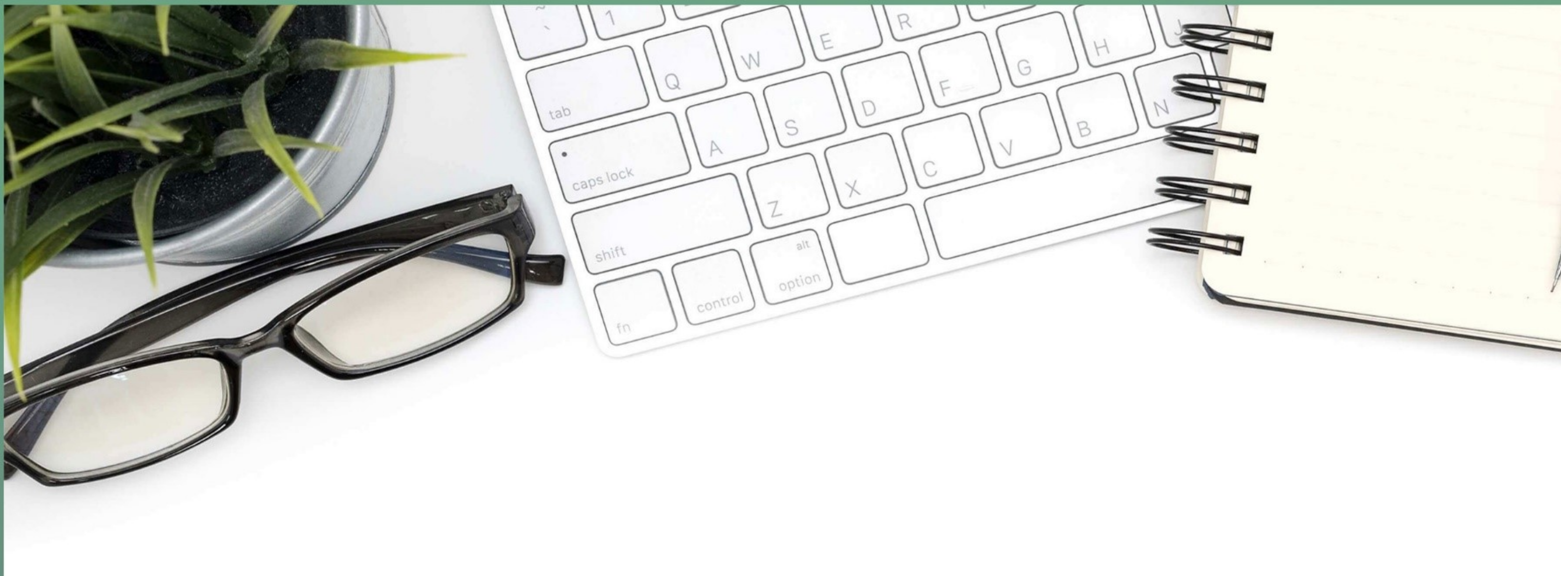

NEET Biology

Short Notes

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LOCOMOTION AND MOVEMENT

Introduction

Movement is the characteristic feature of the living organisms. It is defined as the change is body orientation, change in position, either of some part of the body or of the whole organism. When the movement results in displacement of the organism, it is called the locomotion. An organism shows the locomotion for the following reasons:

- Search for food
- Search for shelter
- Mating
- Escape from predator

Walking, running, swimming, climbing, flying etc. are the forms of locomotion. The organs specified for the locomotion need not be different from those involved in the movement. For example, the tentacles in jelly-fishes are used in capture of prey and locomotion, the cilia in *Paramecium* gather the food and also perform locomotion and the forelimbs and hindlimbs in humans perform the locomotion as well as the movements.

Types of Movements

There are following three types of movements:

MOVEMENT	DESCRIPTION	EXAMPLES
Amoeboid or Pseudopodal Movement	A crawling type of movement that occurs due to the emergence of finger-like projections called the pseudopodia.	It occurs in *Amoeba* for phagocytosis. It is shown by the leucocytes in blood and the microfilaments.
Ciliary Movement	Cilia are the tiny hair-like projections, present all over the body surface of an organism. They exhibit coordinated beatings that result in movement, called ciliary movement.	Shown by the internal organs that are lined with the ciliated epithelium. Movement of the ovum across the fallopian tube, elimination of the dust particles in trachea etc.
Muscular Movement	This type of movement occurs due to contraction of the contractile proteins within the muscles. It occurs in response to the nerve impulse.	Majority of the movements, including, swallowing, peristalsis, contraction of blood vessels etc.

Introduction to the Muscles

The muscular tissue is mesodermal in origin. It is made up of the cells called muscle fibres. These constitute around 40% to 50% of the human body weight. These show the following types of features:

1. Excitability: The muscles are capable of responding to the nerve impulse, that is, they are capable of depolarising and polarising their membranes and transfer the potential difference across the membrane to the sarcoplasmic reticulum.
2. Contractility: While showing excitability, the muscles respond by contraction along the long axis. This property is called contractility.

3. Elasticity: The property of the muscles to regain the original shape after an event of the excitation and the contraction is called elasticity.
4. Extensibility: The property to extension and stretching is called the extensibility.

Types of Muscles

There are the following three types of muscles:

1. **Skeletal muscles or the Striated muscles:**
   These can be located below the skin, specifically, the skin covering the limbs. The skeletal muscles contract and bring about stimulation or inhibition of the movement.

   Structure of the Skeletal Muscles

   Each skeletal muscle can be seen covered with three layers of connective tissues that provide integrity to the structure and function of the muscles.

   a) The outer most layer of dense irregular connective tissue is called the epimysium. It provides structural separation to the muscles from other tissues.
   b) Within the epimysium, many bundles of muscles called fascicles are arranged. These fascicles are covered with another layer of connective tissue called perimysium.
   c) Within the fascicles, the muscle fibres are arranged and are covered with the third layer of connective tissue called the endomysium.
   d) The muscle fibre represents the individual cell of the muscular tissue, surrounded by the plasma membrane called the sarcolemma. The cytoplasm of the muscle fibre is called sarcoplasm and it contains sarcoplasmic reticulum and special contractile proteins arranged as myofibrils.
   e) These are multi-nucleated and appear striated.
   f) These are innervated by the motor neurons of the voluntary nervous system.

2. **Cardiac Muscles:**
   These are exclusively located in the heart. These are also striated but are not under voluntary control. These are uninucleate. These are branched and their branches are connected via the intercalated discs. These intercalated discs have gap-junctions due to which a coordinated contraction can be achieved.

3. **Smooth Muscles or Visceral Muscles:**
   These are unstriated in appearance. These are associated with the visceral organs like stomach, urinary bladder etc., so they are also not under the voluntary control. These are spindle-shaped, uninucleate, and are innervated by the autonomic nervous system.

Structure of the Contractile Proteins

The functional unit of the skeletal muscles is called the sarcomere, due to which they appear striated. Each sarcomere shows the proper arrangement of the myofilaments made up of contractile proteins called the actin and the myosin. Within each sarcomere, the following types of protein filaments are seen:

1. **The Thin Filament**:
   It is made up of the actin and the associated proteins called troponin and tropomyosin. Actin is a globular protein. Two filaments helically wound around each other form the thin filament. Two filaments of the tropomyosin are also placed along the actin filaments throughout their length. The troponin is a complex protein which appears distributed across the length of the thin filament. When at rest, the troponin proteins mask the active myosin binding site on the actin filament. Troponin has the binding sites for the Ca^{++} ions.

2. **The Thick Filament**:
   It is made up of the myosin protein that shows the following structural details:
   a) Head: The short arm called the heavy meromyosin represents the head. It shows ATPase activity and binding site for the actin.
   b) Tail: It is the light meromyosin and controls the contraction.

Mechanism of the Muscle Contraction

The muscle contraction is the functionality of the sarcomere. Following is the structure of the sarcomere:

1. Each sarcomere shows light bands and heavy bands. The light bands are called I-bands and are made up of thin filaments. The heavy bands are called the A-bands and are made up of thick filaments.
2. Each sarcomere lies within two Z-lines to which the thin filaments are anchored.
3. Within A-band, there is H-zone which represents only the thick filaments at rest. The M-line holds the thick filaments together.

Sliding Filament Theory for Muscle Contraction

This theory states that the contraction of the muscles occurs when the thick and the thin filaments slide past each other due to the formation of the cross-bridges and this sliding movement reduces the length of the sarcomere, thereby contracting the muscles. This theory was put forward by Andrew Huxley and Niedergerke. The muscle contraction occurs in the following steps as per the sliding filament theory:

1. The axons of the motor neuron from the voluntary nervous system synapse with the muscles at the neuromuscular junction or the end-plate. Upon receiving the stimulus from the sensory neurons, these release the acetylcholine that binds to the receptors on the muscles and depolarises the sarcolemma.
2. The sarcolemma shows special T-shaped proteins. These proteins allow the spread of the depolarisation to the membrane of the sarcoplasmic reticulum.
3. The Ca^{++} are released from the sarcoplasmic reticulum and bind to the troponin complex of the thin filaments.
4. This binding changes the conformation of the troponin, which in turn rotates the tropomyosin filaments and the myosin binding site of the actin filament is exposed.
5. When at rest, the myosin is bound with ATP. As soon as the myosin binding site of the actin is exposed, the ATPase of the head of the myosin hydrolyses the ATP into ADP and iP, the energy so released is used in forming the cross-bridges between the actin and the myosin.
6. The cross-bridge formation results in pulling of the thin filaments towards the thick filament and the distance between the two successive Z-lines is reduced.

7. The shortening of the distance between the Z-lines shorten the sarcomere and the muscle contraction is said to have taken place. This is called the power-stroke and involves the movement of the thin filament.
8. The myosin head continues binding with the actin filament until the ATP binds with another site on the myosin head. This binding of ATP detaches the myosin head from the actin. But soon, this ATP is hydrolysed and the power-stroke is generated once again.
9. Thus, as long as the ATP continues to bind and hydrolyse, and the myosin binding sites on the actin are exposed, the muscle contraction will continue.

Relaxation of Muscles

It occurs when the action potential terminates at the motor neurons and so, the Ca^{++} ions are taken back in the sarcoplasmic reticulum. The myosin binding sites are masked with tropomyosin and cross-bridges are broken.

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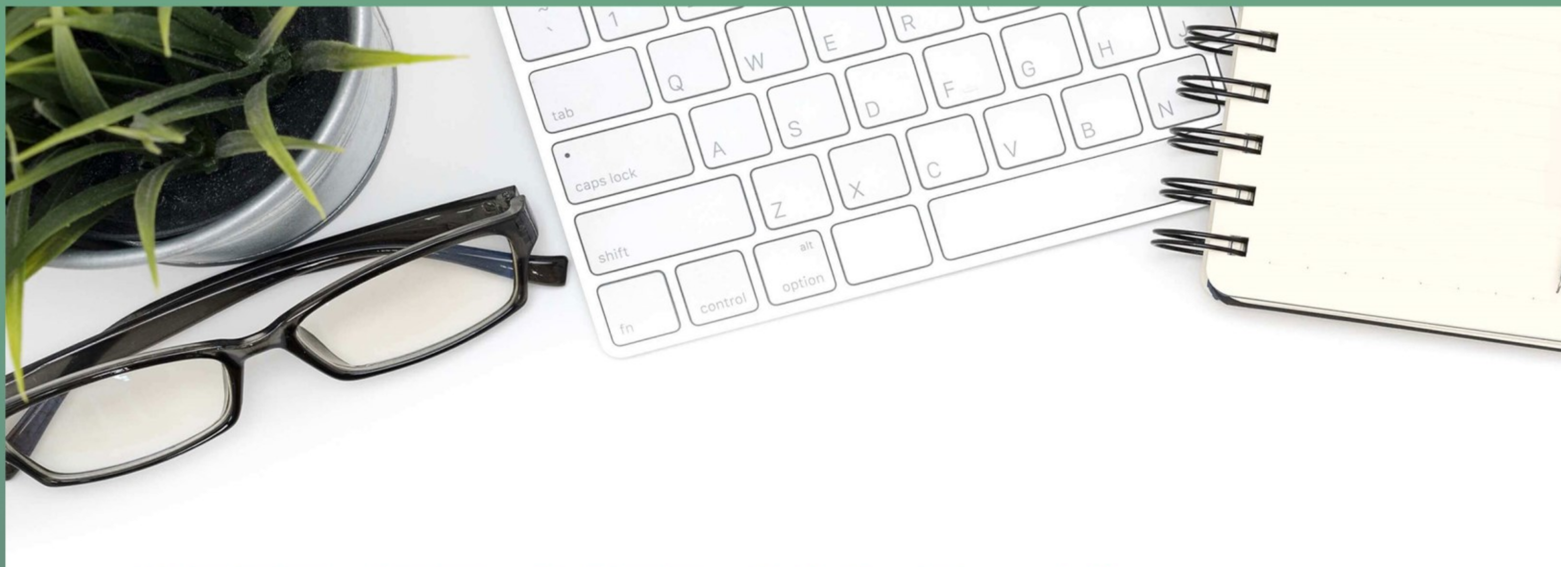

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