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Locomotion and Movement Class 11 Notes | CBSE Biology Chapter 17

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Locomotion and Movement Class 11 Notes | CBSE Biology Chapter 17

Locomotion and Movement is Chapter 17 of CBSE Class 11 Biology — and one of the most fact-loaded, scoring chapters for NEET. It explains *how* our body moves, from a single cell crawling like an amoeba to the coordinated pull of skeletal muscles on bones across joints. Almost every part of this chapter — the sliding filament theory, muscle fibre types, the human skeleton count, and joint classification — is a direct NEET favourite.

By the end of these notes you will be able to distinguish the three types of movement, explain the ultrastructure of a skeletal muscle and the molecular mechanism of contraction, list every bone of the axial and appendicular skeleton, classify joints, and recall the key features of common muscular and skeletal disorders. This is a high-yield chapter: master the numbers and definitions and you can answer any board or NEET question on it.

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Key Concepts

1. Movement and Locomotion

Watch your eyelid blink or your heart beat — that is **movement**, a change in position of a body part. When you walk to school, your whole body changes place — that is **locomotion**.

Movement is a characteristic feature of all living organisms; it may or may not change the position of the whole body.

Locomotion is the voluntary movement of an organism from one place to another. **All locomotion is movement, but not all movement is locomotion.**

Key idea: Animals move for food, shelter, a mate, breeding, a suitable climate, or to escape predators.

2. Types of Movement

Cells of the human body show three main types of movement.

- **Amoeboid movement:** shown by macrophages and leucocytes (WBCs). It occurs by the streaming of cytoplasm to form **pseudopodia**, involving the cytoskeleton (microfilaments).
- **Ciliary movement:** occurs in internal tubular organs lined by ciliated epithelium — the trachea (moves dust-trapped mucus), and the female reproductive tract (moves the ovum/egg through the oviduct).
- **Muscular movement:** movement of limbs, jaws, tongue, etc. needs the contraction of muscle. Most locomotion in higher animals depends on it.

3. Muscle — Properties and Types

Muscle is a specialised contractile tissue of mesodermal origin, making up 40–50% of an adult human's body weight. Its key properties are **excitability**, **contractility**, **extensibility**, and **elasticity**.

Three Types of Muscle

Type	Location	Striations	Control / Nuclei
Skeletal (striated)	Attached to bones	Striated	Voluntary; multinucleate
Smooth (visceral)	Inner walls of hollow organs (gut, blood vessels)	Non-striated	Involuntary; uninucleate, spindle-shaped
Cardiac	Heart wall	Striated	Involuntary; uninucleate, branched, with intercalated discs

4. Structure of Skeletal Muscle

A skeletal muscle is built like a bundle of bundles. Each muscle is made of many parallel **muscle fibres (myofibres)** grouped into bundles called **fascicles**, held together by connective tissue (fascia).

Each muscle fibre is a long, cylindrical, multinucleate cell. Its plasma membrane is the **sarcolemma**, the cytoplasm is the **sarcoplasm**, and the endoplasmic reticulum is the **sarcoplasmic reticulum (SR)** — the store of calcium ions.

[DIAGRAM: Muscle → fascicle → muscle fibre → myofibril → sarcomere, showing A-band, I-band, H-zone, Z-line and M-line.]

The sarcoplasm contains many parallel **myofibrils**, each showing alternating dark and light bands — the source of the striations.

- **A-band (dark):** contains thick **myosin** filaments (with overlapping actin). Anisotropic.
- **I-band (light):** contains only thin **actin** filaments. Isotropic.
- **Z-line:** bisects each I-band; the thin filaments are anchored to it.
- **H-zone:** the central part of the A-band with only myosin (no overlap).
- **M-line:** holds the myosin filaments together at the centre of the H-zone.

The portion between two successive Z-lines is the **sarcomere** — the functional (contractile) unit of a muscle.

5. Thick and Thin Filaments

The two contractile proteins are arranged as overlapping filaments.

- **Thin filament (actin):** two F-actin strands helically wound; each F-actin is a polymer of **G-actin** monomers. Two filaments of **tropomyosin** run alongside, and a complex protein **troponin** sits at regular intervals over tropomyosin, masking the active (myosin-binding) sites in a resting muscle.
 - **Thick filament (myosin):** a polymer of many **meromyosin** molecules. Each meromyosin has a globular **head with a short arm (HMM)** projecting outward — this head is the **cross-bridge** and carries ATPase activity and binding sites for ATP and actin — and a **tail (LMM)**.
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6. Sliding Filament Theory of Muscle Contraction

Proposed by H. E. Huxley and A. F. Huxley, the **sliding filament theory** states that muscle contraction occurs because the thin (actin) filaments slide over the thick (myosin) filaments — the filaments themselves do not shorten.

Steps of Contraction

- A signal from the CNS reaches the **neuromuscular junction (motor end plate)**, releasing the neurotransmitter **acetylcholine**.
- This generates an action potential in the sarcolemma, causing the sarcoplasmic reticulum to release **Ca²⁺** into the sarcoplasm.
- Ca²⁺ binds to **troponin** on actin, shifting tropomyosin and exposing the active sites.
- Myosin heads bind to the exposed actin sites, forming **cross-bridges**, and pull the thin filaments inward (the power stroke) — ATP is hydrolysed by myosin ATPase.
- The Z-lines are pulled closer, so the **sarcomere and I-band shorten while the A-band stays constant length**; the H-zone shrinks.
- Fresh ATP binds the myosin head, breaking the cross-bridge; the head returns and the cycle repeats. When Ca²⁺ is pumped back into the SR, the active sites are masked again and the muscle relaxes.

Key idea (NEET favourite): During contraction the A-band length is unchanged; only the I-band and H-zone get shorter.

7. Red and White Muscle Fibres

Skeletal muscle fibres are of two types based on the amount of the red pigment **myoglobin**.

Feature	Red fibres (Type I)	White fibres (Type II)
Myoglobin	High (red colour)	Low (pale)
Mitochondria	Numerous	Few
Sarcoplasmic reticulum	Less	Abundant
Respiration	Aerobic	Anaerobic
Contraction	Slow, sustained (do not fatigue easily)	Fast, fatigue quickly

Note: Red fibres are suited for posture and endurance; white fibres for quick, powerful bursts.

8. The Skeletal System

The **skeletal system** is the framework of bones and a few cartilages that supports the body, protects organs, and provides surfaces for muscle attachment. **Bone** has a hard matrix rich in calcium salts; **cartilage** has a slightly pliable matrix (chondroitin salts).

The adult human skeleton has **206 bones**, divided into the axial and the appendicular skeleton.

9. Axial Skeleton (80 bones)

The **axial skeleton** forms the main axis of the body — skull, vertebral column, ribs, and sternum.

- **Skull (29 bones):** 8 cranial + 14 facial bones, 6 ear ossicles (3 in each middle ear — malleus, incus, stapes), and 1 hyoid. A single **U-shaped hyoid** bone lies at the base of the buccal cavity.
- **Vertebral column (26 bones):** 7 cervical, 12 thoracic, 5 lumbar, 1 sacrum (fused), 1 coccyx (fused). The first vertebra is the **atlas**, which articulates with the occipital condyles of the skull.
- **Ribs (24 / 12 pairs):** 7 pairs **true** (vertebrosternal), 3 pairs **false** (vertebrochondral), 2 pairs **floating** (vertebral) ribs. Each rib is a thin flat bone connecting the vertebral column and the sternum.
- **Sternum (1):** a flat bone on the ventral midline of the thorax. Ribs + sternum + thoracic vertebrae form the **rib cage**.

10. Appendicular Skeleton (126 bones)

The **appendicular skeleton** consists of the bones of the limbs and the two girdles.

- **Forelimb (30 bones each):** humerus, radius and ulna, 8 carpals, 5 metacarpals, 14 phalanges.
- **Hindlimb (30 bones each):** femur (the longest bone), tibia and fibula, patella (kneecap), 7 tarsals, 5 metatarsals, 14 phalanges.
- **Pectoral girdle:** each half has a **clavicle** (collar bone) and a **scapula** (shoulder blade). The scapula bears a socket — the **glenoid cavity** — for the humerus.

- **Pelvic girdle:** two coxal (hip) bones, each formed by the fusion of **ilium, ischium, and pubis**. The socket — the **acetabulum** — receives the head of the femur.

11. Joints

A **joint (articulation)** is the point of contact between two or more bones, or between bone and cartilage. Joints are essential for all movement and locomotion. They are classified by their degree of mobility.

Type of joint	Mobility	Example
Fibrous (fixed)	Immovable	Sutures of the skull
Cartilaginous	Slightly movable	Joints between adjacent vertebrae
Synovial	Freely movable (synovial fluid in the cavity)	See below

Types of Synovial Joints

- **Ball and socket:** shoulder and hip — movement in all planes.
- **Hinge:** knee, elbow — movement in one plane.
- **Pivot:** between the atlas and axis — rotation.
- **Gliding:** between carpals (wrist).
- **Saddle:** between the carpal and metacarpal of the thumb.

12. Disorders of the Muscular and Skeletal System

A few named disorders are almost guaranteed in NEET and boards — learn the one-line cause for each.

Disorder	Cause / Key Feature
Myasthenia gravis	Auto-immune disorder affecting the neuromuscular junction → fatigue, weakness and paralysis of skeletal muscle.
Muscular dystrophy	Genetic disorder → progressive degeneration of skeletal muscle.
Tetany	Rapid spasms (wild contractions) of muscle due to low Ca²⁺ in body fluid.
Arthritis	Inflammation of joints.
Osteoporosis	Age-related disorder; decreased bone mass and higher fracture risk, commonly due to lowered oestrogen levels.
Gout	Inflammation of joints due to accumulation of uric acid crystals.

Weightage in Board & Entrance Exams

Exam	Typical Weightage	Most-Tested Areas
CBSE Board (Class 11)	4–6 marks	Sliding filament theory, muscle structure, joints, disorders
NEET	1–2 questions almost every year	Sarcomere bands, contraction mechanism, bone count, red vs white fibres

[TABLE: Question-type split — VSA (1 mark): definitions, examples of movement, disorder causes; SA (2–3 marks): muscle ultrastructure, red vs white fibres, joint types; LA (5 marks): sliding filament theory, axial vs appendicular skeleton.]

Important Definitions

Term	Definition
Movement	A change in the position of a body part; need not move the whole body.
Locomotion	Voluntary movement of an organism from one place to another.
Sarcomere	The portion of a myofibril between two successive Z-lines; the functional unit of contraction.
Sarcoplasmic reticulum	The endoplasmic reticulum of a muscle fibre; stores and releases Ca^{2+} .
Sliding filament theory	Contraction occurs by thin filaments sliding over thick filaments.
Cross-bridge	The myosin head that binds actin and pulls it during contraction.
Joint / articulation	Point of contact between bones (or bone and cartilage) enabling movement.
Tetany	Rapid muscle spasms caused by low Ca^{2+} in body fluid.
Osteoporosis	Age-related fall in bone mass; raises fracture risk (low oestrogen).
Gout	Joint inflammation due to deposition of uric acid crystals.

Solved Examples & NEET Facts

Example 1

During muscle contraction, which bands of the sarcomere change in length and how?

Answer: The **I-band and H-zone shorten** and the sarcomere length decreases. The **A-band length stays unchanged** because the myosin filaments do not shorten — the actin filaments merely slide inward.

Example 2

Name the protein to which Ca^{2+} binds during contraction and state its effect.

Answer: Ca^{2+} binds to **troponin** on the thin filament. This shifts tropomyosin and exposes the myosin-binding (active) sites on actin, allowing cross-bridge formation.

Example 3

How many bones are there in (a) the human vertebral column and (b) the adult skull (including ear ossicles and hyoid)?

Answer: (a) Vertebral column = **26 bones** (7 cervical, 12 thoracic, 5 lumbar, 1 sacrum, 1 coccyx). (b) Skull = **29 bones** (8 cranial + 14 facial + 6 ear ossicles + 1 hyoid).

Example 4

Classify the following joints: (i) shoulder, (ii) knee, (iii) between atlas and axis, (iv) skull sutures.

Answer: (i) Ball and socket, (ii) Hinge, (iii) Pivot, (iv) Fibrous (fixed) joint.

Example 5

A patient shows muscle fatigue and weakness from an auto-immune attack at the neuromuscular junction. Name the disorder.

Answer: **Myasthenia gravis.**

Example 6

Give two differences between red and white muscle fibres.

Answer: Red fibres have **more myoglobin and mitochondria** and respire **aerobically**, contracting slowly without easy fatigue; white fibres have **less myoglobin**, respire **anaerobically**, and contract fast but fatigue quickly.

Important Questions for Board Exams

1-Mark Questions (VSA)

1. Differentiate between movement and locomotion with one example each.
2. Name the contractile proteins of the thin and thick filaments.
3. What is the functional unit of a muscle called?
4. Name the disorder caused by deposition of uric acid crystals in joints.
5. Which ion is stored in the sarcoplasmic reticulum?

2–3-Mark Questions (SA)

1. Describe the structure of a sarcomere, naming the A-band, I-band, H-zone, Z-line and M-line.
2. Differentiate between red and white muscle fibres (any three points).
3. Name and give one example each of any three types of synovial joints.
4. Distinguish between the axial and the appendicular skeleton with examples.

5-Mark Questions (LA)

1. Explain the sliding filament theory of muscle contraction in detail.
 2. Describe the structure of a skeletal muscle from the whole muscle down to the myofibril.
 3. Give an account of the human skeletal system, listing the bones of the axial and appendicular skeleton.
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Quick Revision Points

- All locomotion is movement, but not all movement is locomotion
- Three movements: amoeboid (WBCs, pseudopodia), ciliary (trachea, oviduct), muscular (limbs)
- Sarcomere = region between two Z-lines = functional unit of muscle
- A-band = myosin (dark); I-band = actin (light); H-zone = only myosin; M-line at centre
- Thin filament: actin + tropomyosin + troponin; Thick filament: myosin (meromyosin, head = cross-bridge)
- Sliding filament theory: actin slides over myosin; I-band & H-zone shorten, A-band unchanged
- Ca^{2+} binds troponin → exposes active sites → cross-bridge → power stroke (needs ATP)
- Red fibres: more myoglobin, aerobic, slow, fatigue-resistant; White: less myoglobin, anaerobic, fast
- Skeleton = 206 bones: axial (80) + appendicular (126)
- Vertebral column = 26; skull = 29; ribs = 12 pairs (7 true, 3 false, 2 floating)
- Joints: fibrous (fixed), cartilaginous (slight), synovial (free: ball-socket, hinge, pivot, gliding, saddle)

- Disorders: myasthenia gravis (auto-immune NMJ), tetany (low Ca^{2+}), gout (uric acid), osteoporosis (low oestrogen), arthritis
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Next Chapter: Chapter 18 — Neural Control and Coordination



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