## SCIENCE THEATER CARD SET EXPLORE 2 LESSON 11



#### **Materials**

Materials included on the following pages include:

- **Table Tents** for each organ (or, in some cases, grouping of organs) represented in the model (*Pages 2-5*)
- **Tokens** for each represent relevant nutrients, stimuli, and responses represented in the model (*Pages 6-12*)
- Role Cards for each organ, (including any specialized cells (*Pages 13-20*)

Instructions for printing and preparing materials:

- Print one copy of the materials on the following pages (printing on cardstock weight is suggested)
- Cut along dotted lines
- Fold along solid lines marked "FOLD."

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Postgame Analysis - Module 2 - Lesson 11: Table Tents This work is licensed under a Creative Commons Attribution 4.0 License







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Increased amount of ADH	Starting Location: Kidnev	Decreased amount ADH	Starting Location: Kidnev
Thirst         Sensation	Starting Location: Brain	No longer thirsty	Starting Location: Brain

Lower water levels in blood	Starting Location: Blood Vessels	Filter water and wastes of out blood to make urine	Startine Location: Kidnev
Decreased absorption of water	Starting Location: Kidnev	Higher water levels in blood	Startine Location: Blood Vessels

Low volume, dark-colored urine	Starting Location: Bladder	High volume, light-colored urine	Starting Location: Bladder
Decreased urine volume	Starting Location: Bladder	Increased urine volume	Starting Location: Bladder

Postgame Analysis - Module 2 - Lesson 11





# Detect low water in blood

# Signal - low water in blood

Starting Location: Blood Vessels - Osmoreceptors

#### Starting Location: Blood Vessels - Osmoreceptors

# Signal increase ADH production

Signal decrease ADH production

Starting Location: Brain - Hypothalamus

Starting Location: Brain - Hypothalamus

## Detect increased water in blood

Starting Location: Blood - Osmorectors

# Signal increased water in blood

Starting Location: Blood - Osmoreceptors

# Exercise begins

# Recovery with milk begins

Starting Location: Facilitator

Starting Location: Facilitator

## Brain - Hypothalamus, Pituitary Neurons, & Osmoreceptors

The brain is the central organ of the human nervous system, responsible for processing information, controlling bodily functions, and enabling cognitive functions such as perception, thought, and memory. It consists of billions of cells called neurons that communicate through complex networks of electrical signals. These signals form the basis of human consciousness and behavior. The brain sends signals to the rest of the body via nerves, which are composed of long chains of neurons. They send electrical



signals throughout your body to control sensations, movement, and other body functions.

The brain has a structure called the hypothalamus. The hypothalamus is responsible for controlling and managing body temperature, feelings of hunger and thirst, blood pressure, and other biological functions. It receives chemical messages from elsewhere in the brain and throughout the body. These are often signals that correspond to external changes that are impacting the body internally, such as increasing or decreasing temperature or loss of water in the bloodstream due to sweat production. Responding to these factors is important to keep your body in a balanced, stable state known as homeostasis.

**PITUITARY GLAND** 



Osmoreceptors are specialized nerve cells located in the hypothalamus that detect changes to the balance of water and salts in the blood that flow through the brain. When someone has lost significant amounts of water via sweat, urine, or other means, the osmoreceptors detect the lack of water in the blood. Osmoreceptors also detect when the amount of water in the blood is at the body's preferred stable state or when there is excess water in the blood. In each case, the osmoreceptors send a signal to neurons in the other part of the brain called the pituitary to communicate the state of water in the blood.

Act 1: During Exercise	Act 2: Recovery with Milk
<ul> <li>The hypothalamus detects that the amount of water in the bloodstream has decreased and the body is dehydrated. The hypothalamus responds by creating the sensation of thirst. The pituitary receives a signal from the hypothalamus and responds by increasing the amount of ADH hormone it produces and secretes into the bloodstream.</li> <li>Receive the Low Water in Blood Nerve Signal token from the osmoreceptors.</li> <li>Activate Sensation of Thirst token.</li> <li>Activate the Increased Amount of ADH Hormone token and send it to the bloodstream.</li> </ul>	<ul> <li>The hypothalamus receives a signal from the osmoreceptors in the blood vessels, indicating that a proper balance of water has been achieved in the bloodstream. The hypothalamus responds by decreasing the sensation of thirst in the body. The pituitary responds by decreasing the amount of ADH hormone in the amount of ADH hormone in the amount of ADH hormone it produces and secretes into the bloodstream.</li> <li>Receive the Increased Water in Blood Nerve Signal token from the osmoreceptors.</li> <li>Activate the No Longer Thirsty token.</li> <li>Activate the Decreased Amount of ADH Hormone token and send it to the bloodstream.</li> </ul>

#### Science Theater Actions: Brain - Hypothalamus, Pituitary Neurons

#### **Science Theater Actions: Brain - Osmoreceptors**

Act 1: During Exercise	Act 2: Recovery With Milk
<ul> <li>During exercise, osmoreceptors detect a decrease in the amount of water in the blood.</li> <li>Activate the Low Water in Blood Nerve Signal token.</li> <li>Send the Low Water in Blood Nerve Signal token to the hypothalamus and pituitary neurons in the brain.</li> </ul>	<ul> <li>After drinking milk, osmoreceptors detect an increase in the amount of water in the blood.</li> <li>Activate the Increased Water in the Blood Nerve Signal token.</li> <li>Send the Increased Water in Blood Nerve Signal token to the hypothalamus and pituitary neurons in the brain.</li> </ul>

## **Kidney - Epithelial Cells**

The kidneys are part of the urinary system and are responsible for filtering the blood, removing waste from the body as urine, and regulating the amount of water in the urine and blood.

The kidneys filter approximately 200 quarts of fluid and blood by receiving blood from the renal artery. There are approximately 1 million tiny structures, called nephrons, that are made up of a specialized type of epithelial cell. They work to filter the blood and return it to the bloodstream through the renal vein. Anything that is not returning to the body is released as waste into the urine. Urine is mostly water, but it also contains other waste molecules that were not needed in the body at that time.



One of the main functions of the kidneys is to try to balance fluid in the body. During periods of low water in the bloodstream, the kidney works to not remove any additional water from the bloodstream so the body can conserve water. It does so by reducing the amount of water that it sends into the urine. The brain controls this process by releasing a hormone called ADH. If there is a high amount of ADH being sent to the kidney, the kidney's response is to try to conserve water. It does so by reducing the amount of water it sends to the bladder for urine.

If the bloodstream is at its stable state for water or has somewhat more water than needed, the kidney receives less ADH signal from the brain. The kidney then releases more water as urine to the bladder.



### Science Theater Actions: Kidneys - Epithelial Cells

Act 1: During Exercise	Act 2: Recovery With Milk
<ul> <li>The kidney receives a signal from the brain to reduce the amount of water moving from the bloodstream into the urine.</li> <li>Receive the Increased Amount of ADH token and activate the Filter Water and Wastes Out of Blood to Make Urine token.</li> <li>In response to lower water levels in the blood, activate the Decreased Absorption of Water token. Receive one water token from the bloodstream and pass it to the Bladder.</li> </ul>	<ul> <li>The kidney receives a signal from the brain to maintain or increase the amount of water moving from the bloodstream into the urine.</li> <li>Receive the Decreased Amounts of ADH token from the bloodstream and activate the Filter Water and Wastes Out of Blood to Make Urine token.</li> <li>In response to higher water levels in the blood, activate the Increased Absorption of Water token. Receive three water tokens from the Bloodstream and pass them to the Bladder.</li> </ul>

## **Bladder - Urothelial Cells**

The urinary bladder is a hollow organ that is part of the urinary system. It's responsible for storing urine until muscle contractions cause the urethra to relax and release it from the body. As it fills with urine, it expands, holding approximately 350 mL until it needs to be expelled. Most people release about two quarts of urine from the bladder each day.

The bladder is in the lower abdomen. It is held in place by ligaments and housed in attached to the pelvic bones. It has a layer of fat and thick muscle lined with highly specialized urothelial cells that can change shape as a response to the amount of urine in the bladder. These cells can sense changes in the extracellular environment and respond to stimuli.

During periods of dehydration, less urine is produced by the kidney, sending a lower volume of urine to the bladder. When the volume of urine is low, it is more concentrated with waste, and its color becomes darker as a result. When the body is overhydrated, a higher volume of clearer urine is sent to the bladder to be released from the body.



#### Science Theater Actions: Bladder - Urothelial Cells

Act 1: During Exercise	Act 2: Recovery With Milk
<ul> <li>The bladder stores urine to be released as waste.</li> <li>When the volume of urine is low, the concentration of waste solutes in urine is higher.</li> <li>Because of this, the small amount of urine that does exit the body is dark in color.</li> <li>With only one water token, activate the Decreased Urine Volume token and the Release the Low Volume, Dark-Colored Urine token.</li> </ul>	<ul> <li>The bladder stores urine to be released as waste.</li> <li>When the volume of urine is high, the concentration of waste in urine is lower. Because of this, the urine is larger in volume and lighter in color.</li> <li>With three water tokens, activate the Increased Urine Volume Token and the Release the High Volume, Light-Colored Urine token.</li> </ul>

## **Blood Vessels**

Blood vessels are a complex network of structures, including arteries, veins, and capillaries, that transport blood throughout the body. Blood vessels facilitate the delivery of oxygen, nutrients, and hormones to cells and organs while removing waste products, playing a crucial role in maintaining the body's internal balance and supporting various physiological functions.



## CIRCULATORY SYSTEM

The heart, a muscular organ, pumps blood through the blood vessels. Blood contains important molecules such as water, electrolytes, and nutrients. Arteries carry blood away from the heart, veins return it, and capillaries facilitate the exchange of nutrients and gases with tissues.

Blood vessels also carry various signaling hormones throughout the body. For example, ADH, which is also known as vasopressin, is a signal that is sent to the kidneys to regulate the amount of water the kidneys pull out of the bloodstream as urine.

#### **Science Theater Actions: Blood Vessels**

Act 1: During Exercise	Act 2: Recovery With Milk
<ul> <li>Blood vessels transport water, oxygen, nutrients, and hormones throughout the body.</li> <li>Deactivate two water tokens when losing water to sweat during exercise.</li> <li>Receive the Increased Amount of ADH token from the brain and deliver it to the epithelial cells of the kidney.</li> </ul>	<ul> <li>Blood vessels transport water, oxygen, nutrients, and hormones throughout the body.</li> <li>Activate all five water tokens when the athlete drinks milk to recover.</li> <li>Receive the Decreased Amounts of ADH token from the pituitary gland and deliver to the epithelial cells of the kidney.</li> </ul>