronchial tube**



Bronchial tube

within the lungs, it branches further into **bronchioles**



Bronchioles

tiny, thin walled sacs are on the end of the bronchioles, called **alveoli**



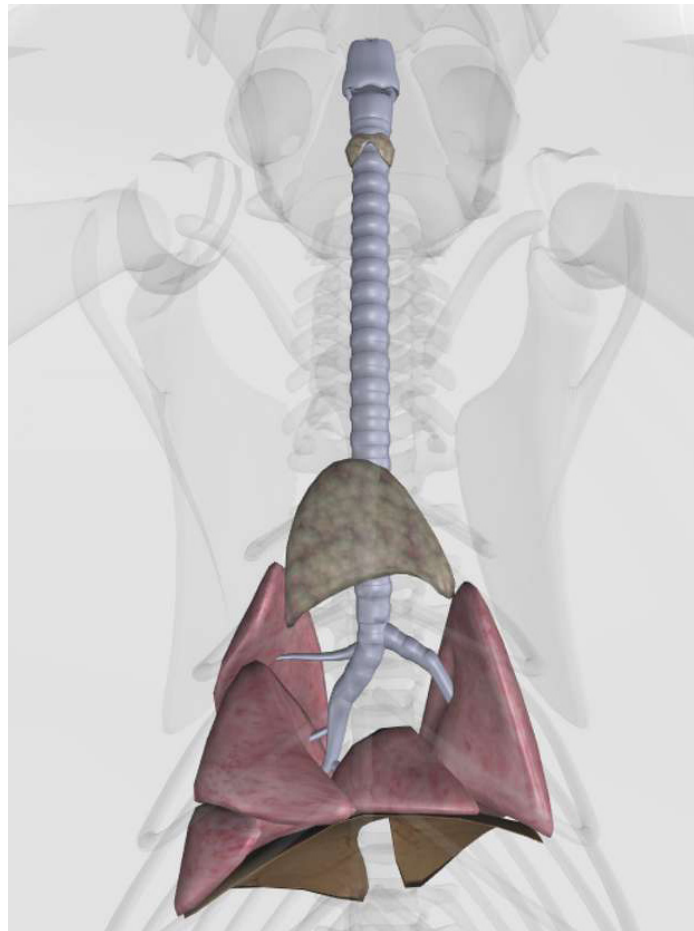
Alveoli

site of **oxygen exchange**

Picture the branches of trees, but with thousands of little balloons on them instead of leaves!

The Diaphragm

The **diaphragm** is the layer of muscle separating the thoracic and abdominal cavity. Can you label it on the image?

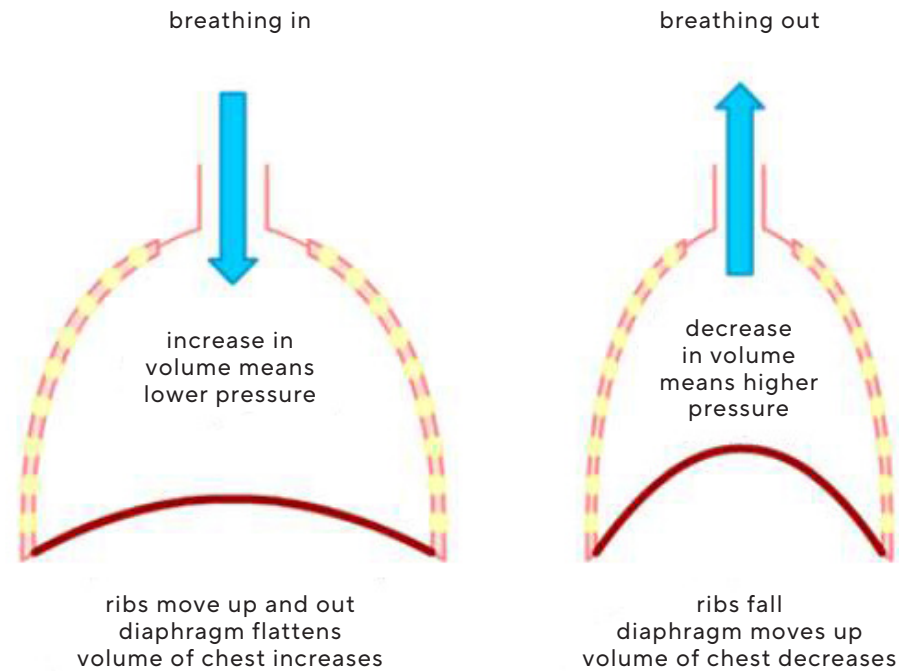


What would happen to the thoracic cavity if the diaphragm flattens?

How does this assist in breathing?

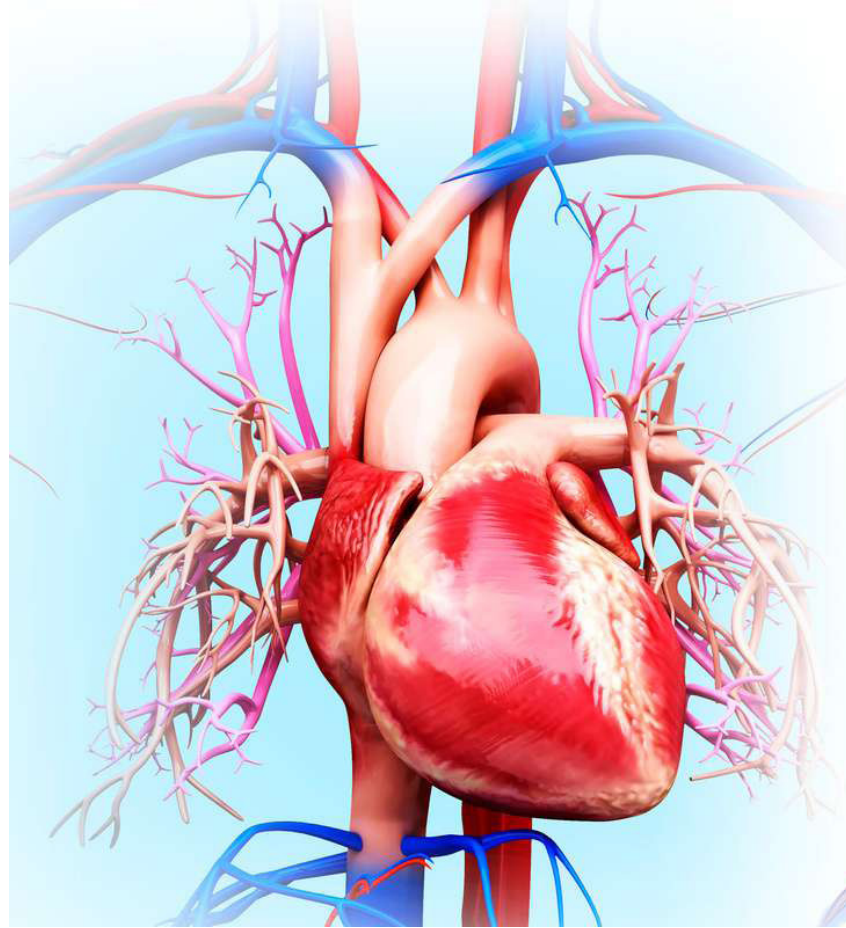
What happens during an exhale?

Most animals breath using **negative pressure** breathing.
Gases move from **high** pressure areas to **low** pressure areas.



REVIEW BREAK

With your group, trace the path of air from the moment it is breathed in through the nose or mouth, to the moment it is exhaled. Choose one person to explain it to the class.



CIRCULATORY SYSTEM

TURN OFF ALL OTHER BODY SYSTEMS AND FOCUS ON THESE:

: Skeleton

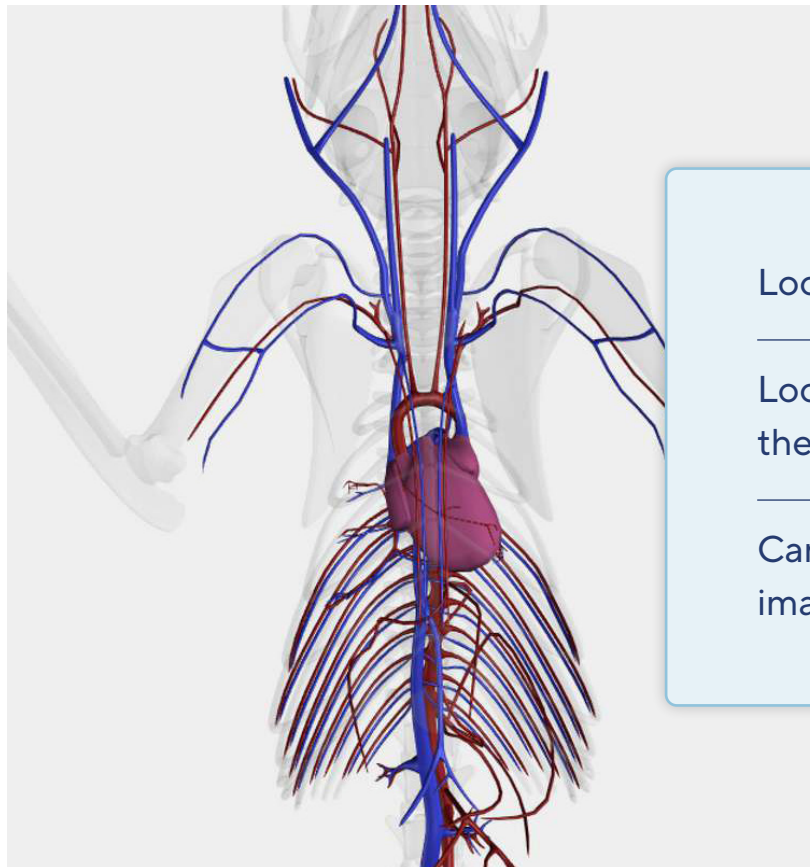
:: Circulatory

Heart

Location: center of the chest, nestled between the two lungs

Structure: strong muscular organ with four chambers (two atria, two ventricles)

Function: pumps blood to lungs and the rest of the body through strong rhythmic contractions



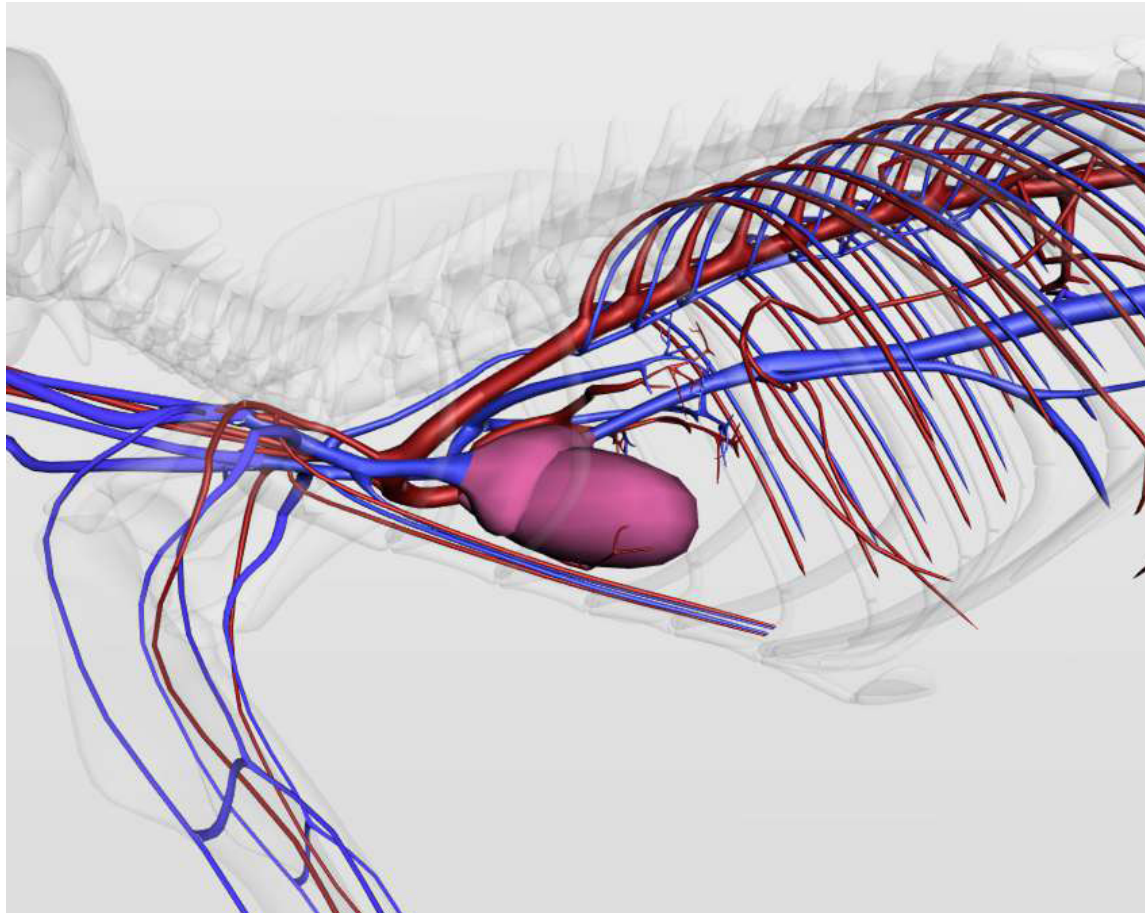
Locate the rat's **heart**.

Locate the **aorta** (red) and the **vena cava** (blue).

Can you label them on the image?

← HEAD

TAIL →



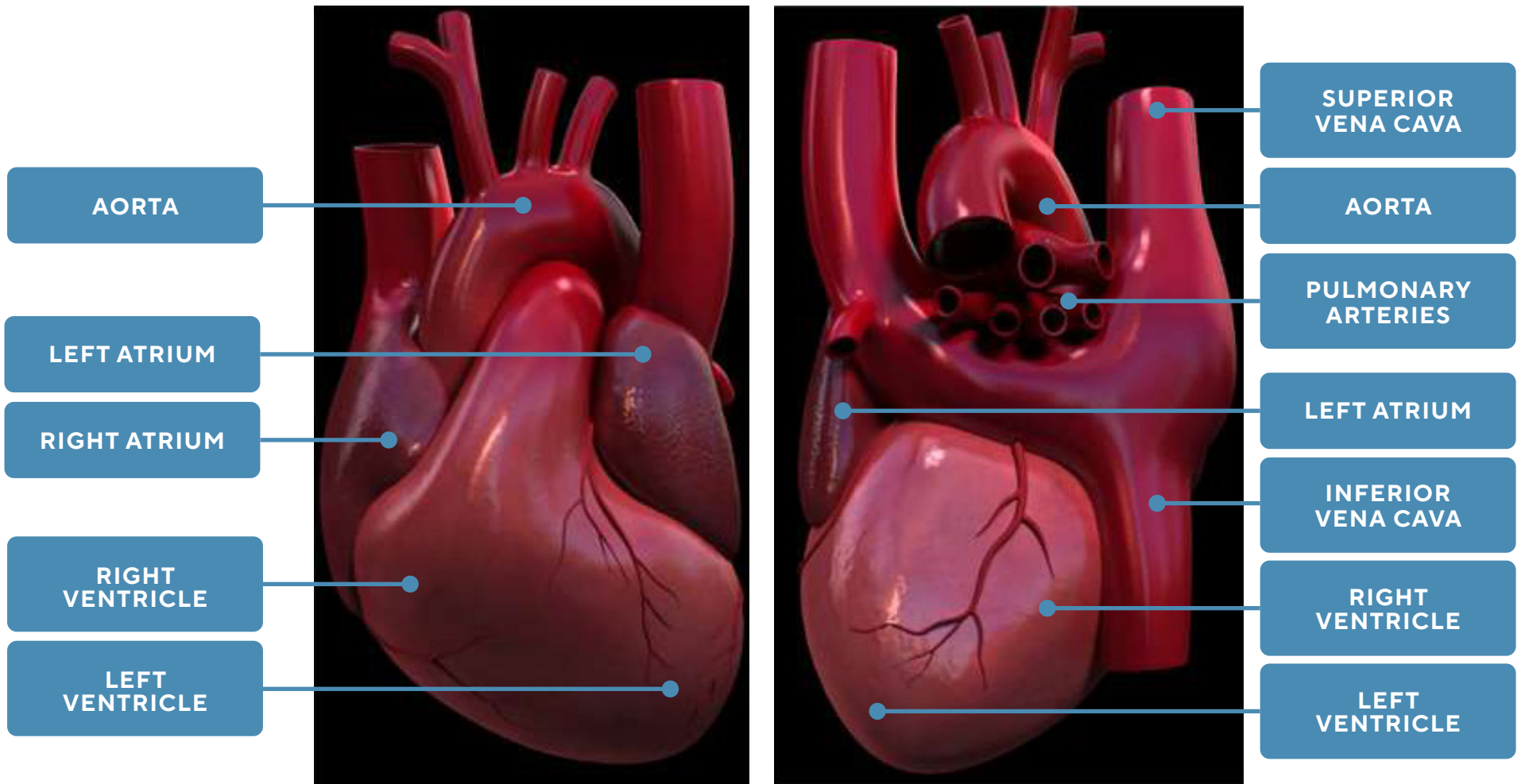
Do **arteries** always carry oxygenated blood and the veins deoxygenated blood? No, there are two exceptions, but **arteries always** carry blood away from the heart, and **veins always** carry blood towards the heart

The **pulmonary artery** and **pulmonary vein** are the exceptions. Can you locate them and label them on the image?

Hint: You'll need to rotate your rat so that they are sideways.

For this more detailed view of the heart, we're using screenshots from the [Emantras Virtual Rat Dissection](#).

Heart



Bloodflow Through the Heart

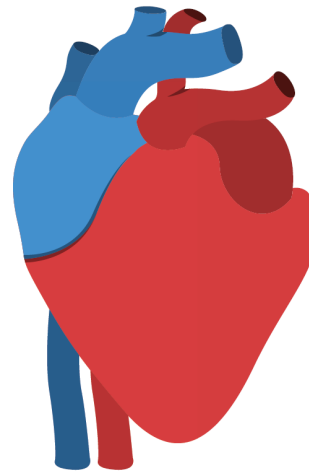
The caudal, inferior and superior vena cava vessels carry **deoxygenated** blood to the right **atrium**.



Blood is then pumped from the right atrium to the **ventricle**.



Blood is pumped from the right ventricle out to the **pulmonary arteries**, which carry the blood to the lungs to receive oxygen.



The left ventricle pumps oxygenated blood out to the body via the aorta.



Blood is then pumped from the left atrium to the **ventricle**.



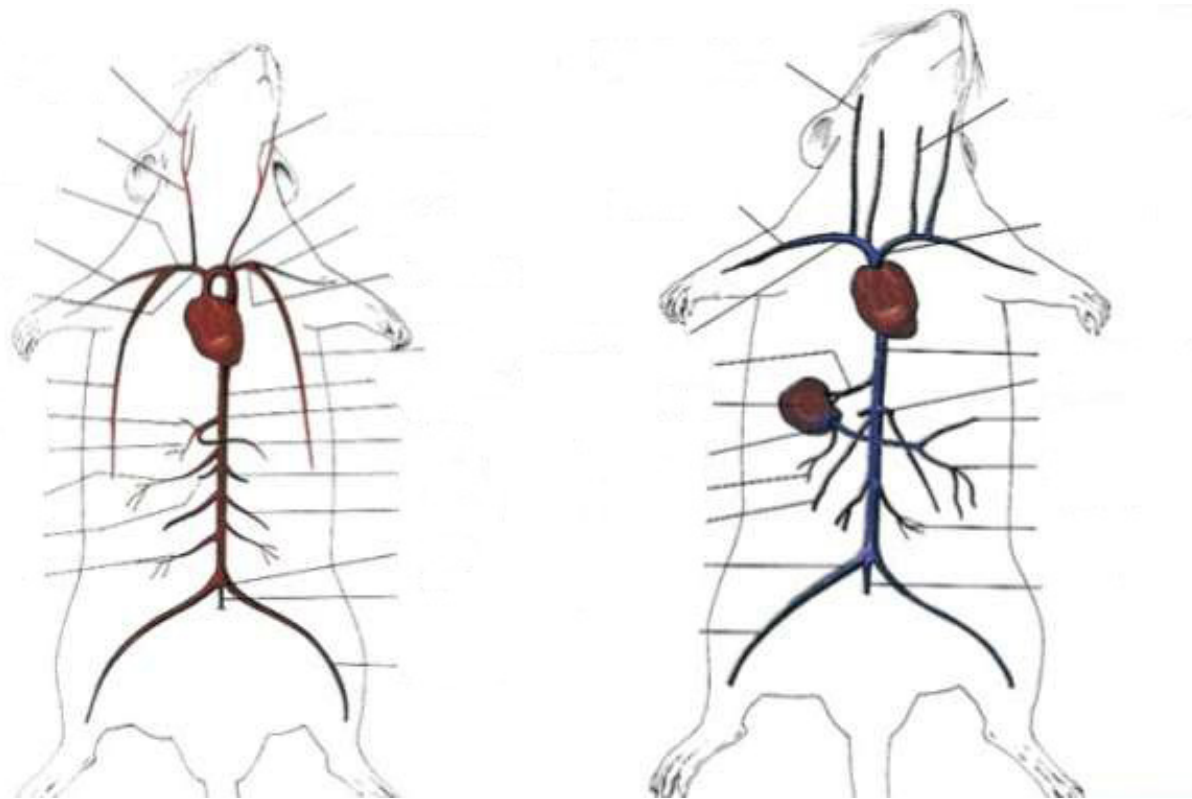
Pulmonary veins carry oxygenated blood back to the heart and into the **left atrium**.

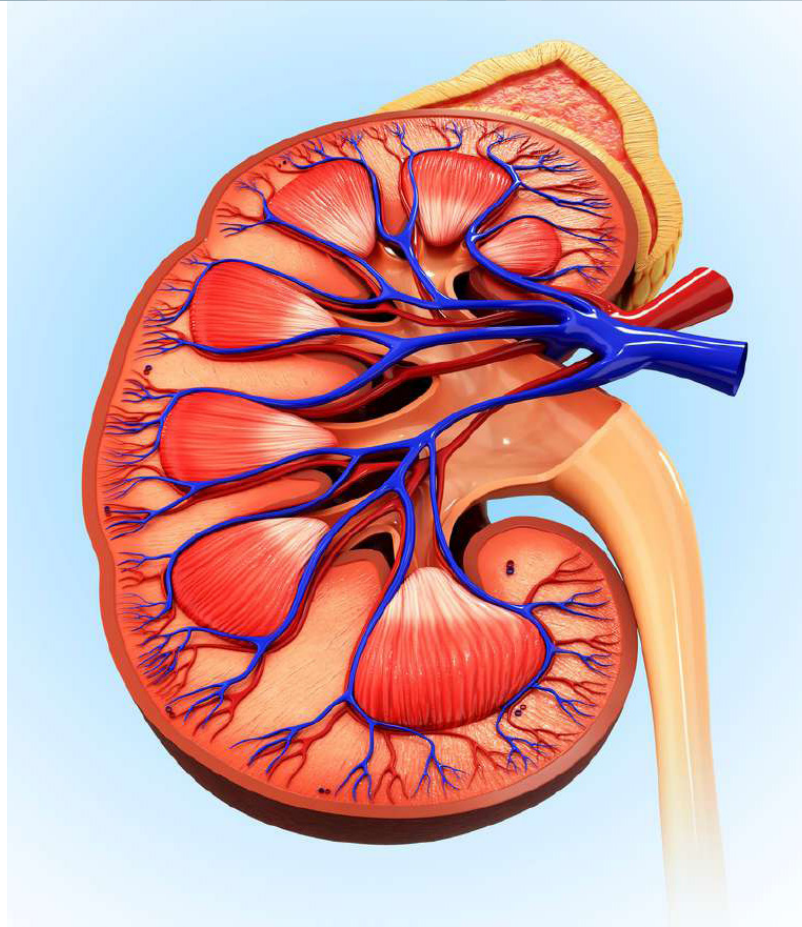
REVIEW BREAK

With your group, trace the path of blood as it flows through the heart, to the lungs, and back again. Choose one person to explain it to the class.

QUIZ!

Label the rat circulatory system diagram below.





URINARY SYSTEM

SEE ENDOCRINE SYSTEM FOR DETAILS OF REPRODUCTIVE ORGANS

TURN OFF ALL OTHER BODY SYSTEMS AND FOCUS ON THESE:

: Skeleton

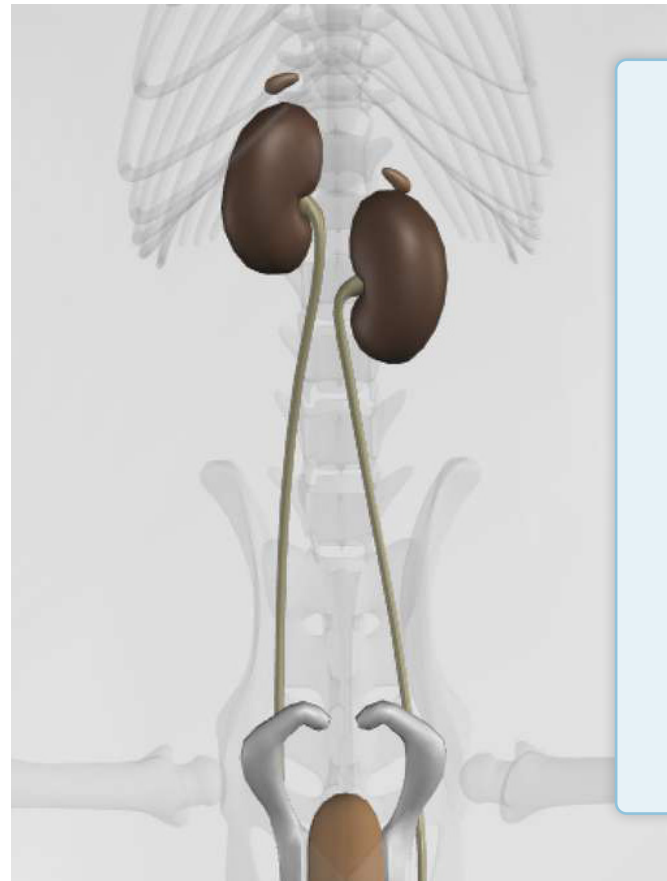
::: Urogenital

Kidneys

Location: high in abdominal cavity, one on each side of the spine

Structure: bean-shaped, surrounded by tough fibrous tissue

Function: removes nitrogenous wastes (eg. urea/urine) from the blood and **maintains osmolality** (salt balance) in blood

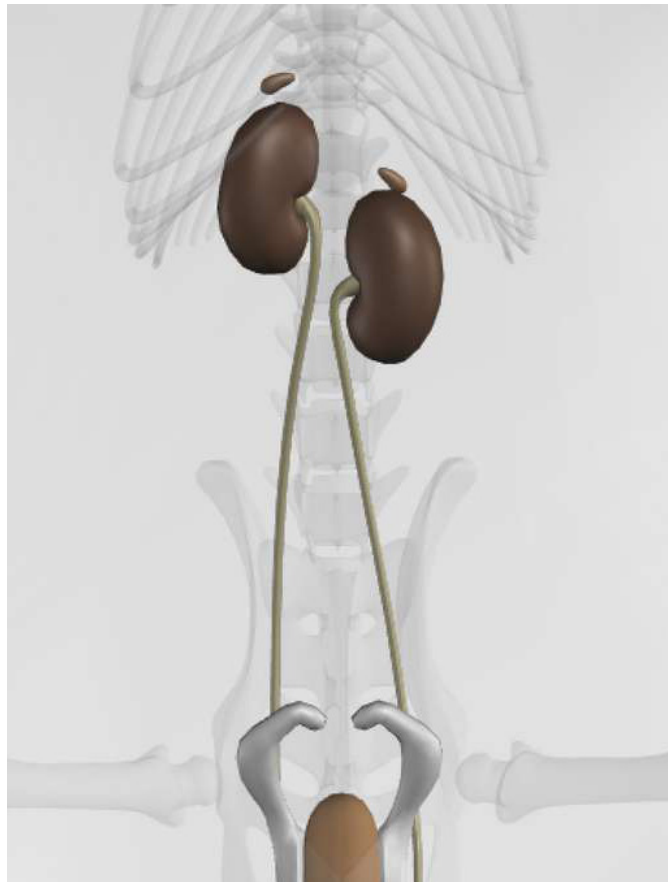


Locate the **kidneys** found embedded in the fat in the dorsal body wall.

Find the other smaller bean-shaped mass called the **adrenal glands** on the anterior end of each kidney.

Can you label them on the image?

Ureter and Urinary Bladder



Locate the **ureter** and **urinary bladder**. Also locate the **urethra**.

Can you label them on the image?

Change the sex of the rat. Why do you think the female and male **urethras** are different?

Ureter

Location: a vessel running between the **kidneys** and the **urinary bladder**

Structure: thin tube

Function: **carries** excretory products produced by the **kidneys**

Urinary Bladder

Location: connected to the **ureter** and **urethra**

Structure: sac-like structure

Function: **stores** urine produced by **kidneys** and releases it into the **urethra**

FEMALE:

Location: duct runs between the urinary bladder and urethral opening

Function: tube carrying urine from the bladder to the outside of the body

MALE:

Location: duct runs between urinary bladder through the most distal part of the penis to the urethral opening

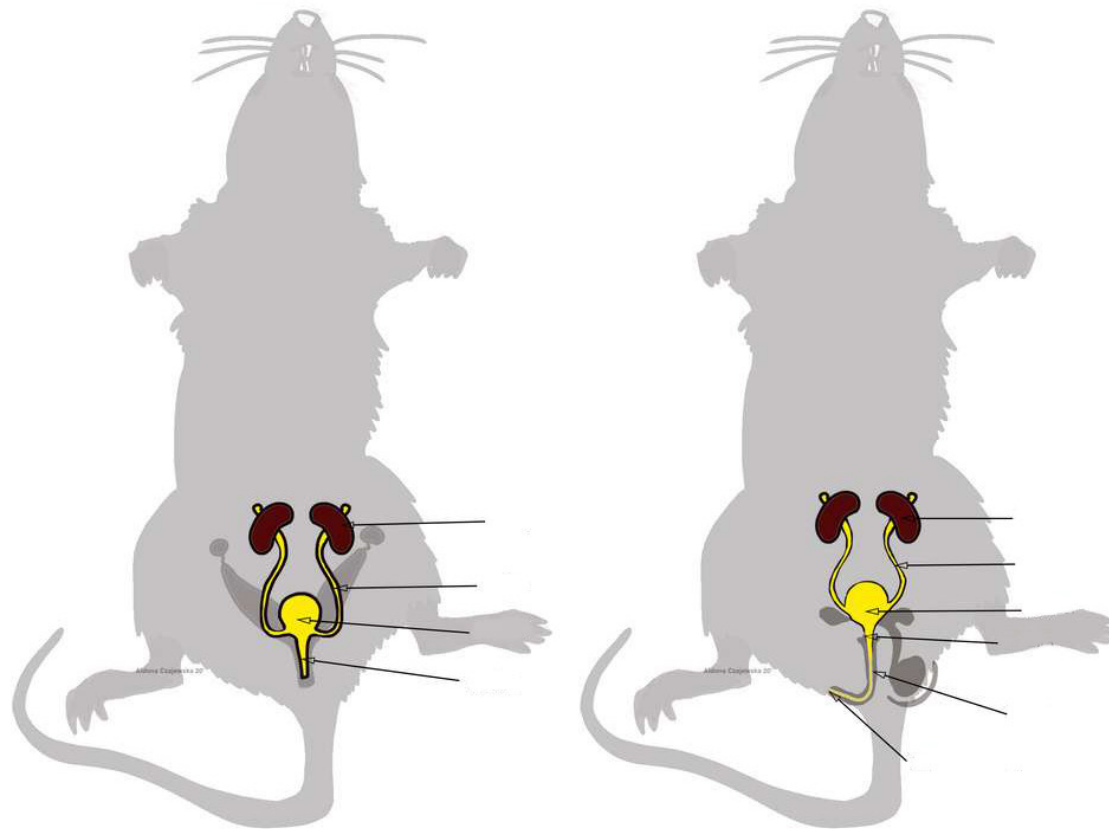
Function: tube carrying urine and sperm to the outside of the body

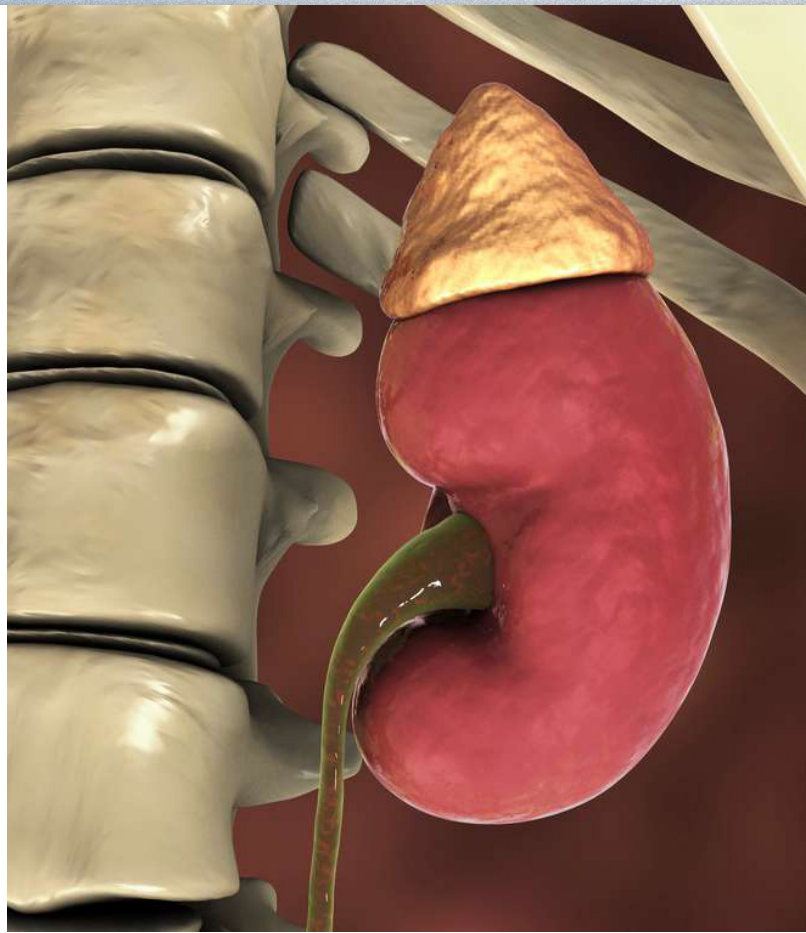
REVIEW BREAK

With your group, trace the path of urine from the kidneys to the outside of the body. Choose one person to explain it to the class.

QUIZ!

Label the rat urinary system diagram below.





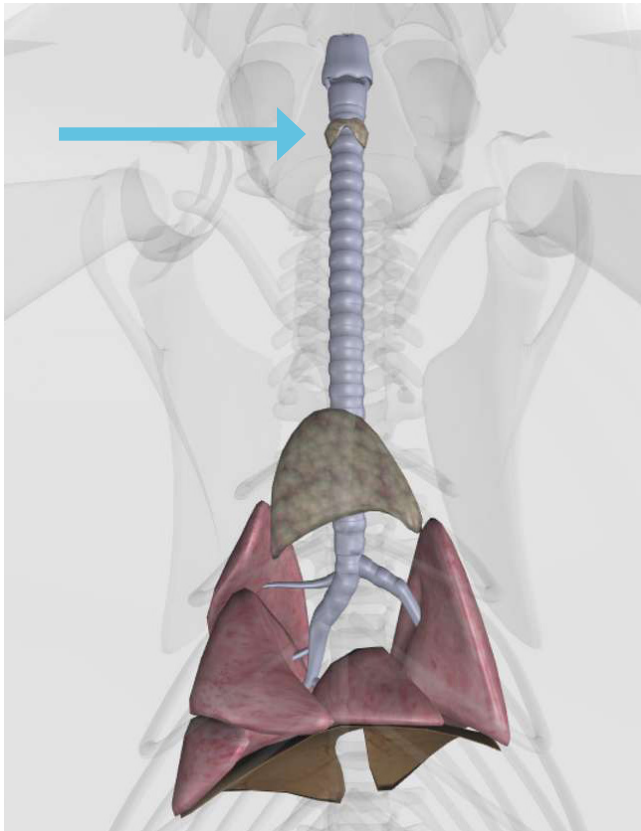
ENDOCRINE SYSTEM

TURN OFF ALL OTHER BODY SYSTEMS AND FOCUS ON THESE:

: Skeleton

:: Respiratory

Thyroid



Location: around the trachea in the throat area

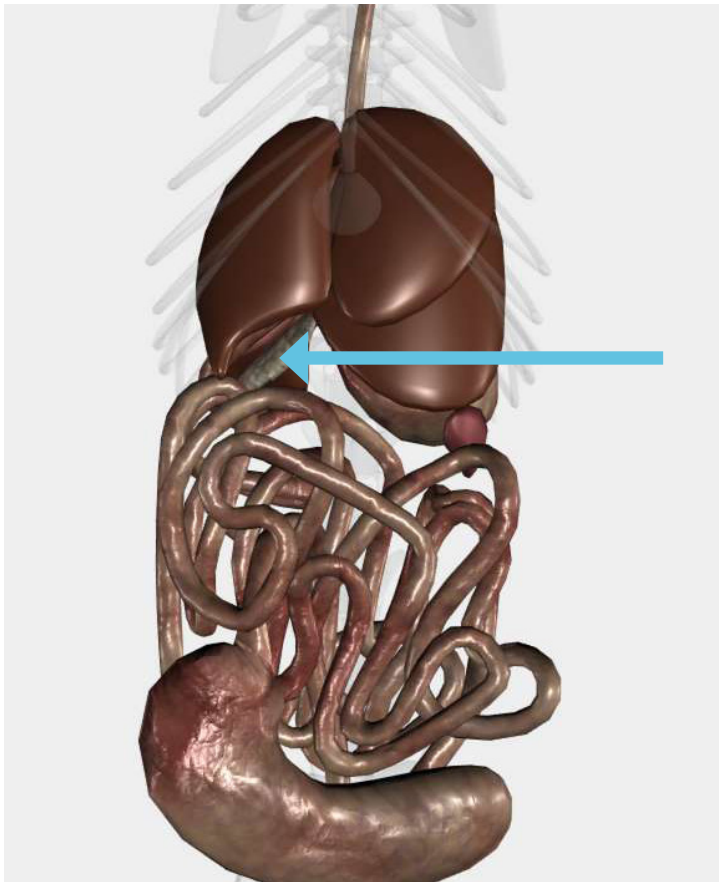
Function: produces hormones that regulate the body's **metabolic rate** controlling heart, muscle and digestive function, brain development, and bone maintenance

TURN OFF ALL OTHER BODY SYSTEMS AND FOCUS ON THESE:

: Skeleton

:: Digestive

Pancreas



Location: near stomach in abdominal cavity

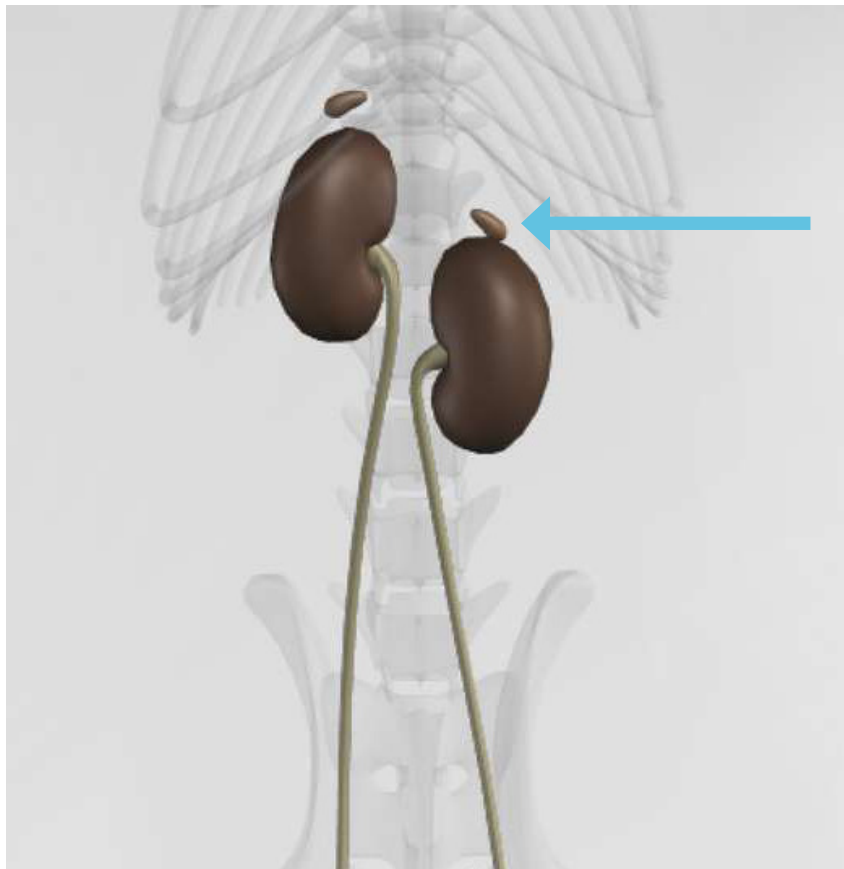
Function: produces **insulin** (which reduces blood sugar) and **glucagon** (which increases blood sugar)

TURN OFF ALL OTHER BODY SYSTEMS AND FOCUS ON THESE:

: Skeleton

:: Urogenital

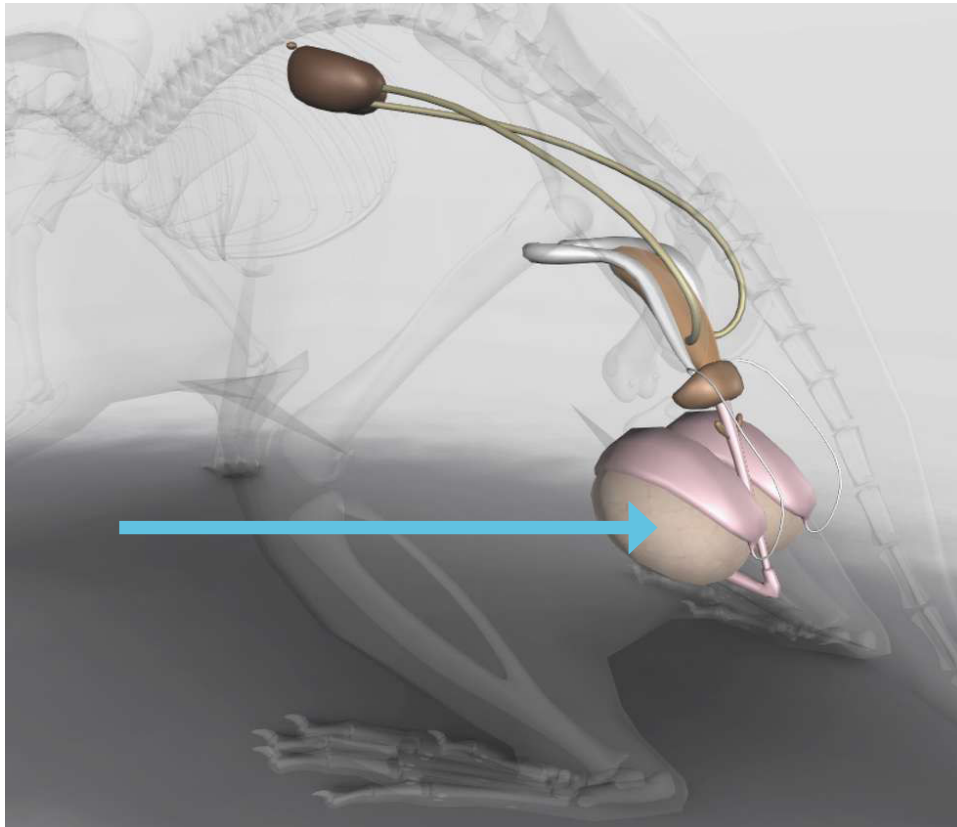
Adrenal Glands



Location: anterior end of kidneys

Function: produce **adrenaline** and **corticosterone** (the stress hormone—called cortisol in humans)

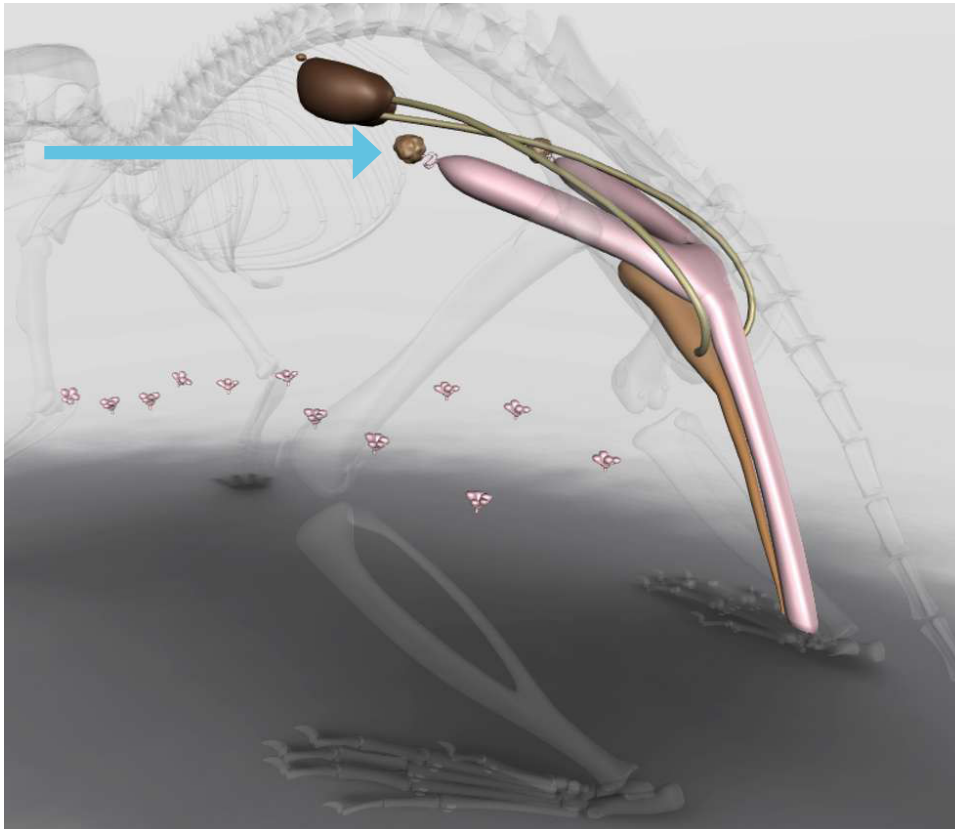
Testes



Location: at the rear end of male rats, by the tail

Function: produce testosterone—the male sex hormone—and produce sperm

Ovaries



Location: in the internal pelvic region of female rats

Function: produce estrogen and progesterone—the female sex hormones—and produce eggs

TURN OFF ALL OTHER BODY SYSTEMS AND FOCUS ON THESE:

: Skeleton

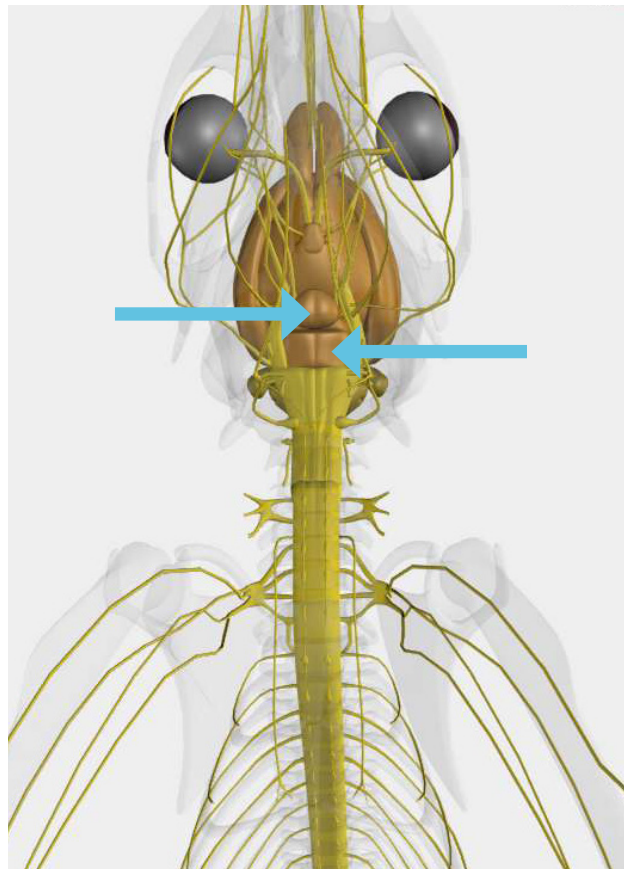
:: Nervous

Pituitary and Hypothalamus

PITUITARY

Location: the underside of the rat brain

Function: The pituitary gland controls the function of most other endocrine glands and is therefore sometimes called the **master gland**. It produces a wide variety of different hormones that influence other endocrine glands.



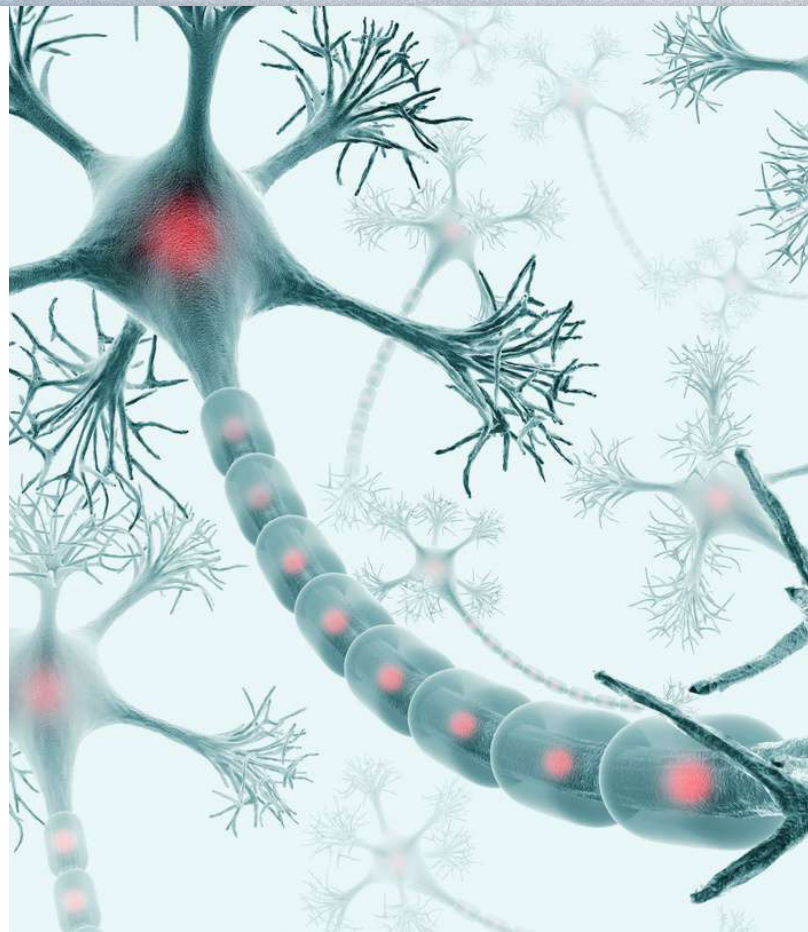
HYPOTHALAMUS

Location: the underside of the rat brain

Function: The hypothalamus **produces a variety of hormones** that are responsible for body temperature, hunger, moods and the release of hormones from other glands; and also controls thirst and sleep.

REVIEW BREAK

With your group, draw an outline of a rat's body, and then add in the major endocrine glands. Choose one person to explain these to the class.



NERVOUS SYSTEM

TURN OFF ALL OTHER BODY SYSTEMS AND FOCUS ON THESE:

: Skeleton

:: Nervous

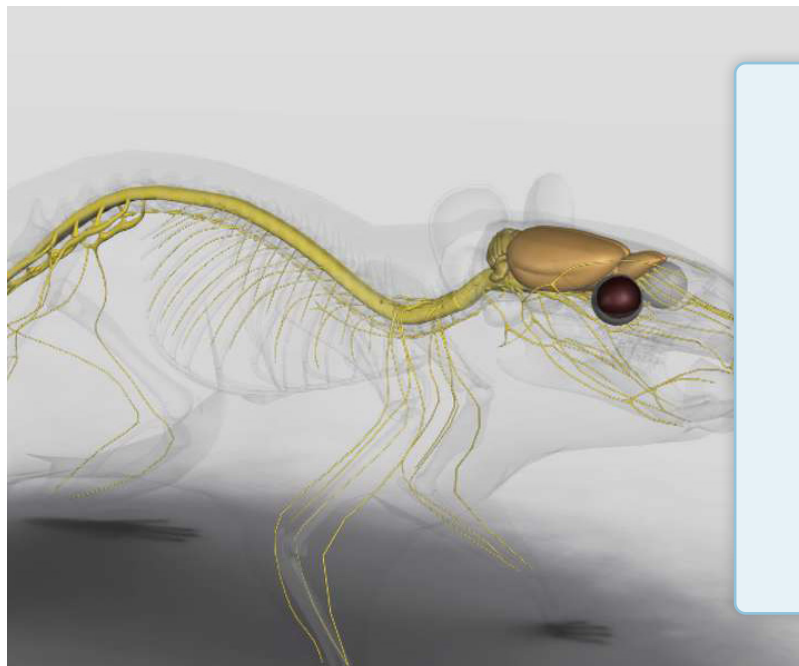
Central Nervous System

BRAIN

Location: in the skull

Structure: about the size of a peanut, smooth surface, packed with neurons

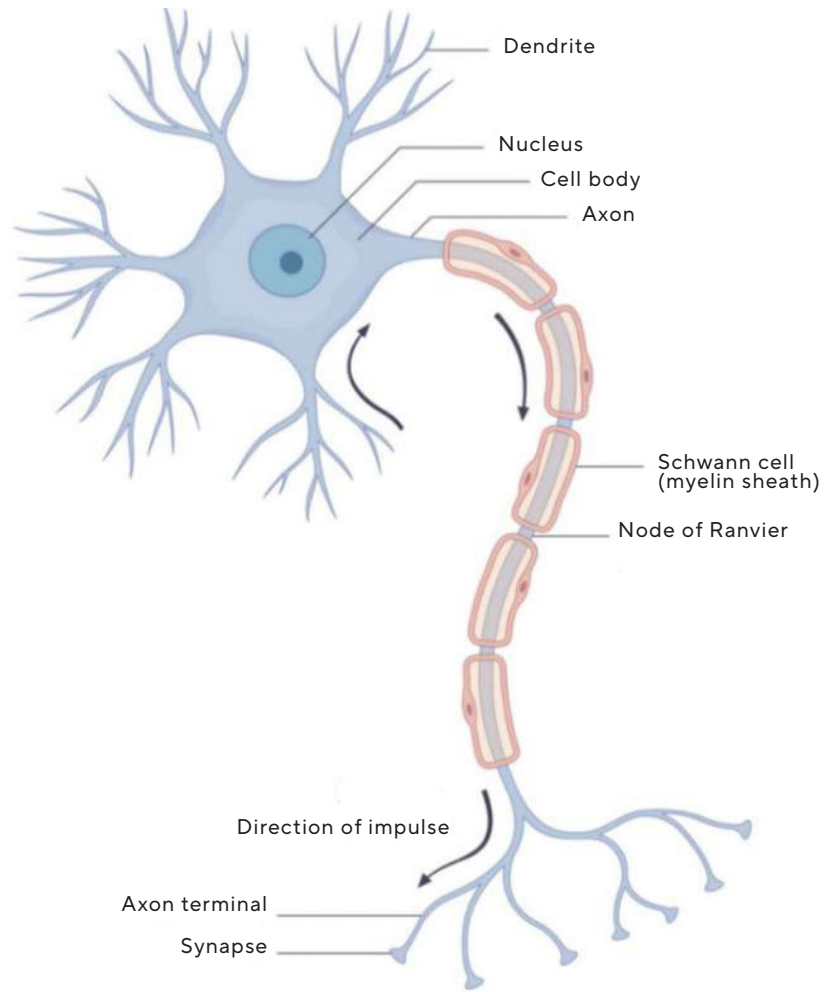
Function: the rat's **central information processor**



Locate the **brain** and **spinal cord**.

Can you label them on the image? Use the app to label more features of the nervous system!

Nerves



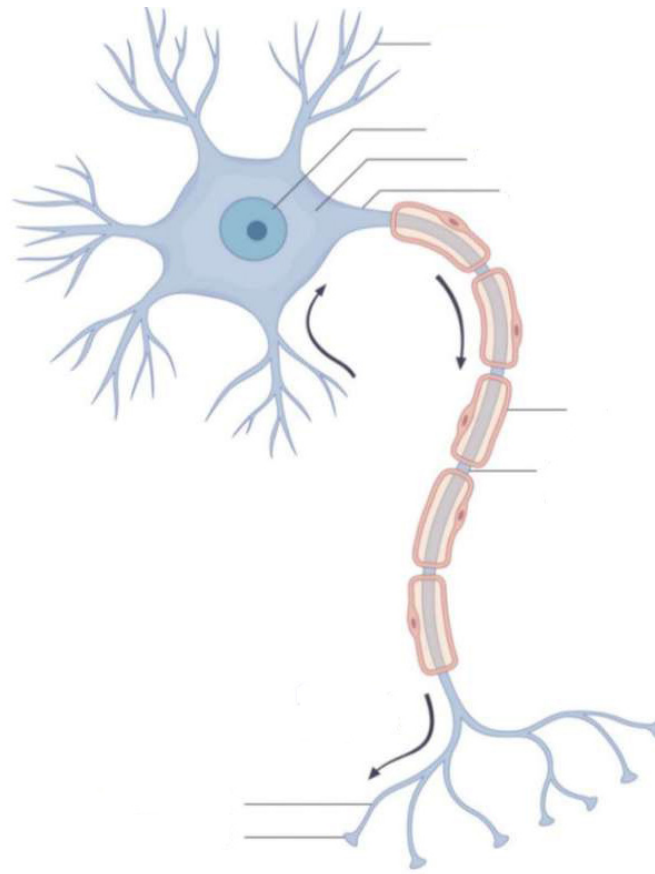
Nerves are bundles of **neurons** (like the one pictured to the left) that transmit electrical “nerve impulses.” Nerve impulses are part of a special information system in the body. For example, when you touch something warm with your hand, the nerves in your hand transmit the information about temperature to your brain, which then translates that into your feeling of “warmth” in your hand.

REVIEW BREAK

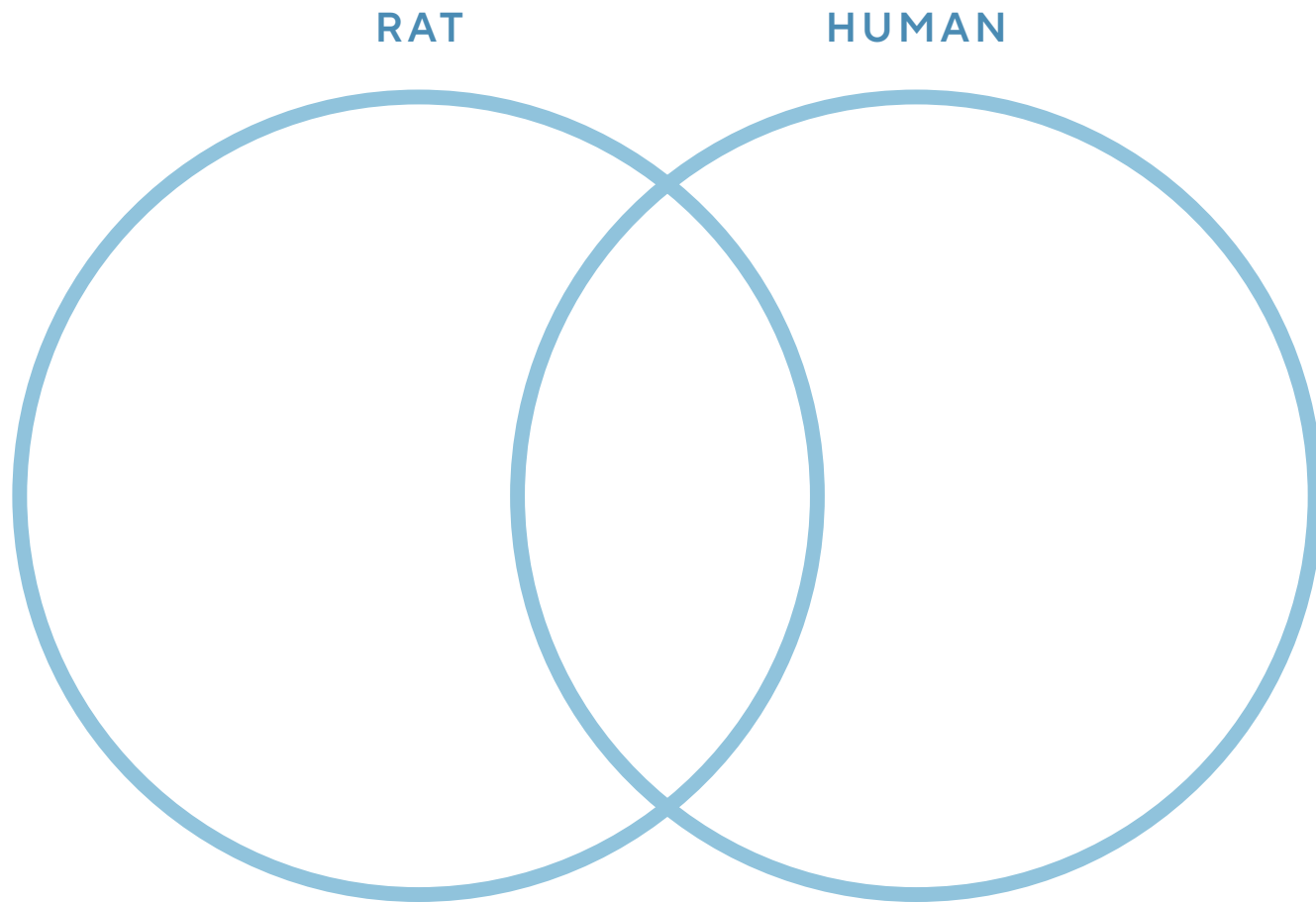
With your group, try to draw the major features of the rat nervous system. Include the brain, spinal cord, and some nerves. Can you name some of the nerves? With your group, draw a single nerve cell (neuron) and try to label it. Choose one person to explain these to the class.

QUIZ!

Label the nerve cell (neuron) below.



Identify Some Key Similarities and Differences Between Rats and Humans



Extra Study Questions:

1. How does oxygen get into the bloodstream? How do the respiratory and circulatory systems connect with each other?
2. How do nutrients from the rat's food get into the bloodstream? How do the digestive and circulatory systems connect with each other?
3. How are harmful substances filtered from the blood? How do the circulatory and digestive/urinary systems connect with each other?
4. How do hormones interact with other body systems?
5. How do the nervous and musculoskeletal systems interact with each other?