

NCERT Exemplar Solutions of Class 11 Biology – Chapter 20: Locomotion and Movement
VERY SHORT ANSWER TYPE QUESTIONS

1. Name the cells/tissues in the human body which

a. exhibit amoeboid movement b. exhibit ciliary movement

Enhanced Solution:

a) Cells/tissues exhibiting amoeboid movement:

Macrophages: Large phagocytic cells that engulf pathogens and cellular debris

Leucocytes (White Blood Cells): Including neutrophils, monocytes, and other WBCs that move through tissues to fight infections

Amoebocytes: Found in some body fluids

b) Cells/tissues exhibiting ciliary movement:

Fallopian tube epithelium: Cilia help move the ovum toward the uterus

Tracheal epithelium: Cilia sweep mucus and trapped particles upward

Bronchiolar epithelium: Cilia help clear the respiratory tract

Nasal cavity epithelium: Cilia help filter and humidify incoming air

2. Locomotion requires a perfect coordinated activity of muscular, _____, _____ systems

Enhanced Solution: Locomotion requires a perfect coordinated activity of muscular, Skeletal, Nervous systems.

Explanation:

Muscular system: Provides the force for movement through muscle contractions

Skeletal system: Provides the framework and leverage points for muscle attachment

Nervous system: Coordinates and controls muscle contractions through motor neurons and reflexes

3. Sarcolemma, sarcoplasm and sarcoplasmic reticulum refer to a particular type of cell in our body. Which is this cell and to what parts of that cell do these names refer to?

Enhanced Solution: These terms refer to **muscle cells** or **muscle fibres**.

Definitions:

Sarcolemma: The plasma membrane of muscle fiber that conducts electrical impulses

Sarcoplasm: The cytoplasm of muscle fiber containing myofibrils, mitochondria, and other organelles

Sarcoplasmic reticulum: Modified endoplasmic reticulum that stores and releases Ca^{2+} ions for muscle contraction

4. Label the different components of actin filament in the diagram given below



Enhanced Solution: Based on the diagram shown, the components of the actin filament are:

Troponin: Regulatory protein complex with three subunits (TnC, TnI, TnT)

Tropomyosin: Long protein that winds around the actin helix and blocks myosin binding sites when muscle is relaxed

F-actin: Filamentous actin formed by polymerization of G-actin monomers

Active sites: Specific binding sites on actin for myosin heads

5. The three tiny bones present in the middle ear are called ear ossicles. Write them in correct sequence beginning from the eardrum.

Enhanced Solution: The correct sequence of ear ossicles from the eardrum is:

Malleus → Incus → Stapes

Function and details:

Malleus (Hammer): Attached to the tympanic membrane (eardrum)

Incus (Anvil): Middle bone that transfers vibrations

Stapes (Stirrup): Smallest bone, attached to the oval window of the inner ear

These bones amplify sound vibrations and transmit them from the outer ear to the inner ear.

6. What is the difference between the matrix of bones and cartilage?

Enhanced Solution:

Bone Matrix:

Vascular: Contains blood vessels (Haversian canals)

Has lamellae: Organized in concentric layers around central canals

Protein: Contains ossein (a modified form of collagen)

Mineralized: Rich in calcium phosphate and calcium carbonate

Hard and rigid: Provides structural support

Cartilage Matrix:

Non-vascular: Lacks blood vessels; nutrients diffuse through matrix

Lamellae absent: Homogeneous matrix without layered organization

Protein: Contains chondrin (a form of collagen)

Less mineralized: Flexible with some calcium deposits

Flexible and elastic: Provides cushioning and flexibility

7. Which tissue is afflicted by Myasthenia gravis? What is the underlying cause?

Enhanced Solution:

Affected tissue: Neuromuscular junction tissue (specifically the connection between motor neurons and skeletal muscles)

Underlying cause: Myasthenia gravis is an **autoimmune disease** where:

The immune system produces antibodies against acetylcholine receptors at the neuromuscular junction

These antibodies block or destroy acetylcholine receptors

Results in impaired transmission of nerve impulses to skeletal muscles

Leads to muscle weakness and fatigue, especially in facial muscles, eyelids, and limbs

8. How do our bone joints function without grinding noise and pain?

Enhanced Solution:

Bone joints function smoothly due to **synovial fluid** present in synovial joints.

Mechanisms:

Synovial fluid: Acts as a lubricant, reducing friction between articulating bones

Articular cartilage: Smooth cartilage covering bone ends provides a slippery surface

Synovial membrane: Secretes synovial fluid and maintains joint health

Joint capsule: Provides stability while allowing movement

Properties of synovial fluid:

Viscous, clear fluid similar to egg white

Contains hyaluronic acid for lubrication

Provides nutrients to cartilage

Acts as a shock absorber

9. Give the location of a ball and socket joint in a human body

Enhanced Solution:

Ball and socket joints are located at:

1. Shoulder Joint:

Between the head of humerus and glenoid cavity of scapula (pectoral girdle)

Allows movement in all planes including rotation

2. Hip Joint:

Between the head of femur and acetabulum of pelvic girdle

More stable than shoulder joint due to deeper socket

Total: There are **four ball and socket joints** in the human body - two shoulder joints and two hip joints.

Movements allowed:

Flexion and extension

Abduction and adduction

Rotation (medial and lateral)

Circumduction

10. Our forearm is made of three different bones. Comment.

Enhanced Solution:

The statement needs clarification. The **forearm** itself contains **two bones**, but the **arm region** as a whole contains three bones:

Forearm bones (2):

Radius: Located on the thumb side, extends from elbow to wrist, allows rotation of forearm

Ulna: Located on the little finger side, forms the main hinge joint with humerus at elbow

Upper arm bone (1):

Humerus: The long bone of the upper arm, articulates with scapula at shoulder and with radius/ulna at elbow

Functional arrangement:

Humerus provides the main leverage for arm movement

Radius and ulna work together to allow forearm rotation (pronation and supination)

All three bones coordinate to provide the wide range of arm and forearm movements

SHORT ANSWER TYPE QUESTIONS

1. With respect to the rib cage, explain the following:

a. Bicephalic ribs b. True ribs c. Floating ribs

Enhanced Solution:

a) Bicephalic ribs:

Definition: Ribs that have two articulating surfaces (heads) on their dorsal end

Structure: Each rib has a head and a tubercle that articulate with vertebrae

Articulation: The head articulates with the body of vertebrae, while the tubercle articulates with the transverse process

Function: Provides stable but flexible attachment to the vertebral column

b) True ribs:

Number: First seven pairs of ribs (ribs 1-7)

Connection: Directly attached to the sternum via their own costal cartilages

Structure: Each has its individual cartilaginous connection to the sternum

Function: Provide maximum protection to vital organs and structural support to chest cavity

c) Floating ribs:

Number: Last two pairs of ribs (ribs 11 and 12)

Connection: Not attached to the sternum at all

Structure: Shorter than other ribs, have only vertebral attachment

Function: Provide protection to lower organs while allowing flexibility for breathing and movement

2. In old age, people often suffer from stiff and inflamed joints. What is this condition called? What are the possible reasons for these symptoms?

Enhanced Solution:

Condition: Rheumatoid Arthritis and Osteoarthritis

Possible reasons:

1. Autoimmune factors:

Immune system attacks synovial membrane cells

Production of inflammatory cytokines

Formation of immune complexes in joint spaces

2. Age-related factors:

Wear and tear of articular cartilage

Reduced synovial fluid production

Decreased collagen synthesis

3. Environmental triggers:

Smoking: Increases inflammatory response

Infections: Can trigger autoimmune reactions

Genetic predisposition: Family history increases risk

4. Nutritional factors:

Vitamin D deficiency: Affects bone and cartilage health

Calcium deficiency: Leads to bone weakening

5. Hormonal changes:

Reduced estrogen in post-menopausal women

Changes in growth hormone levels

3. Exchange of calcium between bone and extracellular fluid takes place under the influence of certain hormones

a. What will happen if more of Ca^{2+} is in extracellular fluid? b. What will happen if very less amount of Ca^{2+} is in the extracellular fluid?

Enhanced Solution:

a) Excess Ca^{2+} in extracellular fluid (Hypercalcemia):

Hormone involved: Thyrocalcitonin (Calcitonin) - secreted by parafollicular cells of thyroid gland

Effects:

Bone deposition: Excess calcium gets deposited into bones

Osteoblast activation: Bone-forming cells become more active

Reduced intestinal absorption: Less calcium absorbed from diet

Increased renal excretion: More calcium excreted through kidneys

Overall result: Blood calcium levels return to normal

b) Deficient Ca^{2+} in extracellular fluid (Hypocalcemia):

Hormone involved: Parathyroid Hormone (PTH) - secreted by parathyroid glands

Effects:

Bone resorption: Calcium released from bone matrix into blood

Osteoclast activation: Bone-resorbing cells become more active

Increased intestinal absorption: More calcium absorbed from diet

Reduced renal excretion: Kidneys retain more calcium

Vitamin D activation: Enhanced vitamin D₃ production for better calcium absorption

Overall result: Blood calcium levels return to normal

4. Name at least two hormones which result in fluctuation of Ca²⁺ level.

Enhanced Solution:

Two main hormones controlling calcium levels:

1. Thyrocalcitonin (Calcitonin):

Source: Parafollicular cells (C-cells) of thyroid gland

Function: Lowers blood calcium and phosphate levels

Mechanism:

Inhibits osteoclast activity

Promotes calcium deposition in bones

Increases renal calcium excretion

Trigger: Released when blood calcium levels are high

2. Parathyroid Hormone (PTH):

Source: Chief cells of parathyroid glands

Function: Increases blood calcium levels

Mechanism:

Stimulates osteoclast activity (bone resorption)

Increases renal calcium reabsorption

Enhances intestinal calcium absorption via Vitamin D₃

Trigger: Released when blood calcium levels are low

Additional hormone: 3. Vitamin D₃ (Calcitriol):

Enhances intestinal calcium absorption

Works synergistically with PTH

5. Rahul exercises regularly by visiting a gymnasium. Of late he is gaining weight.

What could be the reason? Choose the correct answer and elaborate.

Enhanced Solution:

Correct Answer: (b) Rahul has gained weight due to increased muscle mass and decreased fat.

Detailed explanation:

Physiological changes during regular exercise:

1. Muscle hypertrophy:

Increased sarcoplasm volume: More cytoplasm in muscle fibers

Myofibril thickening: Individual contractile units become larger

Enhanced protein synthesis: More actin, myosin, and other muscle proteins

Mitochondrial proliferation: More mitochondria for energy production

2. Body composition changes:

Muscle tissue is denser than fat: 1 kg muscle occupies less space than 1 kg fat

Muscle weighs more than fat: Same volume of muscle tissue weighs more than fat tissue

Fat reduction: Regular exercise burns fat for energy

Water retention: Muscles store more glycogen and water

3. Metabolic adaptations:

Increased BMR: More muscle tissue increases basal metabolic rate

Enhanced glucose storage: Muscles store more glycogen

Improved cardiovascular fitness: Heart muscle also strengthens

Why weight increases:

The gain in muscle mass often exceeds the loss in fat mass initially

This is a positive change indicating improved fitness and health

6. Radha was running on a treadmill at a great speed for 15 minutes continuously. She stopped the treadmill and abruptly came out. For the next few minutes, she was breathing heavily/fast. Answer the following questions.

Enhanced Solution:

a) What happened to her muscles when she did strenuous exercise?

Muscle changes during strenuous exercise:

1. Anaerobic respiration:

High intensity exercise depletes oxygen supply to muscles

Muscles switch from aerobic to anaerobic respiration

Lactic acid accumulation: Byproduct of anaerobic glycolysis builds up in muscles

2. Muscle fatigue:

Reduced contractility: Muscles become less efficient at contracting

pH changes: Lactic acid lowers muscle pH, affecting enzyme function

ATP depletion: Energy stores become temporarily exhausted

Ion imbalance: Disrupted Na^+/K^+ balance affects membrane potential

3. Metabolic changes:

Creatine phosphate depletion: Immediate energy source gets used up

Glycogen utilization: Muscle glycogen stores are rapidly consumed

b) How did her breathing rate change?

Breathing changes and reasons:

1. Increased respiratory rate:

Oxygen debt: Body needs extra oxygen to metabolize accumulated lactic acid

CO₂ removal: Need to eliminate excess carbon dioxide produced

ATP restoration: Oxygen required to regenerate ATP stores

2. Physiological mechanisms:

Chemoreceptor activation: Sensors detect increased CO₂ and decreased O₂

Neural stimulation: Respiratory center in medulla increases breathing rate

Cardiovascular response: Heart rate remains elevated to deliver oxygen

3. Recovery process:

Excess Post-Exercise Oxygen Consumption (EPOC): Body continues consuming oxygen at elevated rates

Lactate clearance: Oxygen needed to convert lactic acid back to glucose

Temperature regulation: Heavy breathing helps cool the body

7. Write a few lines about Gout.

Enhanced Solution:

Gout is a form of inflammatory arthritis caused by the accumulation of **sodium urate crystals** in joints.

Pathophysiology:

Hyperuricemia: Elevated uric acid levels in blood

Crystal formation: Uric acid crystallizes in joint spaces and tissues

Inflammatory response: Crystals trigger intense inflammatory reaction

Clinical manifestations:

Acute attacks: Sudden onset of severe joint pain

Affected joints: Commonly affects big toe, but can involve ankles, knees, wrists

Physical signs: Intense pain, redness, swelling, warmth, and tenderness

Duration: Attacks typically last 3-10 days without treatment

Risk factors:

Dietary factors: High purine foods (red meat, seafood, alcohol)

Metabolic conditions: Obesity, diabetes, hypertension

Medications: Diuretics, aspirin

Gender and age: More common in men over 40 and post-menopausal women

Complications:

Chronic gout: Permanent joint damage

Tophi formation: Urate crystal deposits in soft tissues

Kidney stones: Uric acid kidney stones

8. What is the source of energy for muscle contraction?

Enhanced Solution:

The primary source of energy for muscle contraction is **ATP (Adenosine Triphosphate)**.

ATP hydrolysis mechanism: $ATP \rightarrow ADP + Pi + Energy$

Role of myosin ATPase:

Location: Present on the globular head of myosin molecules

Function: Catalyzes ATP hydrolysis

Cofactors: Requires Mg^{2+} and Ca^{2+} ions for optimal activity

Energy release: Provides energy for myosin head movement during power stroke

ATP sources for muscle contraction:

1. Immediate energy (0-15 seconds):

Creatine phosphate system: $CP + ADP \rightarrow ATP + Creatine$

Stored ATP: Limited supply lasts only few seconds

2. Short-term energy (15 seconds - 2 minutes):

Anaerobic glycolysis: Glucose \rightarrow Lactic acid + ATP

No oxygen required: Can function during high-intensity exercise

3. Long-term energy (2 minutes+):

Aerobic respiration: Complete oxidation of glucose, fats, proteins

Oxygen dependent: Most efficient ATP production

Sustainable: For prolonged, moderate-intensity activities

Energy utilization in contraction cycle:

Cross-bridge formation: ATP binding causes myosin head to detach

Cocking of myosin head: ATP hydrolysis provides energy for head preparation

Power stroke: Stored energy released when P_i is released

Relaxation: New ATP required for next cycle

9. What are the points for the articulation of Pelvic and Pectoral girdles?

Enhanced Solution:

PECTORAL GIRDLE ARTICULATION:

Bones involved:

Clavicle: Collar bone

Scapula: Shoulder blade

Articulation point:

Glenoid cavity: Cup-shaped depression in the scapula

Joint formed: Ball and socket joint with head of humerus

Joint name: Glenohumeral joint (shoulder joint)

Characteristics:

High mobility: Allows movement in all planes

Less stability: More prone to dislocation

Range of motion: 360° rotation possible

PELVIC GIRDLE ARTICULATION:

Bones involved:

Ilium: Upper, largest portion

Ischium: Lower, posterior portion

Pubis: Lower, anterior portion

Articulation point:

Acetabulum: Deep cup-shaped cavity formed by fusion of all three bones

Joint formed: Ball and socket joint with head of femur

Joint name: Hip joint (coxofemoral joint)

Characteristics:

High stability: Deep socket provides strong support

Moderate mobility: Less range than shoulder but very stable

Weight bearing: Designed to support body weight

Comparison:

Pectoral girdle: Mobility > Stability

Pelvic girdle: Stability > Mobility

