SCIENCE THEATER CARD SET
EXPLORE 1 LESSON 9

Food and Agriculture Center for Science Education

Materials

Materials included on the following pages include:

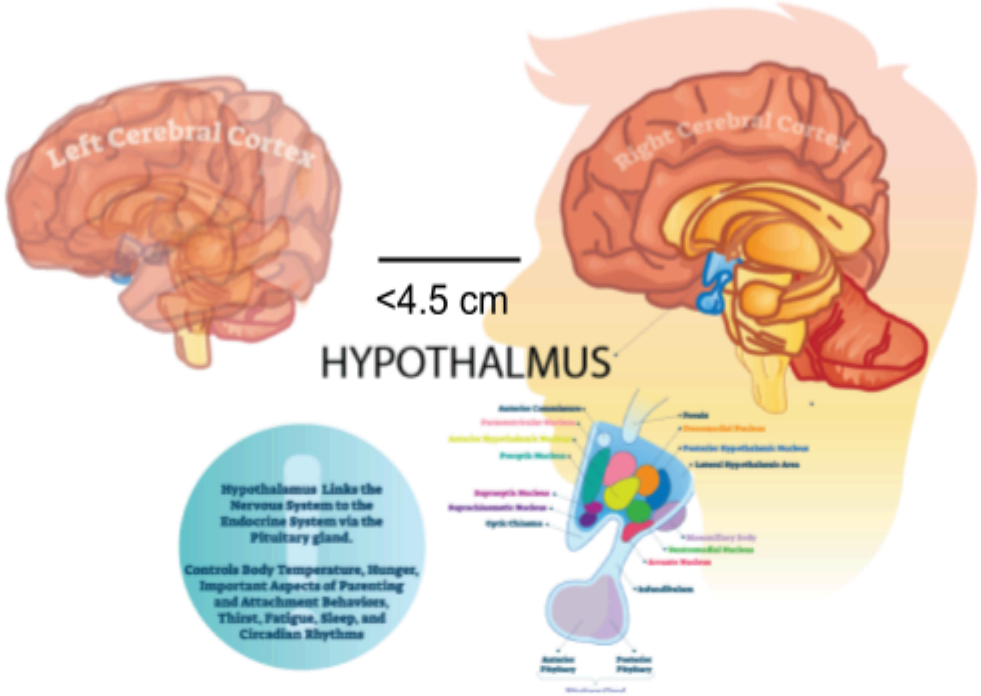
- **Table Tents** for each organ (or, in some cases, grouping of organs) represented in the model *(Pages 2-6)*
- **Tokens** for each represent relevant nutrients, stimuli, and responses represented in the model *(Pages 7-12)*
- **Role Cards** for each organ, including any specialized cells *(Pages 13-22)*

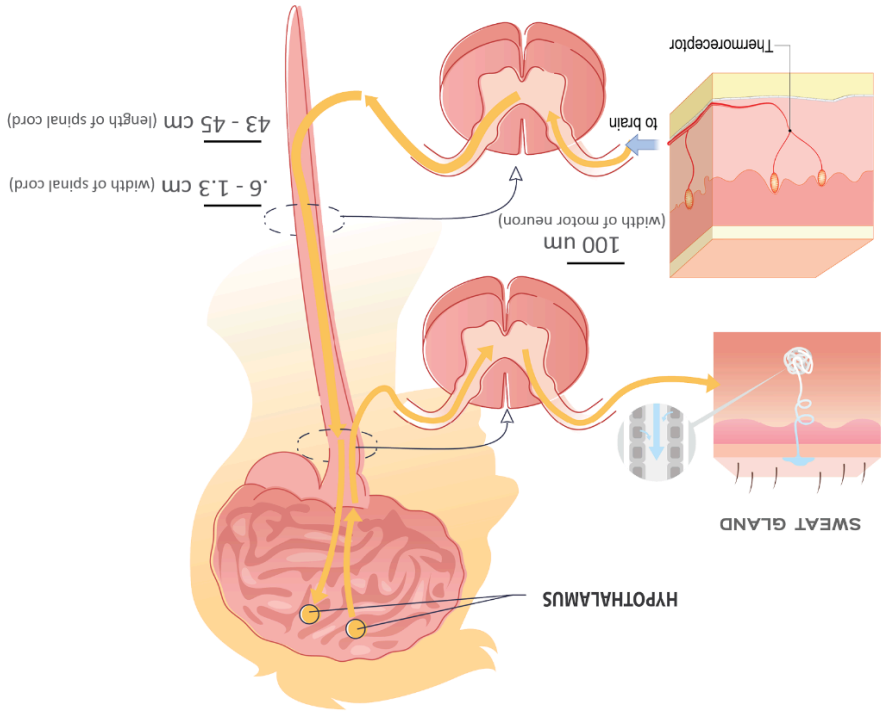
Instructions for printing and preparing materials:

- 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.”

FOLD

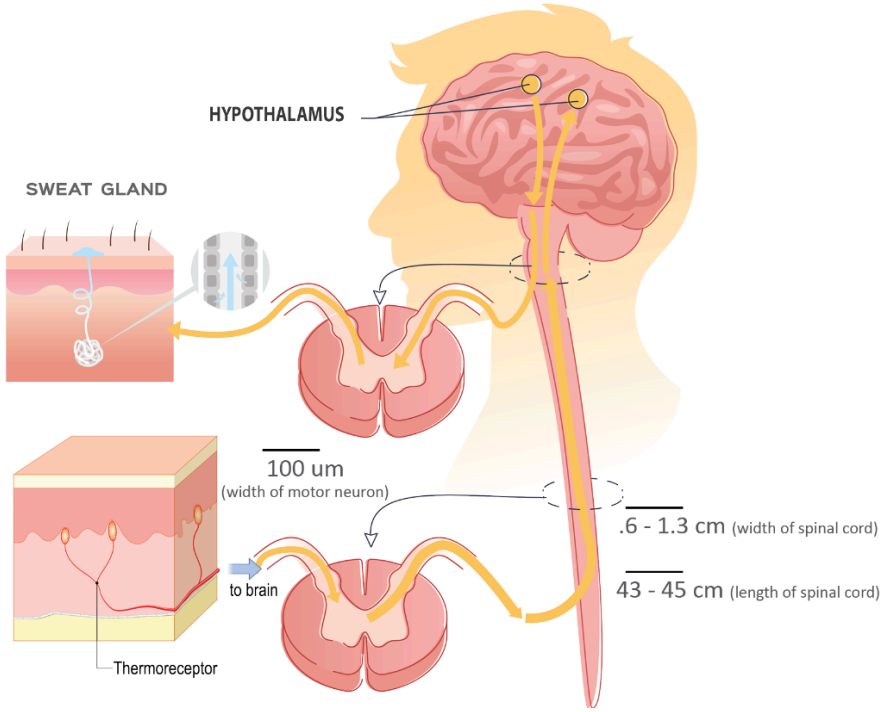
Brain: Hypothalamus

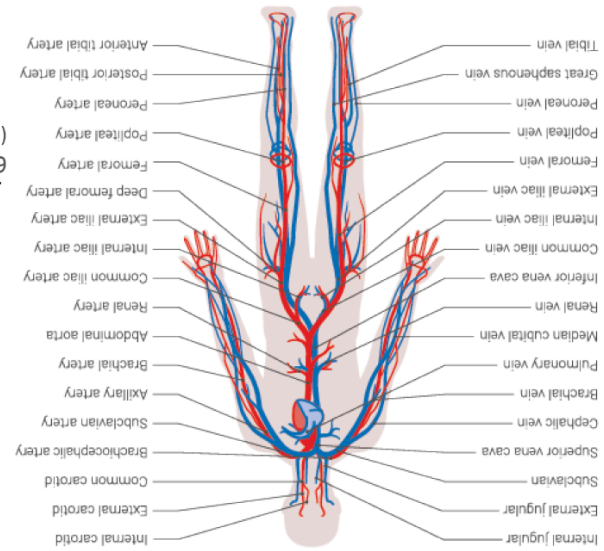




FOLD

Nerves, Spinal Cord: Thermoreceptors





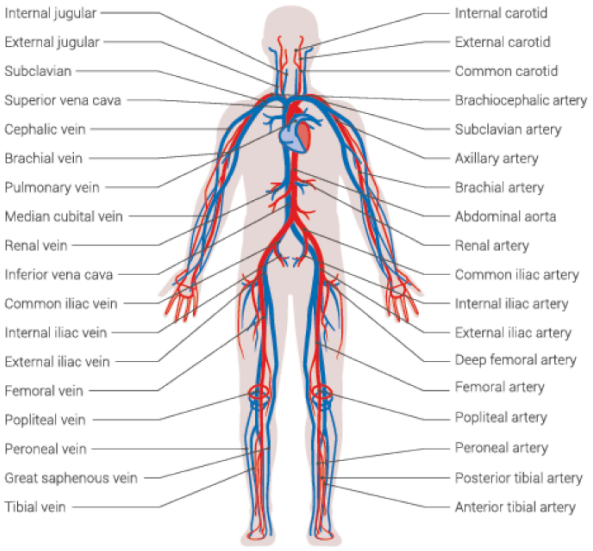
4.3 - 7.7 mm
(diameter Cartotid)

6 - 7 mm
(diameter femoral artery)

Blood Vessels

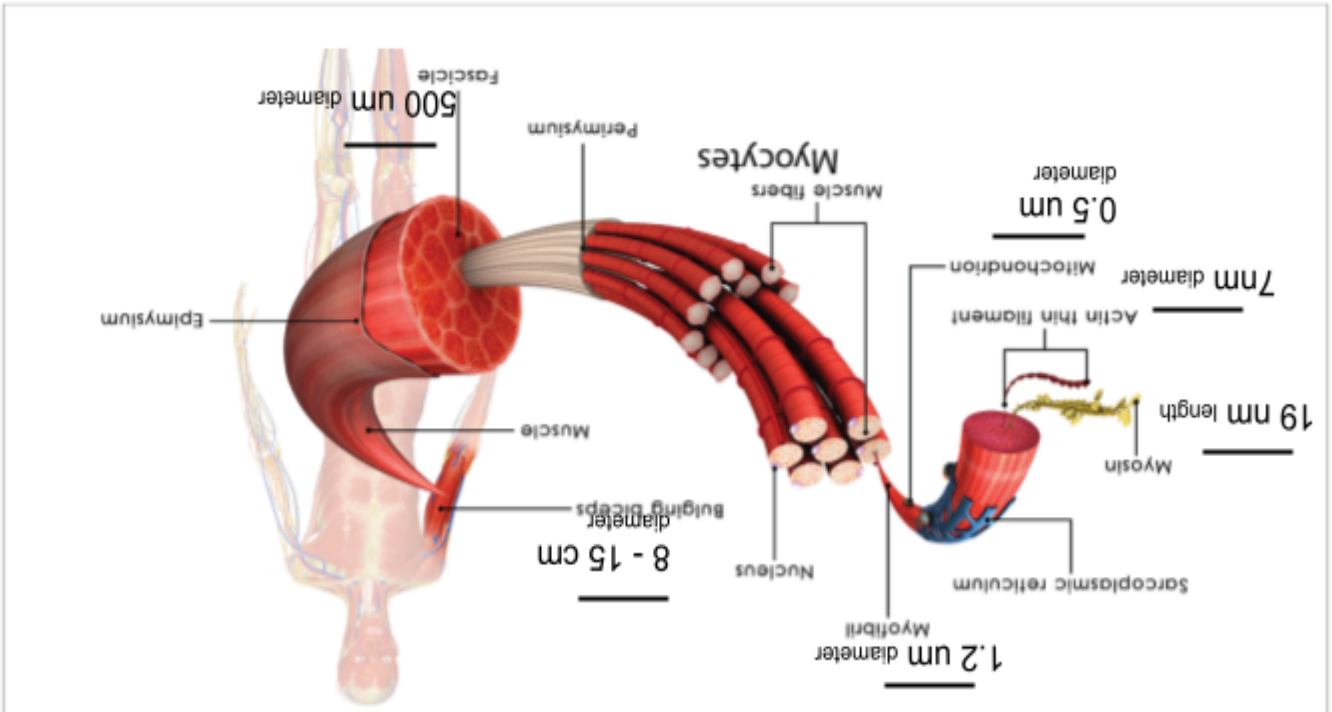
FOLD

Blood Vessels

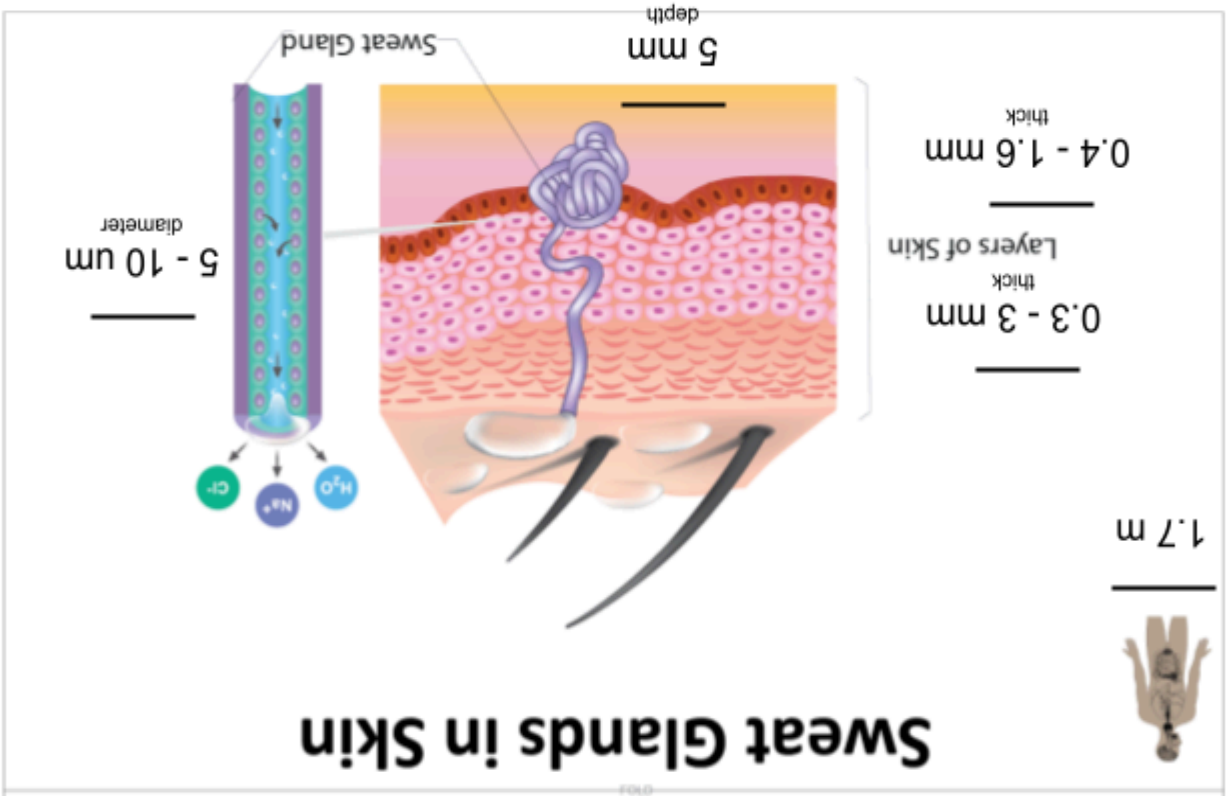


4.3 - 7.7 mm
(diameter Cartotid)

6 - 7 mm
(diameter femoral artery)



Skeletal Muscle: Myocytes



Sweat Glands in Skin
1.7 m
0.3 - 3 mm
thick
Layers of Skin
0.4 - 1.6 mm
thick
5 mm
depth
5 - 10 um
diameter
Sweat Gland
H_2O
Na^+
Cl^-

Body temperature increasing

Starting Location: Skin - Thermoreceptors

Produce and secrete sweat

Starting Location: Skin - Sweat Glands

Release body heat via evaporation

Starting Location: Skin

Muscle cells expand and contract

Starting Location: Skeletal Muscle - Myocytes

Release body heat to surroundings

Starting Location: Skin

Dilate (expand) blood vessels

Starting Location: Blood Vessels

Decrease blood flow from core organs to body surface

Starting Location: Blood Vessels

Decrease body heat loss to evaporation

Starting Location: Skin

Body temperature decreases

Starting Location: Skin - Thermoreceptors/Nerves

Stop producing sweat

Starting Location: Skin - Sweat Glands

Blood vessels constrict/ shrink

Starting Location: Blood Vessels

Decrease body heat loss to surroundings

Starting Location: Skin

Sweat

Starting Location: Skin - Sweat Glands

Decrease blood flow between core organs and surface

Starting Location: Blood Vessels

Detect body temperature increase

Starting Location: Skin - Thermoreceptors/Nerves

Signal increasing body temperature

Starting Location: Skin - Thermoreceptors/Nerves

Signal stop producing sweat

Starting Location: Brain - Hypothalamus

Signal vasodilation

Starting Location: Brain - Hypothalamus

Detect body temperature decrease

Starting Location: Skin - Thermoreceptors/Nerves

Signal decrease in body temperature

Starting Location: Skin - Thermoreceptors/Nerves

Signal constrict/ shrink blood vessels

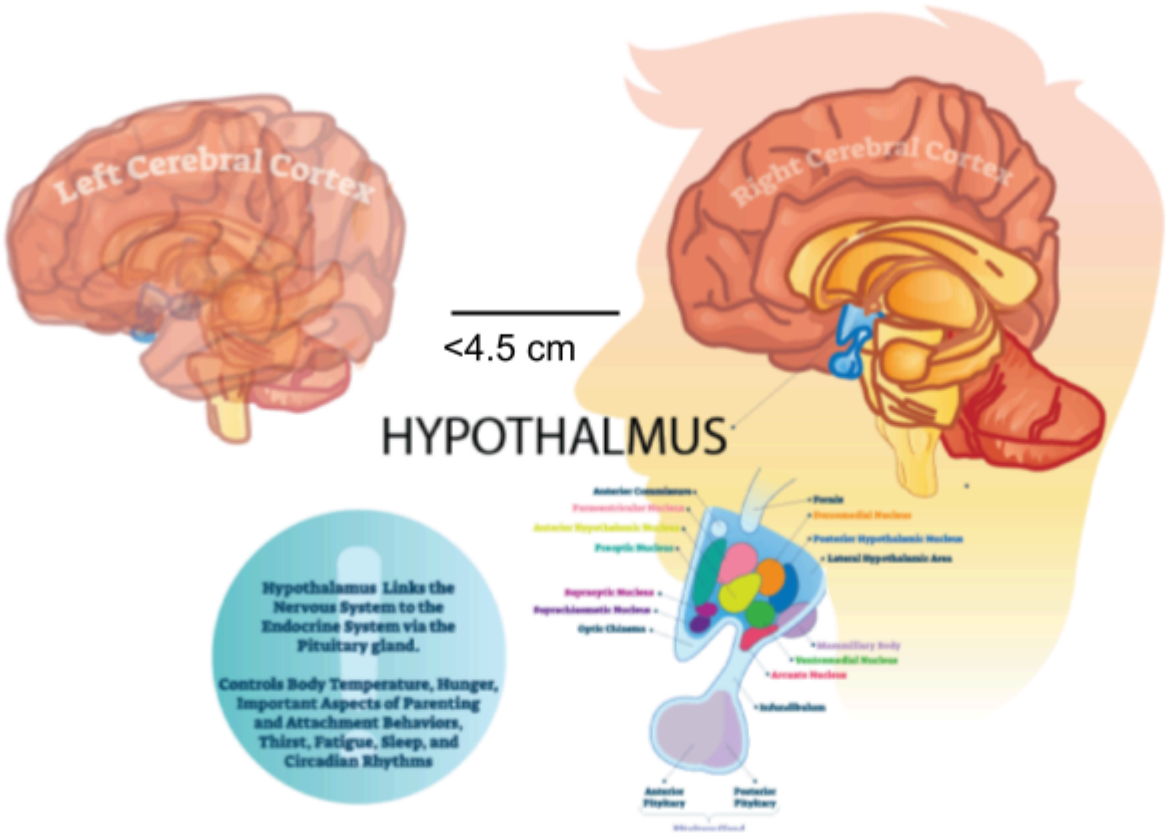
Starting Location: Brain - Hypothalamus

Signal produce sweat

Starting Location: Brain - Hypothalamus

Exercise begins Starting Location: Facilitator	**Exercise ends** Starting Location: Facilitator
Less energy needed/ generated Starting Location: Facilitator	**Exercise continues** Starting Location: Facilitator

Hypothalamus - Neurons



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.

One section of the brain is called the hypothalamus. The hypothalamus is responsible for controlling and managing body temperature, feelings of hunger and thirst, blood pressure, mood, and sleep. 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.

To regulate changes in body temperature, nerve signals are sent to and from the hypothalamus depending on the external conditions. As body temperature increases, for example, nerve signals are received from thermoreceptors in the skin, and the hypothalamus responds by sending signals to other parts of the body to begin processes to help cool the body.

Science Theater Actions: Hypothalamus - Neurons

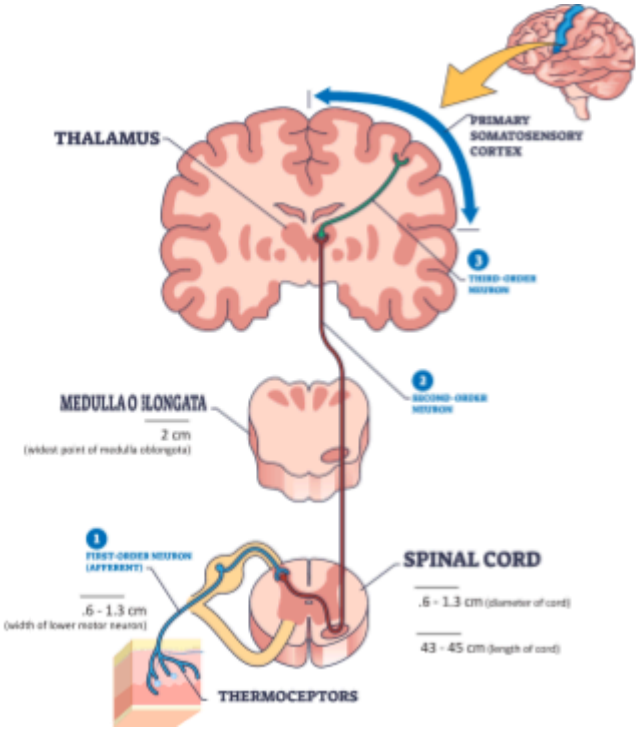
Act 1: During Exercise	Act 2: At Rest
Receive increasing body temperature signal from thermoreceptor nerves in skin and respond by: ● sending a signal to the sweat glands via the nerves to begin producing and secreting sweat. ● sending a signal to the vasodilating nerves to dilate the blood vessels and increase blood flow.	Receive the decreasing body temperature signal from the nerves and respond by: ● sending a signal to the sweat glands via the nerves to stop producing sweat. ● sending a signal to the vasoconstricting nerves to constrict the blood vessels and decrease blood flow.

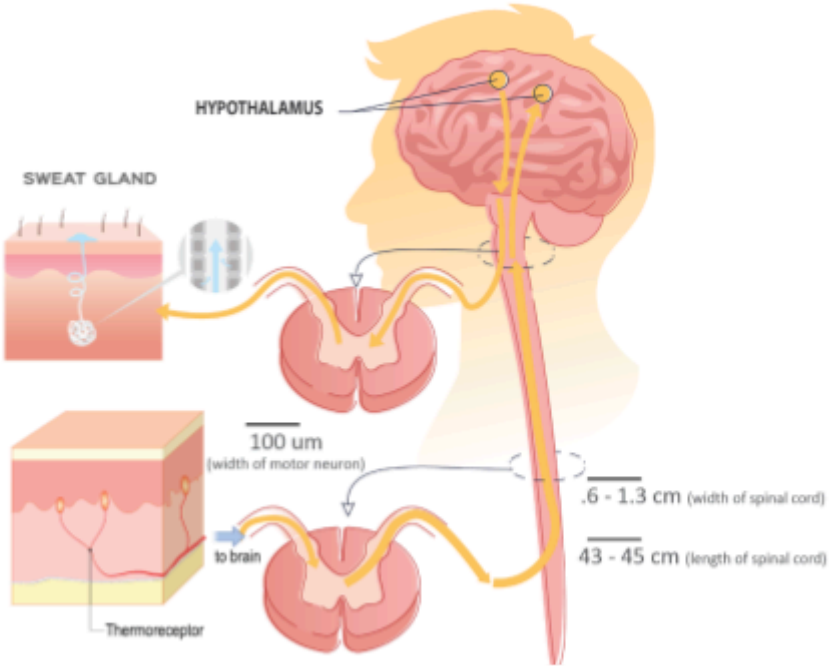
Nerves - Thermoreceptor Neurons

Two sets of nerves run throughout the body. First, the somatic nervous system consists of nerves that go to the skin and muscles and are involved in conscious activities. These include motor neurons, or nerve cells connected directly to muscle fibers that control their movement. Second, the autonomic nervous system consists of several different types of nerves that mediate unconscious activities such as breathing, heartbeat, and digestion.

Nerves are composed of chains of cells called neurons. Neurons function by sending an electrical signal from one end of the cell to another and then a chemical signal from one neuron to the next. Signals can, therefore, be passed down chains of neurons and travel long distances in the body.

Thermoreceptors are specialized autonomic nerve cells that detect temperature differences in different tissues in the body. Thermoreceptors are located throughout the body but are especially dense in the muscles and skin. There are separate thermoreceptors to detect changes in warmth and cold. Thermoreceptors detect external temperature changes and send signals to the brain (hypothalamus). When they detect an increase in body temperature, they signal the brain, which initiates processes to help bring body temperature down. As the body's temperature decreases, the brain receives signals from the thermoreceptors to initiate processes to maintain body temperature at the stable state.



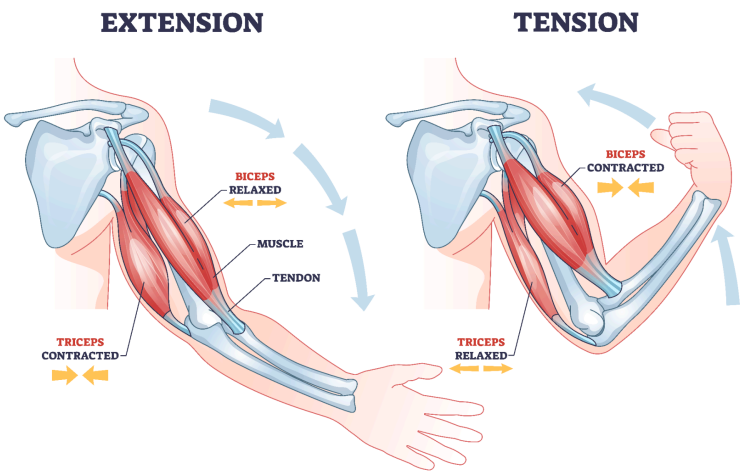


Science Theater Actions: Nerves - Thermoreceptor Neurons

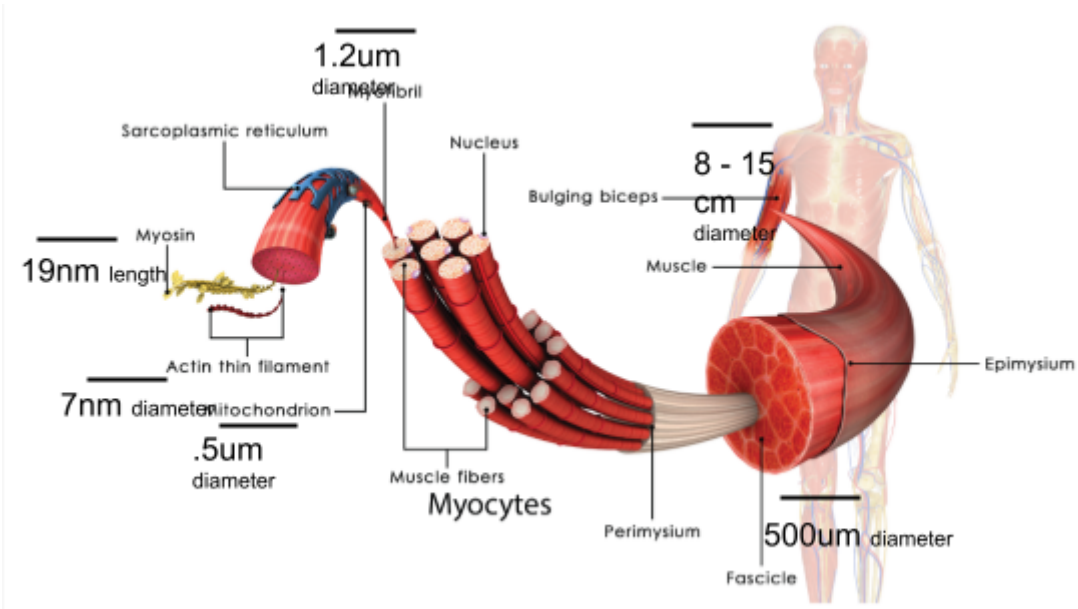
Act 1: During Exercise	Act 2: At Rest
During exercise, thermoreceptors detect an increase in temperature of the muscles and skin. ● Receive the Increasing Body Temperature token from muscles and pass it to the hypothalamus.	When exercise stops, thermoreceptors detect decreasing body temperature of the muscles and skin. ● Receive the Decreasing Body Temperature token from the muscles and pass it to the hypothalamus.

Skeletal Muscles - Myocytes

Skeletal muscles are voluntary muscles attached to the bones by tendons, responsible for movement and maintaining posture. They work in pairs, contracting and relaxing, to facilitate coordinated and controlled motions in response to signals from the nervous system.



Muscle tissue is a highly specialized type of tissue made up of cells called myocytes that can be stimulated by nerves and contract to shorten the length of the muscle tissue, which results in movement. Skeletal muscles are made of long, thin cells packed with highly organized proteins and organelles. Skeletal muscles use cellular energy to undergo the process of contraction. When they do so, muscles also produce heat that keeps the body warm. During strenuous exercise, the rate of energy use in skeletal muscles can increase by more than 100-fold almost instantly. As a result, when more energy is used by the muscles during exercise, the muscle cells also produce more heat.



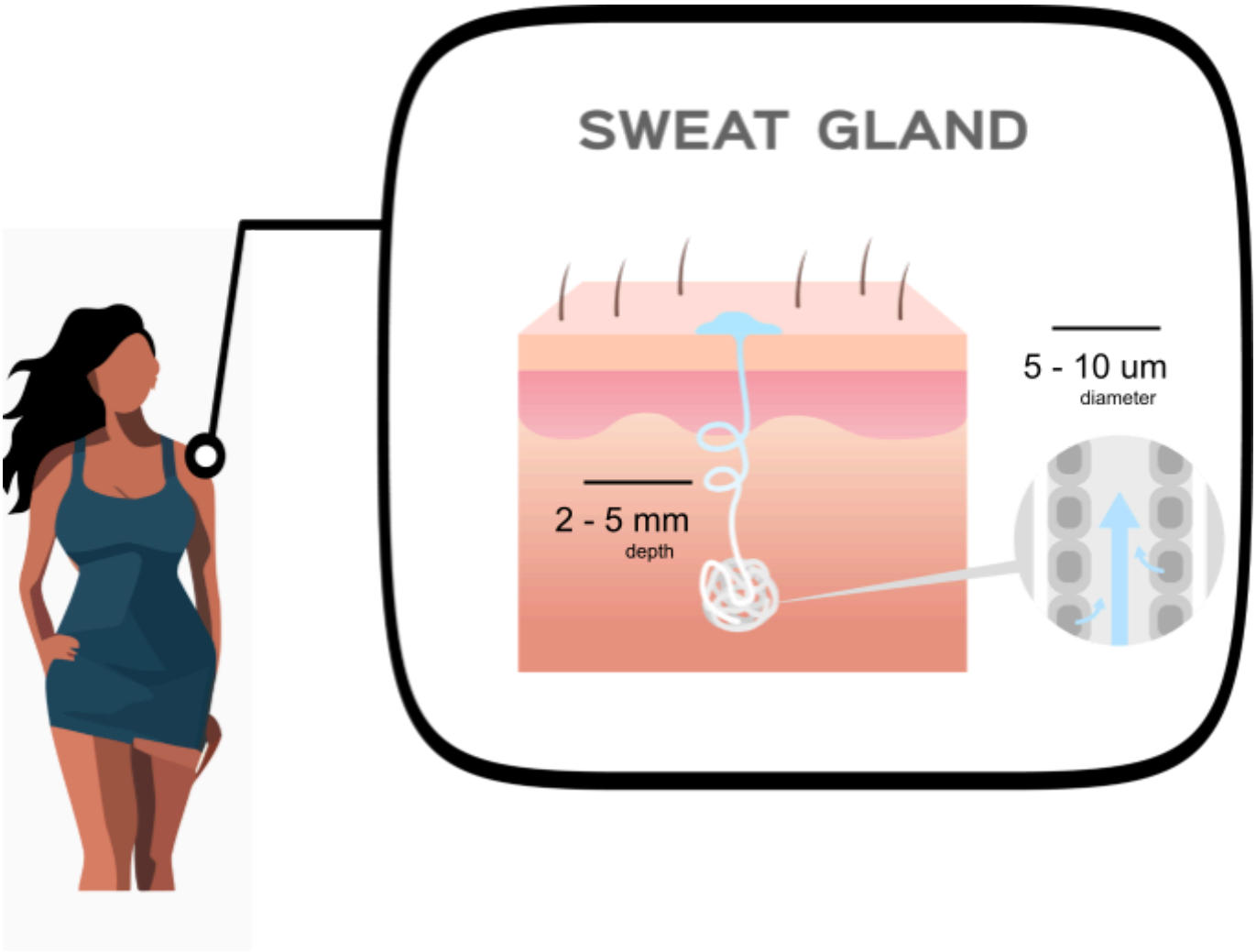
Science Theater Actions: Skeletal Muscles - Myocytes

Act 1: During Exercise	Act 2: At Rest
When undergoing exercise, the myocytes use cellular energy to contract and move the body rapidly. They also produce large amounts of excess heat, which increases body temperature. ● Muscle Cells Expand and Contract and Increasing Body Temperature tokens.	At rest, the myocytes use less cellular energy to contract and move the body. They produce small amounts of excess heat, which maintains a stable body temperature. ● Muscle Cells Expand and Contract and Increasing Body Temperature tokens.

Sweat Glands - Myoepithelial Cells

The largest organ of the body is the skin. It contains two to four million sweat glands distributed across the body. There are two types of sweat glands, one of which is the eccrine sweat gland. It is controlled by the sympathetic nervous system. It is a secretory gland that activates as a response to body temperature changes. The eccrine sweat glands secrete an odorless, clear fluid composed of water and electrolyte salts such as sodium and magnesium. Sweat glands draw water and electrolytes from the bloodstream and release them onto the skin. The release of sweat helps the body control its temperature through heat exchange due to evaporation. When sweat is present on the surface of the body, it absorbs body heat. The warmed sweat then evaporates and carries heat away as it evaporates.

The eccrine sweat gland consists of a tube-shaped duct that ends in a coil or lumen. There are specialized cells called myoepithelial cells that surround the coil that contract to help the sweat gland secrete sweat when nerve signals are detected.

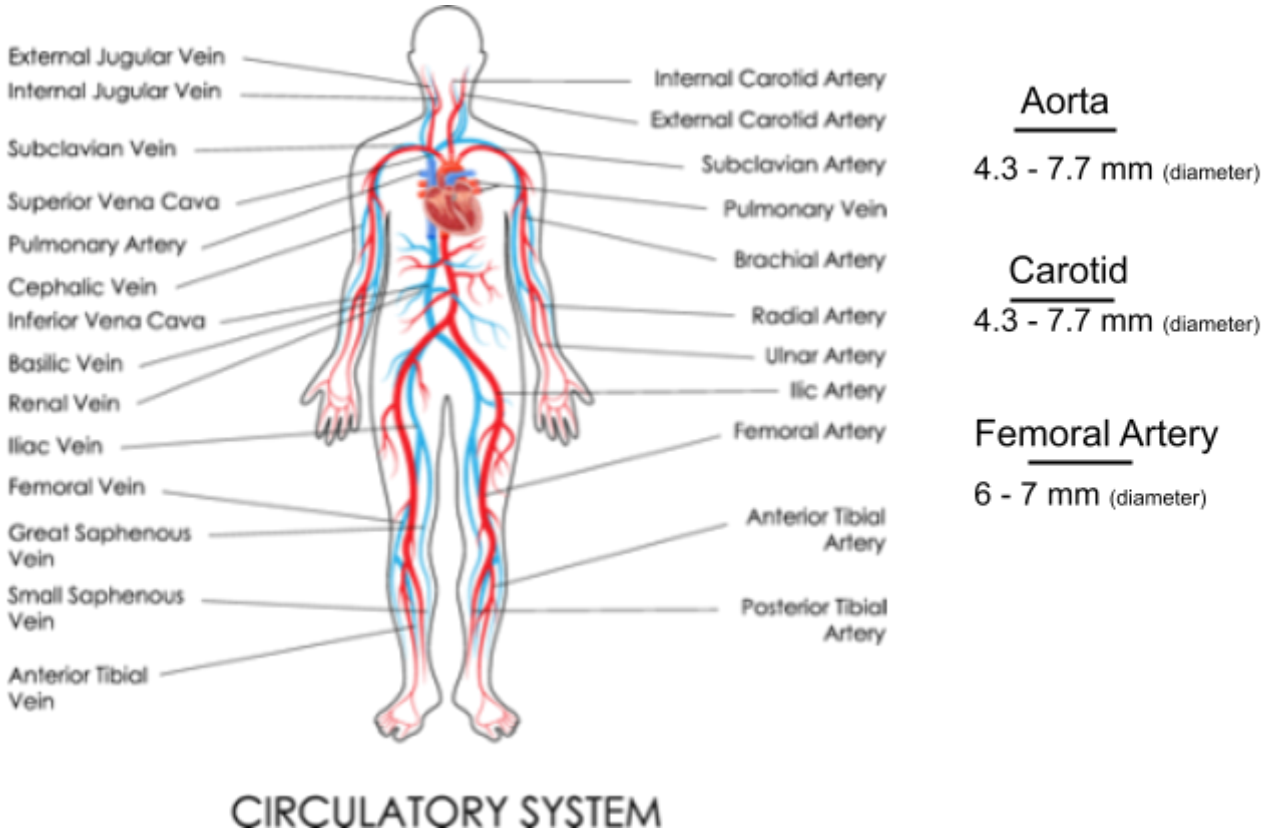


Science Theater Actions: Sweat Glands - Myoepithelial Cells

Act 1: During Exercise	Act 2: At Rest
Sweat glands receive signals from the hypothalamus to start producing sweat. ● Receive the signal to secrete and produce sweat and activate the sweat token. Sweat is used to activate the release of body heat by evaporation token.	Sweat glands receive signals from the hypothalamus to stop producing sweat. ● Receive the signal from the hypothalamus to stop producing sweat. Remove the sweat token from the table. Without sweat, activate the maintain body heat token.

Blood Vessels

Blood vessels are a complex network of structures that include arteries, veins, and capillaries, which 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.



Blood vessels run throughout the body. They provide blood to the body's core internal organs, such as the brain, heart, lungs, liver, stomach, and intestines, as well as to the organs elsewhere throughout the body, such as the muscles and skin. Blood vessels play an important role in the regulation of the body's temperature. As the body temperature increases, blood vessels dilate, or open wider, to facilitate more blood flow throughout the body. Blood vessels dilate because blood can carry heat from within the body to the body's surface, where it can be lost to the surroundings, such as the air around the body.

When the body's temperature needs to decrease, blood vessels constrict, or shrink to have a smaller opening, to make less blood flow throughout the body. This happens to prevent heat loss from the blood to the surroundings.

Science Theater Actions: Blood Vessels

Act 1: During Exercise	Act 2: At Rest
The body continues to exercise, and body temperature increases. ● Receive the vasodilating signal from the hypothalamus and activate the dilated blood vessels token. ● Activate the increased blood flow and release heat from the body via conduction tokens.	The body rests, and body temperature returns to a stable state. ● Receive the vasoconstricting signal from the hypothalamus and activate the constrict blood vessels token. ● Activate the reduced blood flow token. With less blood flowing, activate the decreased body temperature token.