SAWA UNIVERSITY

Muscle physiology

جامعة ساوة

كلية العلـــــــــــوم

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Muscle physiology

Classification of Muscles

There are more than 600 muscles in our body. Muscles perform many useful functions and help us in doing everything in day-to-day life. Muscles are classified by three different methods based on different factors:

I. Depending upon the presence or absence of striations

II. Depending upon the control

III. Depending upon the function

Depending upon control

Depending upon control, the muscles are classified into two types: 1. Voluntary muscle 2.Involuntary muscle.

Feature	Voluntary Muscles	Involuntary Muscles
Control	Controlled by will (voluntary control)	Not controlled by will (involuntary control)
Type	Skeletal muscles	Smooth muscles and cardiac muscle
Location	Attached to bones, forming the skeletal system	Found in walls of internal organs (stomach, intestines, heart, etc.)
Function	Responsible for voluntary movements such as walking, writing	Responsible for involuntary movements such as heartbeat.
Microscopic Structure	Striated, long cylindrical fibers, multinucleated	Non-striated (smooth or branched), usually single nucleus

Depending upon situation:

The muscles are classified into three types depending upon the situation:

1. Skeletal muscle 2. Cardiac muscle 3. Smooth muscle.

Feature	Skeletal Muscle	Cardiac Muscle	Smooth Muscle
Location	Attached to bones	In the heart	In walls of internal organs
Control	Voluntary	Involuntary	Involuntary
Appearance	Striated	Striated	Non-striated (smooth)
Nuclei	Many, at periphery	One or two, central	One, central
Nerve Supply	Somatic nerves	Autonomic nerves	Autonomic nerves
Function	Body movement	Pumps blood	Moves internal organs

Structure of Skeletal Muscle:

 Skeletal muscle is made up of many long, slender cells called muscle fibers (myocytes).

 The fibers are multinucleated and arranged parallel to each other.

 A fibrous layer called fascia surrounds the entire muscle.

 Beneath the fascia:

o Epimysium covers the whole muscle.

o Perimysium surrounds each bundle of fibers.

o Endomysium covers each individual muscle fiber.

Structure of a Muscle Fiber:

 Each muscle fiber is cylindrical.

 Fibers are attached to bones by tendons.

 Inside the fiber are myofibrils—fine, parallel filaments running the full length of the muscle fiber.

Microscopic Structure of a Myofibril:

Each myofibril shows alternating light (I) bands and dark (A) bands, creating cross striations. The Z line divides; the part between two Z lines is a sarcomere, the structural and functional unit of skeletal muscle. Each sarcomere contains myofilaments of two types:

Actin (thin) filaments: Extend from Z lines.

Myosin (thick) filaments: have bridges with myosin heads that attach to actin.

Muscle contraction occurs by the sliding mechanism, where myosin heads pull actin filaments closer together.

Contractility

- Contractility: is the response of the skeletal muscle to a stimulus by change in either
- the length or tension of the muscle fibers.
- Types of contraction:
- Muscular contraction is classified into two types based on change in the length of muscle
- fibers or tension of the muscle: 1. Isotonic contraction 2. Isometric contraction.

Feature	Isotonic Contraction	Isometric Contraction
Meaning	Muscle tension stays the same, but muscle length changes	Muscle length stays the same, but tension increases
Muscle Length	Changes (shortens or lengthens)	No change
Example	Flexion of the arm	Trying to lift a heavy object (no movement)

Skeletal muscles are classified based on contraction time into

Red (slow) muscles and pale (fast) muscles.

Red muscles contain mostly Type I fibers, have a small diameter, and contract slowly (e.g., back muscles, gastrocnemius). Pale muscles contain mostly Type II fibers, have a large diameter, contract quickly, and are suited for rapid and powerful movements (e.g., hand and ocular muscles).

The force and pattern of muscle contraction are influenced by several factors:

- Strength of stimulus: Stronger stimulus produces stronger contraction.

Number of stimuli:

 o A single stimulus produces one contraction.

o Multiple stimuli can cause:

1. Fatigue: Decrease in muscle activity due to repeated low-frequency stimuli; eventually the muscle stops responding.

2. Tetanus: Sustained contraction caused by high-frequency stimuli; stimulus stops or fatigue occurs.

 Temperature and load also affect contraction.