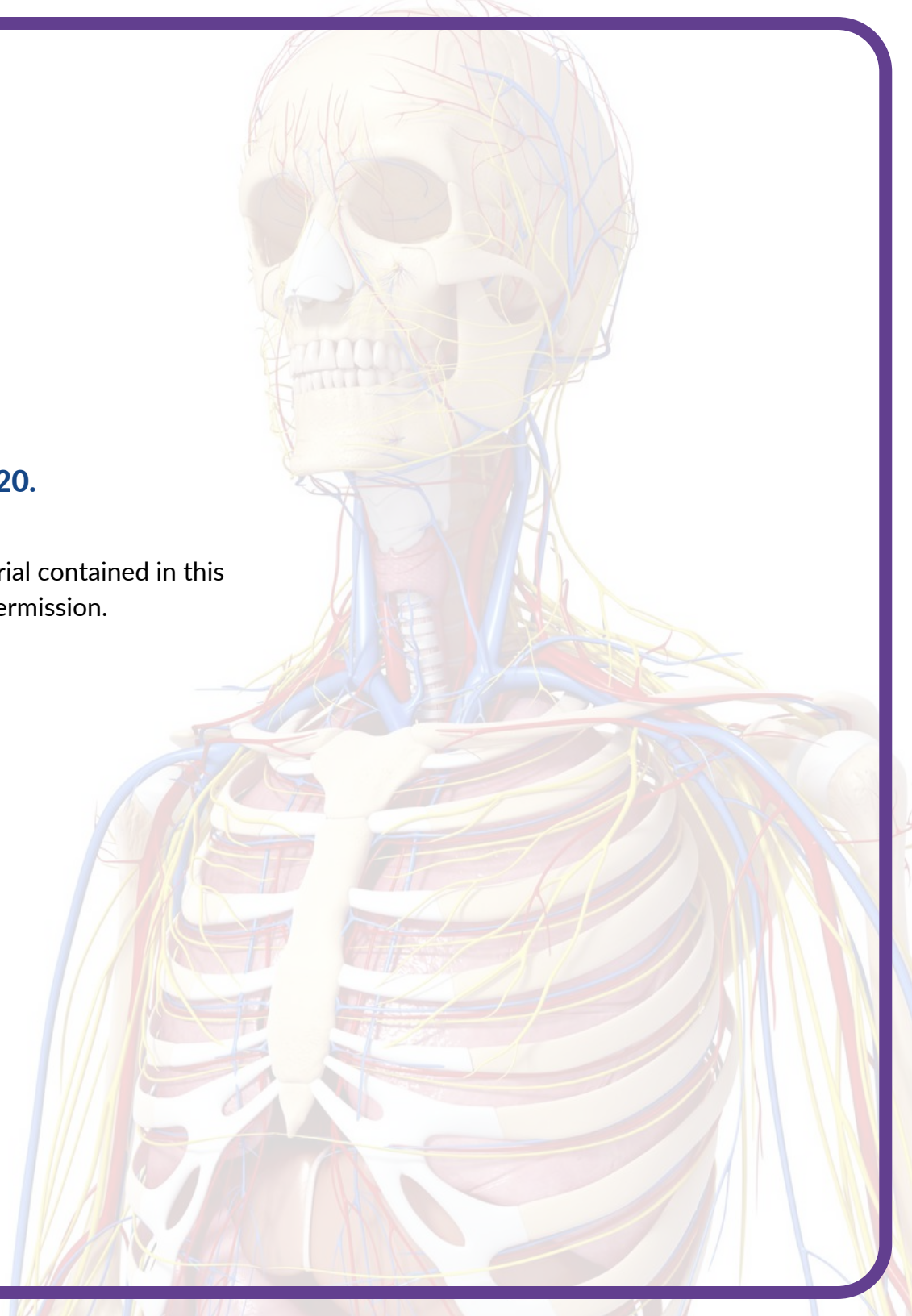




Musculoskeletal System Workbook

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Learning Objectives

- Describe the function of the musculoskeletal system and its major components.
- Describe the relationships between the different components of the musculoskeletal system.
- Explain how the musculoskeletal system is interdependent with other organ systems.
- Explain how the musculoskeletal system maintains homeostasis in the body

Musculoskeletal System Overview

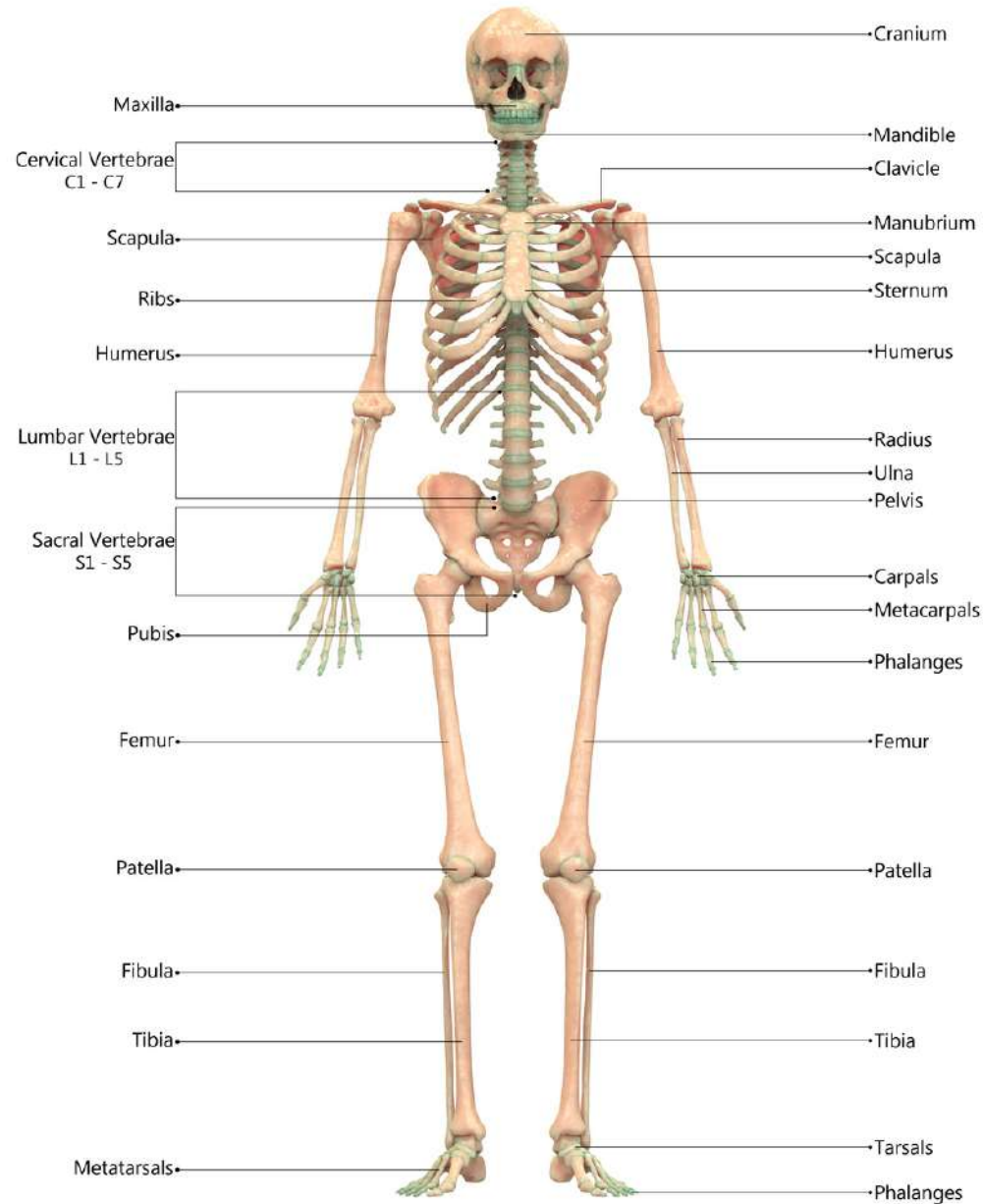


The **musculoskeletal system** enables movement (with the muscle system), and helps to maintain body temperature.

COMPONENTS

Bones
Muscles
Ligaments
Tendons
Fascia

Human Skeleton

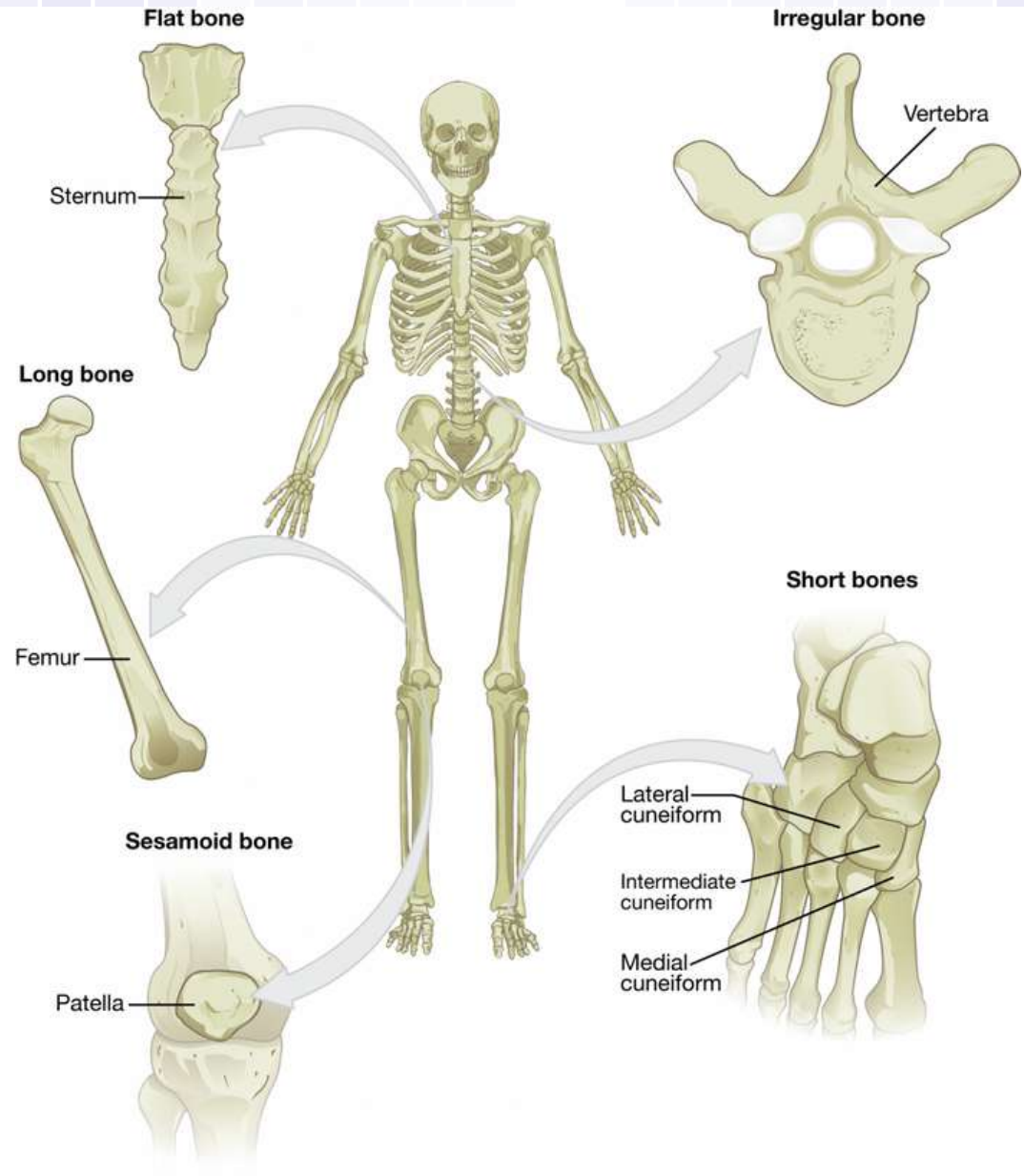


Bone Types & Function

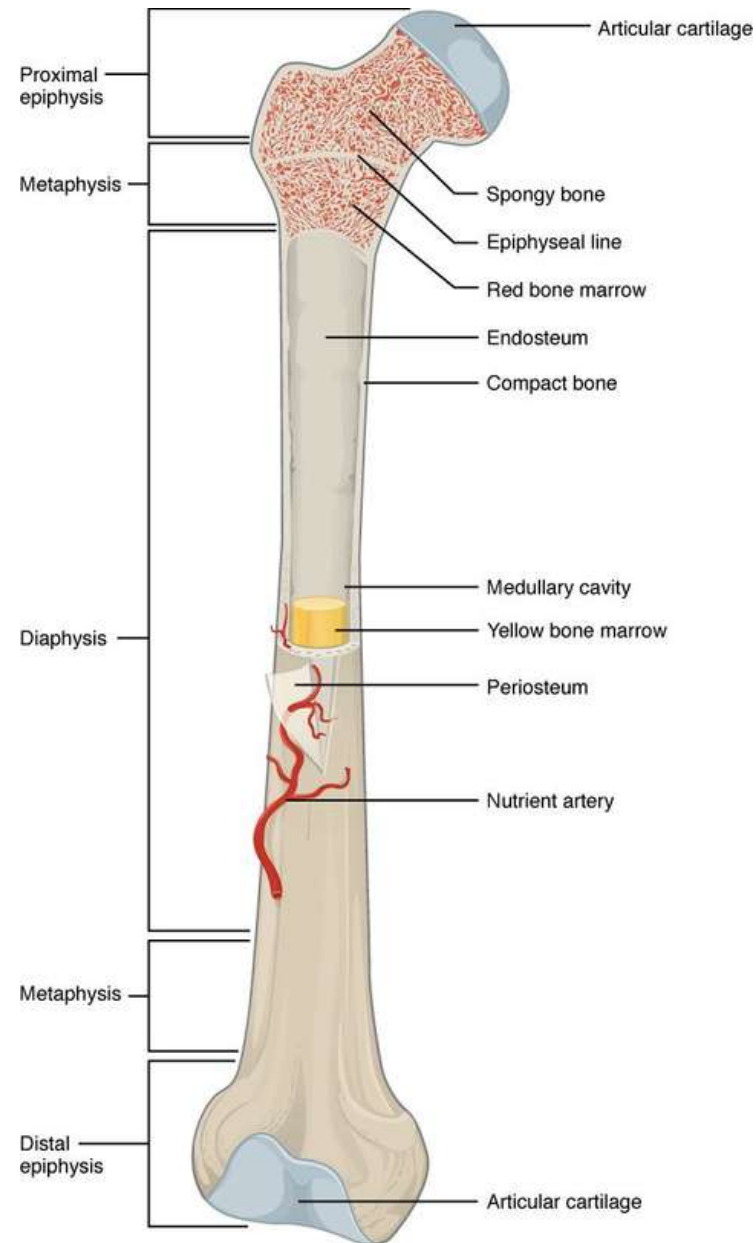
Bones come in different shapes and sizes, and are based on their functions. For example, short, slender bones in your fingers allow your fingers to move and grasp things.

Types of bones:

- **Long bones** - found in the legs and arms
- **Short bones** - found in the fingers and toes
- **Flat bones** - found in the skull and pelvis
- **Irregular bones** - found in the spine and ears



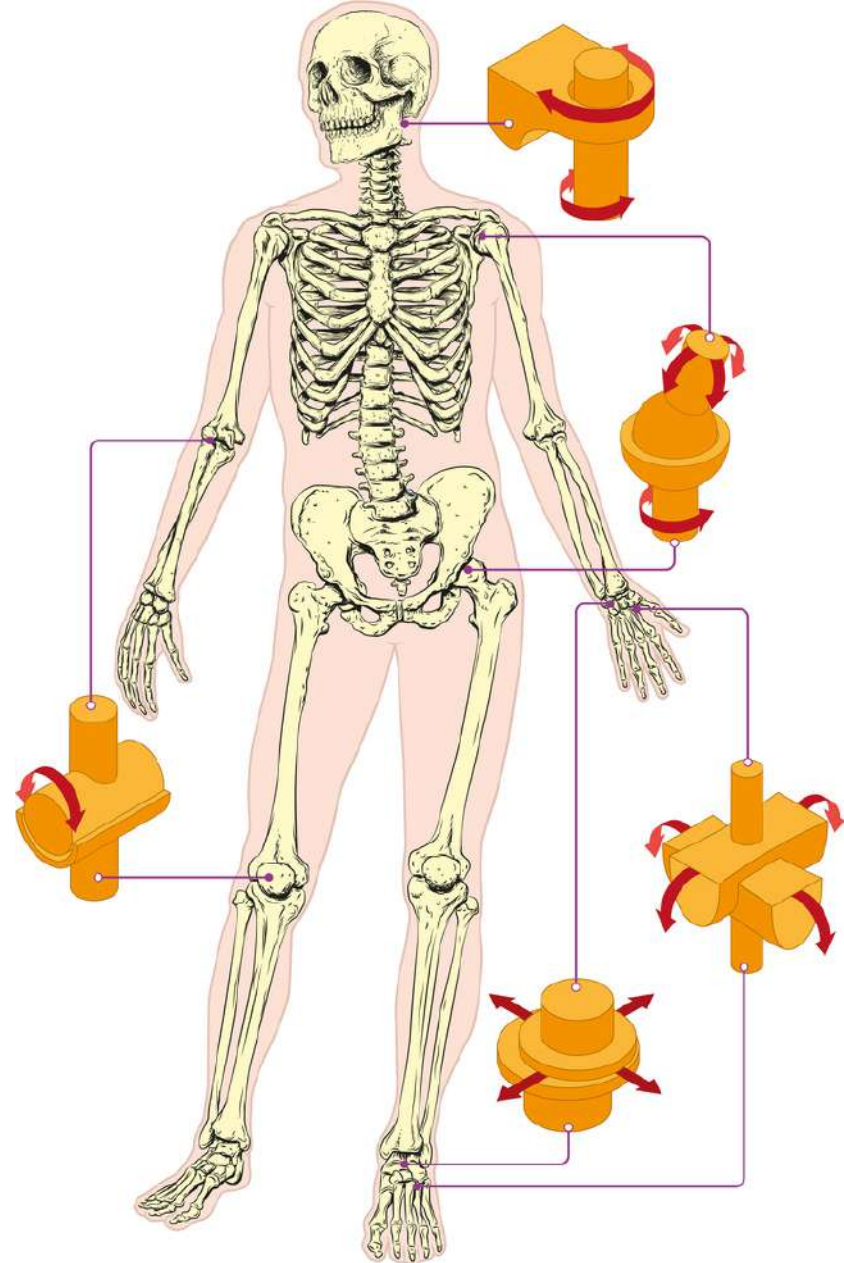
Bone Anatomy



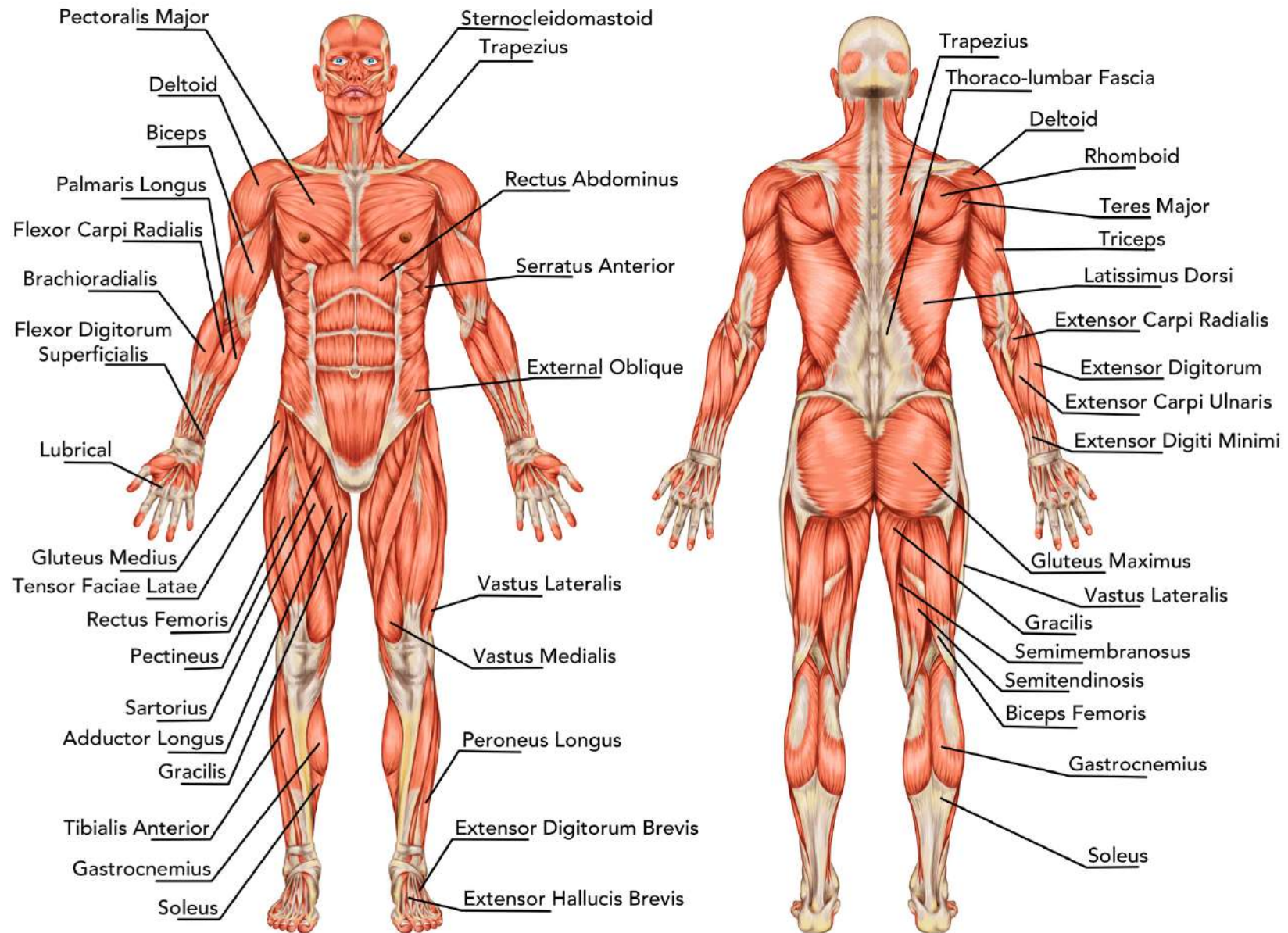
Joint Types & Function

The amount of bone movement at a joint varies. For example, joints in the skull are not movable, while joints in the shoulder allow a wide range of motion. Joints are classified by the type of movement they allow and the shapes of their parts:

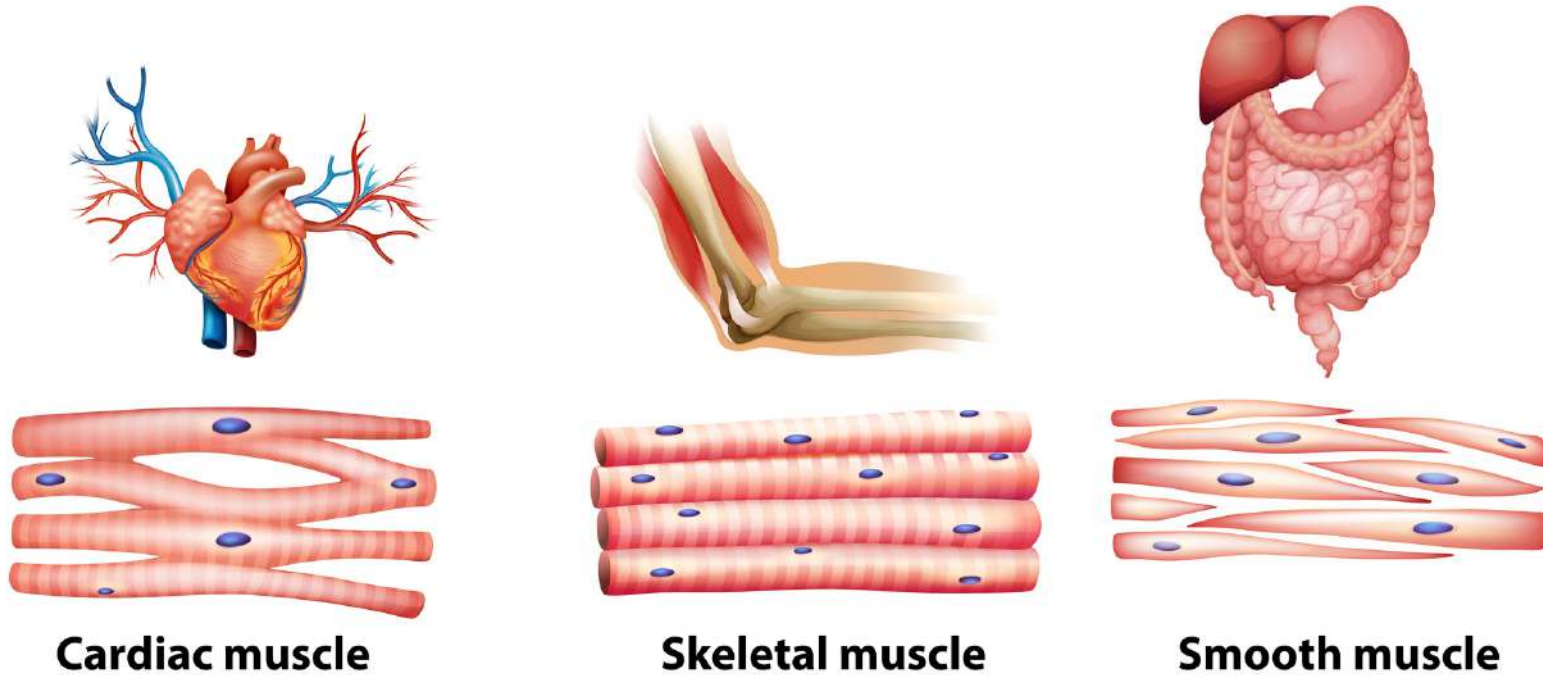
- **Ball-and-socket joints**, found in the shoulders and hips, allow for movement in almost all directions.
- **Hinge joints**, found in elbows and knees, allow for movement in one direction.
- **Gliding joints**, found in wrists and ankles, allow limited movement in many directions.
- **Pivot joints**, found between vertebrae in the spine, mainly allow rotating movement from side to side.
- **Fixed joints**, found in the skull, hold the bones of the skull together and do not allow for any movement.
- **Condyloid joints** allow movement similar to ball-and-socket joint without rotation. Found in the wrist.



Human Musculature



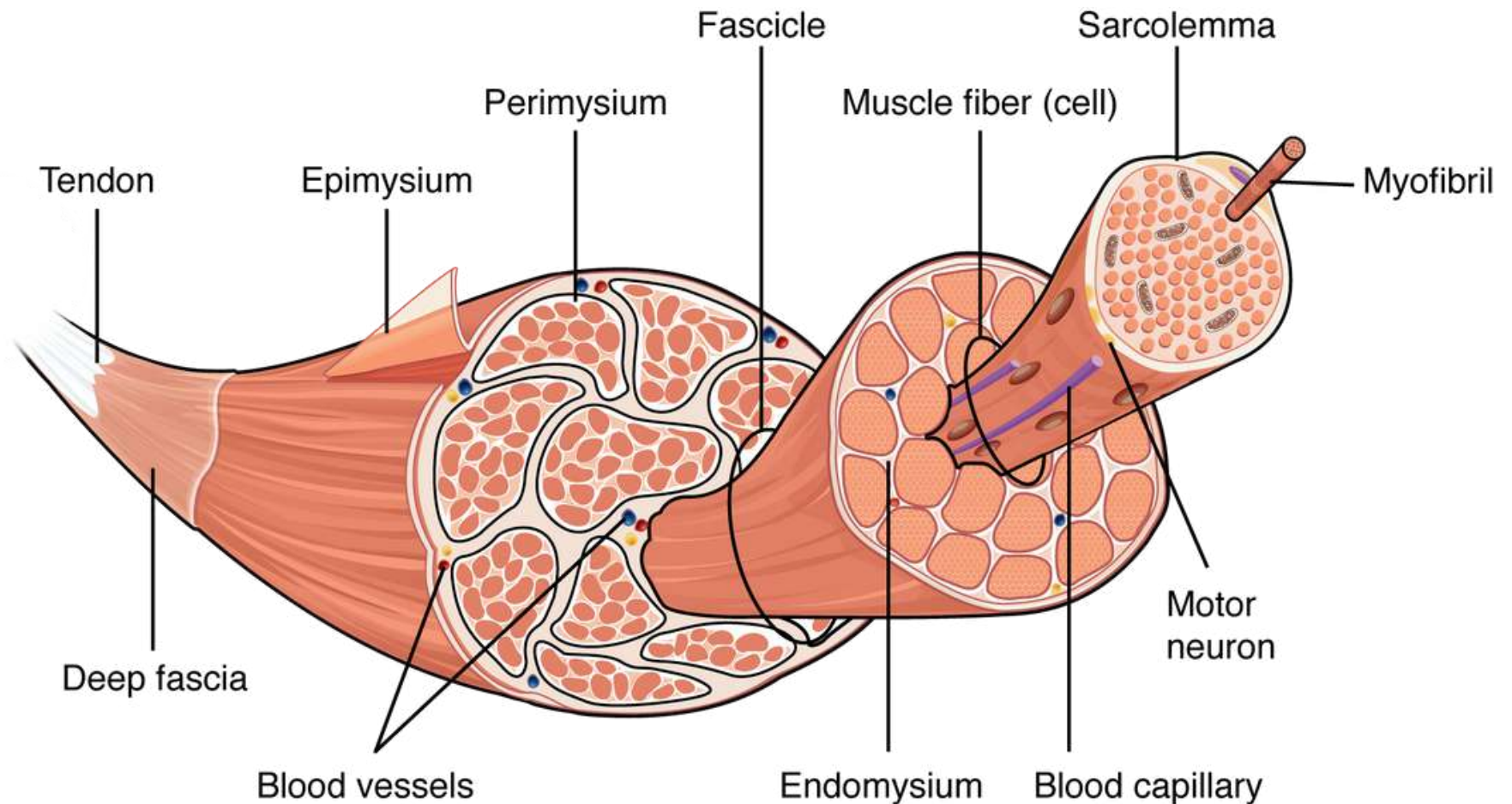
Muscle Types & Function



Types of muscle:

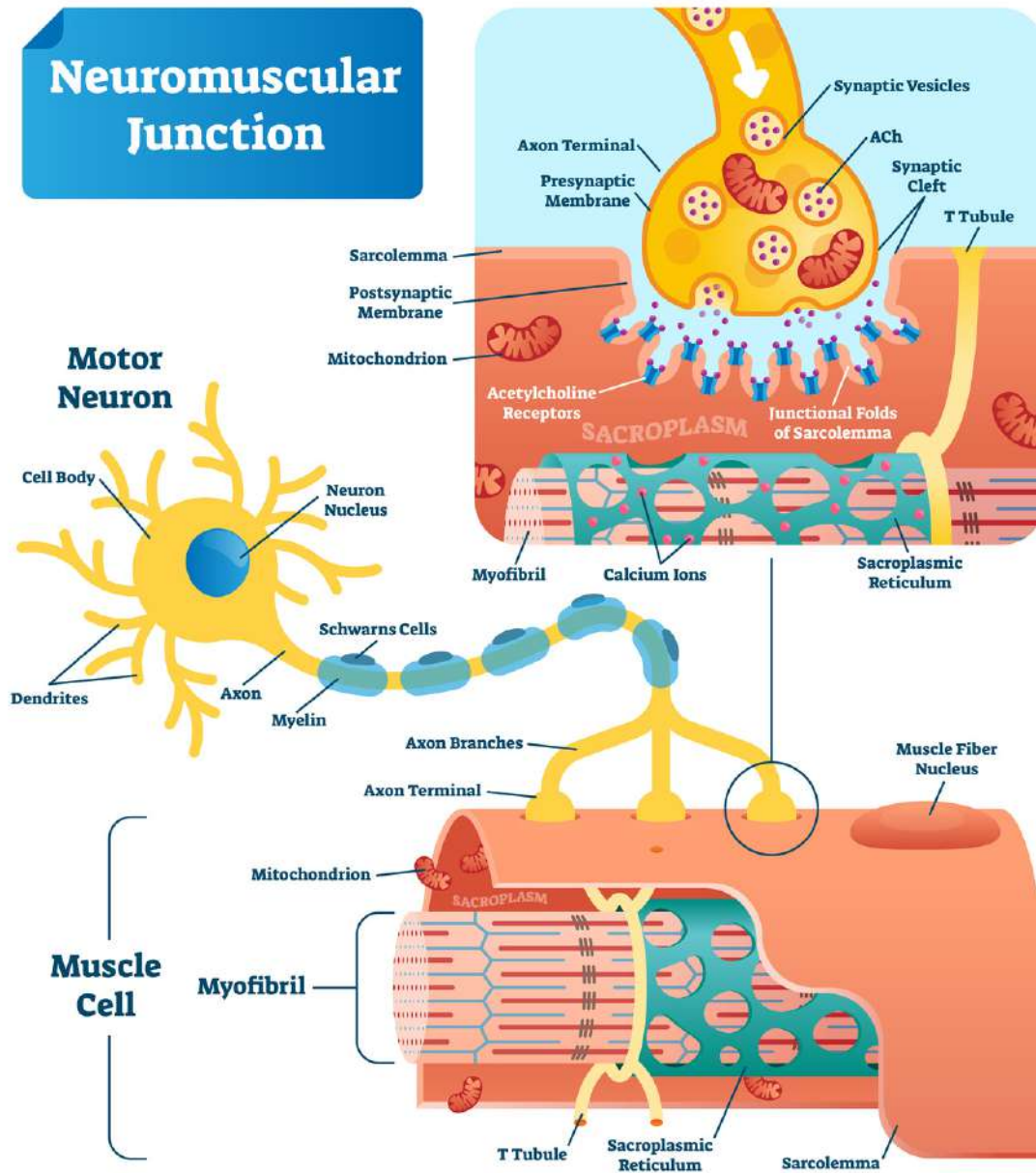
- **Skeletal muscle** - Skeletal muscle, **attached to bones**, is responsible for skeletal movements. The peripheral portion of the central nervous system (CNS) controls the skeletal muscles. Thus, these muscles are under conscious, or **voluntary**, control. The basic unit is the muscle fibre with many nuclei. These muscle fibres are striated (having transverse streaks) and each acts independently of neighbouring muscle fibres.
- **Smooth muscle** - Smooth muscle, found in the walls of the hollow internal **organs** such as blood vessels, the gastrointestinal tract, bladder, and uterus, is under control of the **autonomic nervous system**. Smooth muscle cannot be controlled consciously and thus acts involuntarily. The non-striated (smooth) muscle cell is spindle-shaped and has one central nucleus. Smooth muscle contracts slowly and rhythmically.
- **Cardiac muscle** - Cardiac muscle, found in the walls of the **heart**, is also under control of the **autonomic nervous system**. The cardiac muscle cell has one central nucleus, like smooth muscle, but it also is striated, like skeletal muscle. The cardiac muscle cell is rectangular in shape. The contraction of cardiac muscle is involuntary, strong, and rhythmical.

Skeletal Muscle Anatomy



Musculoskeletal System & Other Organ Systems

Neuromuscular Junction



Nervous System - The musculoskeletal system works with the nervous system. Receptors in muscles provide the brain with information about body position and movement. **The brain controls the contraction of skeletal muscle.** The nervous system regulates the speed at which food moves through the digestive tract (smooth muscle). Nerve impulses stimulate muscle contractions at special junctions between nerves and muscles called **neuromuscular junctions**. A neuromuscular junction is a chemical synapse between a **motor neuron** and a **muscle fibre**. It allows the motor neuron to transmit a signal to the muscle fibre, causing **muscle contraction**. Muscles require innervation to function—and even just to maintain muscle tone, avoiding atrophy.

Musculoskeletal System & Homeostasis

Homeostasis in the Muscular System

Skeletal muscles contribute to maintaining **temperature homeostasis** in the body by generating heat. Muscle contraction requires energy and produces heat as a byproduct of **metabolism**. All types of muscle produce heat, but because of the large amount of skeletal muscle present in the body, skeletal muscle contributes most greatly to heat production. This is very noticeable during **exercise**, when sustained muscle movement causes body temperature to rise. In cases of extreme cold, **shivering** produces random skeletal muscle contractions to generate heat as part of the negative feedback mechanism of maintaining body temperature.

Our body can use skeletal muscle contractions to maintain body temperature when we are cold, but excessive contractions can lead to the body overheating to the point that the body's metabolic reactions are interrupted. This can occur in a condition called malignant hyperthermia, which develops in genetically susceptible individuals who are administered a specific combination of anesthetic agents during surgery. In these individuals, a drastic increase in skeletal muscle calcium leads to sustained contractions and heat generation. Because the individuals are anesthetized, they have little ability to cool themselves. If proper interventions are not administered, they will die due to a greatly increased body temperature. Because this condition is genetic, patients are asked prior to surgery if there is a family history of such problems occurring.

Muscle Homeostasis and Growth

Physical training alters the appearance of skeletal muscles and can produce changes in muscle performance. Conversely, a lack of use can result in decreased performance and muscle appearance. Mature muscle cells grow from hypertrophy, not cell division. The loss of structural proteins and muscle mass occurs during atrophy. Cellular components of muscles can also undergo changes in response to changes in muscle use.

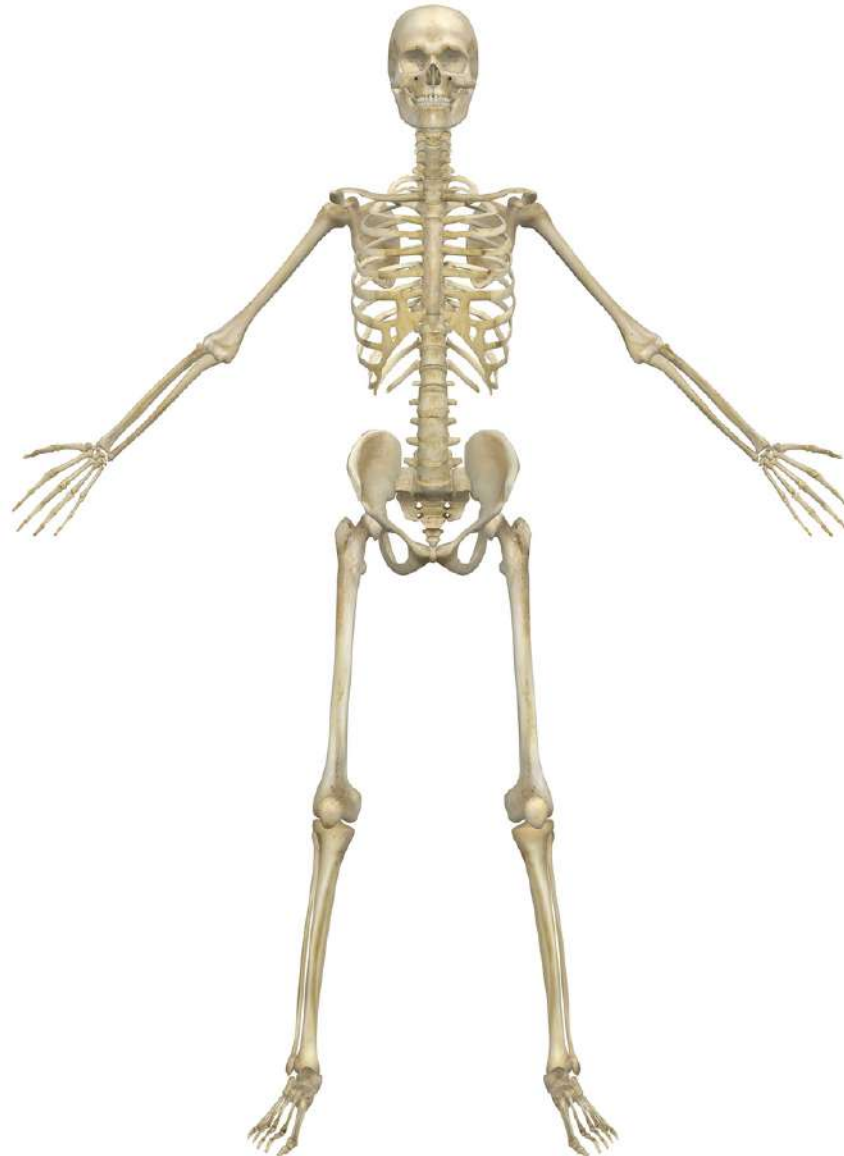
Although atrophy due to disuse can often be reversed with exercise, muscle atrophy that comes with age is irreversible. This is why even highly trained athletes succumb to declining performance with age, although extensive training may slow the decline. This is especially noticeable in sports that require an explosion of strength and power over a very short period of time. Examples of these kinds of sports include sprinting, competitive weight lifting, gymnastics and diving. The effects of age are less noticeable in endurance sports such as marathon running or long-distance cycling. Age-related muscle atrophy is called **sarcopenia**. As muscles age, muscle fibres die, and they are replaced by connective tissue and adipose tissue. Because those tissues cannot contract as muscle can, muscles lose the ability to produce powerful contractions.

Review Break

- What is one way the musculoskeletal system maintains homeostasis within the body?
- What is one way the musculoskeletal system interacts with other body systems?
- Name three major bones and three major muscles in the human body.

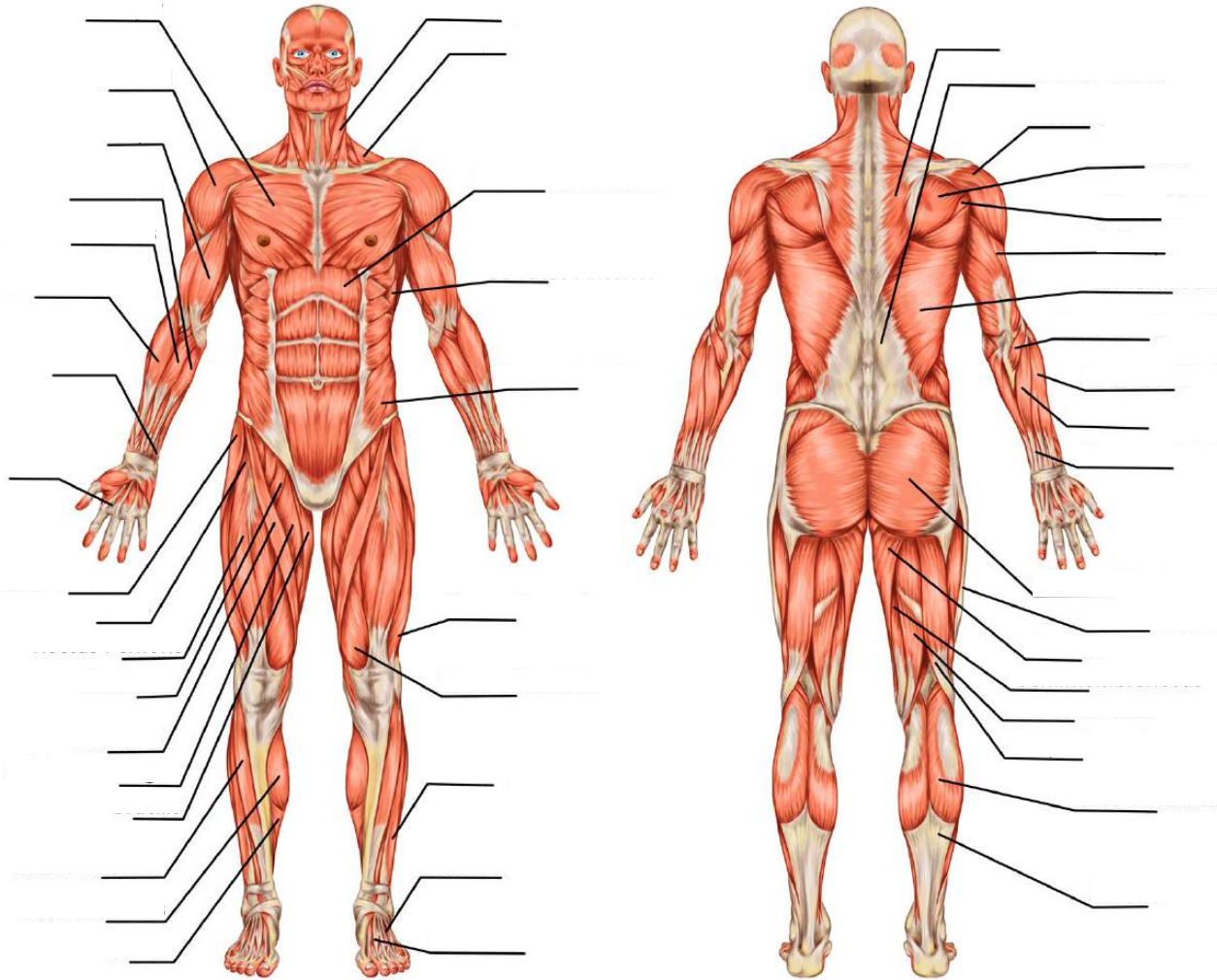
QUIZ!

Label the major bones of the human body



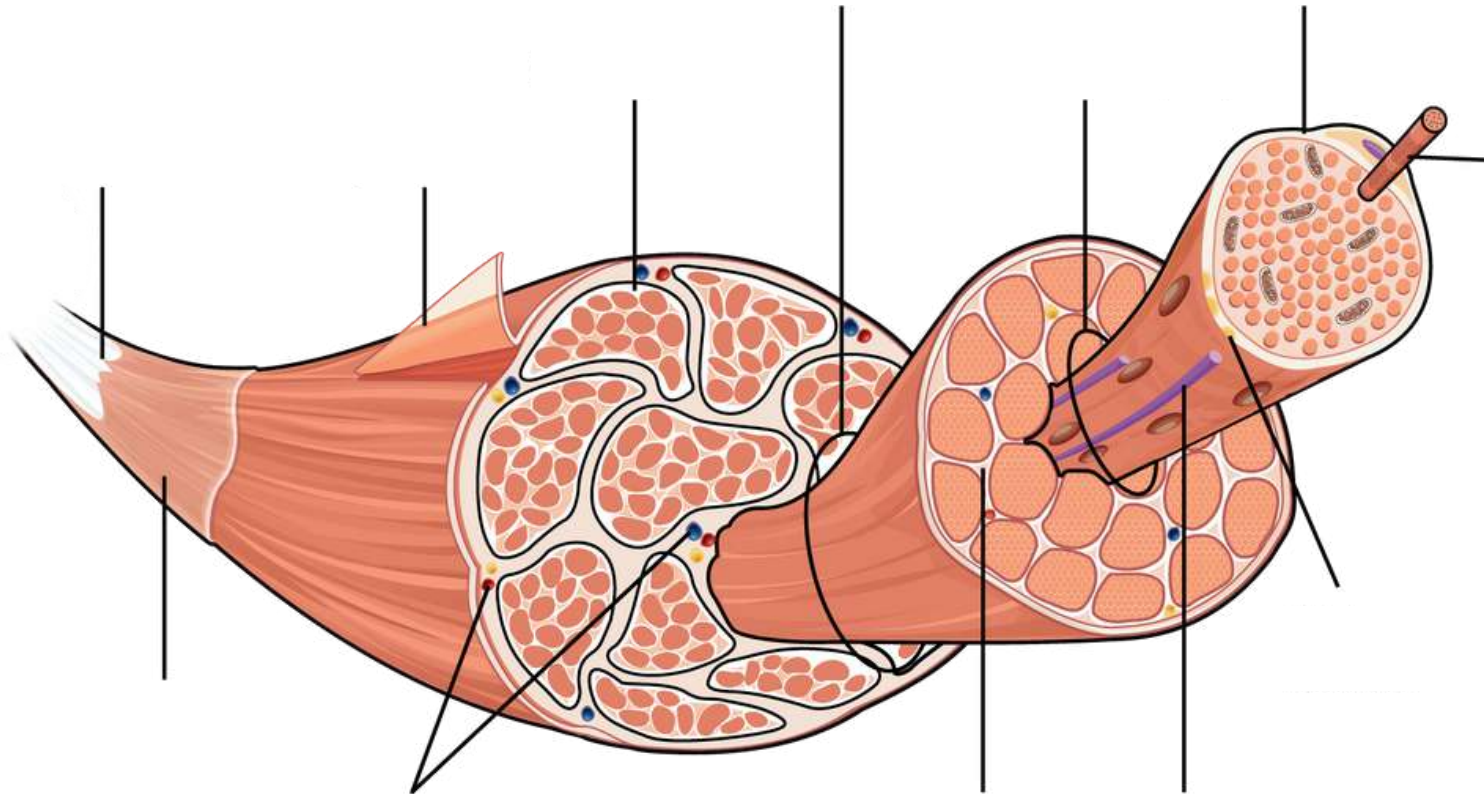
QUIZ!

Label the major muscles of the human body



QUIZ!

Label the major components of skeletal muscle



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We gratefully acknowledge the support of the following funders of this Humane Science Education Program:



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