FREE EDITION · NOTES + 3 SAMPLE MCQS

CUET · BIOLOGY · CLASS XI · CODE 304

Locomotion and Movement

CUET unit: Human Physiology → Locomotion and Movement

By **UniDrill** · NCERT-grounded study material

WWW.UNIDRILL.IN

📌 Snapshot

- Establishes the distinction that "all locomotions are movements but all movements are not locomotions," and classifies cellular movements into amoeboid, ciliary and muscular types.
- Develops the structure–function story of skeletal muscle from fascicle → muscle fibre → myofibril → sarcomere, then explains contraction by the sliding-filament theory with the actin–myosin–troponin–tropomyosin–Ca++–ATP cast.
- Catalogues the human skeleton (206 bones — 80 axial + 126 appendicular), the three classes of joints (fibrous, cartilaginous, synovial) and six named muscular/skeletal disorders.
- A perennial CUET favourite: numeric facts (cranium = 8, ribs = 12 pairs, cervical vertebrae = 7, vertebrae total = 26) and band-behaviour during contraction account for most of the questions.

📖 Detailed Notes

2.1 Core concepts

- Movement is one of the significant features of living beings; streaming of protoplasm in unicellular organisms like Amoeba is its simplest form, while voluntary movements that change place or location are called **locomotion** — walking, running, climbing, flying and swimming (NCERT §17, p. 217).
- Locomotory structures need not be different from those affecting other movements: Paramoecium cilia move food through the cytopharynx and also drive locomotion; Hydra uses tentacles for both prey capture and locomotion; hence all locomotions are movements but all movements are not locomotions (NCERT §17, p. 217).
- Cells of the human body show three types of movement: **amoeboid** (macrophages, leucocytes — via pseudopodia driven by protoplasmic streaming and microfilaments of the cytoskeleton), **ciliary** (in ciliated epithelium of internal tubular organs — clears dust in trachea, moves ova in the female reproductive tract), and **muscular** (limbs, jaws, tongue — requires coordinated action of muscular, skeletal and neural systems) (NCERT §17.1, p. 217–218).
- Muscle is a specialised tissue of **mesodermal origin** contributing **40–50%** of adult body weight and shows the properties **excitability, contractility, extensibility and**

elasticity; on location, muscles are classified as Skeletal, Visceral and Cardiac (NCERT §17.2, p. 218).

- **Skeletal muscles** are striated and voluntary (locomotion, posture). **Visceral / smooth muscles** are non-striated and involuntary (alimentary canal, reproductive tract — move food and gametes). **Cardiac muscles** are striated, branched and involuntary (NCERT §17.2, p. 218–219).
- A skeletal muscle is built of **fascicles** (muscle bundles) wrapped by a collagenous **fascia**; each fascicle contains many **muscle fibres**, each fibre lined by **sarcolemma** enclosing **sarcoplasm**, which is a syncytium (many nuclei); the sarcoplasmic reticulum stores Ca++ (NCERT §17.2, p. 219, Fig. 17.1).
- Each muscle fibre contains parallel **myofibrils** showing alternate dark (A, anisotropic — contains myosin) and light (I, isotropic — contains actin) bands; the **Z line** bisects the I band and anchors thin filaments; the **M line** holds thick filaments at the centre of the A band; the unit between two successive Z lines is the **sarcomere**, the functional unit of contraction; the central part of thick filaments not overlapped by thin filaments is the **H zone** (NCERT §17.2, p. 219–220, Fig. 17.2).
- **Thin filament** = two helically wound F-actins (each F-actin is a polymer of G-actin monomers) + two tropomyosin strands + troponin at regular intervals; in the resting state a subunit of troponin masks the myosin-binding sites on actin (NCERT §17.2.1, p. 221, Fig. 17.3a).
- **Thick filament** = polymerised myosin made of monomers called **meromyosins**, each with a globular head + short arm (heavy meromyosin, HMM — the "cross arm") and a tail (light meromyosin, LMM); the head bears an **ATPase** with binding sites for ATP and active sites for actin (NCERT §17.2.1, p. 221, Fig. 17.3b).
- **Sliding-filament theory**: contraction = thin filaments slide over thick filaments. A signal from the CNS travels along a **motor neuron** to the **neuromuscular junction / motor-end plate**; **acetylcholine** is released, an action potential spreads along the sarcolemma, Ca++ is released from the sarcoplasmic reticulum, Ca++ binds troponin, unmasks the active sites on actin; the myosin head (using ATP hydrolysis) binds actin, forms a **cross-bridge**, pulls the thin filaments toward the centre of the A band — the **I band shortens, the A band length is unchanged**, the Z lines move inward and the sarcomere shortens; a new ATP breaks the cross-bridge and the cycle repeats until Ca++ is pumped back to the sarcoplasmic cisternae (NCERT §17.2.2, p. 222–223, Fig. 17.4, 17.5).
- A **motor unit** = one motor neuron + all the muscle fibres it innervates. Repeated stimulation causes **fatigue** from accumulation of lactic acid due to anaerobic breakdown of glycogen (NCERT §17.2.2, p. 222–223).
- **Red fibres** = high myoglobin, plenty of mitochondria, aerobic; **White fibres** = low myoglobin, few mitochondria, abundant sarcoplasmic reticulum, anaerobic (NCERT §17.2.2, p. 223).

- The human skeleton has **206 bones** — 80 axial + 126 appendicular. The **axial skeleton** comprises skull, vertebral column, sternum and ribs. The skull has 22 bones (8 cranial + 14 facial), plus a U-shaped **hyoid**; each middle ear has three ear ossicles — Malleus, Incus, Stapes. The skull articulates with the vertebral column via two **occipital condyles** (dicondylic skull) (NCERT §17.3, p. 224).
- **Vertebral column** = 26 vertebrae arranged as cervical (7), thoracic (12), lumbar (5), sacral (1 fused) and coccygeal (1 fused); the atlas (1st vertebra) articulates with the occipital condyles; the column protects the spinal cord, supports the head and gives attachment for ribs and back muscles (NCERT §17.3, p. 225, Fig. 17.7).
- **Sternum** is a flat bone on the ventral midline of the thorax. **12 pairs of ribs**, each **bicephalic** (two articulation surfaces dorsally) — pairs 1–7 are true ribs (joined directly to sternum by hyaline cartilage), pairs 8–10 are vertebrochondral / false ribs (join the 7th rib via cartilage), and pairs 11–12 are floating ribs (not connected ventrally); together with thoracic vertebrae they form the rib cage (NCERT §17.3, p. 225, Fig. 17.8).
- **Appendicular skeleton** = limb bones + girdles, with each limb of 30 bones. Forelimb: humerus, radius, ulna, 8 carpals, 5 metacarpals, 14 phalanges. Hindlimb: femur (longest bone), tibia, fibula, 7 tarsals, 5 metatarsals, 14 phalanges; **patella** is the kneecap. **Pectoral girdle** halves = clavicle + scapula (glenoid cavity of scapula receives humerus to form the shoulder joint; acromion of the scapular spine articulates with the clavicle). **Pelvic girdle** = two coxal bones, each formed by fusion of **ilium, ischium and pubis**, meeting ventrally at the **pubic symphysis** (fibrous cartilage); the **acetabulum** receives the head of the femur (NCERT §17.3, p. 226, Fig. 17.9, 17.10).
- **Joints** are points of contact between bones, or between bones and cartilages, and act as the fulcrum for muscle-generated force. Three structural classes: **Fibrous** (no movement — sutures of cranium), **Cartilaginous** (limited movement — between adjacent vertebrae), and **Synovial** (fluid-filled cavity, considerable movement — ball-and-socket between humerus and pectoral girdle, hinge at knee, pivot between atlas and axis, gliding between carpals, saddle between carpal and metacarpal of thumb) (NCERT §17.4, p. 226–227).
- **Disorders**: Myasthenia gravis (autoimmune, attacks neuromuscular junction → fatigue, weakness, paralysis of skeletal muscle); Muscular dystrophy (progressive degeneration of skeletal muscle, mostly genetic); Tetany (rapid spasms / wild contractions due to low Ca++ in body fluid); Arthritis (inflammation of joints); Osteoporosis (age-related, decreased bone mass and higher fracture risk, often from low estrogen); Gout (joint inflammation from uric-acid crystal accumulation) (NCERT §17.5, p. 227).

2.2 Definitions to memorise

Term	Definition	Page
Locomotion	Voluntary movement that results in a change of place or location (walking, running, swimming, flying).	217
Sarcolemma	Plasma membrane of a muscle fibre, enclosing the sarcoplasm.	219
Sarcomere	Portion of a myofibril between two successive Z lines; functional unit of contraction.	220
H zone	Central part of the thick filament in the A band that is not overlapped by thin filaments.	220
Meromyosin	Monomer of the thick filament; has a globular head + short arm (HMM, the cross arm) and a tail (LMM).	221
Motor unit	A motor neuron together with all the muscle fibres connected to it.	222
Neuromuscular junction (motor-end plate)	Junction between a motor neuron and the sarcolemma; site of acetylcholine release.	222
Sliding-filament theory	Theory that contraction occurs by thin filaments sliding over thick filaments.	221
Red fibres	Aerobic muscle fibres rich in myoglobin and mitochondria, giving a reddish appearance.	223
White fibres	Anaerobic muscle fibres low in myoglobin and mitochondria, with abundant sarcoplasmic reticulum.	223
Axial skeleton	80 bones along the main axis — skull, vertebral column, sternum and ribs.	224
Appendicular skeleton	Limb bones together with the pectoral and pelvic girdles.	225–226
Bicephalic rib	Rib with two articulation surfaces on its dorsal end.	225
Acetabulum	Cavity at the fusion point of ilium, ischium and pubis that articulates with the head of the femur.	226
Synovial joint	Joint characterised by a fluid-filled synovial cavity between articulating bones; allows considerable movement.	227
Tetany	Rapid spasms (wild contractions) of muscle caused by low Ca++ in body fluid.	227

2.3 Diagrams / processes to remember

- **Figure 17.1, p. 219** — Cross-section of a muscle showing fascicle, muscle fibre, sarcolemma and blood capillary.

- **Figure 17.2, p. 220** — Anatomy of a muscle fibre and a single sarcomere; label Z line, A band, I band, H zone.
- **Figure 17.3, p. 221** — (a) Thin filament with F-actin, tropomyosin and troponin; (b) myosin monomer (meromyosin) with head, cross arm, actin-binding sites and ATP-binding sites.
- **Figure 17.4, p. 222** — Cross-bridge cycle: ATP-loaded myosin → cross-bridge formation → sliding/rotation (release of P + ADP) → ATP rebinding and cross-bridge breaking.
- **Figure 17.5, p. 223** — Sliding-filament view of two sarcomeres in relaxed, contracting and maximally contracted states; track I band and H zone shrinking while A band stays constant.
- **Figure 17.6, p. 224** — Human skull labels: frontal, parietal, temporal, occipital, sphenoid, ethmoid, lacrimal, nasal, zygomatic, maxilla, mandible, hyoid, occipital condyle.
- **Figure 17.7, p. 225** — Vertebral column (right lateral view) with cervical, thoracic and lumbar regions, intervertebral disc, sacrum and coccyx.
- **Figure 17.8, p. 225** — Rib cage with true (1–7), false (8–10) and floating (11–12) ribs.
- **Figure 17.9, p. 226** — Right pectoral girdle and upper arm: clavicle, scapula, humerus, radius, ulna, carpals, metacarpals, phalanges.
- **Figure 17.10, p. 226** — Right pelvic girdle and lower limb: ilium, ischium, pubis, coxal bone, femur, patella, tibia, fibula, tarsals, metatarsals, phalanges.

2.4 Common confusions / NTA trap points

- During contraction the **I band shortens and the H zone shrinks, but the A band length is unchanged** — NTA loves to flip this and put "A band shortens" as a distractor (p. 222–223).
- It is **troponin** (not tropomyosin) whose subunit masks the active sites; tropomyosin is the long strand running along F-actin. Ca++ binds **troponin**, not actin directly (p. 221–222).
- The skull has **22 bones** total (8 cranial + 14 facial) — the hyoid and the three ear ossicles per ear are additional and are not counted within the 22 (p. 224).
- The vertebral column has **26 units** (7+12+5+1+1), not 33, because the sacrum and coccyx are each counted as one fused bone (p. 225).
- The **pivot joint** is between atlas and axis; the **ball-and-socket** joint at the shoulder is between humerus and pectoral girdle (glenoid cavity), while the **hip ball-and-socket** is between femur and acetabulum — students mix these up (p. 226–227).
- **Tetany** (low Ca++ spasms) ≠ **tetanus** (the bacterial disease) — NCERT only names tetany; do not confuse them (p. 227).

- **Osteoporosis** is linked to **decreased estrogen**, not decreased calcium intake per se, in NCERT's wording (p. 227).
- **Sliding filament theory** — actin slides over myosin; the filaments themselves do not shorten or change length, only their overlap increases (p. 222).
- **Cervical vertebrae count** — All mammals (including the giraffe) have 7 cervical vertebrae; NTA sometimes asks this comparative trap.
- **Myasthenia gravis is autoimmune** — the neuromuscular junction is attacked; muscle itself is not the primary defect (p. 227).

2.5 Quick comparison table — locomotion & movement at a glance

#	Item	Detail (NCERT)	Page
1	Types of movement	Amoeboid, ciliary, muscular	220
2	Muscle types	Skeletal, visceral, cardiac	220
3	Sarcomere	Between two Z lines	221
4	I band contents	Only actin (thin)	222
5	A band contents	Myosin + overlapping actin	222
6	H zone	Myosin-only zone within A band	222
7	Red fibres	Aerobic, many mitochondria, myoglobin-rich	223
8	White fibres	Anaerobic, few mitochondria, low myoglobin	223
9	Skull bones	22 (8 cranial + 14 facial)	224
10	Vertebral column	26 units (7+12+5+1+1)	225
11	Ribs	12 pairs (7 true + 3 false + 2 floating)	225
12	Sternum	Flat bone on ventral midline of thorax	225
13	Pectoral girdle bones	Clavicle + scapula (each side)	226
14	Pelvic girdle bones	Ilium + ischium + pubis fused	226
15	Synovial joint examples	Ball-socket (shoulder, hip), hinge (knee, elbow), pivot (atlas-axis), gliding (carpals), saddle (thumb)	226–227

🎯 Practice MCQs

Q1. Which of the following correctly pairs a movement type with the cells/structures that perform it in humans?

A. Amoeboid — ciliated epithelium of the trachea

B. Ciliary — macrophages and leucocytes

C. Amoeboid — macrophages and leucocytes via pseudopodia

D. Muscular — pseudopodia formed by streaming of protoplasm

Q2. During muscle contraction, which of the following statements is/are correct? I. The A band retains its length. II. The I band gets reduced. III. The H zone disappears as thin filaments slide further over thick filaments. IV. The length of thick filaments decreases.

A. I and II only

B. I, II and III only

C. II and IV only

D. I, III and IV only

Q3. Match the items in Column I with those in Column II. | Column I | Column II | |---|---| | (a) Smooth muscle | (i) Myoglobin | | (b) Tropomyosin | (ii) Thin filament | | (c) Red muscle | (iii) Sutures | | (d) Skull | (iv) Involuntary |

A. a–iv, b–ii, c–i, d–iii

B. a–iii, b–ii, c–iv, d–i

C. a–iv, b–i, c–ii, d–iii

D. a–ii, b–iv, c–iii, d–i

PYQ Alignment

This chapter is one of the most reliably tested units of Class XI Biology in CUET — typically 2–3 direct MCQs each year, with statement-based and match-the-following formats favoured. NTA frequently probes the band changes during contraction (A vs I vs H), the precise counts of axial bones (cranium = 8, skull total = 22, vertebral column = 26, ribs = 12 pairs), examples of each synovial joint type, and the one-line definitions from §17.5 (especially osteoporosis, myasthenia gravis and gout).

Locomotion and Movement appeared in CUET (UG) Biology across 1 cycle(s) — 1 question(s) total. The questions below were extracted from official CUET (UG) papers and matched to this chapter by topic. See `/pyq/biology` for the full PYQ archive.

CUET 2025 — Actual PYQs from this chapter

Q.25 (CUET 2025) Which statements are true regarding homologous organs? (A) Homology indicates common ancestry (B) Whale and cheetah share similar forelimb bone pattern (C) Vertebrate heart is example of homologous organ (D) Thorn of Bougainvillea and tendril of Cucurbita

- A)
- B)
- C)
- D)

Tests: aligns with chapter content Answer: Not in extracted key — verify against official NTA key