Unit 7:
Skeletal and muscular systems

Think and answer?

a. What is the relationship between bones and muscles?

b. What are the functions of bones? And the functions of muscles?

c. How do skeletal muscles contract?

d. Name some bones and muscles of the human body.

UNIT OBJECTIVES

In this unit you will learn:

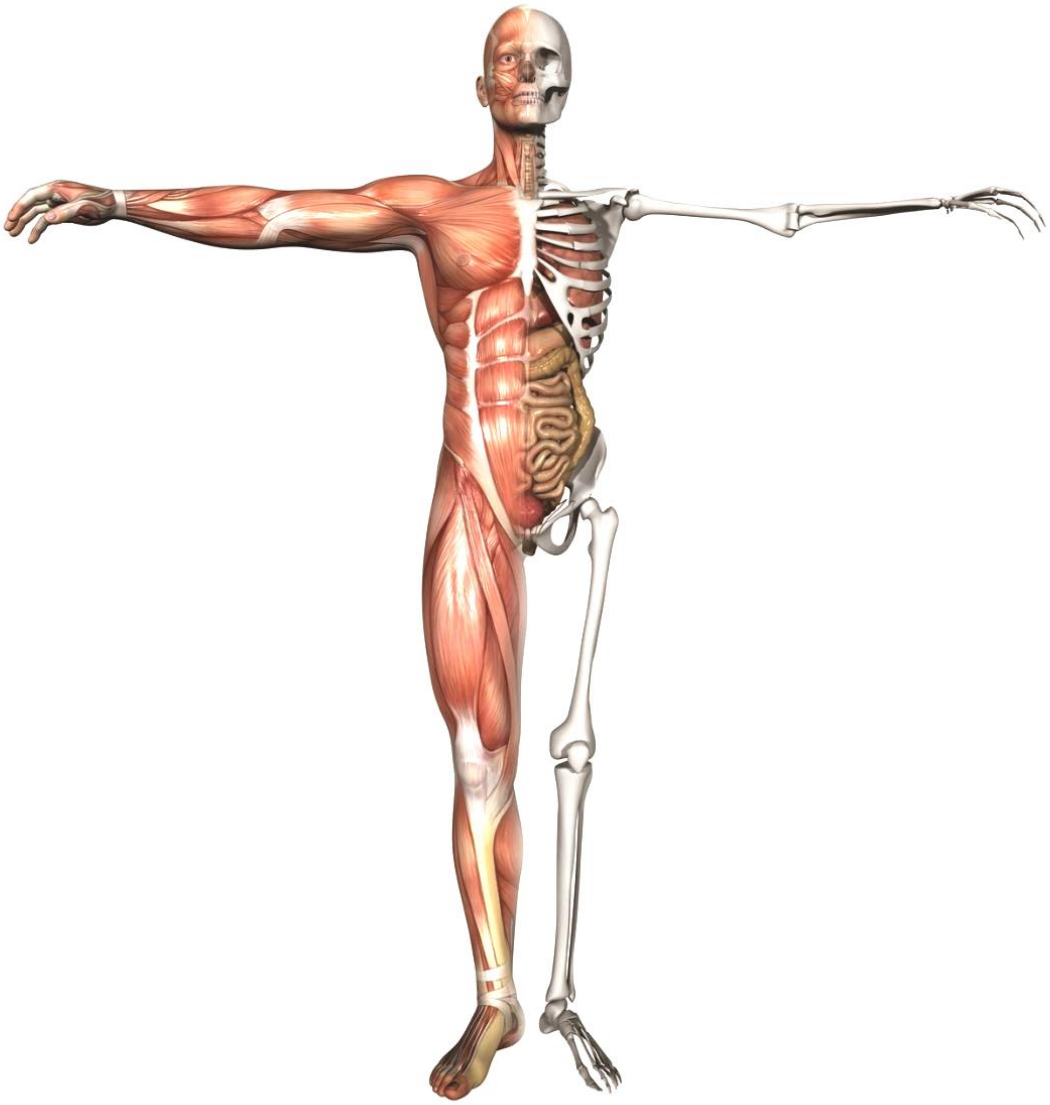
- The functions of bones.
- To understand the operation of muscular contraction.
- To relate the function of bones and muscles.
- To distinguish the main bones and muscles in your body.
- To appreciate the importance of healthy habits related to locomotor system.
- The main diseases and disorders of the locomotor system.

1. The locomotor system

The **locomotor system** (or musculoskeletal system) is in charge to perform the **motor responses** elaborated by the nervous system.

The locomotor system is formed by two systems: the skeletal system and the muscular system.

- **The skeletal system**. It is the passive part of the locomotor system. It is formed by the skeleton.
- **The muscular system**. It is the active part of the locomotor system. It is formed by the skeletal muscles.



2. The skeletal system

The skeletal system is formed by organs called **bones** that are connected by **joints** and **ligaments**.

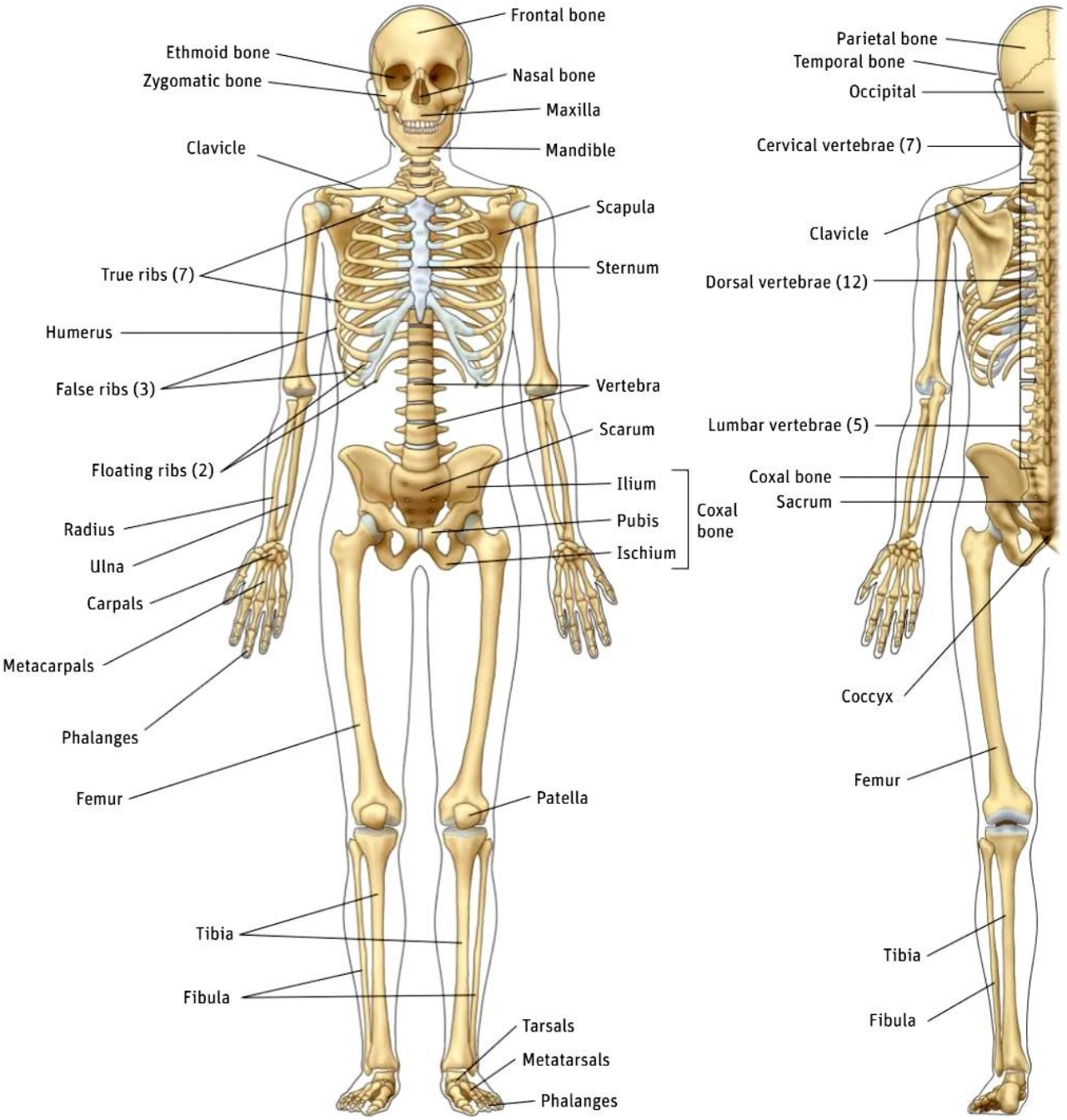
2.1. The human skeleton

The skeleton forms an internal scaffold that has several functions:

- To provide a framework that supports the body.
- To provide an anchorage to the muscles.
- To protect internal organs.
- To contain the red bone marrow that produces blood cells.
- To store calcium, which is released into the blood if required.

The adult human skeleton is formed by 206 bones, divided into two parts:

- The **axial skeleton.** It is formed by the bones of the head (skull and face) and trunk.
- The **appendicular skeleton.** It is formed by the bones of the limbs, arms and legs as well as the bones of the shoulder and hip.



2.2. Bones

Bones are hard and rigid organs composed by **osseous** (bone) **tissue**. This tissue is formed by:

- Mineral salts (**calcium** and phosphorous)
- **Collagen** fibres
- **Osteocytes** (star-shaped cells)

There are two types of bone tissue:

- **Spongy bone tissue**. It has cavities that give it the shape of a sponge.
- **Compact bone tissue**. It is solid and has no holes in it.

The skeleton is also made up by **cartilage**. Cartilage is less hard and more flexible than bone because it does not contain calcium. Cartilage is found in the ears, the front part of the nose and between vertebrae. It also forms the skeleton of embryos. There are areas of cartilage in the long bones. They remain for a long time allowing the bones to grow. When these areas calcify completely, the individual stops growing.

a) Types of bones

There several types of bones depending on their shape.

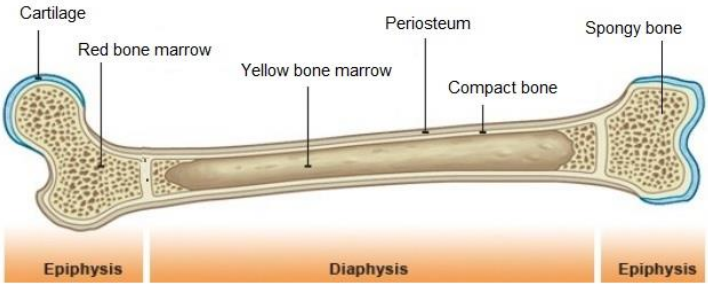
Long bones	Short bones	Flat bones
Long bones are elongated. They have spongy bone tissue at the ends covered by a layer of compact tissue (epiphysis) and only compact bone tissue in the central part (diaphysis). These bones provide support and movement.	Short bones are rounded. They are made up of compact bone tissue on the outside and spongy bone tissue on the inside.	Flat bones are plate-like. They are made up of an internal layer of spongy bone tissue which is restricted by two layers of compact bone tissue. Their function is to protect.
E.g. Femur, humerus, radius, etc 	E. g. Vertebrae, wrist bones, etc 	E. g. Skull bones, scapula, etc. 

b) Structure of bones

In a long bone we can distinguish several parts:

- **Periosteum**. It is an external layer of connective tissue that attached nerves and blood vessels to the bone.
- **Bone marrow.** This is soft tissue that fills the bone cavities.
  - **Red bone marrow** is located within the epiphysis. It manufactures the blood cells.
  - **Yellow bone marrow** is located in the hollow interior of the diaphysis. It is formed by fat cells.
- **Endosteum**. It is an internal layer of connective tissue that lines the interior of the diaphysis.

In addition bones have a **cartilage capsule** covering at the ends to avoid friction.



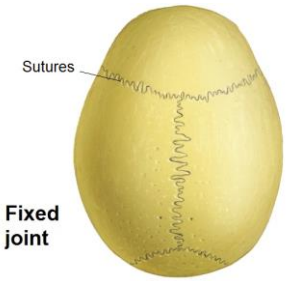
2.3. Joints

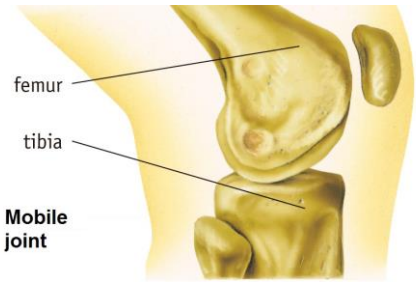
Bones link together and form joints. There are three kinds of joint: fixed, mobile and semi-mobile:

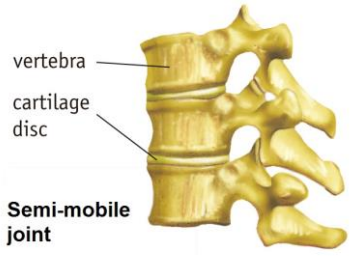
- **Fixed joints** (sutures) avoid the movement of bones. The skull bones are connected by this type of joint.

- **Mobile joints** allow us to change position. There is a lubricant liquid in these joints, called synovial fluid, which stops them rubbing. In this type of joint there are ligaments that keep the bones together. The elbow, the shoulder and the knee are examples of this kind of joint.

- **Semi-mobile joints** only allow a limited movement of the bones, for example between vertebrae.



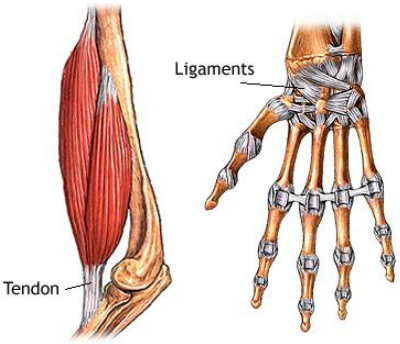




2.4. Ligaments and tendons

- **Ligaments** are groups of connective tissue fibres that connect the bones in a joint and keep them together.

- **Tendons** are the connexion of muscles to bones. They are formed by connective tissue. They allow muscles move bones.



ACTIVITIES

2.1. Indicate what type of bone is each one of the following and where it is.

a. Frontal bone b. Carpals c. Tibia d. Vertebrae f. Coxal bone

2.2. Listen and complete the text:

Bones

Bones are …….. composed mainly of …… bone tissue on the …… and …… bone tissue at the ……..

To avoid friction, the ends of our bones are covered with ……., which is softer and more elastic. The …… in the sponge bone tissue are filled with bone ……

There two types of bone marrow: …… bone marrow, in which …… cells are produced, and …… bone marrow, which is made up of …… tissue (or fat cells)

Bones are …… because bone tissue contains …… mineral salts.

2.3. Explain the difference among the types of joints and put an example of each one.

2.4. What elements can we find in a mobile joint such as the knee?

2.5. Indicate the function of the following parts of a long bone:

a. Red bone marrow b. Periosteum c. Cartilage capsule

3. The muscular system

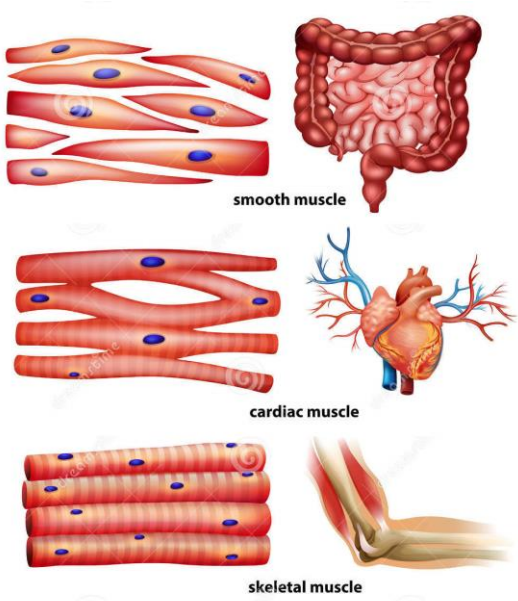
The muscular system is formed by organs called **muscles** that conect to bones by **tendons**.

Muscles are formed by elongated cells called **muscles fibres**, because they are elongated and their shape is fibrous. Muscles can contract and relax; this modifies their length and allows the movement.

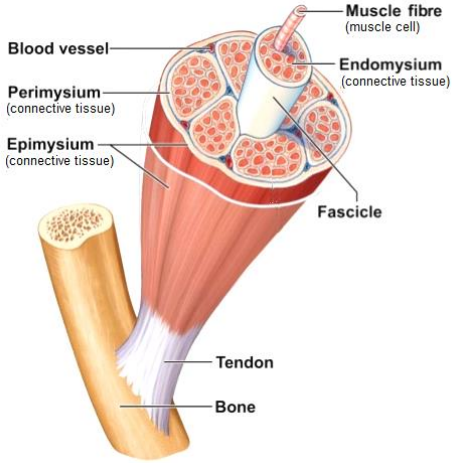
a) Types of muscles

There are three types of muscles:

- **Smooth muscles**.
  Their contraction is slow and involuntary.
  They are formed by smooth muscle tissue.
  Their cells are spindle-shaped and have one nucleus.
  These muscles are located in the internal organs, such as the digestive tube or blood vessels.
- **Cardiac muscles**.
  Their contraction is fast and involuntary.
  They are formed by cardiac muscle tissue.
  Their cells are short, striated and have one nucleus.
  They form the myocardium of the heart.
- **Skeletal muscles**.
  Their contraction is fast and voluntary.
  They are formed by striated muscle tissue.
  Their cells are very elongated and have several nuclei.
  They form in association with the skeleton, the locomotor system and are responsible for the movement of the body.



b) Structure of the skeletal muscle



Skeletal muscles are formed by cells called **striated muscle fibres**.

Each fibre is wrapped by a thin layer of connective tissue (endomysium).

These fibres group to form muscle bundles (**muscle fascicles**) wrapped by a layer of connective tissue (perimysium).

Several fascicles join together to form the muscle itself that is wrapped by a layer of connective tissue (epimysium).

At the end of the muscle, the reunion of all these coverings forms the **tendon** that attaches the muscle to the bone.

ACTIVITIES

3.1. Answer these questions:

a. What are tendons? Which is their function?
b. How are muscle cells called? Why?

3.2. Summarise the differences among the three types of muscles in a comparative chart.

3.3. Listen and identify what type of muscle is described:

a. Smooth muscle b. Cardiac muscle c. Skeletal muscle

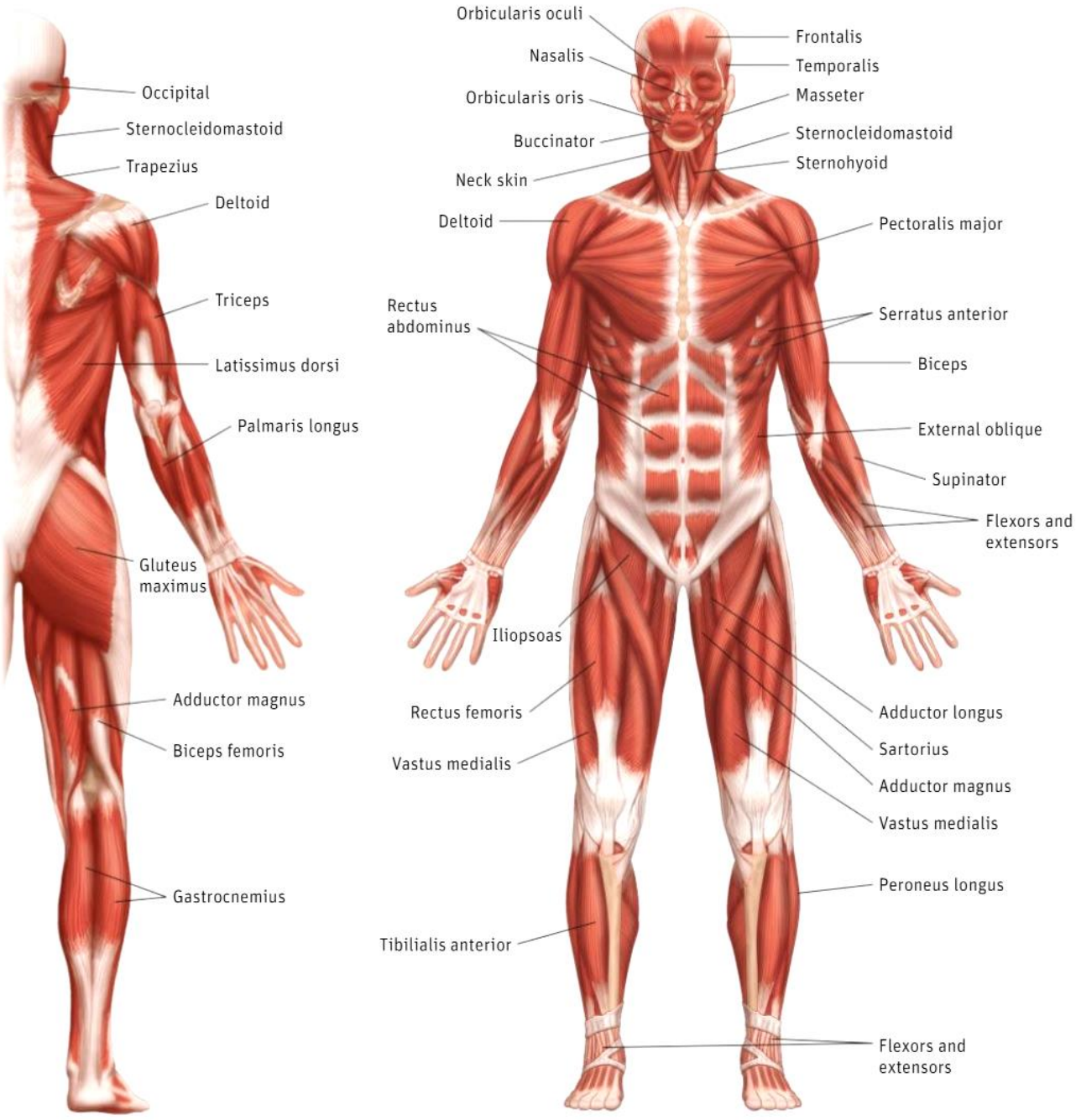
3.1. The muscles of the human body

Muscles can be classified according to different criteria:

- Shape:
  - **Fusiform** or **long muscles** (spindle-shaped) such as biceps.
  - **Flats (**plate-shaped) such as the abdominal muscles.
  - **Circular** or **sphincters** (ring-shaped) such as the lips muscles.

- Movement:
  - **Flexors** and **extensors**. They allow to extend or to flex a part of the body. E.g. Biceps and triceps in the arm, quadriceps or biceps femoris in the leg.
  - **Pronators** and **supinators**. They rotate outwards or inwards a part of the body. E.g. Pronator and supinator muscles of the forearm.
  - **Adductors** and **abductors**. They move a limb towards or away from the midline of the body. E.g. Muscles that bring the legs together and those that spread them apart.

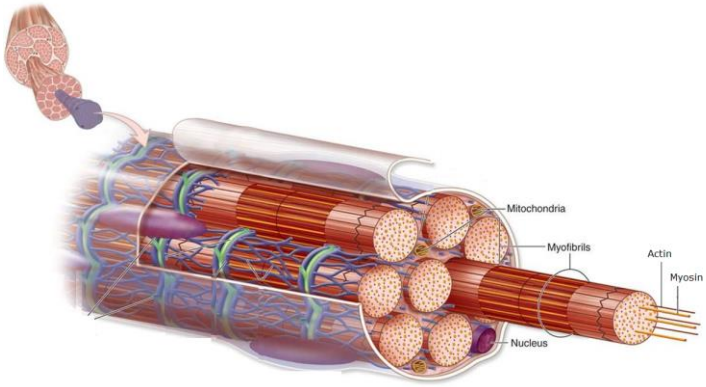
The main muscles of the human body are represented in the picture:



3.2. The muscular contraction

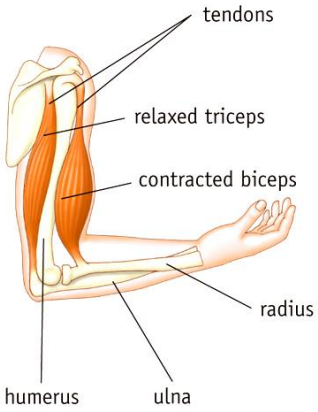
Muscles contract by becoming shorter in response to a nerve motor impulse.

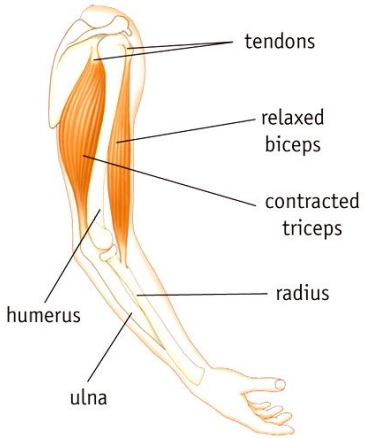
Striated muscle cells are very long and contain bundles of filaments called **myofibrils.** Each myofibril is formed by a repeated structure called **sarcomere**, formed by two types of proteins, **actin** and **myosin**.



These proteins are disposed forming bands that slide over each other when the nerve impulse arrives. This provokes the shortening of the sarcomere and as a result the contraction of the muscle.

For muscle contraction to produce the movement, various muscles must be coordinated at the same time. Muscles that work together in a coordinate way to make a specific movement are called **agonist muscles**. **Antagonist muscles** act against agonists. When one contracts, the other relaxes. This is a case of biceps and triceps which moves the forearm bones:





ACTIVITIES

3.4. Indicate where the following muscles are located in the human body:

a. Pectoralis major b. Buccinator c. Gastrocnemius d. Biceps

3.5. Classify the following muscles according to their shape:

a. Orbicularis oculi b. Deltoid c. Sartorius d. Sternocleidomastoid

3.6. Answer these questions:

a. There are agonist and antagonist muscles that work in coordination. Why is it necessary?
b. What is the difference between flexor and extensor muscles?
c. What type of muscles allows you separate arms from your body?

3.7. Listen and find six differences in the following text:

The muscular contraction

Muscles relax by becoming longer. A motor nerve acts on a muscle and the muscle glands use energy to contract.

This energy is obtained from aerobic nutrition in the cells, which requires a source of energy (usually carbohydrate molecules) and hydrogen.