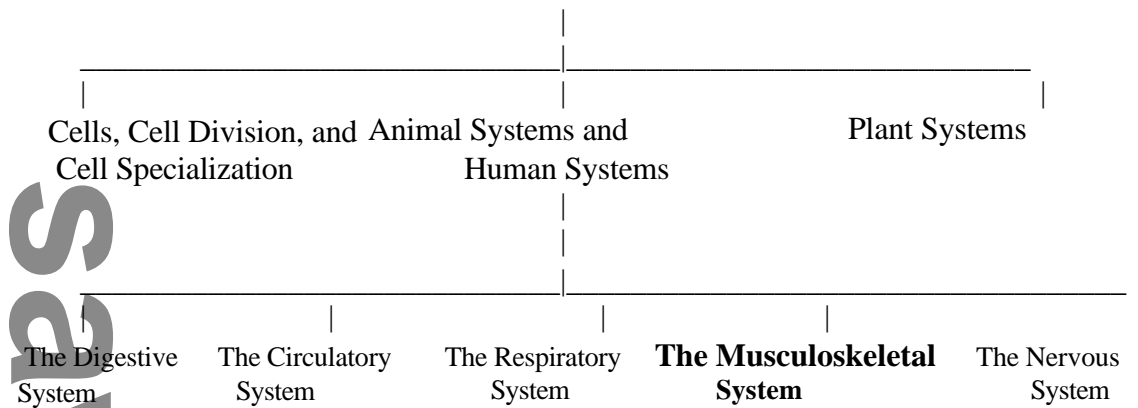


Animal Systems: The Musculoskeletal System

Tissues, Organs, and Systems of Living Things



The Musculoskeletal System

An **organ system** is a group of organs that are co-ordinated to work together to perform specific tasks in the body. Organ systems are made up of groups of organs.

Organs are made up of tissues.

Tissues are made up of specialized cells.

Two organ systems, the skeletal system and the muscular system, work together to support the human body and allow it to move. The two systems together are combined to call the musculoskeletal system.

Musculoskeletal system: the organ system that is made up of bones and skeletal muscle, the system that supports the body, protects delicate organs, and makes movement possible.

Babies are born with ~300 bones, but many of them fuse together soon after birth and others fuse in early childhood. Children's bones are *softer* than the bones of adults.

The number of bones found in a human body is ~ 206, this is because what one source describes as a single bone formed from several parts may be described by another source as several different bones working together. The bones support the muscles that allow the body to move.

Bones are:

- I. part of the skeletal system and the musculoskeletal system, and
- II. the muscles that make the bones move are also part of the musculoskeletal system.

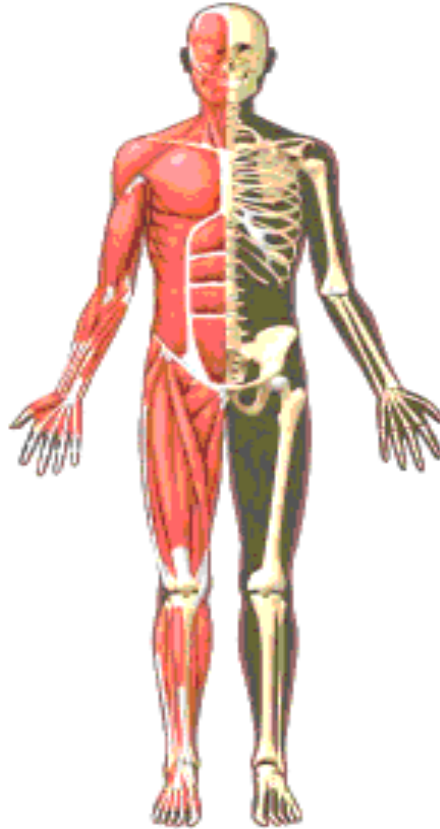
In addition to movement, the musculoskeletal system performs three other vital functions: **protection**, **blood-cell production**, and **mineral storage**.

Bones protect many organs of the body, e.g. the skull protects the brain, the ribs protect the heart and the lungs, and the bones of the vertebral protect the spinal cord.

Bone marrow produces blood cells and releases them into the bloodstream. Bone marrow contains immature cells called stem cells that can develop into a variety of mature cells, including red and white blood cells.

Minerals such as calcium and phosphorus gives the bones strength and rigidity. These dissolved minerals circulate in the bloodstream, and are also necessary to maintain healthy muscles.

The Musculoskeletal system: the bones and muscles work together to provide structure, support, protection and movement.



I. The skeleton consists of three different types of connective tissue:

1. bone tissue,
2. ligaments tissue, and
3. cartilage tissue.

1. Bone Tissue

Bone tissue is hard, composed of :

1. bone cells (made within a complex matrix of calcium and phosphorus mainly), and
2. collagen fibres.

The interior of bones is composed of nerves and blood vessels.

Bones are connected to other structures by **tendons** and **ligaments**.

Tendons connect bones to muscles, whereas ligaments connect bones to other bones, usually at joints.

A tendon connects a muscle to a bone, so the muscular contraction can move the bone.

Ligaments are long fibres of connective tissue that can stretch, made mostly of long fibres of **collagen** that hold the bones of movable joints together. Collagen is a network of protein fibres.

2. Ligament Tissue

Ligament tissue are long connective tissue, made mostly of long fibres of collagen, these connect bones to other bones, usually at the joints.

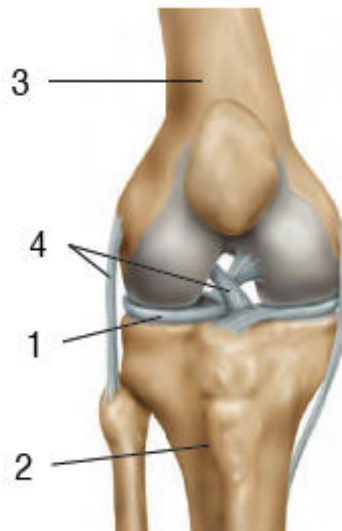
Ligaments exist in joints between bones to prevent scraping or damage to the bones.

A **joint** is simply where two bones come together.

The joints are held together by ligaments, which also allow the joints movement in only the correct directions.

In between the bones is a padding, called **cartilage**, which prevents the bones from damaging each other when rubbing, reduces friction between the bones.

The following diagram of the knee joint is held together by several ligaments, the cartilage acts as a cushion between the ends of femur bone and the tibia bone.



1 = cartilage 2 = tibia 3 = femur 4 = ligaments

3. Cartilage Tissue

Some parts of the skeleton, such as the tip of the nose, esophagus, the disks between the vertebrae and joints, and the ears, are made of semi-solid, flexible connective tissue called cartilage.

Cartilage tissue is connective tissue made up special cells in a matrix of **collagen fibres**.

Cartilage tissue provides strong, flexible, low-friction support for bones and other tissue.

Pads of **cartilage** at the ends of bones act as shock absorbers that reduce friction and wear and tear.

The skeleton of a developing embryo begins as a framework of cartilage. As the baby grows, the cartilage is replaced by compact bone, continuing into the late teens and early twenties.

If a person is experiencing pain in the knee resulting from bone rubbing against bone, the cartilage is damaged or missing.

II The other part of the musculoskeletal system is the muscle tissue.

Movement depends on the ability of muscles to move the bones of the skeleton. Muscles are attached to bones in such a way as to allow the bones to move when the muscles contract.

Bundles of long cells called muscle fibres that contain specialized proteins capable of shortening or contracting (i.e. movement) are called **muscle tissue**.

These proteins cause the muscle to contract, becoming shorter and thicker, *when signalled by the nerve cells*.

There are **three types of muscle tissue** found in the body: *cardiac muscles, smooth muscles and skeletal muscles*.

1. Cardiac muscles are found only in the heart, (thus not considered part of the musculoskeletal system, when exercising: cardiac and skeletal muscles are working).

Cardiac muscle is the muscle that makes the heart beat, it contracts and relaxes automatically.

2. Smooth muscles is found in the lining of organs such as the stomach, the esophagus, the uterus and the walls of the blood vessels.

Smooth muscle contractions move substances through organs, e.g. the muscles that move the digested food through the digestive system.

Smooth muscle is also controlled automatically.

3. Skeletal muscles is attached to the bones of the skeleton by tendons.

These muscles allow for movement of body parts. Skeletal muscles are attached to bones by tough, largely inflexible strips of connective tissue called **tendons**.

A tendon connects the skeletal muscle to a bone, so the muscular contraction can move the bone.

Skeletal muscle is voluntary muscle tissue because it does not move on its own like cardiac muscle or smooth muscle in the intestine.

Skeletal muscles can pull, but they can not push— the skeletal muscles all work in opposing pairs.

The role of the skeleton is to:

1. provide structure for the body
2. provide support for the body
3. provide movement for the body
4. provide anchor points for muscles

The skeleton provides support to our bodies so that we are not just blob of tissue.

Certain bones in the skeleton provide protection to internal organs and the brain.

The muscles contract and extend, which moves the bones.

How Muscles Make Bones Move

Tendons connect each end of a skeletal muscle to one or more different bones in the skeleton, so the muscular contraction can move the bone. Tendons are less elastic than ligaments.

Muscles contract, becoming shorter and thicker, (they can not extend or pull), when signalled by the nerve cells, and in doing so they exert a force.

This force moves one or both of the bones to which the skeletal muscle is attached.

Summary of Muscles in the Muscular System

Muscular System → muscles → skeletal muscle tissue

The following diagram illustrates how skeletal muscles all work in opposing pairs:



The diagram above shows how muscles work in pairs.

Muscles cannot push, so opposite pairs must contract.

As the biceps contract, the triceps relax.

As the triceps contract, the biceps relax.

This demonstrates how muscles can only contract and how opposing muscles work together to allow the body to function.

Note: As you exercise, the muscular system produces more carbon dioxide, which needs to be removed, and requires more nutrients and oxygen. The circulatory system brings these nutrients to the muscle tissues and takes away the carbon dioxide.

Musculoskeletal Disorders

Osteoporosis: affects all ages, but common in older women, due to loss of bone tissue caused by a loss of calcium in the bones; making the bones brittle and weak.

Osteoporosis is difficult to diagnose because there are not any outward physical symptoms.

Bone density test must be done to determine if a person has osteoporosis.

The function of the musculoskeletal system is support and protection, thus physical stresses can have effect, e.g. tears in ligaments, tendons, and muscle tissues can result, in severe cases bone fractures can result.

Example: A person who has experienced a knee injury affecting the stability of the knee has probably injured a ligament.

Arthritis is a result of inflammation of bursa: these are fluid-filled sac between bones. The joints swell, become stiff and deformed. The cause is unknown, but the treatment includes anti-inflammatory drugs, steroids and physiotherapy.

Gout affects toes, fingers, knees, mostly in males. Gout is due to the formation of excess uric acid in joints. The treatment includes anti-inflammatory drugs, physiotherapy, controlling uric acid levels, joint rest.

Assignment

1. Fill in the following spaces:

- a. The function of muscle tissue is _____.
- b. Bundles of long cells called muscle fibres that contain specialized proteins capable of shortening or contracting are called _____ tissue.
- c. _____ muscles move food along in the digestive tract.
- d. Bone density scans are used to identify _____.
- e. The ear is composed of _____.
- f. Skeletal muscle is attached to the bones by _____.
- g. The skeleton consists of the following three types of tissue: _____, _____, _____.
- h. When someone is running for exercise, the muscle types being worked are: _____, _____.
- i. If a person is experiencing pain in the knee resulting from bone rubbing against bone, then the _____ is damaged.
- j. A person who has experienced a knee injury affecting the stability of the knee has probably injured a _____.

2. What is the role of the musculoskeletal system?

3. Explain the difference between a ligament and a tendon.

4. Why is skeletal muscle tissue considered “voluntary”?

5. a. Name the system that provides support and structure for the body.

b. What is another function of this system.

c. Name the tissue types that make up this system.

6. Explain how the musculoskeletal system carries out each of the following functions:

a. Support

b. Protection

c. Movement

7. Why are the skull bones of a fetus not fused together as they are in an adult?

8. Describe two methods used by the body to cushion the force of movement and prevent wear and tear.

9. Distinguish between smooth muscle and skeletal muscle.

10. a. What is osteoporosis?

b. What causes osteoporosis?

c. How is osteoporosis treated?