SCIENCE THEATER CARD SET
EXPLORE 3 LESSON 28

Food and Agriculture Center for Science Education

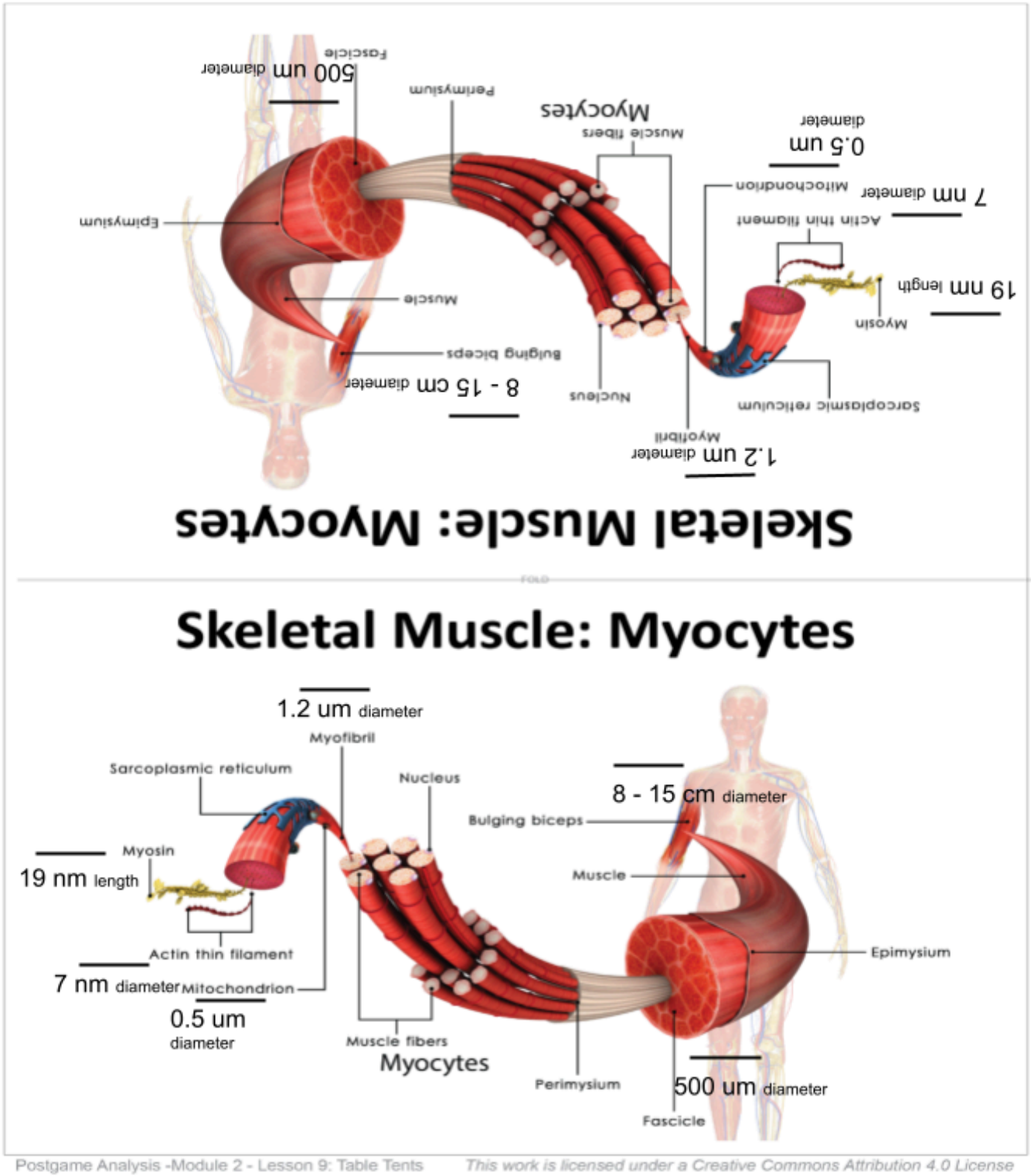
Materials

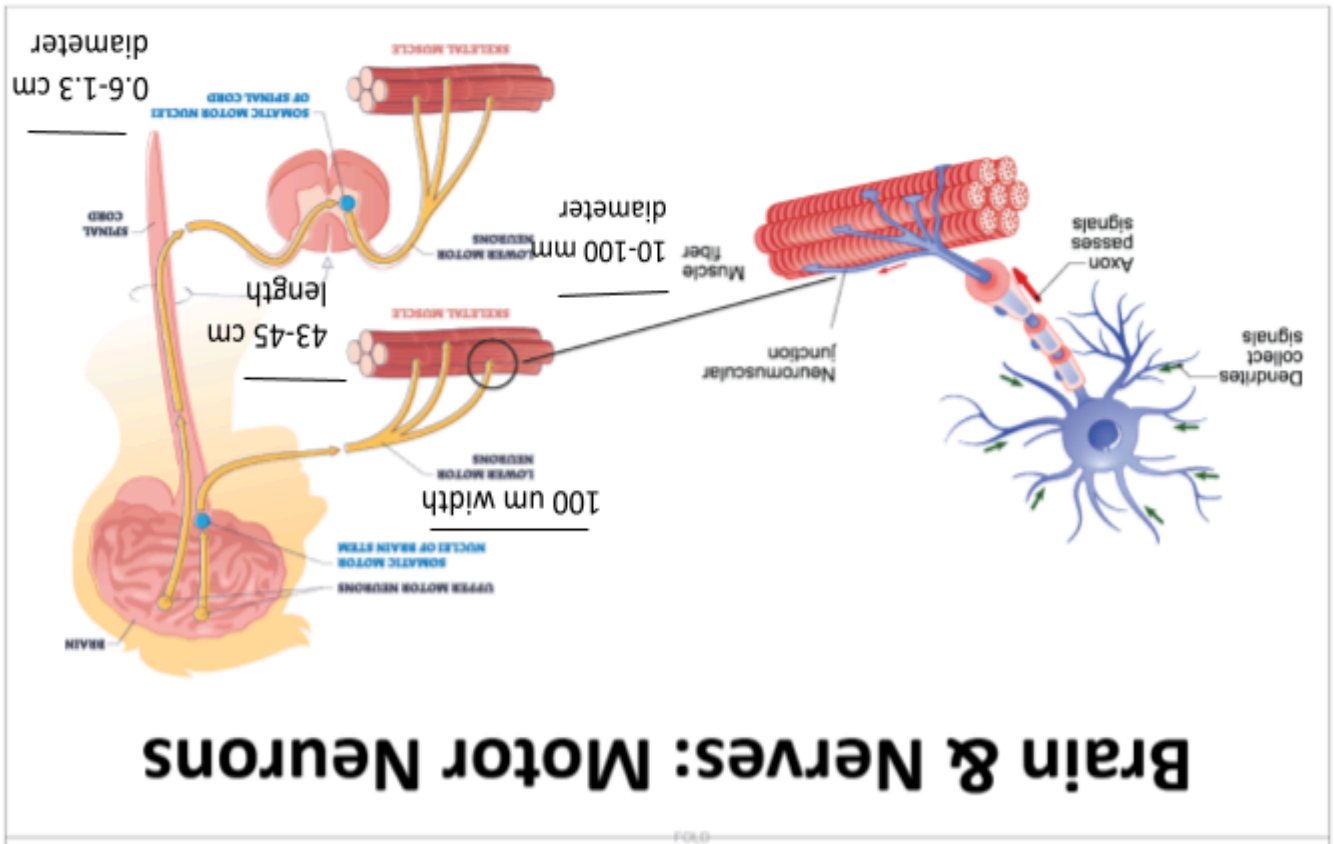
Materials included on the following pages include:

- **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 13-21)*

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.”





Brain & Nerves: Motor Neurons

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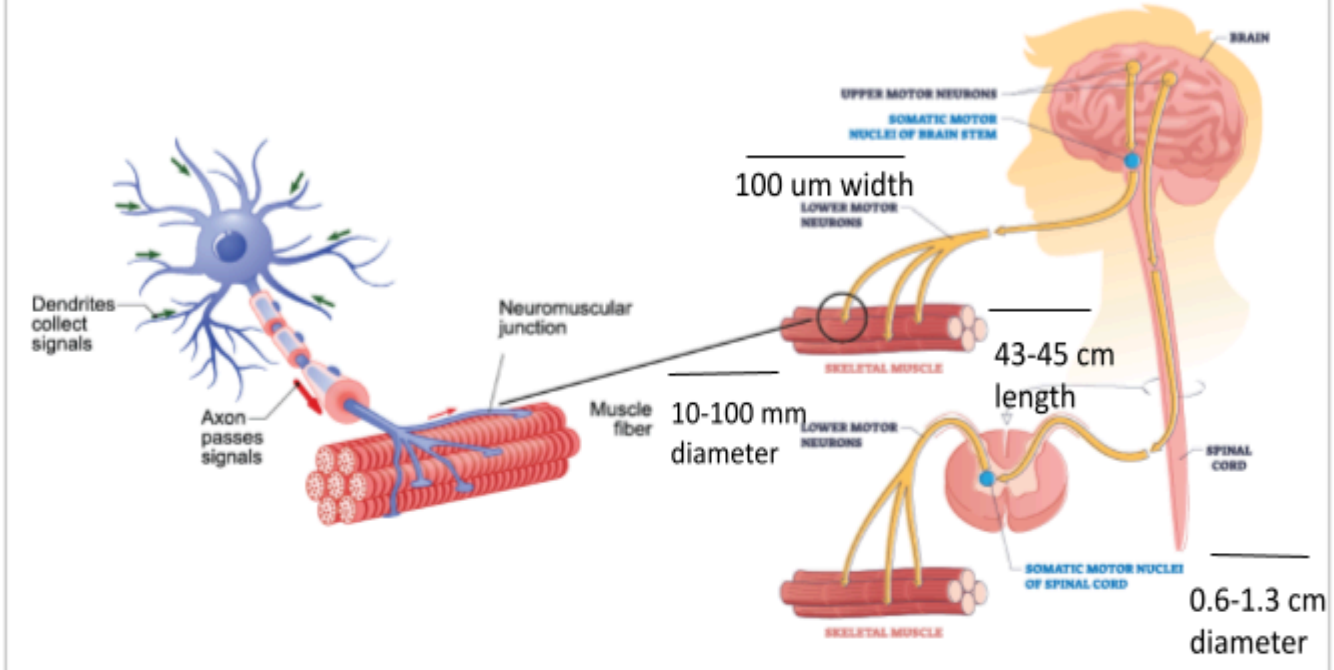
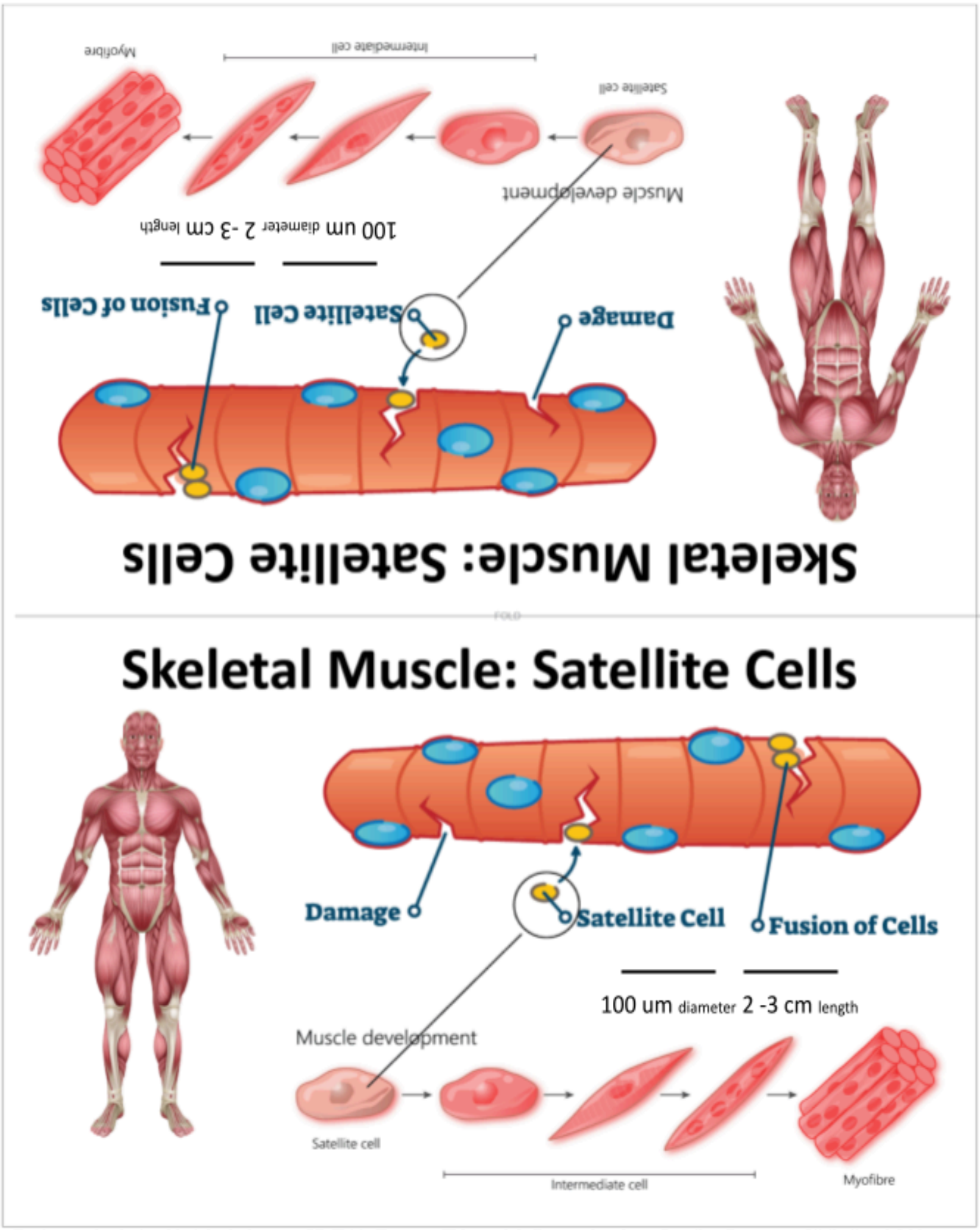
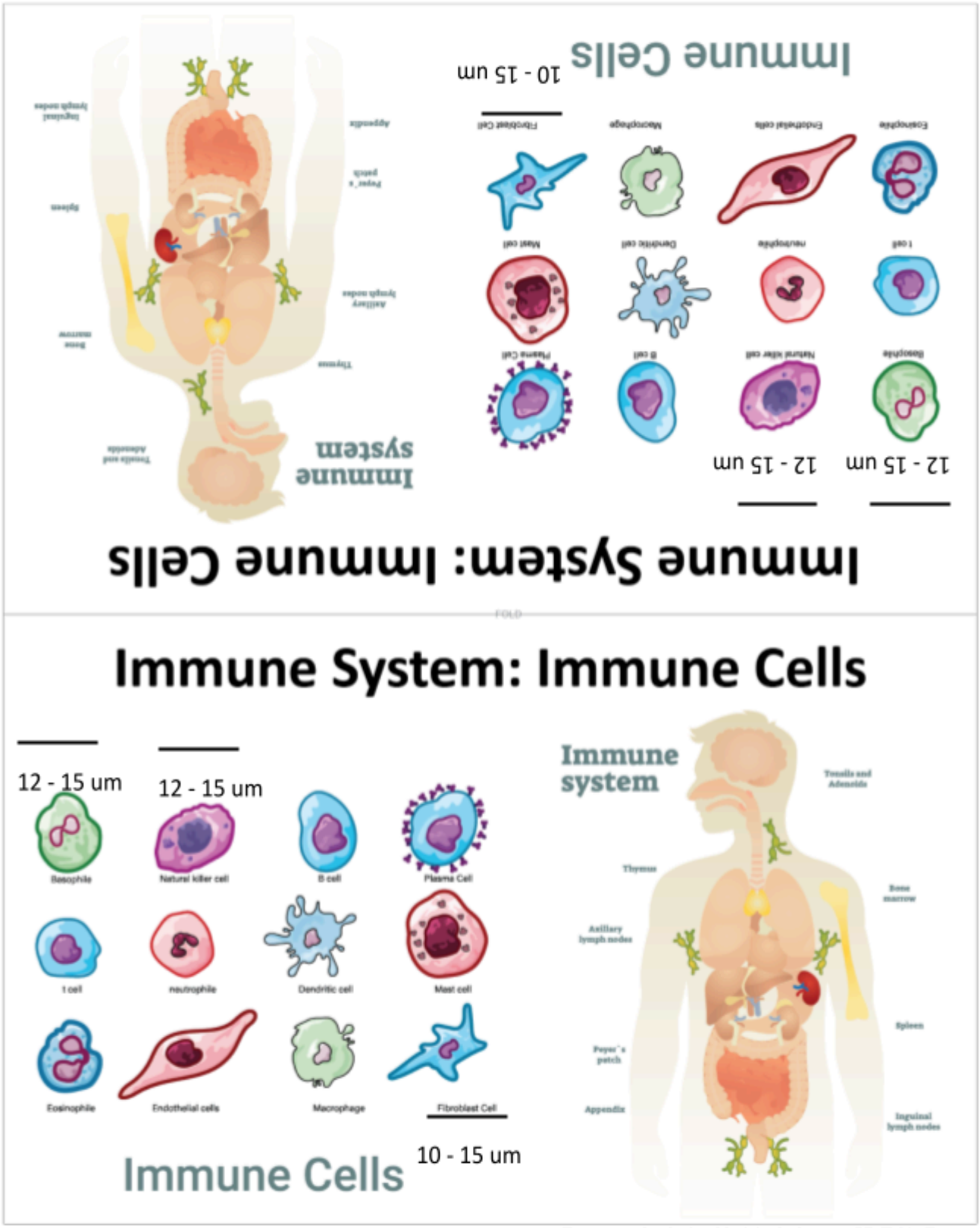
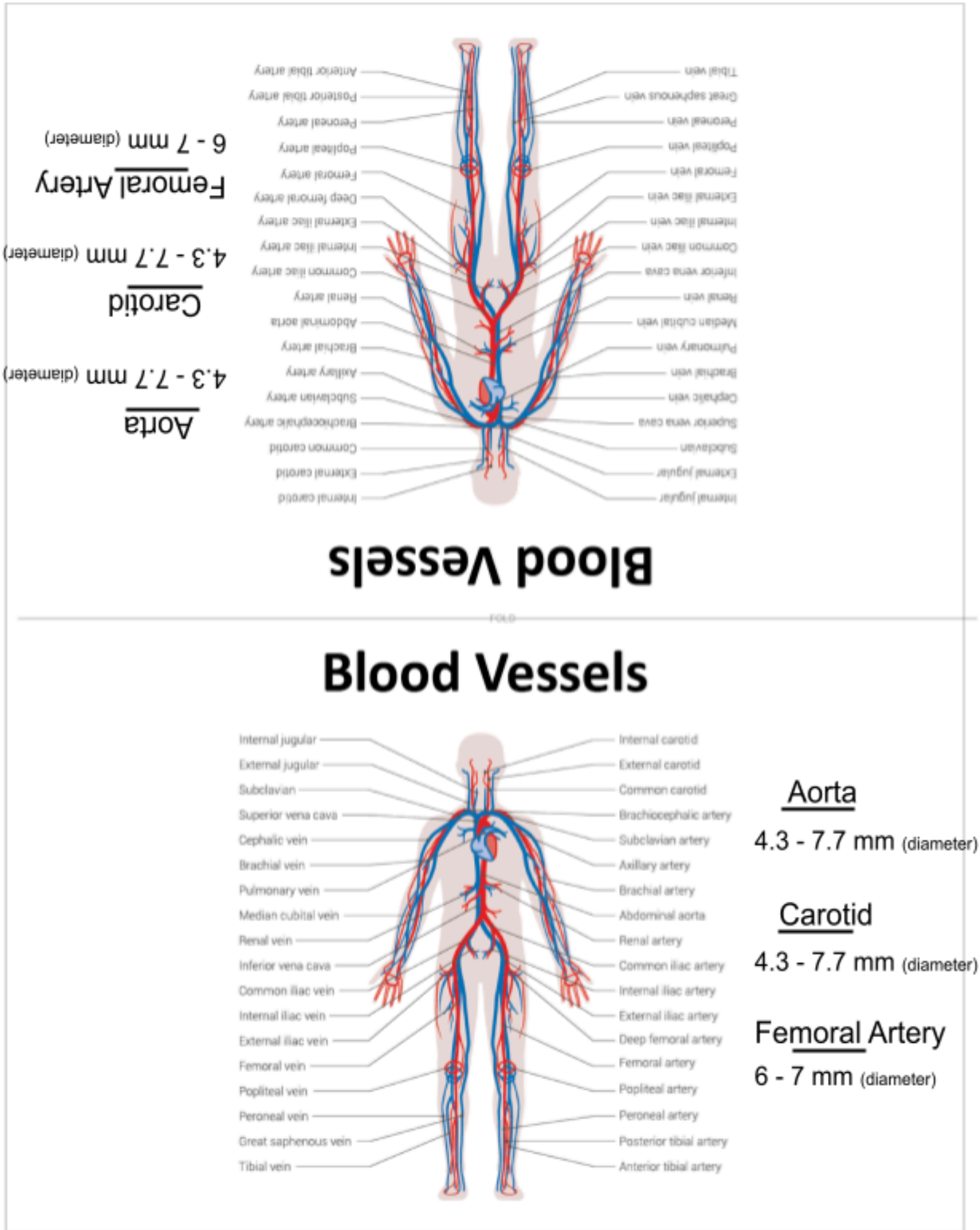




Skeletal Muscle: Satellite Cells





Tokens

Repair damaged myocytes

Starting Location: Skeletal Muscles - Satellite Cells

Functional myocytes

Starting Location: Skeletal Muscles - Satellite Cells

Formation of new myocytes

Starting Location: Skeletal Muscle - Satellite Cells

Increased levels of protein synthesis

Starting Location: Skeletal Muscles - Myocytes

Myocytes w/ microtears

Starting Location: Skeletal Muscles - Myocytes

Deactivate cellular debris

Starting Location: Immune System - Immune Cells

Contracted muscle

Starting Location: Skeletal Muscles - Myocytes

Return to dormant state

Starting Location: Skeletal Muscles - Satellite Cells

Muscle Soreness

Starting Location: Skeletal Muscles - Myocytes

Migrate back to blood vessels

Starting Location: Immune System - Immune Cells

Increased amount of muscle cells contracting

Starting Location: Skeletal Muscles - Myocytes

Continuous muscle contractions

Starting Location: Skeletal Muscles - Myocytes

Peptides

From broken down muscle proteins

Starting Location: Skeletal Muscles - Myocytes

Cellular Debris

From broken down muscle cells

Starting Location: Skeletal Muscles

Amino Acids

Starting Location: Blood Vessels

Muscle fatigue and myocytes with microtears

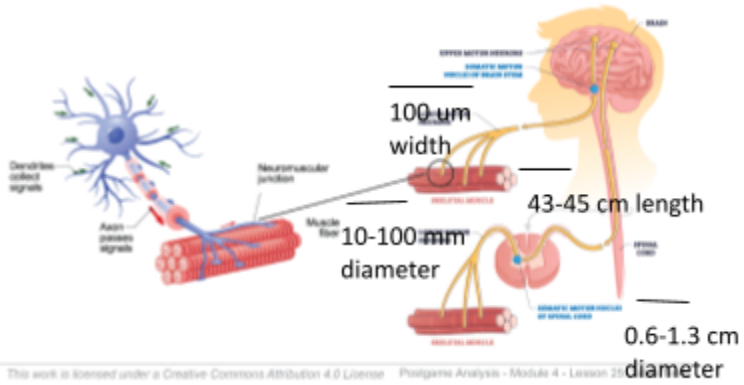
Starting Location: Skeletal Muscles - Myocytes

Detect damaged muscle tissue Starting Location: Skeletal Muscle - Satellite Cells	**Signal for amino acids** Starting Location: Skeletal Muscle - Satellite Cells
Increased amount of electrical signals Starting Location: Brain - Motor Neurons	**Deactivate cellular debris** Starting Location: Skeletal Muscles - Satellite Cells
Initial electrical signal (contract muscle) Starting Location: Brain - Motor Neurons	**Continuous electrical signals** Starting Location: Brain - Motor Neurons
Detect peptides from broken down muscle cells Starting Location: Immune Cells	**Electrical signals stop** Starting Location: Brain - Motor Neurons

Exercise begins Starting Location: Facilitator	**Exercise ends** Starting Location: Facilitator
Resistance is added, pedaling continues for 45 mins Starting Location: Facilitator	**Time passes (12 hours)** Starting Location: Facilitator

Brain & Nerves - Motor 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 long chains of neurons. They send electrical signals throughout your body to control sensations, movement, and other body functions.



The brain is structurally divided into several regions, including the cerebrum, cerebellum, and brainstem. The cerebrum, with its cerebral cortex, is responsible for higher cognitive functions such as thinking, memory, and perception. The cerebellum coordinates motor movements, while the brainstem regulates essential functions like breathing and heart rate.

The brain controls two sets of nerves that run throughout the body. The somatic nervous system consists of nerves that go to the skin and muscles and are involved in conscious activities. Motor neurons are nerve cells that are connected directly to muscle fibers and control their movement. The autonomic nervous system consists of nerves that connect the brain and spinal cord to the organs such as the heart, stomach, and intestines. The autonomic nervous system mediates unconscious activities such as breathing, heartbeat, and digestion.

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 over long distances in the body.

At the start of exercise, the brain has to initiate movement by sending an electrical signal through the nerves to the neuromuscular junction of the muscles. To continue exercise, the brain continuously sends electrical signals to the active leg muscles. To stop movement, the brain stops sending the electrical signal through the nerves to the muscle cells.

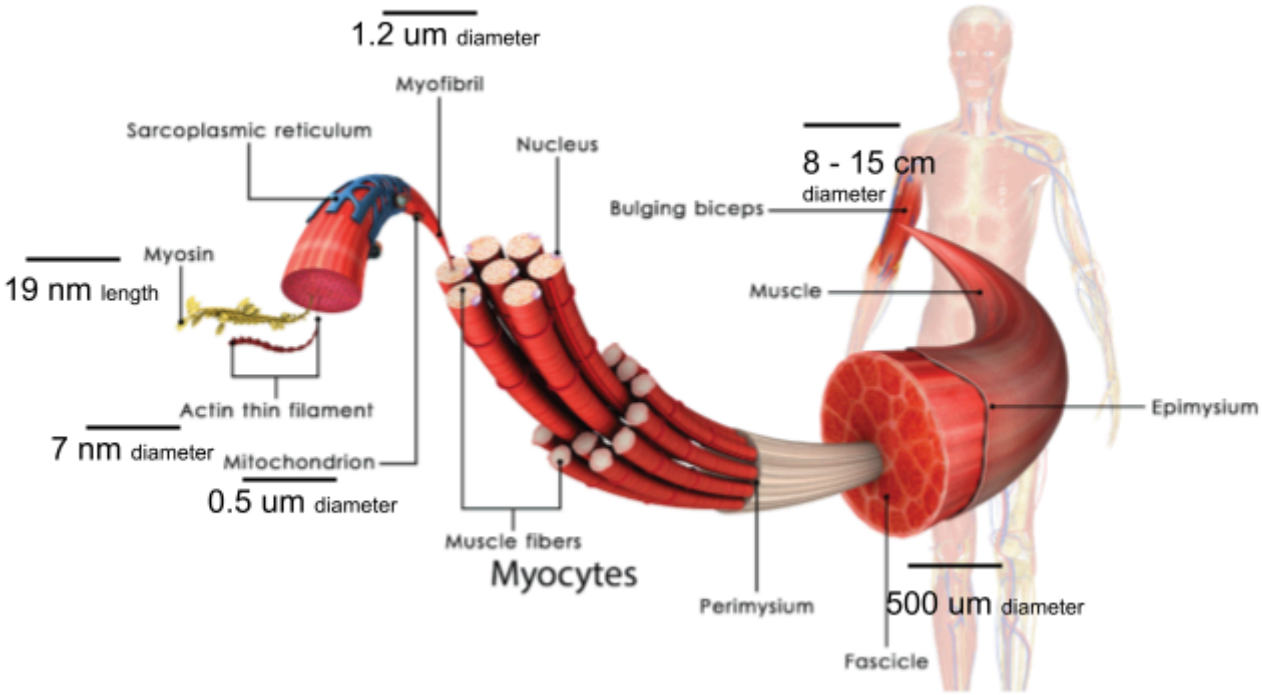
Science Theater Actions: Brain & Nerves - Motor Neurons

Act 1: Exercise	Act 2: Recovery

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 that can be stimulated by nerves and can contract to shorten the length of the muscle tissue, which results in movement. Muscle tissues are composed of structures called muscle fibers, or myocytes, because of the elongated shape they have. Each muscle fiber contains multiple myofibrils, which, on the molecular level, consist of very long overlapping actin and myosin filaments. When the actin and myosin filaments slide past one another, the muscle fiber contracts.



When stimulated by nerve impulses from the central nervous system, skeletal muscles contract, generating force and causing bones to move at joints. This contraction and relaxation of muscles allow for a wide range of voluntary movements, including walking, running, lifting, and other activities.

Over time, microtears form in the myocytes. Tiny protein fragments from the broken-down muscles are released to the blood vessels, and cellular debris from the damaged muscles remains in the skeletal muscles. Beginning twenty-four hours after the workout, muscles experience muscle soreness. Damaged myocytes are repaired with the assistance of satellite cells.

Science Theater Actions: Skeletal Muscles - Myocytes

Act 1: During Exercise	Act 2: Recovery

Skeletal Muscles - Satellite Cells

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.

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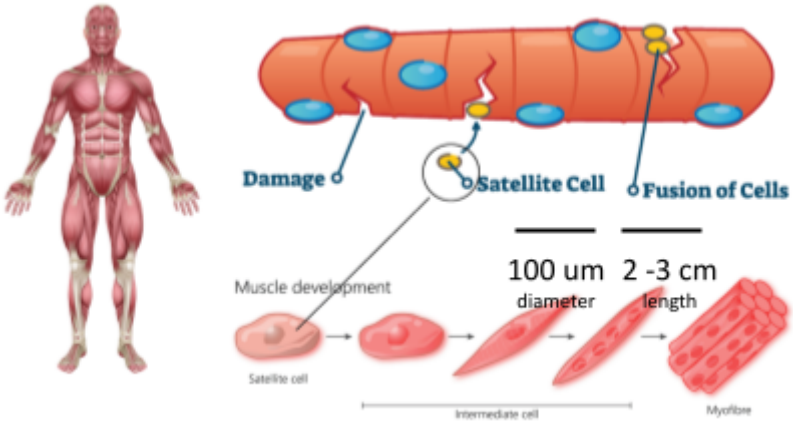


Within skeletal muscle tissue, stem cells called satellite cells reside. These satellite cells are present to help repair muscle fibers when they are damaged. Satellite cells are types of stem cells that are precursors to skeletal muscle cells and are responsible for the ability of muscle tissue to repair. They do so by dividing and forming new myocytes, which fuse into the damaged muscle cells.

To begin the repair process, protein fragments from nearby damaged myocytes are detected by satellite cells. They migrate to the myocytes. Upon arriving at the damaged myocytes, a signal is sent to the blood vessels that amino acids will be needed to repair damaged cells.

Amino acids are received from the bloodstream. The amino acids are used to increase the levels of protein synthesis. The amino acids are used to build new proteins, which create additional muscle fibers and repair damaged muscle fibers.

After cellular debris is removed by the immune cells, satellite cells begin to undergo cell division and form new muscle fiber cells that are incorporated into the damaged muscle fibers. Satellite cells also fuse into the damaged muscle fiber cells to repair their structure.

After muscle fibers are repaired, satellite cells return to their dormant state in the muscle tissue.

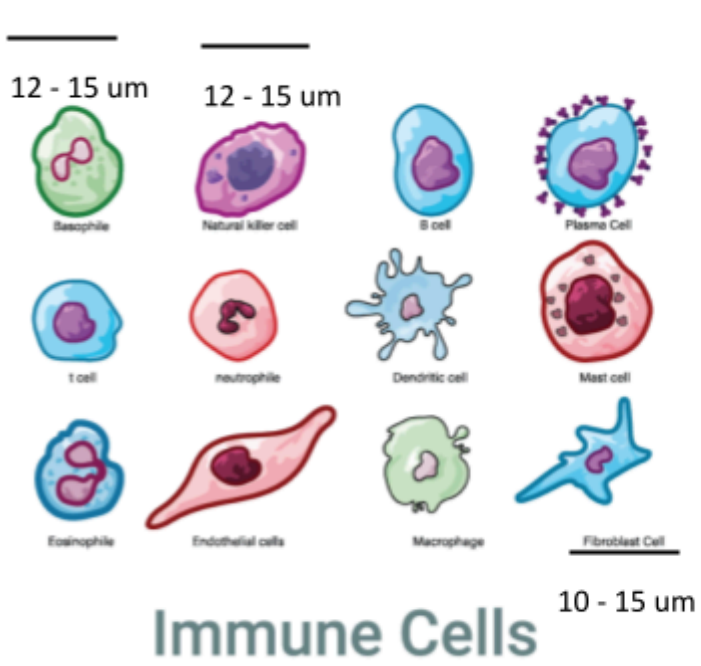
Science Theater Actions: Skeletal Muscles - Satellite Cells

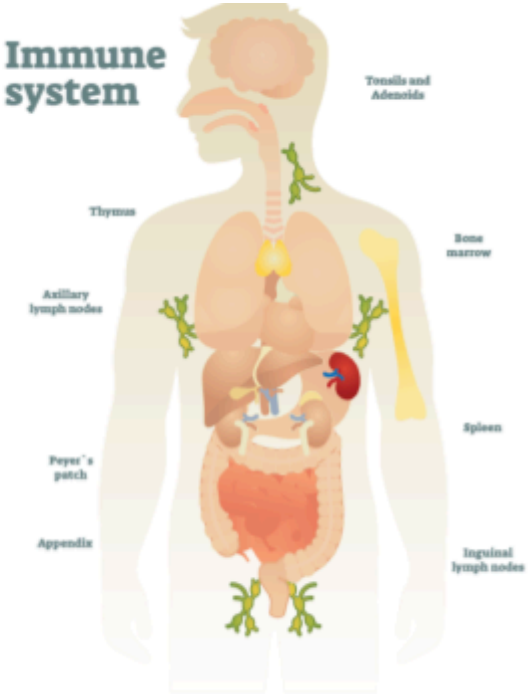
Act 1: During Exercise	Act 2: Recovery

Immune Cells

The immune system is a complex network of cells, tissues, and organs that work together to defend the body against harmful pathogens such as viruses, bacteria, and fungi. Its primary functions include recognizing and attacking foreign invaders, as well as maintaining a memory of past infections to mount faster and more effective responses in the future. They are also involved in various processes in the body, such as healing the body from damage.

Unlike other body systems, the immune system is primarily made of mobile cells that move throughout the body. Most immune cells are created from stem cells located in the bone marrow. Others originate in the bone marrow and then migrate to the thymus, where they mature. In both structures, immature immune cells specialize in various types of immune functions. For example, macrophages and neutrophils play a role in detecting and eliminating pathogens. Other immune cells, such as white blood cells, like T cells and B cells, play a role in the immune system's ability to form a "memory" in which it can detect and eliminate pathogens years after the body's first encounter with them. These different immune cells then travel throughout the body to carry out their functions.





The immune system also plays a role in repairing damaged tissues in the body. Broken-down muscle protein fragments in the bloodstream are detected by the immune system. Immune cells move through the bloodstream to move toward the site of the damaged myocytes. Upon arriving, immune cells assist the muscle fibers in removing and breaking down damaged muscle fiber proteins and cleaning up the cellular debris. After muscle fibers are repaired, immune cells leave the site of the damaged muscle fiber cells and return to the bloodstream.

Science Theater Actions: Immune Cells

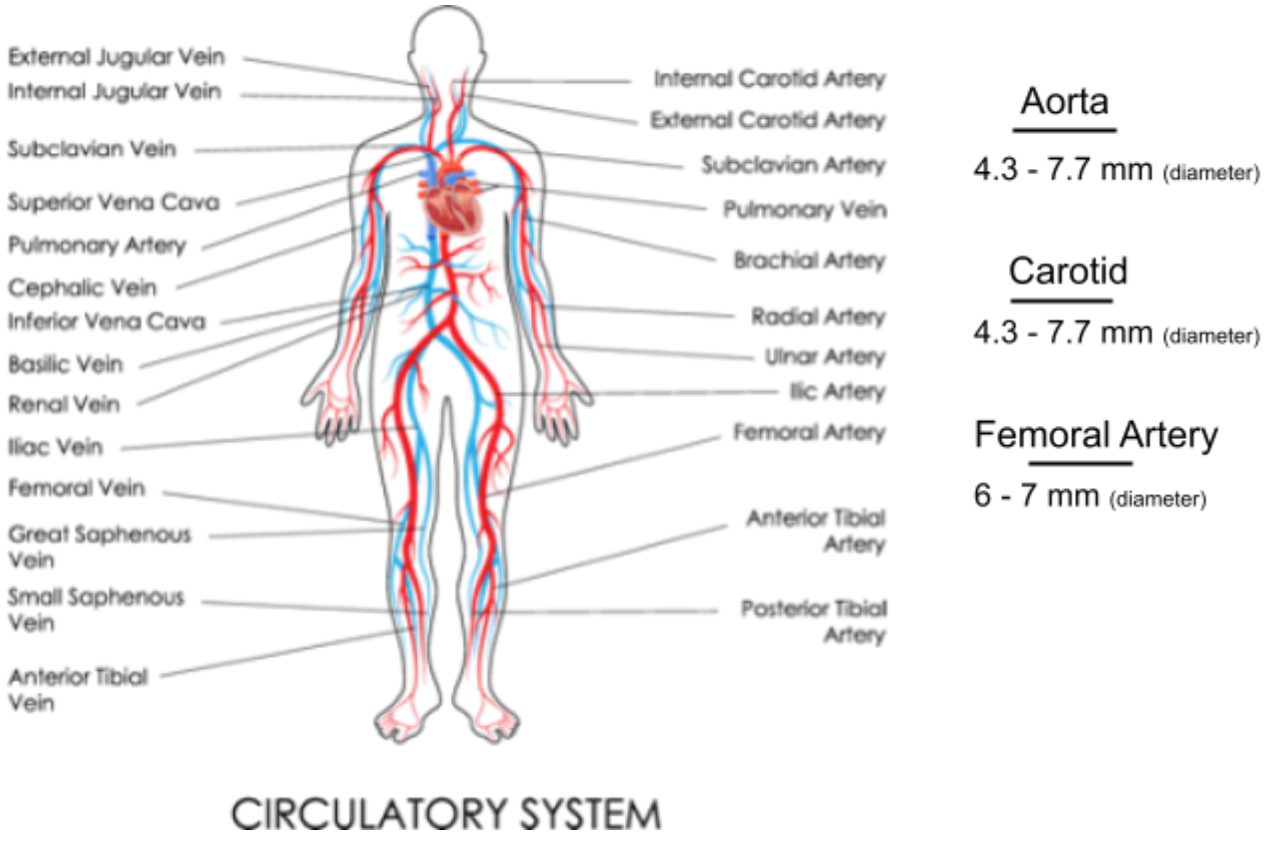
Act 1: Exercise	Act 2: Recovery

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.

The heart, a muscular organ, pumps blood through two main pathways: the pulmonary blood vessels, where blood is oxygenated in the lungs, and the systemic vessels, where oxygenated blood is distributed to the body. Arteries carry blood away from the heart, veins return it, and capillaries facilitate the exchange of nutrients and gasses with tissues. This intricate network ensures the continuous circulation of blood, supporting vital functions such as oxygen delivery, nutrient transport, and waste removal. Additionally, the circulatory system plays a key role in regulating body temperature, immune responses, and maintaining overall homeostasis.

In muscle repair, the bloodstream transports signals from muscles to other parts of the body. Tiny fragments of proteins from broken-down muscles are released into the bloodstream when muscles undergo microtears. The cells of the immune system use the bloodstream (and lymphatic vessels) to travel throughout the body to support in defense against pathogens and in repairing damaged body tissues.



Science Theater Actions: Blood Vessels

Act 1: Exercise	Act 2: Recovery