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CBSE CLASS 10 • SCIENCE • BIOLOGY

BIO BLITZ 100

Score Full Marks in Biology

The Complete CBSE Class 10 Biology Question Bank

Board Exam 2027 Pattern • All Chapters • All Question Types

✦ 400+ Questions ✦ MCQ + Assertion-Reason ✦ Case Studies ✦ Full Answer Keys
✦ Trend Analysis 2019–2026 ✦ 2027 Predictions ✦ Quick Revision Tables

CHAPTERS COVERED

BIO BLITZ 100

The Complete CBSE Class 10 Biology Question Bank

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ABOUT THIS BOOK

Why BIO BLITZ 100?

Every year, thousands of Class 10 students walk into the biology exam knowing their textbook well — but still losing marks on twisted MCQs, tricky assertion-reason questions, and case studies they've never practised. BIO BLITZ 100 closes that gap.

This book was built from scratch by reverse-engineering the CBSE board exam pattern from 2019 to 2026, chapter by chapter, mark by mark. Every question in this book exists because the data says it will appear — or a version of it will.

What makes this different?

★ TREND-FIRST DESIGN: Every chapter opens with a data table showing marks asked per topic from 2019–2026 and a 2027 prediction — so you know exactly where to focus.

★ ALL QUESTION TYPES: MCQ, Assertion-Reason, 2-mark, 3-mark, 5-mark long answer, and case-based CBQs — the complete paper pattern in every chapter.

★ ANSWERS THAT TEACH: Every single answer — including MCQs — has a full explanation. Wrong options are explained too. You don't just know the answer; you understand why.

★ CHEMICAL EQUATIONS BALANCED: Every equation in Life Processes is balanced with correct reactants and products. No shortcuts.

★ PUNNETT SQUARES SOLVED: Heredity has fully worked-out genetic crosses with genotype and phenotype ratios explained step by step.

★ CASE STUDIES MODELLED ON REAL CBQ FORMAT: The case studies replicate the exact format CBSE introduced — real-life scenarios followed by 4 sub-questions.

★ QUICK REVISION TABLES: Every chapter ends with a concise table of the most important facts, formulas, and ratios — perfect for last-night revision.

Who is this book for?

→ Students who have completed the NCERT textbook and want to test themselves seriously.

→ Students targeting 90+ marks in Science and need biology to pull their score up.

→ Teachers who want ready-to-use test questions for class tests, unit tests, and pre-boards.

→ Students doing self-study who need both questions AND complete answers in one place.

HOW TO USE THIS BOOK

Recommended Study Plan

Phase	When to Use	Focus
Phase 1 First Read	After finishing each NCERT chapter	Do only the MCQs and VSA (1-mark) sections to check basic recall.
Phase 2 Deep Practice	4–6 weeks before exams	Attempt all 2-mark and 3-mark questions. Write full answers by hand. Match with answer key.
Phase 3 Exam Drill	2–3 weeks before board exam	Attempt the Case Studies (Section E) and 5-mark Long Answers under timed conditions.
Phase 4 Final Sprint	Last 3 days before exam	Use ONLY the Quick Revision Tables at the end of each chapter. Re-read all Trend Analysis tables.

Section Guide — What Each Section Tests

Section	How to Use It
Section A — MCQ (1 mark)	Tests recall and conceptual clarity. Attempt ALL. Never skip MCQs — they add up fast.
Section B — Assertion-Reason (1 mark)	Tests analytical thinking. Read BOTH statements before choosing — this is where average students lose easy marks.
Section C — 2-Mark SA	Tests ability to write precise, point-based answers. Practice writing under 6–8 lines.
Section D — 3-Mark SA	Tests structured explanation. Every answer should have a definition, explanation, and example.
Section E — Case-Based (4 marks)	Tests application. Read the passage twice before answering. All answers are based on the passage + chapter knowledge.
Section F — 5-Mark LA	Tests comprehensive understanding. Use headings, numbered points, and equations where relevant.
Section G/H — VSA Rapid Fire	Use these for quick daily revision — 5 questions per day from each chapter keeps concepts sharp.
Quick Revision Tables	Pin these to your study wall. Read them every morning in the last week before the exam.

⚡ **Pro Tip:** Attempt every question by writing it out — even if you think you know the answer. Writing activates a different kind of memory than reading, and board exams are a written test. Your hand needs to practise, not just your brain.

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Total: 400+ Questions • 78+ Pages of Content • Complete Answer Keys Throughout

C H A P T E R

5

Life Processes

Nutrition • Respiration • Transportation • Excretion

★★★★★ **Marks Weightage: Very High**

Sections: A (MCQ) • B (Assertion-Reason) • C–D (Short Answer) • E (Case-Based) • F (Long Answer) • VSA • Quick Revision

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CBSE Class 10 | Science (Biology)

CHAPTER 5
LIFE PROCESSES

Master Question Bank ● Board Exam 2027 Pattern

📊 CBSE EXAM TREND ANALYSIS (2019 – 2026) | *Chapter 5: Life Processes*

What the data shows about this chapter:

Topic	Marks Asked (Approx.)	Most Common Format	Prediction 2027
Photosynthesis	5–8 marks/year	Equation + Conditions + Explain Steps	★★★★★ Very High
Human Digestion	3–5 marks/year	Describe Organs + Role of Enzymes	★★★★★ Very High
Aerobic vs Anaerobic Respiration	3–5 marks/year	Comparison + Pathway Diagram	★★★★★ Very High
Human Heart & Double Circulation	3–5 marks/year	5-mark Long Answer / Diagram	★★★★★ Very High
Nephron & Kidney	3–5 marks/year	3-mark or Case-based	★★★★☆ High
Xylem & Phloem Transport	2–3 marks/year	Compare + Mechanism	★★★★☆ High
Transpiration	1–2 marks/year	1-mark or 2-mark SA	★★★☆☆ Medium
ATP & Energy Currency	1–2 marks/year	Assertion-Reason / MCQ	★★★☆☆ Medium
Blood Pressure / Haemoglobin	1–2 marks/year	1-mark MCQ or AR	★★★☆☆ Medium

2027 Pattern Key Notes:

✦ Competency-Based Questions (CBQ) now form 40–50% of the paper — case studies with reading comprehension + application.

✦ Assertion-Reason (AR) questions are asked in every CBSE board paper — expect 4–5 from Biology alone.

✦ Chemical equations must be written in the balanced form with state symbols. Marks are deducted for unbalanced equations.

✦ Double Circulation, nephron diagram description, and photosynthesis steps were individually asked in 2022, 2023, 2024 and 2025 papers.

SECTION A | *Multiple Choice Questions | 1 Mark Each*

Instructions: Choose the BEST option. All questions carry 1 mark.

Q1. Which of the following is NOT a life process? *[1 mark]*

A) Nutrition
B) Respiration
C) Walking
D) Excretion

✔ **Answer: (C)** Walking is a voluntary movement, not a maintenance/life process. Life processes are those that are necessary to maintain living structures — nutrition, respiration, transportation, and excretion.

Q2. The correct balanced equation for photosynthesis is: *[1 mark]*

A) $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$
B) $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ + Energy
C) $6CO_2 + H_2O \rightarrow C_6H_{12}O_6 + O_2$
D) $6CO_2 + 6H_2O \rightarrow 6C_6H_{12}O_6 + O_2$

✔ **Answer: (A)** $6CO_2 + 6H_2O \rightarrow$(Sunlight + Chlorophyll)$\rightarrow C_6H_{12}O_6 + 6O_2$. This is the balanced photosynthesis equation. Option B is aerobic respiration. Options C and D are unbalanced.

Q3. The breakdown of pyruvate to give ethanol and CO_2 takes place in: *[1 mark]*

A) Muscle cells during exercise
B) Yeast during fermentation
C) Mitochondria during aerobic respiration
D) Chloroplasts during photosynthesis

✔ **Answer: (B)** In the absence of oxygen, yeast converts pyruvate to ethanol (C_2H_5OH) and CO_2. This is anaerobic respiration, specifically called fermentation. Muscle cells form lactic acid, not ethanol.

Q4. Which structure in the human kidney is the basic filtration unit? *[1 mark]*

A) Ureter
B) Bowman's capsule
C) Nephron
D) Urethra

✔ **Answer: (C)** The nephron is the basic filtration unit of the kidney. The Bowman's capsule is a part of the nephron (the cup-shaped beginning), but the nephron as a whole is the functional unit.

Q5. Bile juice is produced by: *[1 mark]*

A) Pancreas
B) Stomach
C) Liver
D) Small intestine

✔ **Answer: (C)** Bile is produced by the liver and stored in the gall bladder. It is released into the small intestine to emulsify (break down) large fat globules into smaller ones, making enzyme action more efficient.

Q6. Which blood vessel carries oxygenated blood AWAY from the heart to the body? *[1 mark]*

A) Pulmonary vein
B) Pulmonary artery
C) Aorta
D) Vena cava

✔ **Answer: (C)** The aorta is the largest artery and carries oxygenated blood from the left ventricle to the rest of the body. The pulmonary vein brings oxygenated blood from lungs to the heart (left atrium).

Q7. In plants, transport of water from roots to leaves is mainly driven by: *[1 mark]*

A) Osmosis only
B) Root pressure only
C) Transpiration pull
D) Active transport using ATP

✔ **Answer: (C)** During the day, transpiration pull (suction created by evaporation of water from leaves through stomata) is the major driving force moving water upward through xylem. Root pressure is more important at night.

Q8. The enzyme that digests starch in the mouth is: *[1 mark]*

A) Pepsin
B) Salivary amylase
C) Trypsin
D) Lipase

✔ **Answer: (B)** Salivary amylase (also called ptyalin) is present in saliva and begins the digestion of starch (a complex carbohydrate) into simpler sugars in the mouth. Pepsin digests proteins; Trypsin digests proteins in small intestine; Lipase digests fats.

Q9. Which of the following animals has a two-chambered heart? *[1 mark]*

A) Frog
B) Crocodile
C) Fish
D) Pigeon

✔ **Answer: (C)** Fish have a two-chambered heart (1 atrium + 1 ventricle). Blood passes through the heart once per cycle (single circulation). Frogs and most amphibians have three chambers; birds and mammals have four chambers (double circulation).

Q10. Nitrogenous waste in human beings is removed from blood in the: *[1 mark]*

A) Liver
B) Lungs
C) Kidneys
D) Skin

✔ **Answer: (C)** The kidneys filter nitrogenous wastes like urea and uric acid from the blood. These are dissolved in water to form urine, just as the lungs remove CO_2. The liver produces urea from amino acids, but the kidneys excrete it.

Q11. The energy released during cellular respiration is stored immediately in the form of: *[1 mark]*

A) Glucose
B) Glycogen
C) ATP
D) Starch

✔ **Answer: (C)** ATP (Adenosine Triphosphate) is the immediate energy currency of the cell. Energy released from glucose breakdown is used to make ATP from ADP + inorganic phosphate. ATP then powers all cellular activities.

Q12. The fluid that leaks from capillaries into intercellular spaces is called: *[1 mark]*

A) Blood plasma
B) Lymph
C) Serum

D) Dialysing fluid

✔ **Answer: (B)** Lymph (tissue fluid) is formed when plasma, proteins, and blood cells escape through capillary pores into intercellular spaces. It is colourless, has less protein than blood, and drains back into veins via lymph vessels. Lymph also carries digested fats from the intestine.

Q13. The guard cells of stomata are responsible for: *[1 mark]*

A) Photosynthesis only
B) Controlling the opening and closing of stomatal pores
C) Absorbing water from soil
D) Transporting glucose to phloem

✔ **Answer: (B)** Guard cells are specialised cells that surround the stomatal pore. When water flows into them, they swell and the pore opens. When they shrink (lose water), the pore closes. This regulates gas exchange and water loss.

Q14. Translocation of food material in plants happens through: *[1 mark]*

A) Xylem vessels
B) Root hair cells
C) Phloem sieve tubes
D) Stomata

✔ **Answer: (C)** Phloem transports the products of photosynthesis (sucrose, amino acids) from leaves to other parts of the plant. Translocation occurs in sieve tubes with the help of adjacent companion cells. This requires energy (ATP).

Q15. Cramps in muscles during sudden intense exercise are caused by the accumulation of: *[1 mark]*

A) CO_2
B) Pyruvate
C) Ethanol
D) Lactic acid

✔ **Answer: (D)** When oxygen is insufficient during intense exercise, muscle cells undergo anaerobic respiration, converting pyruvate to lactic acid (a 3-carbon molecule). The buildup of lactic acid causes muscle cramps and fatigue.

Q16. The walls of the alveoli are one-cell thick because: *[1 mark]*

A) They need to be strong to hold air pressure
B) Thin walls allow fast diffusion of gases between air and blood
C) They need to produce mucus to trap germs
D) This increases the total volume of air in lungs

✔ **Answer: (B)** Thin, delicate walls of alveoli and their rich blood supply ensure rapid diffusion of O_2 from air into blood and CO_2 from blood into air. The large surface area (≈80 m^2) combined with thin walls makes gas exchange highly efficient.

Q17. Which of the following is an example of autotrophic nutrition? *[1 mark]*

A) Amoeba engulfing food particles
B) A green plant making food by photosynthesis
C) Cuscuta deriving nutrition from a host plant
D) Yeast absorbing dissolved sugar

✔ **Answer: (B)** Autotrophs make their own food using simple inorganic substances (CO_2 + H_2O) and sunlight. Green plants do this through photosynthesis. Amoeba and yeast are heterotrophs. Cuscuta is a parasite (heterotroph).

Q18. Normal systolic and diastolic blood pressure in a healthy adult is: *[1 mark]*

A) 80/120 mm Hg
B) 120/80 mm Hg
C) 100/60 mm Hg
D) 140/90 mm Hg

✔ **Answer: (B)** The normal blood pressure is 120 mm Hg (systolic — during ventricular contraction) over 80 mm Hg (diastolic — during ventricular relaxation). This is measured using a sphygmomanometer. Values above 140/90 indicate hypertension.

Q19. In which part of the cell does the breakdown of glucose to pyruvate (glycolysis) take place? *[1 mark]*

A) Mitochondria
B) Nucleus
C) Cytoplasm
D) Chloroplast

✔ **Answer: (C)** Glycolysis (the first step of respiration) occurs in the cytoplasm of the cell. Glucose (6C) is broken down to pyruvate (3C). This step is common to both aerobic and anaerobic respiration. Further breakdown of pyruvate occurs in the mitochondria (aerobic) or cytoplasm (anaerobic).

Q20. Haemoglobin is present in: *[1 mark]*

A) White blood cells
B) Blood plasma
C) Red blood corpuscles
D) Lymph

✔ **Answer: (C)** Haemoglobin is the respiratory pigment that gives red blood corpuscles (RBCs) their red colour. It has a very high affinity for oxygen and picks it up in the lungs, then releases it to cells throughout the body. CO_2 is transported mainly in dissolved form in plasma.

SECTION B | *Assertion–Reason Questions* | *1 Mark Each*

Directions: In each question, a statement of Assertion (A) and a Reason (R) is given. Choose the correct option:

(A) Both A and R are true, and R is the correct explanation of A.
(B) Both A and R are true, but R is NOT the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

Q1. *[1 mark]*

Assertion (A): Plants do not need a special excretory system like animals.

Reason (R): Plants store waste products in cell vacuoles, dead tissues, fallen leaves, and as resins and gums, and excrete some wastes into the surrounding soil.

✔ **Answer: (A)** Both A and R are true, and R correctly explains why plants can manage without a dedicated excretory system. They have multiple low-energy strategies to deal with metabolic wastes, unlike animals that need kidneys and lungs.

Q2. *[1 mark]*

Assertion (A): Veins have valves but arteries do not.

Reason (R): Blood in veins flows under very low pressure and valves prevent backflow. Arteries carry blood under high pressure directly from the heart.

✔ **Answer: (A)** Both A and R are true, and R correctly explains A. Blood returning to the heart through veins moves against gravity in many parts of the body and is under low pressure, so valves are needed to prevent backflow. Arteries have thick elastic walls instead.

Q3. *[1 mark]*

Assertion (A): Small intestine is longer in herbivores than in carnivores.

Reason (R): Cellulose (plant cell wall material) is harder to digest and takes more time and surface area to break down completely compared to meat.

✔ **Answer: (A)** Both A and R are true and R correctly explains A. Grass-eating animals need a longer small intestine to provide more time and area for digesting cellulose using specialised bacteria. Carnivores digest meat faster, so a shorter intestine is enough.

Q4. *[1 mark]*

Assertion (A): Aerobic respiration produces more energy than anaerobic respiration.

Reason (R): In aerobic respiration, glucose is completely broken down to CO_2 and H_2O using oxygen, releasing all available energy. In anaerobic respiration, pyruvate is only partially broken down.

✔ **Answer: (A)** Both A and R are true and R correctly explains A. Complete oxidation in aerobic respiration releases far more ATP (≈38 molecules) per glucose molecule compared to anaerobic respiration (only 2 ATP). The partial breakdown in anaerobic pathways leaves much energy locked in ethanol or lactic acid.

Q5. *[1 mark]*

Assertion (A): Birds and mammals have four-chambered hearts, while fish have two-chambered hearts.

Reason (R): Birds and mammals are warm-blooded and need a complete separation of oxygenated and deoxygenated blood to maintain high metabolic rates and body temperature.

✔ **Answer: (A)** Both A and R are true and R explains A. The four-chambered heart enables double circulation, ensuring oxygenated blood never mixes with deoxygenated blood. This supports the high energy demands of endothermic (warm-blooded) animals. Cold-blooded animals tolerate some mixing.

Q6. *[1 mark]*

Assertion (A): The primary event of photosynthesis is the reduction of CO_2 to form carbohydrates.

Reason (R): Light energy captured by chlorophyll is used to split water molecules, releasing oxygen, and the hydrogen from water is used to reduce CO_2.

✔ **Answer: (B)** Both A and R are true BUT R does not correctly explain A. The primary (first) event of photosynthesis is actually the absorption of light by chlorophyll, not the reduction of CO_2. CO_2 reduction is the last step. R describes a true process but explains a different step, so they are not directly linked as A explains R.

Q7. *[1 mark]*

Assertion (A): Glucose is first broken down to pyruvate in the cytoplasm during respiration.

Reason (R): The mitochondria contains the enzymes needed for the first step of glucose breakdown (glycolysis).

✔ **Answer: (C)** A is true — glycolysis occurs in the cytoplasm. R is false — glycolysis enzymes are in the cytoplasm, NOT in the mitochondria. The mitochondria is the site for the second stage of aerobic respiration (pyruvate breakdown), not for glycolysis.

Q8. *[1 mark]*

Assertion (A): Stomata close at night in most plants.

Reason (R): In the absence of sunlight at night, photosynthesis does not occur, so CO_2 is not needed; closing stomata also prevents water loss.

✔ **Answer: (A)** Both A and R are true and R correctly explains A. During the day, stomata open to let CO_2 in for photosynthesis. At night, since there is no photosynthesis, CO_2 is not required and the plant closes stomata to conserve water and prevent unnecessary transpiration.

SECTION C | *Short Answer Questions* | *2 Marks Each*

Write precise, point-form answers. Each question carries 2 marks.

Q1. Differentiate between autotrophic and heterotrophic nutrition. Give one example of each. *[2 marks]*

Answer:

Autotrophic nutrition: The organism makes its own food from simple inorganic substances (CO_2 and H_2O) using sunlight energy. Example: Green plants (photosynthesis).

Heterotrophic nutrition: The organism cannot make its own food and depends on other organisms (directly or indirectly) for complex, ready-made food. Example: Human beings, fungi.

Q2. What is the role of hydrochloric acid (HCl) in the stomach? *[2 marks]*

Answer:

① It creates an acidic medium (low pH) in the stomach, which is necessary for the protein-digesting enzyme pepsin to work effectively.

② It kills harmful bacteria and pathogens that may have entered with the food, providing a defence against infection.

Q3. What are villi? What is their function? *[2 marks]*

Answer:

Villi are tiny finger-like projections lining the inner wall of the small intestine.

Function: They greatly increase the surface area available for absorption of digested food into the blood. Villi are richly supplied with blood vessels, allowing rapid transfer of absorbed nutrients (glucose, amino acids, fatty acids) to all body cells.

Q4. Write the balanced chemical equation for aerobic respiration. Where in the cell does this process occur? *[2 marks]*

Answer:

Balanced equation:

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{Energy (ATP)}$

(Glucose) (Oxygen) (Carbon dioxide) (Water)

Location: The breakdown of pyruvate to give CO_2, H_2O, and energy takes place in the mitochondria. The initial step (glucose → pyruvate) occurs in the cytoplasm.

Q5. How does Amoeba obtain its nutrition? *[2 marks]*

Answer:

Amoeba uses a process called phagocytosis (engulfing). It extends temporary, finger-like projections called pseudopodia which surround the food particle.

The pseudopodia fuse over the food, trapping it inside a food vacuole. Inside the vacuole, digestive enzymes break the food into simpler molecules, which diffuse into the cytoplasm. The undigested waste is moved to the cell surface and expelled.

Q6. What is transpiration? State its TWO important functions. *[2 marks]*

Answer:

Transpiration: The loss of water as vapour from the aerial parts (mainly leaves) of a plant through stomata.

Functions: ① It creates a suction force (transpiration pull) that helps in the upward movement of water and dissolved minerals from roots to leaves through the xylem. ② It helps in regulating the temperature of the plant by cooling it through evaporation.

Q7. Why is the left ventricle of the human heart thicker than the right ventricle? *[2 marks]*

Answer:

The left ventricle pumps oxygenated blood to the entire body (systemic circulation), which requires much greater force to push blood through the long distances to all organs.

The right ventricle only pumps deoxygenated blood to the nearby lungs (pulmonary circulation), which is a shorter distance and requires less muscular force. Therefore, the left ventricle has thicker muscular walls.

Q8. What is double circulation? Name two groups of animals that show this. *[2 marks]*

Answer:

Double circulation: A type of blood circulation where blood passes through the heart TWICE during one complete cycle through the body — once through the pulmonary circuit (heart → lungs → heart) and once through the systemic circuit (heart → body → heart).

Animals showing double circulation: ① Mammals (e.g., humans, dogs) ② Birds (e.g., sparrows, pigeons)

Q9. Distinguish between aerobic and anaerobic respiration. *[2 marks]*

Answer:

Aerobic respiration: Occurs in the presence of oxygen. Glucose is completely oxidised to CO_2 and H_2O. Takes place in the mitochondria. Produces a large amount of energy (ATP). Example: Most cells in humans.

Anaerobic respiration: Occurs in the absence of oxygen. Glucose is incompletely broken down to ethanol + CO_2 (in yeast) or lactic acid (in muscles). Takes place in the cytoplasm. Produces very little energy. Example: Yeast, muscle cells during intense exercise.

Q10. What is the difference between how xylem and phloem transport materials in plants? *[2 marks]*

Answer:

Xylem: Transports water and dissolved minerals upward from roots to leaves. The movement is mostly one-directional (upward). It is largely driven by physical forces — transpiration pull and root pressure. No energy (ATP) is directly required.

Phloem: Transports dissolved food (mainly sucrose) and amino acids from leaves to all other parts — both upward and downward. The process (translocation) requires energy from ATP to load sucrose into sieve tubes.

Q11. What is the role of the pancreas in digestion? *[2 marks]*

Answer:

The pancreas secretes pancreatic juice into the small intestine. Pancreatic juice contains:

① Trypsin — a protein-digesting enzyme that breaks down proteins into smaller peptides/amino acids.

② Lipase — a fat-digesting enzyme that breaks down emulsified fat globules into fatty acids and glycerol.

The pancreatic juice is alkaline and helps neutralise the acidic food (chyme) coming from the stomach, creating the right pH for intestinal enzymes to work.

Q12. What is haemodialysis? When is it needed? *[2 marks]*

Answer:

Haemodialysis is a medical procedure using an artificial kidney to remove nitrogenous wastes (urea, uric acid) from a patient's blood when their kidneys fail.

In the dialysis machine, blood is passed through semi-permeable tubes surrounded by dialysing fluid. Waste products diffuse out from the blood into the fluid. The cleaned blood is returned to the patient.

It is needed when a person's kidneys are damaged by infection, injury, or restricted blood flow and can no longer filter waste effectively.

SECTION D | *Short Answer Questions* | *3 Marks Each*

Write structured answers. Each question carries 3 marks.

Q1. Describe the process of photosynthesis. What are its three main steps? Write the balanced equation. *[3 marks]*

Photosynthesis is the process by which green plants (autotrophs) convert CO_2 and H_2O into carbohydrates using sunlight energy trapped by chlorophyll.

Balanced Equation:

$6CO_2 + 6H_2O \rightarrow (\text{Sunlight + Chlorophyll}) \rightarrow C_6H_{12}O_6 + 6O_2$

Three main steps:

① Absorption of light energy by chlorophyll molecules present in chloroplasts.

② Conversion of light energy into chemical energy, and splitting of water molecules into hydrogen and oxygen (the O_2 is released as a by-product).

③ Reduction of CO_2 using the hydrogen from water to form carbohydrates (glucose). The energy stored in ATP drives this step.

Note: Desert plants (CAM plants) absorb CO_2 at night and prepare an intermediate compound, which is later used during the day when sunlight is available.

Q2. Trace the pathway of food through the human digestive system, naming the key enzyme and its action at each stage. *[3 marks]*

The pathway of food through the alimentary canal:

① Mouth: Salivary amylase (in saliva) breaks down starch into simple sugars. Food is mechanically crushed by teeth and formed into a bolus.

② Oesophagus: Food is pushed down by peristaltic movements (rhythmic muscle contractions) into the stomach.

③ Stomach: Gastric glands secrete — Pepsin digests proteins into peptides; HCl creates acidic medium for pepsin; Mucus protects the stomach lining.

④ Small Intestine:
— Bile (from liver) emulsifies fats into small globules.
— Trypsin (from pancreas) digests proteins → amino acids.
— Lipase (from pancreas) digests fats → fatty acids + glycerol.
— Intestinal juice enzymes complete digestion of carbohydrates → glucose, proteins → amino acids.
— Villi absorb digested food into blood.

⑤ Large Intestine: Absorbs remaining water from undigested material.

⑥ Anus: Undigested waste is expelled.

Q3. How does the human respiratory system ensure efficient gas exchange? Explain the role of alveoli and haemoglobin. *[3 marks]*

The human respiratory system is designed to maximise gas exchange between air and blood:

Pathway of air: Nostrils → Throat (with cartilage rings) → Bronchi → Bronchioles → Alveoli

Role of alveoli:
• Alveoli are tiny balloon-like sacs at the end of bronchioles.
• If spread out, their total surface area is about 80 m^2 — much greater than the body surface.
• Their walls are extremely thin (one-cell thick) and surrounded by a dense network of blood capillaries.
• This allows O_2 to rapidly diffuse from alveolar air into blood, and CO_2 to diffuse from blood into the alveoli for exhalation.
• Lungs always retain a residual volume of air to ensure continuous gas exchange without interruption.

Role of haemoglobin:
• Haemoglobin is a respiratory pigment in red blood cells with a very high affinity for O_2.
• It picks up O_2 in the lungs (where O_2 concentration is high) → carried as oxyhaemoglobin.
• It releases O_2 to body tissues where O_2 concentration is low.
• CO_2 is more soluble in water, so it travels mainly dissolved in blood plasma.

Q4. Describe the structure and function of a nephron in the human kidney. *[3 marks]*

A nephron is the basic structural and functional unit of the kidney. Each kidney contains millions of nephrons.

Structure:
• Bowman's Capsule: Cup-shaped, double-walled structure enclosing a knot of capillaries called the glomerulus. It collects the initial filtrate from blood.
• Glomerulus: A cluster of thin-walled capillaries inside the Bowman's capsule. High blood pressure forces small molecules (water, urea, glucose, salts) out of blood into the Bowman's capsule — this is called ultrafiltration.

• Renal Tubule: A long, coiled tube where selective reabsorption occurs. Useful substances like glucose, amino acids, most water, and essential salts are reabsorbed back into the blood surrounding the tubule.
• Collecting Duct: Carries the remaining fluid (urine) to the ureter. The amount of water reabsorbed here is regulated by the body's water balance.

Function:
The nephron filters blood, reabsorbs useful substances, and concentrates the remaining nitrogenous wastes (urea, uric acid) as urine. Urine flows: nephron → collecting duct → ureter → urinary bladder → urethra.

Q5. What is meant by translocation in plants? How does it occur? *[3 marks]*

Translocation is the transport of soluble products of photosynthesis (mainly sucrose/sugar), amino acids, and other substances from the leaves (where they are produced) to other parts of the plant through the phloem tissue.

Direction: Unlike xylem (only upward), phloem can transport food both upward and downward depending on the plant's needs.

How it works:
① Sugar (sucrose) produced in leaves is actively loaded into the phloem sieve tubes using energy from ATP. This increases the osmotic pressure inside the sieve tubes.
② Water enters the sieve tubes by osmosis (from surrounding cells), creating high pressure at the source end (leaves).
③ This pressure moves the sugar solution toward regions of lower pressure — storage organs (roots, fruits, seeds) or growing regions that need energy.
④ At the destination, sucrose is unloaded into the surrounding cells.

Key point: Phloem transport is an active, energy-requiring process, unlike water transport in xylem which is mainly passive.

Q6. Explain the circulation of blood in the human heart. Why is it called "double circulation"? *[3 marks]*

Blood circulation in the human heart involves two separate circuits:

Circuit 1 — Pulmonary Circulation (Deoxygenated → Lungs):
• Deoxygenated blood (with CO_2) from the body collects in the right atrium.
• Right atrium contracts → blood flows to right ventricle.
• Right ventricle contracts → pumps blood to the lungs via the pulmonary artery.
• In the lungs, CO_2 is removed and O_2 is absorbed.

Circuit 2 — Systemic Circulation (Oxygenated → Body):
• Oxygenated blood from the lungs returns to the left atrium via the pulmonary vein.
• Left atrium contracts → blood flows to left ventricle.
• Left ventricle contracts powerfully → pumps blood through the aorta to the entire body.

Why "double circulation"?
Because blood passes through the heart TWICE in each complete cycle — once for oxygenation (pulmonary circuit) and once for body supply (systemic circuit). This ensures that oxygenated and deoxygenated blood NEVER mix, allowing maximum oxygen delivery to tissues. This is essential for warm-blooded mammals and birds with high energy needs.

Q7. What are the differences between arteries and veins? *[3 marks]*

Differences between Arteries and Veins:

Arteries:
① Carry blood AWAY from the heart to body organs.

② (Except pulmonary artery) carry oxygenated blood.
③ Blood flows under HIGH pressure.
④ Walls are THICK and ELASTIC to withstand pressure.
⑤ Do NOT have valves (high pressure prevents backflow).
⑥ Lumen (opening inside) is relatively narrow.

Veins:
① Carry blood TOWARD the heart from body organs.
② (Except pulmonary vein) carry deoxygenated blood.
③ Blood flows under LOW pressure.
④ Walls are THIN (less muscular).
⑤ Have VALVES to prevent backflow of blood.
⑥ Lumen is relatively wider.

Common feature: Both are blood vessels connected through capillaries (the thinnest vessels, one-cell thick walls, site of exchange).

Q8. How do plants get rid of their waste products? Name at least FOUR methods. *[3 marks]*

Plants use various strategies to excrete waste products as they lack a dedicated excretory system:

① Storage in Vacuoles: Metabolic waste products are stored in the vacuoles of cells where they cannot harm the cell. This is the most common method.

② Excretion through Falling Leaves: Many waste products accumulate in leaves during their lifetime. When leaves fall off (leaf senescence), the stored waste is removed from the plant body.

③ Storage as Resins and Gums: Some plants store waste products, especially in old xylem tissue, as resins and gums. Example: Rubber tree produces latex; conifers produce resins.

④ Excretion into the Soil: Some plants release waste substances directly into the surrounding soil through their roots. These substances may also inhibit the growth of nearby competing plants (allelopathy).

⑤ Transpiration: Water lost through transpiration carries with it some dissolved waste substances.

⑥ Oxygen as waste: Oxygen is produced as a waste product of photosynthesis and is released through stomata.

SECTION E | *Case-Based / Competency Questions | 4 Marks Each*

Read each passage carefully and answer ALL sub-questions.

Case Study 1: The Breathing Machine

> *Riya noticed that when she runs fast for a long time, her legs start to hurt and feel heavy. Her biology teacher explained that during intense running, her muscle cells may not get enough oxygen. In such a situation, the cells switch to a different pathway to get energy quickly. Meanwhile, when she breathes hard after the race, her body is trying to repay the "oxygen debt". A friend told her that fish also face a similar challenge because the oxygen dissolved in water is much less than oxygen in air.*

(i) What pathway do Riya's muscle cells switch to when oxygen is insufficient? Name the product that causes leg pain. [1 mark]

Anaerobic respiration. The product that causes leg pain is lactic acid (a 3-carbon molecule). When lactic acid builds up in muscles, it causes cramps and fatigue.

(ii) Write the chemical equation for this anaerobic process in muscle cells. [1 mark]

$C_6H_{12}O_6 \rightarrow 2C_3H_6O_3 + \text{Energy}$
(Glucose) (Lactic acid)

Note: This process occurs in the cytoplasm and produces only a small amount of ATP compared to aerobic respiration.

(iii) Why do fish need to breathe much faster than Riya? [1 mark]

Because the amount of dissolved oxygen in water is far less than the oxygen present in air. Fish must pass much more water over their gills to extract the same amount of oxygen that a terrestrial organism gets from a much smaller volume of air. So the rate of breathing (gill movement) in fish is much faster.

(iv) How does Riya's body remove the lactic acid after exercise? [1 mark]

After exercise, when adequate oxygen becomes available again (she breathes hard to repay the "oxygen debt"), the lactic acid is converted back to pyruvate in the liver. The pyruvate then undergoes normal aerobic respiration to release energy. This is why heavy breathing continues even after stopping running — it helps clear the lactic acid.

Case Study 2: The Green Factory

A scientist placed two healthy potted plants inside separate transparent bell jars. She sealed both jars air-tight. In Jar A, she placed a small container of potassium hydroxide (KOH) solution to absorb CO_2. In Jar B, no such container was placed. Both setups were kept in bright sunlight for three hours. Afterwards, she tested one leaf from each plant for the presence of starch using iodine solution. She observed that the leaf from Jar A did NOT turn blue-black with iodine, while the leaf from Jar B turned deep blue-black.

(i) What does the blue-black colour with iodine indicate? [1 mark]

Blue-black colour with iodine (iodine solution turns blue-black) indicates the PRESENCE of starch. Iodine solution (iodine dissolved in potassium iodide) reacts with starch to form a dark blue-black complex, which is a standard test for starch.

(ii) Why did the leaf from Jar A NOT show blue-black colour? [1 mark]

In Jar A, KOH absorbed all the CO_2 inside the bell jar. Without CO_2, the plant in Jar A could not carry out photosynthesis (CO_2 is a raw material). Since no photosynthesis occurred, no glucose was produced, and therefore no starch was formed. The iodine test was negative.

(iii) Name TWO raw materials needed for photosynthesis and state the energy source. [1 mark]

Raw materials: ① Carbon dioxide (CO_2) — absorbed through stomata ② Water (H_2O) — absorbed from soil through roots.
Energy source: Sunlight (solar energy), captured by chlorophyll in chloroplasts.

(iv) What would happen if the scientist covered the jar with a dark cloth after keeping it in sunlight? Explain. [1 mark]

If the jar is covered with a dark cloth, the plant will not receive sunlight. Without sunlight, chlorophyll cannot absorb light energy, so photosynthesis will stop. The existing starch will gradually be used up for the plant's own respiration and other activities. If tested again after a long time in the dark, the iodine test would become negative (no starch).

Case Study 3: The Heart's Journey

Dr. Mehta is explaining heart disease to her patient. She says that the heart is a pump that works non-stop throughout life. Blood carries oxygen, food and waste materials to and from all organs. In some patients, the arteries become narrow due to cholesterol deposits, which raises blood pressure dangerously. She measures the patient's blood pressure at 150/100 mm Hg and explains that this is much higher than normal. She also mentions that the right side and left side of the heart must stay separated to prevent a serious problem.

(i) What are the normal values of systolic and diastolic blood pressure? What do these terms mean? [1 mark]

Normal: 120 mm Hg (systolic) / 80 mm Hg (diastolic).
Systolic pressure: Blood pressure in arteries during ventricular contraction (heart beat).
Diastolic pressure: Blood pressure in arteries when ventricles relax (between beats).
The patient's reading (150/100) indicates hypertension (high blood pressure).

(ii) Why must the right and left sides of the heart stay separated? What serious problem would mixing cause? [1 mark]

The right side carries deoxygenated blood and the left side carries oxygenated blood. If they mix:
• Oxygenated blood would be diluted with CO_2-rich blood.
• The body would receive blood with reduced oxygen content.
• This would lower the efficiency of oxygen delivery, making it impossible for warm-blooded animals to maintain high metabolic rates and body temperature.
Mixing is harmless in cold-blooded animals (frogs, some reptiles) but fatal for mammals and birds.

(iii) Why do arteries have thick, elastic walls? [1 mark]

Arteries receive blood directly from the heart under very HIGH pressure (during ventricular contraction). Thick walls prevent the artery from bursting under this pressure. Elastic walls allow the artery to expand when blood rushes in and contract between heartbeats to maintain continuous blood flow. If arteries become rigid (arteriosclerosis) or narrowed (atherosclerosis due to cholesterol), blood pressure rises to dangerous levels — as in Dr. Mehta's patient.

(iv) Name the instrument used to measure blood pressure. What is the function of platelets in blood? [1 mark]

Instrument: Sphygmomanometer is used to measure blood pressure.
Function of platelets: Platelets (thrombocytes) help repair leaks in blood vessels. When a blood vessel is damaged, platelets gather at the site and help form a blood clot (thrombus) to plug the leak. This stops bleeding and prevents blood loss. Without platelets, even a minor injury could cause dangerous internal or external bleeding.

SECTION F | *Long Answer Questions* | *5 Marks Each*

Write detailed, structured answers covering all parts. 5 marks each.

Q1. (a) What is photosynthesis? Write its balanced equation. (b) Explain the three main events that occur during photosynthesis. (c) Why is it important that plants close their stomata at night? [5 marks]

(a) Photosynthesis is the process by which green plants (and some bacteria) use chlorophyll to trap sunlight energy and convert carbon dioxide and water into glucose (carbohydrate) and oxygen.

Balanced Equation:
$6CO_2 + 6H_2O \xrightarrow{\text{(Sunlight + Chlorophyll)}} C_6H_{12}O_6 + 6O_2$

This equation must be memorised with the catalyst condition written above the arrow. [1 mark for equation]

(b) Three main events of photosynthesis: [3 marks — 1 each]

Event 1 — Light Absorption:
Chlorophyll molecules present in the chloroplasts of leaf cells absorb sunlight. Chloroplasts are found mainly in the mesophyll cells of leaves. Without chlorophyll, light energy cannot be captured.

Event 2 — Splitting of Water and Conversion of Light to Chemical Energy:

The absorbed light energy is used to split water molecules into hydrogen and oxygen (photolysis of water). The oxygen is released as a by-product through the stomata. The light energy is converted into chemical energy stored in ATP and NADPH molecules, which will be used in the next step.

Event 3 — Reduction of CO_2 to Carbohydrates (Carbon fixation):

The hydrogen from water (carried by NADPH) and energy (from ATP) are used to reduce CO_2 into glucose. CO_2 enters the leaf mainly through stomata. This glucose is the food for the plant — it provides energy through respiration or is stored as starch.

(c) Why stomata close at night: [1 mark]

At night, there is no sunlight, so photosynthesis cannot take place. CO_2 is not needed. If stomata remained open at night, the plant would lose water vapour unnecessarily through transpiration without any benefit (since no photosynthesis is occurring). To conserve water and prevent wilting, plants close their stomata at night. The guard cells lose water and shrink, closing the pore.

Q2. (a) Draw a labelled diagram of the human digestive system (description format). (b) Describe the complete digestion of a roti (which mainly contains starch) from the mouth to the small intestine. [5 marks]

(a) Main parts of the human alimentary canal (to be labelled in diagram) [2 marks]:

Mouth → Salivary Glands → Oesophagus (Food pipe) → Stomach → Liver → Pancreas → Small Intestine (duodenum, jejunum, ileum) → Large Intestine (Colon) → Rectum → Anus

[Note for students: In the actual exam, draw a neat diagram with all the above parts clearly labelled. The liver and pancreas open into the small intestine via ducts.]

(b) Digestion of Roti (Starch) — Step by Step [3 marks]:

Step 1 — Mouth:

Teeth physically break the roti into smaller pieces (mechanical digestion). Saliva secreted by salivary glands wets the food. Salivary amylase in saliva immediately begins breaking starch (a polysaccharide) into simpler sugars (maltose). The food is mixed and formed into a bolus (soft lump).

Step 2 — Oesophagus:

The bolus is pushed down to the stomach by peristalsis (rhythmic wave-like contractions of the oesophageal muscles). No digestion of starch occurs here.

Step 3 — Stomach:

Gastric juice (containing HCl and pepsin) is secreted. HCl makes the medium acidic, which stops the action of salivary amylase. So starch digestion pauses in the stomach. The stomach's muscular walls churn and mix the food. The food (now called chyme) exits in small amounts through the pyloric sphincter.

Step 4 — Small Intestine (key site):

• Pancreatic juice (from the pancreas) contains pancreatic amylase, which resumes breaking down remaining starch → maltose and dextrins.

• Bile (from liver) neutralises the acidic chyme and makes the medium alkaline (suitable for pancreatic enzymes).

• Intestinal juice (from intestinal glands) contains maltase and other disaccharidases that finally convert maltose → glucose.

• Final product: Glucose molecules are absorbed through the villi into the bloodstream and transported to all cells.

Q3. (a) Compare aerobic and anaerobic respiration with equations. (b) What is the role of ATP in the cell? (c) Where does the breakdown of pyruvate take place in aerobic respiration? [5 marks]

(a) Comparison of Aerobic and Anaerobic Respiration [3 marks]:

AEROBIC RESPIRATION:
• Occurs in the presence of oxygen.
• Complete oxidation of glucose.
• Products: CO_2 + H_2O + large amount of energy.
• Takes place in the cytoplasm (glycolysis: glucose → pyruvate) and mitochondria (pyruvate breakdown).
• Produces ~38 ATP molecules per glucose.
• Equation: $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ + Energy (ATP)

ANAEROBIC RESPIRATION:
• Occurs in the ABSENCE of oxygen.
• Incomplete breakdown of glucose.
• Products (two types):
  — In yeast/fungi: Ethanol + CO_2 + small energy
    Equation: $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$ + Energy
  — In muscle cells: Lactic acid + small energy
    Equation: $C_6H_{12}O_6 \rightarrow 2C_3H_6O_3$ + Energy
• Takes place only in the cytoplasm.
• Produces only 2 ATP molecules per glucose.

Key difference: Aerobic gives ≈19× more ATP than anaerobic because glucose is completely oxidised.

(b) Role of ATP in the cell [1 mark]:
ATP (Adenosine Triphosphate) is called the "energy currency" of the cell. Energy released from glucose during respiration is used to make ATP (from ADP + inorganic phosphate). When cells need energy for any activity, ATP is broken down (terminal phosphate bond broken), releasing about 30.5 kJ/mol of energy. This energy powers: muscle contraction, protein synthesis, active transport, nerve impulse conduction, and many other cellular processes.

(c) Where pyruvate breakdown occurs [1 mark]:
In aerobic respiration, after glucose is broken down to pyruvate in the cytoplasm, pyruvate moves into the mitochondria. Inside the mitochondria, it is further broken down to give 3 molecules of CO_2, water, and a large amount of energy (ATP). This is why the mitochondria is called the "powerhouse of the cell." The process involves the Krebs cycle and oxidative phosphorylation in the inner mitochondrial membrane.

Q4. (a) Describe the human excretory system with names of all organs. (b) How is urine formed in the kidney? Describe the process in nephrons. (c) What is an artificial kidney and how does it work? [5 marks]

(a) Human Excretory System [1 mark]:
The excretory system consists of:
① A pair of kidneys — located in the abdomen on either side of the backbone; the main filtration organs.
② A pair of ureters — tubes carrying urine from each kidney to the urinary bladder.
③ Urinary bladder — a muscular sac that stores urine until it is ready to be released.
④ Urethra — the tube through which urine is discharged from the body.

Purpose: To remove nitrogenous waste products (mainly urea, produced from breakdown of amino acids in the liver) from the blood.

(b) Formation of Urine in Nephrons [3 marks]:

Step 1 — Ultrafiltration:

Blood enters the nephron through tiny capillaries in the glomerulus (inside the Bowman's capsule). The high blood pressure in the glomerulus forces small molecules — water, urea, glucose, amino acids, and salts — out of the blood into the Bowman's capsule. Large molecules (proteins) and blood cells remain in the blood. This fluid is called the glomerular filtrate.

Step 2 — Selective Reabsorption (along the renal tubule):

As the filtrate travels through the long, coiled renal tubule:

• Glucose, amino acids, and a major portion of water and useful salts are reabsorbed back into the blood capillaries surrounding the tubule.

• The amount of water reabsorbed is controlled by the body's water level (regulated by ADH hormone).

Step 3 — Urine Formation:

What remains after reabsorption is concentrated urine, containing mainly urea, excess salts, and water. Normally, from ≈180 L of filtrate per day, only 1–2 L of urine is excreted (99% water is reabsorbed).

(c) Artificial Kidney (Haemodialysis) [1 mark]:

When kidneys fail due to disease, infection, or injury, an artificial kidney (dialysis machine) is used.

• The machine contains semi-permeable tubes bathed in dialysing fluid.

• Dialysing fluid has the same composition as blood, except it contains no nitrogenous wastes.

• The patient's blood is passed through these tubes. Urea and other waste products diffuse out of the blood through the semi-permeable membrane into the dialysing fluid.

• The purified blood is returned to the patient's body.

• Key difference from real kidney: NO reabsorption occurs in dialysis (it only filters out wastes). A real kidney selectively reabsorbs useful substances.

Q5. (a) How is water transported from roots to the tip of a very tall tree? Explain the forces involved. (b) How is food transported in plants (translocation)? How does it differ from water transport? [5 marks]

(a) Transport of Water from Roots to Tip of a Tall Tree [3 marks]:

Water transport occurs through the XYLEM tissue. The following forces work together:

Force 1 — Root Pressure (more important at night):

Root cells actively absorb mineral ions from soil. This creates a concentration difference, causing water to move from soil into root cells by osmosis. This pushes water upward into the xylem, creating root pressure. However, root pressure alone is too weak to push water to the tops of very tall trees.

Force 2 — Transpiration Pull (major force during day):

When sunlight hits the leaves, water evaporates from leaf cells through stomata — this is transpiration. As water leaves, the remaining water in leaf cells becomes more concentrated and pulls water from adjacent xylem vessels by osmosis. This creates a continuous tension (suction force) that pulls the water column upward from roots through the stem to leaves. This is called the transpiration pull or cohesion-tension mechanism.

Supporting factor: Water molecules strongly attract each other (cohesion), forming an unbroken water column in xylem vessels. The adhesion of water to xylem walls also helps.

Summary of water pathway: Soil → Root hairs → Root xylem → Stem xylem → Leaf xylem → Mesophyll cells → Stomata → Atmosphere

(b) Translocation of Food in Plants [2 marks]:

Food transport occurs through the PHLOEM tissue (sieve tubes + companion cells).

How it works:
① Sucrose (sugar) made in leaves is actively loaded into sieve tubes using ATP energy. This raises the osmotic pressure inside the sieve tubes.
② Water enters the sieve tubes by osmosis (high pressure at the source — leaves).
③ This pressure drives the sugar solution toward regions of lower pressure — growing tips, roots, fruits, seeds (sinks that need energy).
④ At the destination, sucrose is unloaded and used for respiration or storage.

Key differences from water transport (xylem):
• Phloem uses energy (ATP); xylem is mostly passive.
• Phloem moves in BOTH directions (up and down); xylem moves only upward.
• Phloem transports food (sucrose, amino acids); xylem transports water and minerals.
• Phloem cells are living (sieve tubes); xylem vessels are mostly dead cells.

SECTION G | *Very Short Answer (VSA) | 1 Mark Each | Rapid Fire Round*

One-line answers. These have been directly asked in CBSE papers 2019–2025.

Q1. Name the basic filtration unit of the kidney.

Ans: Nephron

Q2. What is the function of mucus in the stomach?

Ans: Mucus protects the inner lining of the stomach from the corrosive action of HCl and pepsin.

Q3. What is glycogen? Where is it stored in the human body?

Ans: Glycogen is the stored form of carbohydrate (energy reserve) in the human body. It is mainly stored in the liver and muscles.

Q4. Name the pigment that absorbs sunlight in plants.

Ans: Chlorophyll (present in chloroplasts).

Q5. What is the full form of ATP? Why is it called the energy currency of the cell?

Ans: ATP = Adenosine Triphosphate. It is called energy currency because it stores and releases energy for all cellular processes, like currency is used for all transactions.

Q6. Why is the rate of breathing faster in fish than in humans?

Ans: Because dissolved oxygen in water is much less than oxygen in air. Fish need to move much more water over their gills to extract sufficient oxygen, so they breathe faster.

Q7. What is the role of HCl in the stomach?

Ans: HCl creates an acidic medium essential for pepsin (protein-digesting enzyme) to work, and also kills bacteria present in food.

Q8. Name any one parasitic plant and its host.

Ans: Cuscuta (dodder / amar-bel) parasitises host plants like wheat, clover, and tomatoes, deriving water and nutrients from them.

Q9. Where does the first step of respiration (glycolysis) occur in a cell?

Ans: In the cytoplasm (cytosol) of the cell.

Q10. What does the sphygmomanometer measure?

Ans: Blood pressure (both systolic and diastolic pressure).

Q11. Name the enzyme in saliva and the substrate it acts on.

Ans: Enzyme: Salivary amylase (ptyalin). Substrate: Starch (converts starch into simpler sugars).

Q12. What gas is released as a waste product of photosynthesis?

Ans: Oxygen (O_2) is released as a waste product of photosynthesis during the splitting of water (photolysis).

Q13. Name two gases exchanged during respiration.

Ans: Oxygen (O_2) is absorbed from air; Carbon dioxide (CO_2) is released into air.

Q14. What is the function of lymph?

Ans: Lymph carries digested and absorbed fat from the intestine; drains excess fluid from intercellular spaces back into the blood; and helps in immunity.

Q15. Why do herbivores have a longer small intestine than carnivores?

Ans: Cellulose (in plant food) is harder to digest and takes longer. A longer intestine provides more time and surface area for digestion and absorption of plant material.

Q16. Name the force that helps water move up a very tall tree during the day.

Ans: Transpiration pull (also called cohesion-tension mechanism). Evaporation of water from leaves creates a suction that pulls water upward through xylem.

Q17. What is the product of anaerobic respiration in yeast?

Ans: Ethanol (ethyl alcohol, C_2H_5OH) and carbon dioxide (CO_2).

Q18. What is the role of platelets in blood?

Ans: Platelets help in blood clotting. They gather at the site of injury and plug leaks in blood vessels by forming a clot, preventing blood loss.

Q19. Name the tissue responsible for transport of food in plants.

Ans: Phloem (specifically, the sieve tubes with companion cells).

Q20. What is dialysis?

Ans: Dialysis (haemodialysis) is a process of purifying blood using an artificial kidney when the person's own kidneys have failed. Waste products diffuse out of blood through a semi-permeable membrane.

⚡ QUICK REVISION | KEY FORMULAS & FACTS | *Chapter 5: Life Processes*

Fact / Formula	Details / Value
Photosynthesis equation	$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$ (in presence of sunlight + chlorophyll)
Aerobic respiration	$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ + Energy (ATP) | in mitochondria
Anaerobic (yeast)	$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$ + Energy | fermentation
Anaerobic (muscles)	$C_6H_{12}O_6 \rightarrow 2C_3H_6O_3$ (lactic acid) + Energy | causes cramps
Glycolysis location	Cytoplasm (common first step for all respiration types)
Normal BP	120/80 mm Hg (Systolic / Diastolic) | Instrument: Sphygmomanometer
Heart chambers	Fish: 2 | Frog/Amphibians: 3 | Reptiles: 3 (crocodile: 4) | Birds/Mammals: 4
Double circulation	Blood passes through heart TWICE per cycle — mammals and birds only
Xylem	Water + minerals | Upward only | Passive (no ATP) | Dead cells
Phloem	Food (sucrose) | Both directions | Active (needs ATP) | Living cells
Nephron parts	Bowman's capsule → Glomerulus → Renal tubule → Collecting duct
Normal urine output	≈1–2 L per day (from ≈180 L of filtrate — 99% water reabsorbed)
Salivary amylase	Breaks starch → simpler sugars | Acts in mouth | pH 6.8–7
Bile function	Emulsifies fats into small globules | Produced by liver | No enzyme

Alveoli surface area	≈80 m² (if spread out) | One-cell thick walls | Rich blood supply
Haemoglobin	Respiratory pigment in RBCs | Carries O_2 | CO_2 mainly in plasma (dissolved)
Lymph	Colourless | Less protein than blood | Drains fat from intestine | Returns to veins
Transpiration	Water loss from leaves → drives water up xylem (transpiration pull)

C H A P T E R

6

Control and Coordination

Nervous System • Plant Hormones • Endocrine System • Reflexes

★★★★★ **Marks Weightage: Very High**

Sections: A (MCQ) • B (Assertion-Reason) • C–D (Short Answer) • E (Case-Based) • F (Long Answer) • VSA • Quick Revision

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CBSE Class 10 | Science (Biology)

CHAPTER 6
CONTROL AND COORDINATION

Master Question Bank ● Board Exam 2027 Pattern

📊 CBSE EXAM TREND ANALYSIS (2019 – 2026) | *Chapter 6: Control and Coordination*

Topic-wise Prediction for 2027

Topic	Marks Asked/Year	Format	Prediction 2027
Reflex Arc & Reflex Action	3–5 marks	Diagram + Explanation / LA	★★★★★ Very High
Neuron Structure & Function	3–5 marks	Diagram + Label + Function	★★★★★ Very High
Human Brain (Fore/Mid/Hind)	3–5 marks	Diagram / 3-mark SA / LA	★★★★★ Very High
Tropic Movements (Plants)	2–3 marks	Define + Example + Diagram	★★★★★ Very High

Plant Hormones (Auxin, etc.)	2–3 marks	Name + Function Table / SA	★★★★☆ High
Animal Hormones & Glands	2–3 marks	Table / Case-based / SA	★★★★☆ High
Adrenaline / Fight or Flight	1–2 marks	Assertion-Reason / SA	★★★★☆ High
Insulin & Diabetes	1–2 marks	MCQ / AR / SA	★★★☆☆ Medium
Feedback Mechanism	1–2 marks	MCQ / AR	★★★☆☆ Medium
Synapse Function	1 mark	MCQ / 1-liner	★★★★☆ High

✦ Neuron diagram is asked EVERY year — learn to draw and label it correctly.
✦ Reflex arc path: Receptor → Afferent nerve → Spinal cord → Efferent nerve → Effector (muscle). Memorise this.
✦ Plant hormones and animal hormones are compared in Case-Based Questions increasingly.
✦ Brain diagram with forebrain, midbrain, cerebellum and medulla is a recurring 3/5-mark question.

SECTION A | *Multiple Choice Questions* | *1 Mark Each*

Instructions: Choose the BEST option. All questions carry 1 mark.

Q1. Which part of the brain controls balance and posture of the body? *[1 mark]*

A) Fore-brain (Cerebrum)
B) Mid-brain
C) Cerebellum (Hind-brain)
D) Medulla Oblongata

✔️ **Answer: (C)** The cerebellum is part of the hind-brain and is responsible for precision of voluntary actions, maintaining posture and balance. Activities like riding a bicycle, walking in a straight line, and picking up a pencil all require the cerebellum.

Q2. The gap between two consecutive neurons across which nerve impulses are transmitted is called: *[1 mark]*

A) Axon
B) Dendrite
C) Synapse
D) Neuromuscular junction

✔️ **Answer: (C)** The synapse is the tiny gap between the axon terminal of one neuron and the dendrite of the next. At the synapse, the electrical impulse is converted to a chemical signal (neurotransmitter), which crosses the gap and triggers a new impulse in the next neuron.

Q3. Reflex arcs in humans are formed in the: *[1 mark]*

A) Brain only
B) Spinal cord
C) Sense organs
D) Peripheral nerves

✔️ **Answer: (B)** Reflex arcs are formed in the spinal cord. The input nerve and output nerve meet here, allowing a quick response WITHOUT waiting for the brain to process the signal. Information still travels to the brain, but the reflex response happens before the brain acts.

Q4. The movement of the shoot of a plant towards light is called: *[1 mark]*

A) Geotropism
B) Hydrotropism

C) Chemotropism
D) Phototropism

✔ **Answer: (D)** Phototropism is the directional growth movement of a plant in response to light. Shoots show positive phototropism (bend towards light); roots show negative phototropism (bend away from light). This is caused by unequal distribution of auxin hormone.

Q5. Which hormone is responsible for the "fight or flight" response in humans? *[1 mark]*

A) Insulin
B) Thyroxin
C) Adrenaline
D) Oestrogen

✔ **Answer: (C)** Adrenaline is secreted by the adrenal glands in situations of emergency (fear, anger, excitement). It increases heart rate, breathing rate, blood supply to muscles, and dilates pupils — preparing the body to fight or run away. It is called the "emergency hormone".

Q6. Which gland secretes growth hormone in humans? *[1 mark]*

A) Thyroid gland
B) Adrenal gland
C) Pancreas
D) Pituitary gland

✔ **Answer: (D)** The pituitary gland (located at the base of the brain) secretes growth hormone (GH), which regulates growth and development of the body. A deficiency of GH in childhood causes dwarfism. It is also called the "master gland" because it controls other endocrine glands.

Q7. Insulin is produced by the pancreas. Its main function is: *[1 mark]*

A) To regulate body temperature
B) To regulate blood sugar (glucose) levels
C) To control the growth of bones
D) To stimulate secondary sexual characters

✔ **Answer: (B)** Insulin is produced by the beta cells of the islets of Langerhans in the pancreas. It lowers blood glucose levels by helping cells absorb glucose. If insulin is not produced in sufficient amounts, blood sugar rises — causing diabetes mellitus. Treatment: insulin injections.

Q8. Which of the following is a plant growth INHIBITOR hormone? *[1 mark]*

A) Auxin
B) Gibberellin
C) Cytokinin
D) Abscisic acid

✔ **Answer: (D)** Abscisic acid (ABA) is the main growth-inhibiting plant hormone. It causes wilting of leaves, promotes seed dormancy, and causes stomata to close during water stress. The other three (auxin, gibberellin, cytokinin) are all growth-promoting hormones.

Q9. Where is information from receptors first acquired in a nerve cell? *[1 mark]*

A) Axon terminal
B) Cell body
C) Dendritic tip
D) Synapse

✔ **Answer: (C)** The dendritic tip (dendrite end) of a nerve cell is where information from the environment is first received. This sets off a chemical reaction that creates an electrical impulse. The impulse then travels: dendrite tip → cell body → axon → axon terminal → synapse → next neuron.

Q10. Iodine is essential for the synthesis of which hormone? *[1 mark]*

A) Adrenaline
B) Insulin
C) Thyroxin
D) Growth hormone

✔ **Answer: (C)** Thyroxin is produced by the thyroid gland and requires iodine as a raw material. Thyroxin regulates carbohydrate, protein, and fat metabolism for balanced growth. Deficiency of iodine leads to goitre (swollen neck due to enlarged thyroid gland).

Q11. The leaves of the sensitive plant (Mimosa pudica) fold up when touched. This movement is: *[1 mark]*

A) Due to growth of cells
B) Due to change in water content (turgor) in cells
C) Due to electrical impulses in nerve cells
D) Due to auxin redistribution

✔ **Answer: (B)** The touch-me-not (Mimosa/chhui-mui) response is not due to growth. Instead, plant cells change shape by rapidly losing water (turgor pressure changes), causing them to shrink. This is communicated electrically/chemically from cell to cell and causes the leaf to fold — not involving nervous tissue.

Q12. Which part of the brain controls involuntary actions like blood pressure, heartbeat, and salivation? *[1 mark]*

A) Cerebellum
B) Fore-brain (Cerebrum)
C) Medulla (Hind-brain)
D) Mid-brain

✔ **Answer: (C)** The medulla oblongata, located in the hind-brain, controls involuntary (autonomic) functions including blood pressure, salivation, vomiting, swallowing, and heartbeat. We do not need to consciously think about these — they happen automatically.

Q13. Chemotropism refers to the directional movement of a plant in response to: *[1 mark]*

A) Light
B) Gravity
C) Water
D) Chemical substances

✔ **Answer: (D)** Chemotropism is movement in response to chemicals. A classic example is the growth of a pollen tube toward the ovule, guided by chemical substances (sugars and proteins) secreted by the ovule. Roots may also show chemotropism toward specific nutrients in soil.

Q14. Which hormone promotes cell division in plants and is found in high concentration in fruits and seeds? *[1 mark]*

A) Auxin
B) Gibberellin
C) Cytokinin
D) Abscisic acid

✔ **Answer: (C)** Cytokinin promotes cell division (cytokinesis). Since rapid cell division happens during growth of fruits and seeds, cytokinin is found in high concentrations in those plant parts. It also delays leaf ageing and promotes lateral bud growth.

Q15. How do muscles move when a nerve impulse reaches them? *[1 mark]*

A) They grow longer using nutrients from blood
B) Special proteins rearrange and shorten the muscle cell
C) Water enters the cell and causes swelling
D) ATP is directly converted to movement without any protein

✔ **Answer: (B)** Muscle cells contain special contractile proteins (actin and myosin) that change their shape and arrangement in response to nerve impulses, causing the muscle cell to shorten. This shortening is the basis of all muscle movement — from blinking to running.

Q16. The central nervous system (CNS) in human beings consists of: *[1 mark]*

A) Brain only
B) Spinal cord only
C) Brain and spinal cord
D) Brain, spinal cord, and sense organs

✔ **Answer: (C)** The CNS consists of the brain and the spinal cord. The peripheral nervous system (PNS) consists of cranial nerves (from brain) and spinal nerves (from spinal cord) that connect the CNS to the rest of the body. Sense organs are part of the PNS.

Q17. The development of female sex organs and the regulation of the menstrual cycle are controlled by: *[1 mark]*

A) Testosterone
B) Oestrogen
C) Progesterone
D) Adrenaline

✔ **Answer: (B)** Oestrogen is produced by the ovaries and is responsible for developing female secondary sexual characters during puberty (breast development, widening of hips) and regulating the menstrual cycle. Testosterone from testes controls male secondary sexual characters.

Q18. A plant's root grows downward in response to gravity. This is called: *[1 mark]*

A) Phototropism
B) Geotropism
C) Hydrotropism
D) Thigmotropism

✔ **Answer: (B)** Geotropism (or gravitropism) is the directional growth of a plant part in response to the pull of gravity. Roots show positive geotropism (grow toward gravity — downward). Shoots show negative geotropism (grow away from gravity — upward). This ensures roots anchor in soil and shoots reach sunlight.

Q19. The feedback mechanism for hormone regulation means: *[1 mark]*

A) Hormones always increase when triggered
B) The level of a hormone in blood regulates its own production
C) Hormones from the brain control muscles directly
D) All glands work together simultaneously

✔ **Answer: (B)** Feedback mechanism: When blood sugar rises, the pancreas detects this and produces MORE insulin to bring it down. As blood sugar falls, insulin secretion is reduced. This self-correcting loop (negative feedback) ensures hormone levels stay within a normal range.

Q20. Which of the following correctly describes the function of auxin in phototropism? *[1 mark]*

A) Auxin accumulates on the light side and makes cells grow faster there
B) Auxin moves to the shady side, making cells on that side grow longer, bending the plant toward light
C) Auxin is destroyed by light on the shaded side
D) Auxin blocks growth on both sides equally

✔ **Answer: (B)** When light hits from one side, auxin (synthesised at the shoot tip) diffuses to the SHADY side. The higher concentration of auxin on the shady side makes those cells grow LONGER than cells on the lit side. This unequal growth causes the shoot to bend TOWARD the light. (Roots bend away from light because high auxin inhibits root growth.)

SECTION B | *Assertion–Reason Questions | 1 Mark Each*

Directions: Select the correct option for each pair below:

(A) Both A and R are true, and R is the correct explanation of A.
(B) Both A and R are true, but R is NOT the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

Q1. *[1 mark]*

Assertion (A): Reflex actions are faster than voluntary actions.
Reason (R): In reflex actions, the nerve impulse travels via a reflex arc in the spinal cord, bypassing the brain and thus taking less time.

✔ **Answer: (A)** Both A and R are true, and R correctly explains A. Reflex arcs are short circuits in the spinal cord that allow a rapid motor response without waiting for the brain to process information. Voluntary actions must go through the brain's decision-making process, which is slower.

Q2. *[1 mark]*

Assertion (A): Deficiency of iodine in the diet leads to goitre.

Reason (R): Iodine is necessary for the synthesis of thyroxin by the thyroid gland. Without enough iodine, the thyroid gland enlarges in an attempt to produce more hormone.

✔ **Answer: (A)** Both A and R are true, and R perfectly explains A. When iodine is deficient, the thyroid cannot make enough thyroxin. The gland keeps growing larger (hypertrophy) in a compensatory attempt to make more hormone, resulting in a swollen neck (goitre).

Q3. *[1 mark]*

Assertion (A): The sensitive plant (Mimosa) movement is a tropism.

Reason (R): Tropisms are growth-based directional movements in plants. The Mimosa leaf movement involves change in cell turgor pressure, not growth.

✔ **Answer: (D)** A is false. The Mimosa movement is NOT a tropism — it is a nastic (non-directional) movement caused by changes in water content (turgor) of cells, not by growth. Tropisms (like phototropism, geotropism) are directional and growth-based. R is true.

Q4. *[1 mark]*

Assertion (A): Hormones in animals are effective in very small quantities.

Reason (R): Hormones act on specific target organs/cells that have receptors for them, so only a tiny amount reaching those targets is enough to trigger a response.

✔ **Answer: (A)** Both A and R are true, and R correctly explains A. Hormones are secreted in very small amounts into the blood, but because target cells have specific receptors, even trace amounts are enough to produce a full response. This is why hormones are often called "chemical messengers".

Q5. *[1 mark]*

Assertion (A): The fore-brain (cerebrum) is the main thinking part of the brain.

Reason (R): The fore-brain has sensory areas for hearing, sight, smell, and association areas that interpret information, make decisions, and send signals to motor areas for voluntary movement.

✔ **Answer: (A)** Both A and R are true and R correctly explains A. The cerebrum (fore-brain) is the largest part of the brain and is responsible for all conscious thought, sensory interpretation, voluntary movement, memory, and personality. It houses distinct zones for each sensory and motor function.

Q6. *[1 mark]*

Assertion (A): Auxin causes the shoot to bend toward light.

Reason (R): Auxin accumulates on the light-facing side of the shoot, causing faster growth there and bending the shoot toward light.

✔ **Answer: (C)** A is true — shoots DO bend toward light. R is false. Auxin actually accumulates on the SHADY side of the shoot (it moves away from light). The cells on the shady side grow LONGER due to more auxin, which bends the shoot TOWARD the light side. The error in R is that it says auxin accumulates on the light-facing side, which is incorrect.

Q7. *[1 mark]*

Assertion (A): The spinal cord is protected by the vertebral column (backbone).

Reason (R): Delicate nerve tissues of the spinal cord are surrounded by the bony vertebral column, which absorbs shocks and prevents damage.

✔ **Answer: (A)** Both A and R are true and R correctly explains A. Just as the brain is protected by the bony skull and a fluid-filled balloon (meninges + cerebrospinal fluid), the spinal cord is protected by the vertebral column (backbone). This bony casing protects the central nervous system from mechanical damage.

Q8. *[1 mark]*

Assertion (A): Insulin injections are given to patients with type 1 diabetes.

Reason (R): In type 1 diabetes, the pancreas fails to produce enough insulin, so blood sugar cannot be regulated. External insulin must be supplied.

✔ **Answer: (A)** Both A and R are true and R correctly explains A. Type 1 diabetes is an autoimmune condition where the beta cells of the pancreas that produce insulin are destroyed. Without insulin, glucose cannot enter cells and blood sugar rises dangerously. Daily insulin injections mimic the normal function of the pancreas.

SECTION C | *Short Answer Questions* | *2 Marks Each*

Write precise, point-form answers. 2 marks each.

Q1. What is a synapse? What happens at a synapse? *[2 marks]*

Answer:

A synapse is the microscopic gap (junction) between the axon terminal of one neuron and the dendrite of the next neuron.

At the synapse: When the electrical impulse reaches the axon terminal, it triggers the release of chemical substances called neurotransmitters. These chemicals cross the gap and bind to receptors on the dendrite of the next neuron, starting a new electrical impulse there.

Purpose: The synapse allows the nerve impulse to travel in ONE DIRECTION only (from axon to dendrite of next cell), preventing random backward signalling.

Q2. What is a reflex arc? Name its components in the correct order. *[2 marks]*

Answer:

A reflex arc is the pathway taken by a nerve impulse during a reflex action, connecting the receptor (sense organ) to the effector (muscle/gland) via the spinal cord, WITHOUT involving the brain.

Components in order:

Receptor (sense organ) → Afferent/Sensory nerve → Spinal cord (relay neuron) → Efferent/Motor nerve → Effector (muscle or gland)

Example: Touching a flame → pain receptor in skin → sensory nerve → spinal cord → motor nerve → arm muscle (pulls hand away).

Q3. Differentiate between phototropism and geotropism. Give one example of each. *[2 marks]*

Answer:

Phototropism: Directional growth of a plant part in response to LIGHT.

— Shoots show positive phototropism (grow toward light). Example: Sunflower shoot bends toward the sun.

Geotropism: Directional growth of a plant part in response to the force of GRAVITY.

— Roots show positive geotropism (grow downward, toward gravity). Example: Root of a germinating seedling grows into the soil regardless of its orientation.

Q4. What is the role of adrenaline in the human body? Name the gland that secretes it. *[2 marks]*

Answer:

Adrenaline (also called epinephrine) is the "fight or flight" hormone secreted by the adrenal glands (located above the kidneys) in stressful or emergency situations.

Effects of adrenaline: ① Increases heart rate → more oxygen to muscles ② Increases breathing rate ③ Diverts blood from digestive system/skin to skeletal muscles ④ Dilates pupils ⑤ Raises blood sugar for instant energy.

Overall effect: Prepares the body to either confront danger (fight) or escape from it (flight).

Q5. How does auxin cause a shoot to bend toward light? *[2 marks]*

Answer:

Auxin is a plant hormone synthesised at the shoot tip. When light falls from ONE side, auxin diffuses toward the SHADY side of the shoot.

On the shady side, higher auxin concentration stimulates cells to ELONGATE (grow longer) more than cells on the lit side.

This unequal growth — longer cells on the shady side, shorter on the lit side — causes the shoot to CURVE (bend) toward the source of light.

This is called positive phototropism and helps the plant maximise sunlight absorption for photosynthesis.

Q6. What are the three major regions of the human brain? Name ONE function of each. *[2 marks]*

Answer:

① Fore-brain (Cerebrum): The main thinking part. Controls all voluntary actions, intelligence, memory, sensory processing (hearing, sight, smell, taste). Also contains the hunger centre.

② Mid-brain: Controls some involuntary actions, reflex movements of the eye (pupil size), and connects forebrain to hindbrain.

③ Hind-brain: Contains the cerebellum (balance and coordination of voluntary movements) and medulla oblongata (controls involuntary actions — heartbeat, blood pressure, breathing, salivation).

Q7. Name four plant hormones and state whether each promotes or inhibits growth. *[2 marks]*

Answer:

① Auxin — Promotes growth (cell elongation in shoots). Inhibits root growth at high concentrations.

② Gibberellin — Promotes growth (stem elongation, seed germination, flowering).

③ Cytokinin — Promotes growth (cell division; found in high concentration in fruits and seeds).

④ Abscisic acid (ABA) — Inhibits growth (causes wilting of leaves, stomata to close, seed dormancy). Also called the "stress hormone".

Q8. What is goitre? How can it be prevented? *[2 marks]*

Answer:

Goitre is a disease characterised by the abnormal enlargement of the thyroid gland in the neck, causing a visible swelling.

Cause: Deficiency of iodine in the diet. Without iodine, the thyroid gland cannot produce enough thyroxin hormone. The gland grows larger in an attempt to compensate for the shortage.

Prevention: Regular consumption of iodised salt (table salt fortified with potassium iodide) ensures adequate iodine intake, preventing goitre. Seafood and dairy products are also natural iodine sources.

Q9. How is the human brain protected from injury? *[2 marks]*

Answer:

① Bony skull (cranium): The brain is enclosed in a hard bony box (the skull) which protects it from external mechanical injury.

② Fluid-filled balloon (meninges + cerebrospinal fluid): Inside the skull, the brain is surrounded by three protective membranes called meninges and is bathed in cerebrospinal fluid. This fluid acts as a shock absorber, cushioning the brain against sudden movements or impacts.

Similarly, the spinal cord is protected by the vertebral column (backbone), and is also surrounded by meninges and cerebrospinal fluid.

Q10. Why cannot plants use electrical impulses as their only means of communication like animals do? *[2 marks]*

Answer:

There are two key limitations of electrical impulses in plants:

① Electrical impulses can only travel through cells that are connected by nerve tissue. Plants do NOT have specialised nervous tissue, so electrical signals cannot reach every cell.

② Once a cell generates and transmits an electrical impulse, it needs time to "reset" before it can generate another. This means electrical impulses cannot provide continuous, persistent signals.

Therefore, plants primarily use chemical communication (plant hormones/phytohormones) which diffuse slowly but can reach all cells and act persistently. This explains why plant responses (like tropisms) are slower than animal nerve responses.

Q11. What is the role of the cerebellum? Name one condition that would occur if it was damaged. *[2 marks]*

Answer:

The cerebellum is a part of the hind-brain. It is responsible for:
① Maintaining posture and balance of the body.
② Coordinating and fine-tuning voluntary muscular movements (precision of movement).
Activities like riding a bicycle, writing, dancing, and walking in a straight line require the cerebellum.
If damaged: A person would lose coordination and balance. They might stagger while walking, have trembling hands, and be unable to perform precise movements — a condition called ataxia.

Q12. Compare how movement occurs in the leaves of a sensitive plant (Mimosa) and in the legs of a human. *[2 marks]*

Answer:

Mimosa leaf movement:
• Caused by change in turgor pressure (water content) of cells at the base of the leaf — cells lose water and shrink.
• No nervous tissue or muscle tissue involved.
• Information transmitted by electrical-chemical means from cell to cell (slowly).
• NOT growth-related; reversible rapidly.
Human leg movement:
• Caused by contraction of specialised muscle tissue (shortening of muscle cells due to rearrangement of proteins).
• Controlled by nerve impulses sent from the brain (voluntary) through motor nerves.
• Involves both nervous tissue AND muscle tissue working together.

SECTION D | *Short Answer Questions* | *3 Marks Each*

Write structured answers covering all key points. 3 marks each.

Q1. Draw and describe the structure of a neuron. Label any FOUR parts. State the function of each labelled part. [3 marks]

Structure of a Neuron:
A neuron (nerve cell) is the structural and functional unit of the nervous system.

[Diagram description for drawing — students must draw a neuron with these parts labelled:]

① Cell body (Cyton/Soma): Contains the nucleus and most cell organelles. It is the metabolic centre of the neuron and processes information.

② Dendrites: Short, branching projections from the cell body. They RECEIVE impulses (information) from other neurons or sense organs and carry them TO the cell body.

③ Axon: A long, single fibre extending from the cell body. It CARRIES the electrical impulse AWAY from the cell body toward the next neuron or effector organ. Can be up to 1 metre long in humans.

④ Axon terminal (Synaptic knob): The branched tip of the axon. When impulse arrives here, it releases neurotransmitter chemicals into the synapse to pass the signal to the next cell.

⑤ Myelin sheath (bonus): Fatty covering on the axon that insulates it and speeds up impulse conduction.

Direction of impulse: Dendrites → Cell body → Axon → Axon terminal → Synapse → Next neuron's dendrite

Q2. With the help of a flow diagram, explain what happens when you touch a hot object. Include the reflex arc pathway. [3 marks]

Response to touching a hot object — Reflex Action:

Step-by-step flow:

① STIMULUS: Hot object touches the skin of the hand.
↓
② RECEPTOR: Pain/heat receptors in the skin detect the stimulus. A chemical reaction creates an ELECTRICAL IMPULSE.
↓
③ AFFERENT (SENSORY) NERVE: The impulse travels from the receptor to the spinal cord via the sensory (afferent) neuron.
↓
④ SPINAL CORD (NERVE CENTRE): A relay neuron in the spinal cord processes the signal and immediately passes it to the motor neuron — this forms the REFLEX ARC. The same signal also travels up to the brain (so you FEEL the pain slightly after the hand has already moved).
↓
⑤ EFFERENT (MOTOR) NERVE: The impulse travels from the spinal cord to the arm muscles via the motor (efferent) neuron.
↓
⑥ EFFECTOR: The arm muscles contract and the hand is pulled away from the flame.
↓
⑦ RESPONSE: Hand is removed BEFORE the brain consciously decides — this is why reflex actions are faster than voluntary actions.

Key point: The reflex arc bypasses conscious brain processing, enabling a rapid protective response.

Q3. Describe the different types of tropisms in plants. Give one example for each type. [3 marks]

Tropism is the directional growth movement of a plant part in response to an external stimulus. Tropisms can be positive (toward stimulus) or negative (away from stimulus).

① Phototropism — Response to LIGHT:
• Shoots: Positive phototropism — grow toward light.
• Roots: Negative phototropism — grow away from light.
• Example: A shoot in a box with a hole bends toward the hole (light source).
• Mechanism: Auxin redistribution causes unequal cell growth.

② Geotropism — Response to GRAVITY:
• Roots: Positive geotropism — grow downward (toward gravity).
• Shoots: Negative geotropism — grow upward (away from gravity).
• Example: A germinating seed always sends roots downward into the soil regardless of orientation.

③ Hydrotropism — Response to WATER:
• Roots: Positive hydrotropism — grow toward moisture.
• Example: Plant roots grow toward a water source underground.

④ Chemotropism — Response to CHEMICAL stimuli:
• Example: Pollen tube grows toward the ovule, guided by chemical substances secreted by the ovule.

⑤ Thigmotropism — Response to TOUCH:
• Example: Tendrils of pea plants grow around a support they come in contact with (the shaded side grows faster due to auxin, causing it to curl around the support).

Q4. Explain the role of hormones in the human body using THREE specific examples. [3 marks]

Hormones are chemical messengers produced by endocrine glands, secreted directly into the blood, and transported to target organs to coordinate body functions.

Example 1 — Insulin (Pancreas):
• Controls blood sugar levels. When blood sugar rises after a meal, the pancreas releases insulin, which helps cells absorb glucose and lowers blood sugar.
• Deficiency: Diabetes mellitus — blood sugar stays dangerously high. Treatment: insulin injections.

Example 2 — Thyroxin (Thyroid gland):
• Regulates metabolism (rate at which the body uses carbohydrates, proteins, and fats for energy and growth).
• Requires iodine for its synthesis.
• Deficiency of iodine → insufficient thyroxin → goitre (enlarged thyroid).

Example 3 — Adrenaline (Adrenal glands):
• Secreted during emergencies (fear, danger, excitement).
• Increases heart rate, breathing rate, blood supply to muscles; diverts blood from digestive system.
• Prepares body for "fight or flight" response.
• Example: When you hear a sudden loud noise, your heart races — this is adrenaline in action.

Q5. What is meant by "coordination" in organisms? Compare how coordination happens in (i) a single-celled organism like Amoeba, (ii) a plant, and (iii) a human being. [3 marks]

Coordination means the ability of an organism to respond appropriately to changes in the environment by integrating information and producing the correct response.

(i) Amoeba (Unicellular organism):
• Has no nervous system or specialised coordination tissue.
• Coordination is entirely at the cellular level — chemical changes within the single cell control its movement and response.
• Example: Amoeba extends pseudopodia toward food by detecting chemical gradients — coordination is via simple chemical signals within the cell itself.

(ii) Plants (Multicellular, no nervous system):
• Plants have no nervous tissue or muscles.
• Use CHEMICAL coordination via plant hormones (phytohormones like auxin, gibberellin, cytokinin, abscisic acid).
• Hormones are produced in one part and diffuse to another.
• Responses are slower — growth-related (tropisms) or turgor-based (Mimosa).

(iii) Human beings (Complex multicellular animal):
• Use TWO coordination systems working together:
— Nervous system: Fast electrical impulses through neurons for immediate responses (reflexes, voluntary actions).
— Endocrine system: Slower chemical coordination via hormones in blood for long-term regulation (growth, metabolism, reproduction).
• Both systems ensure that all organs function in a perfectly integrated, timed manner.

Q6. Name the endocrine glands in humans and the hormones they secrete. Complete the following table: [3 marks]

Table: Endocrine Glands and Their Hormones

Endocrine Gland → Hormone → Key Function:

① Pituitary gland → Growth Hormone (GH) → Regulates growth and development of all body organs. Deficiency in childhood causes dwarfism.

② Thyroid gland → Thyroxin → Regulates carbohydrate, protein, fat metabolism. Needs iodine for synthesis.

③ Pancreas → Insulin → Regulates blood sugar (glucose) levels. Deficiency causes diabetes mellitus.

④ Adrenal glands → Adrenaline → Emergency/fight-or-flight hormone. Increases heart rate, breathing; redirects blood to muscles.

⑤ Testes (male) → Testosterone → Controls development of male secondary sexual characters at puberty (facial hair, voice change, muscle development).

⑥ Ovaries (female) → Oestrogen → Controls development of female secondary sexual characters at puberty and regulates the menstrual cycle.

⑦ Hypothalamus → Releasing hormones → Stimulates the pituitary gland to release specific hormones (e.g., growth hormone releasing factor).

SECTION E | *Case-Based / Competency Questions* | *4 Marks Each*

Read each passage carefully and answer ALL sub-questions.

Case Study 1: The Emergency Signal

> *Mia was crossing the road when a car suddenly appeared from around a corner. Her heart immediately began to race, her breathing became rapid, and she felt a rush of energy. She jumped out of the way almost before she consciously realised what had happened. Later, her biology teacher explained that her body had released a very important hormone that prepared her for that split-second response.*

(i) Name the hormone and the gland that secreted it. [1 mark]

Hormone: Adrenaline (epinephrine). Gland: Adrenal glands (a pair of glands located just above each kidney). Adrenaline is secreted directly into the bloodstream in response to the emergency (sudden danger).

(ii) List any THREE physiological changes that occurred in Mia's body when this hormone was released. [1 mark]

① Heart rate increased → more blood/oxygen pumped to muscles.
② Breathing rate increased → more O_2 into blood.
③ Blood diverted from digestive system/skin to skeletal muscles → muscles get more fuel.
(Additional effects: pupils dilated, blood sugar levels rose for quick energy, adrenalin alert state.)

(iii) Mia pulled her hand away even before her brain consciously registered danger. Which system is responsible for such rapid responses? [1 mark]

This rapid response is due to the nervous system — specifically a REFLEX ARC. When the stimulus (sight of car) was detected, nerve impulses were processed at the spinal cord level, triggering an immediate motor response (jumping away) before the brain had time to consciously process the situation. Reflexes are faster than voluntary (brain-controlled) actions.

(iv) What is the term used for Mia's response — "fight or flight"? Why is this response important for survival? [1 mark]

This is called the "fight or flight" response, triggered by adrenaline in situations of danger or excitement.

Importance for survival: It rapidly prepares the body to either confront the threat (fight) or escape from it (flight) by maximising energy available to muscles, sharpening senses, and temporarily shutting down non-essential functions (like digestion). This response evolved to help animals survive predatory attacks and emergencies — without it, the body's reaction time would be too slow to avoid danger.

Case Study 2: The Plant Detective

> *A gardener noticed that all the plants near a window were growing at an angle, with their shoots leaning toward the glass. He decided to experiment. He placed three identical seedlings: one near a window (light from one side), one under a lamp directly above, and one in a dark cupboard. After 10 days, the window seedling had bent toward the window, the lamp seedling grew straight upward, and the dark seedling grew in various directions without pattern.*

(i) Name the type of movement shown by the window seedling. Which hormone causes this? [1 mark]

The window seedling shows PHOTOTROPISM (positive phototropism — bending toward light).

Hormone responsible: AUXIN. Auxin is synthesised at the shoot tip and moves to the shady side of the shoot when light comes from one direction. Higher auxin on the shady side causes those cells to elongate more, bending the shoot toward light.

(ii) Explain why the lamp seedling grew straight upward. [1 mark]

When light comes from DIRECTLY ABOVE (uniformly), auxin is distributed EQUALLY on all sides of the shoot. Since all sides receive the same auxin concentration, cell elongation is equal on all sides, and the shoot grows straight up without bending in any direction. This confirms that bending is caused by unequal auxin distribution, not by light itself.

(iii) The roots of all three plants grew downward into the soil regardless of the plant's orientation. What type of movement is this? Explain why it is important. [1 mark]

This is GEOTROPISM (positive geotropism in roots — growing in the direction of gravity, downward).

Importance: ① Roots growing downward anchor the plant firmly in the soil. ② They reach moisture and mineral-rich deeper soil layers. ③ This is an automatic, pre-programmed response that ensures roots always find their way to the correct zone in the soil without the plant needing to "decide".

(iv) The dark seedling grew randomly. What does this tell us about how plant growth direction is controlled? [1 mark]

The dark seedling growing in random directions confirms that DIRECTIONAL GROWTH (tropism) in plants requires an external directional stimulus (like light or gravity). Without a directional cue:

- Auxin is distributed randomly, causing random cell elongation.
- No organised directional growth occurs.

This tells us that plant movement is not pre-programmed in a fixed direction but is RESPONSIVE to environmental signals. The shoot NEEDS a directional gradient (of light or gravity) to grow in a coordinated direction.

Case Study 3: The Coordination Clinic

> *Dr. Sharma is evaluating three patients: • Patient A: Cannot balance when walking and stumbles frequently. • Patient B: Cannot control heartbeat or breathing voluntarily, but these are happening abnormally slowly. • Patient C: Cannot feel sensations on the left side of the body and cannot move the left arm voluntarily, but reflexes work normally.*

(i) Which part of the brain is likely damaged in Patient A? Explain. [1 mark]

Patient A likely has damage to the CEREBELLUM (part of the hind-brain).

The cerebellum controls precision of voluntary movements and maintains posture and balance. When it is damaged, a person loses the ability to walk steadily, stumbles, and cannot coordinate fine movements — a condition called ataxia. Note: reflexes are controlled by the spinal cord, so reflex testing would still be normal.

(ii) Which part of the brain controls the involuntary functions affected in Patient B? [1 mark]

Patient B has damage to the MEDULLA OBLONGATA (part of the hind-brain).

The medulla controls involuntary (autonomic) functions including heartbeat, breathing rate, blood pressure, salivation, and vomiting. Damage to the medulla can cause abnormally slow or irregular heartbeat and breathing, which can be life-threatening. These functions are "automatic" and do not require conscious thought.

(iii) Which area of the brain is affected in Patient C? [1 mark]

Patient C has damage to the FORE-BRAIN (cerebrum/cerebral cortex).

Specifically, sensory areas (for processing sensations like touch, pain, temperature from the left side of the body) and motor areas (for controlling voluntary movement of the left arm) appear to be affected. Note that the right side of the brain controls the left side of the body in humans (contralateral control). Since reflexes are normal, the spinal cord is intact.

(iv) Explain the difference between voluntary and involuntary actions, with one example of each. [1 mark]

Voluntary actions: Actions that require conscious thought and decision-making by the brain (fore-brain). A person can choose to perform or stop them.

Example: Writing, speaking, picking up a glass.

Involuntary actions: Actions controlled by the mid-brain and hind-brain (medulla) that happen WITHOUT conscious control. We cannot normally start or stop them by thinking.

Example: Heartbeat, breathing, digestion movements, salivation.

Note: Reflex actions are a special type — they involve the spinal cord and bypass the brain entirely, making them fastest of all.

SECTION F | *Long Answer Questions | 5 Marks Each*

Write detailed, structured answers covering all key points. 5 marks each.

Q1. (a) Draw a labelled diagram of a neuron and describe its functions. (b) Explain how a nerve impulse travels from a receptor to an effector during a reflex action. (c) Why is it important that reflexes bypass the brain? [5 marks]

(a) Neuron Structure and Function [2 marks]:

A neuron is the structural and functional unit of the nervous system.

[Draw a neuron with the following labels:]

- Dendrites — Receive impulses from other neurons or sense organs; carry them toward the cell body.
- Cell body (Cyton) — Contains the nucleus; metabolic centre of the neuron; integrates signals.
- Axon — Long single fibre; carries impulse AWAY from cell body to the next cell.
- Myelin sheath — Fatty insulation around axon; speeds up impulse transmission.
- Axon terminal (Synaptic knob) — Releases neurotransmitter chemicals into the synapse.
- Synapse — Gap between axon terminal of one neuron and dendrite of next; allows one-way signal transfer.

Direction of impulse in a single neuron:

Dendritic tip → Cell body → Axon → Axon terminal → Synapse → Next neuron

(b) Pathway of nerve impulse during a reflex action [2 marks]:

Step 1: A hot object touches the skin (stimulus).

Step 2: Heat/pain RECEPTORS in the skin detect the stimulus. A chemical reaction generates an ELECTRICAL IMPULSE.

Step 3: The impulse travels along the SENSORY (AFFERENT) NEURON toward the spinal cord.
Step 4: In the spinal cord, a RELAY NEURON connects the sensory neuron to the motor neuron — forming the REFLEX ARC. The signal simultaneously goes to the brain (so we feel pain later).
Step 5: The impulse travels from the spinal cord along the MOTOR (EFFERENT) NEURON to the arm muscles.
Step 6: The EFFECTOR (arm muscle) contracts, and the hand is pulled away — the RESPONSE.

Complete pathway:
Receptor → Sensory nerve → Spinal cord → Motor nerve → Effector

(c) Importance of bypassing the brain [1 mark]:

If the signal had to travel all the way to the brain, be processed consciously, and then a decision sent back to the muscles, it would take significantly longer. During that time, the hand would already be burning. By creating a shortcut through the spinal cord, the reflex arc allows the response to happen in a fraction of a second — BEFORE the brain is even fully aware of the pain. This rapid protective mechanism has evolved to prevent serious injury. Reflex arcs are especially important for animals with simple nervous systems that lack complex brains.

Q2. (a) Describe the human brain with a diagram. Label the major parts and state the function of each. (b) How is the brain protected from damage? [5 marks]

(a) Human Brain — Structure and Functions [4 marks]:

[Draw the human brain showing: Cerebrum (fore-brain), Cerebellum (hind-brain), Medulla oblongata (hind-brain), Pons, Mid-brain, Spinal cord connection]

The brain has THREE major regions:

Region 1 — FORE-BRAIN (Cerebrum):
• The largest and most developed part of the human brain.
• SENSORY AREAS: Receive and interpret impulses from all sense organs — hearing (auditory cortex), sight (visual cortex), smell (olfactory area), taste, touch.
• ASSOCIATION AREAS: Integrate sensory information with memory, compare and interpret it.
• MOTOR AREAS: Send signals to voluntary muscles for controlled movement (writing, talking, walking).
• HYPOTHALAMUS: Controls hunger, thirst, temperature, sleep cycles, and regulates the pituitary gland.
• The cerebrum controls: All conscious thought, memory, intelligence, personality, language, voluntary movements.

Region 2 — MID-BRAIN:
• Connects the fore-brain to the hind-brain.
• Controls some involuntary actions including reflex movements of the eye (pupil dilation/constriction in response to light).

Region 3 — HIND-BRAIN:
• (i) Cerebellum: Coordinates and fine-tunes voluntary movements; maintains balance and posture. Critical for activities like cycling, dancing, writing.
• (ii) Pons: Connects different parts of the brain; involved in sleep regulation.
• (iii) Medulla oblongata: Controls ALL involuntary (autonomic) functions — heartbeat, blood pressure, breathing, salivation, swallowing, vomiting. Damage to medulla is fatal.

(b) Protection of the brain [1 mark]:
① Bony skull (cranium): The rigid bony skull completely encloses the brain, protecting it from mechanical trauma.
② Meninges (3 protective membranes): Three layers of membrane (dura mater, arachnoid, pia mater) surround the brain.
③ Cerebrospinal fluid (CSF): A clear fluid fills the space between the meninges and surrounds the brain, acting as a shock absorber against sudden jolts or impacts.

Analogy: The brain is like a precious object inside a hard box (skull) padded with foam (CSF in meninges).
The spinal cord is similarly protected by the vertebral column (backbone) and meninges/CSF.

Q3. (a) What are plant hormones? Name them and state their functions. (b) Compare chemical coordination in plants and animals. [5 marks]

(a) Plant Hormones (Phytohormones) — Names and Functions [3 marks]:

Plant hormones are chemical substances produced in small quantities in one part of a plant and transported to another part where they control growth, development, and responses to the environment.

① AUXIN:
• Produced at the shoot tip.
• Promotes cell elongation in stems.
• Causes phototropism — accumulates on shady side, making cells there grow longer → plant bends toward light.
• In roots, high auxin INHIBITS growth (roots need very little auxin).
• Controls apical dominance (main shoot suppresses lateral buds).

② GIBBERELLINS:
• Promote stem elongation (internodal growth).
• Stimulate seed germination and flowering.
• Help break seed dormancy.
• Commercial use: Increase fruit/vegetable size in agriculture.

③ CYTOKININS:
• Promote cell division (cytokinesis).
• Found in high concentrations in actively dividing tissues — fruits, seeds, growing root tips.
• Delay leaf ageing (senescence).
• Promote lateral bud growth.

④ ABSCISIC ACID (ABA) — Inhibitor:
• Causes wilting of leaves (promotes leaf fall/abscission).
• Closes stomata during water stress (drought response).
• Promotes seed dormancy (seeds do not germinate until conditions are right).
• Called the "stress hormone" of plants.

(b) Comparison: Chemical coordination in Plants vs Animals [2 marks]:

Plants:
• Use ONLY chemical coordination (hormones) — no nervous system.
• Hormones diffuse slowly through plant tissue (no blood vessels, no nerves).
• Responses are SLOW (minutes to days) — tropisms, growth movements.
• Hormones act locally or at short distances.
• No specialised endocrine glands — hormones produced in ordinary plant cells.
• Examples: Auxin, gibberellin, cytokinin, ABA.

Animals:
• Use BOTH nervous system (electrical) AND endocrine system (chemical) in coordination.
• Hormones travel rapidly through BLOOD to target organs throughout the body.
• Responses can be fast (nervous) or slow and sustained (hormonal).
• Specialised endocrine glands produce specific hormones.
• Hormones are regulated by feedback mechanisms.

• Examples: Insulin, thyroxin, adrenaline, growth hormone.

Q4. (a) What is the endocrine system? How does it differ from the nervous system in controlling body functions? (b) Explain the feedback mechanism of hormone regulation with an example. [5 marks]

(a) Endocrine System vs Nervous System [3 marks]:

The endocrine system is a collection of ductless glands that secrete hormones directly into the bloodstream to coordinate and regulate body functions over longer time periods.

Comparison Table:

Feature | Nervous System | Endocrine System
Messengers | Electrical impulses (nerve impulses) | Chemical messengers (hormones)
Speed | Very fast (milliseconds) | Slow (minutes to hours)
Duration | Short-lived, immediate effect | Long-lasting, sustained effect
Path | Through nerve fibres (neurons) | Through blood vessels
Target | Specific nerve/muscle/gland | Any cell in body with the right receptor
Control of | Rapid responses, reflexes, voluntary actions | Growth, metabolism, reproduction, long-term balance
Example | Withdrawing hand from flame | Insulin controlling blood sugar over hours

Both systems work TOGETHER in many situations — for example, the hypothalamus in the brain controls the pituitary gland (endocrine), linking the two systems. This is called the neuro-endocrine coordination.

(b) Feedback Mechanism [2 marks]:

The feedback mechanism ensures that hormone levels in the blood stay within a narrow, healthy range. It works like a thermostat — when the desired level is reached, production stops; when it falls, production resumes.

Example 1 — Insulin and Blood Sugar:
• After a meal, blood GLUCOSE LEVELS RISE.
• Detected by beta cells of the PANCREAS.
• Pancreas secretes MORE INSULIN.
• Insulin helps cells absorb glucose → blood sugar FALLS.
• When blood sugar returns to normal, insulin secretion DECREASES.
• Result: Blood sugar is maintained at a stable level (~80–120 mg/dL).

Example 2 — Growth Hormone:
• When GH level in blood is LOW, the hypothalamus releases "Growth Hormone Releasing Factor" (GHRF).
• GHRF stimulates the pituitary gland to release more GH.
• When GH level rises high enough, GHRF production is suppressed (negative feedback).
• This self-regulating loop prevents overproduction or underproduction of hormones.

Importance: Without feedback regulation, hormones would either be produced in excess (causing diseases like gigantism from excess GH) or deficiency (causing dwarfism from insufficient GH).

SECTION G | *Very Short Answer (VSA) | 1 Mark Each | Rapid Fire Round*

One-line answers. Directly asked in CBSE papers 2019–2025.

Q1. Name the structural and functional unit of the nervous system.

Ans: Neuron (nerve cell).

Q2. What is the function of dendrites in a neuron?

Ans: Dendrites receive nerve impulses (information) from other neurons or sense organs and carry them toward the cell body.

Q3. What part of the brain is responsible for thinking?

Ans: Fore-brain (Cerebrum / Cerebral cortex).

Q4. Name the part of the neuron where neurotransmitters are released.

Ans: Axon terminal (synaptic knob). Neurotransmitters are released into the synapse to transmit the impulse to the next neuron.

Q5. What is phototropism?

Ans: Phototropism is the directional growth movement of a plant part in response to light. Shoots grow toward light (positive phototropism); roots grow away from light (negative phototropism).

Q6. Which hormone is called the "emergency hormone" and why?

Ans: Adrenaline is called the emergency hormone because it is secreted by the adrenal glands in stressful/dangerous situations and rapidly prepares the body for "fight or flight" response.

Q7. What causes goitre?

Ans: Deficiency of iodine in the diet, which prevents adequate synthesis of thyroxin by the thyroid gland, causing the thyroid gland to enlarge (goitre/swollen neck).

Q8. Name the hormone that regulates blood sugar levels and name the gland that produces it.

Ans: Insulin; produced by the pancreas (specifically by the beta cells of the islets of Langerhans).

Q9. What is the role of the medulla oblongata?

Ans: Controls involuntary (autonomic) actions including heartbeat, breathing rate, blood pressure, salivation, swallowing, and vomiting.

Q10. What is geotropism?

Ans: Geotropism is the directional growth of a plant part in response to gravity. Roots show positive geotropism (grow downward); shoots show negative geotropism (grow upward).

Q11. Why is the pituitary gland called the "master gland"?

Ans: Because the pituitary gland secretes hormones that control and regulate the activity of many other endocrine glands in the body (e.g., it releases hormones that stimulate thyroid, adrenal cortex, gonads).

Q12. What change occurs in plant cells to produce the Mimosa touch response?

Ans: Change in turgor pressure — cells lose water rapidly, causing them to shrink and change shape, making the leaf fold. This is NOT due to growth.

Q13. Define: Tropic movement in plants.

Ans: A tropic movement is a directional growth response of a plant to an external stimulus (light, gravity, water, chemicals, touch) — it can be positive (toward stimulus) or negative (away from stimulus).

Q14. What is the function of the cerebellum?

Ans: Controls and coordinates voluntary movements (balance, posture, precision of actions like walking straight, writing, cycling).

Q15. Name the gland and hormone responsible for dwarfism in humans.

Ans: Gland: Pituitary gland. Hormone: Growth hormone (GH). Deficiency of GH during childhood causes dwarfism.

Q16. What are gustatory and olfactory receptors?

Ans: Gustatory receptors detect taste (located on the tongue). Olfactory receptors detect smell (located in the nasal cavity). Both send signals to the brain for sensory perception.

Q17. How do plant cells transmit information without a nervous system?

Ans: Plant cells use electrical-chemical means — a change in one cell creates a chemical/electrical signal that passes to adjacent cells. For long-distance coordination, plant hormones (phytohormones) are used.

Q18. What is a feedback mechanism in the context of hormones?

Ans: A self-regulating system where the blood level of a hormone controls the rate of its own production. E.g., rising blood sugar → pancreas makes more insulin; falling blood sugar → insulin production reduces.

Q19. Name the hormone that helps the pea plant tendril wrap around a support.

Ans: Auxin. The tendril part that touches the support has less auxin (grows slower); the opposite side has more auxin (grows faster) → causing the tendril to curve around the support. This is called thigmotropism.

Q20. What would happen to a person if the spinal cord was cut at the neck level?

Ans: The person would lose all voluntary movement and sensation below the neck (quadriplegia). Reflex actions below the cut would still occur (spinal cord reflexes don't need the brain), but all voluntary control would be lost. Involuntary functions (heartbeat, breathing via medulla) may also be affected.

⚡ QUICK REVISION | KEY FACTS & TABLES | *Chapter 6: Control and Coordination*

Hormone Reference Table

Hormone	Gland	Function / Deficiency Effect
Growth Hormone	Pituitary	Stimulates growth of all organs. Deficiency → dwarfism; excess → gigantism
Thyroxin	Thyroid	Regulates metabolism (carb/protein/fat). Deficiency + iodine lack → goitre
Insulin	Pancreas	Lowers blood sugar. Deficiency → diabetes mellitus
Adrenaline	Adrenal glands	Fight-or-flight. ↑Heart rate, ↑breathing, redirects blood to muscles
Testosterone	Testes	Male puberty: facial hair, voice deepening, muscle growth
Oestrogen	Ovaries	Female puberty, menstrual cycle regulation, breast development
Abscisic Acid	Plant cells	Growth inhibitor: wilting, stomata closure, seed dormancy
Auxin	Shoot tip	Cell elongation in shoots; phototropism; thigmotropism in tendrils
Gibberellin	Plant cells	Stem elongation, seed germination, breaking dormancy
Cytokinin	Plant cells	Cell division; found in fruits/seeds; delays leaf ageing

Key Facts to Remember

Fact / Concept	Key Detail
Reflex arc path	Receptor → Sensory nerve → Spinal cord → Motor nerve → Effector (muscle/gland)
Brain protection	Skull (bony box) + meninges + cerebrospinal fluid (shock absorber)
Spinal cord protection	Vertebral column (backbone) + meninges + cerebrospinal fluid
CNS	Brain + Spinal cord
PNS	Cranial nerves (from brain) + Spinal nerves (from spinal cord)
Forebrain function	Thinking, memory, voluntary actions, sensory processing, hunger/thirst
Cerebellum function	Balance, posture, precision of voluntary movements
Medulla function	Involuntary: heartbeat, BP, breathing, salivation, vomiting

Synapse	Gap between two neurons; electrical → chemical → electrical signal transfer
Nastic movement	Non-directional movement (e.g., Mimosa folding) — turgor-based, not growth
Tropism	Directional growth in response to stimulus (photo/geo/hydro/chemo/thigmo)
Feedback mech.	Blood level of hormone controls its own production (e.g., insulin ↑ when glucose ↑)

C H A P T E R

7

How do Organisms Reproduce?

Asexual Reproduction • Sexual Reproduction • Human Reproductive Systems • Reproductive Health

★★★★★ **Marks Weightage: Very High**

Sections: A (MCQ) • B (Assertion-Reason) • C–D (Short Answer) • E (Case-Based) • F (Long Answer) • VSA • Quick Revision

AlphaLearn StudyLab

CBSE Class 10 | Science (Biology)

CHAPTER 7
HOW DO ORGANISMS REPRODUCE?

Master Question Bank ● Board Exam 2027 Pattern

📊 CBSE EXAM TREND ANALYSIS (2019–2026) | *Chapter 7: How do Organisms Reproduce?*

Topic-wise Prediction for 2027

Topic	Marks Asked/Year	Format	Prediction 2027
Asexual Reproduction Methods	3–5 marks	Tabulate / Compare / Define	★★★★★ Very High
Male Reproductive System (Human)	3–5 marks	Diagram + Label + Function	★★★★★ Very High
Female Reproductive System (Human)	3–5 marks	Diagram + Label + Function	★★★★★ Very High
Menstruation – Why it Occurs	2–3 marks	SA / AR / Case-based	★★★★★ Very High

Sexual Repro. in Flowering Plants	3–5 marks	Diagram + Pollination + Fertilisation	★★★★★ Very High
Placenta – Structure & Function	2–3 marks	SA / Case-based	★★★★☆ High
Vegetative Propagation	2–3 marks	Advantages + Examples	★★★★☆ High
Contraceptive Methods	1–2 marks	List / AR / MCQ	★★★★☆ High
Variation & Importance in Repro.	1–2 marks	MCQ / AR / VSA	★★★☆☆ Medium
STDs & Reproductive Health	1–2 marks	MCQ / SA	★★★☆☆ Medium

✦ Male and Female reproductive system diagrams are asked in EVERY board paper — draw and label both perfectly.
✦ Menstruation explanation (why it occurs when egg is NOT fertilised) is the most consistently asked 2-3 mark question.
✦ Comparison table of asexual reproduction types is a 3-mark favourite — know all 6 types with organism examples.
✦ Placenta structure and function appears in case-based questions from 2022 onwards.
✦ Advantages of sexual reproduction over asexual = key 3-mark question. Memorise clearly.

SECTION A | *Multiple Choice Questions* | *1 Mark Each*

Instructions: Choose the BEST option. All questions carry 1 mark.

Q1. Asexual reproduction through budding takes place in: *[1 mark]*

A) Amoeba
B) Plasmodium
C) Yeast
D) Spirogyra

✔ **Answer: (C)** Yeast (a unicellular fungus) reproduces asexually by budding — a small outgrowth (bud) forms on the parent cell, grows, and detaches to become a new individual. Hydra also reproduces by budding among multicellular organisms. Amoeba undergoes binary fission; Plasmodium undergoes multiple fission; Spirogyra undergoes fragmentation.

Q2. Which of the following is NOT a part of the female reproductive system in humans? *[1 mark]*

A) Ovary
B) Vas deferens
C) Fallopian tube
D) Uterus

✔ **Answer: (B)** Vas deferens (also called sperm duct) is part of the MALE reproductive system. It carries sperms from the testes to the urethra. The female reproductive system consists of ovaries (produce eggs), fallopian tubes (transport egg), uterus (site of development of embryo), cervix, and vagina.

Q3. The anther in a flower contains: *[1 mark]*

A) Ovules
B) Sepals
C) Pollen grains
D) Pistil

✔ **Answer: (C)** The anther is the top part of the stamen (male reproductive part of a flower). It produces and contains pollen grains, which carry the male gametes. Ovules are found inside the ovary (female part). Sepals are the green leaf-like structures at the base of the flower.

Q4. Fertilisation in human beings occurs in the: *[1 mark]*

A) Uterus
B) Ovary
C) Fallopian tube (oviduct)
D) Vagina

✔ **Answer: (C)** The egg released from the ovary travels through the fallopian tube (oviduct). Sperms travel upward from the vagina through the uterus and enter the fallopian tube. If a sperm meets the egg in the fallopian tube, fertilisation occurs, forming a zygote. The zygote then moves to the uterus for implantation.

Q5. Menstruation is the result of: *[1 mark]*

A) Fertilisation of the egg
B) Release of a new egg from the ovary
C) Breakdown of the uterine lining when fertilisation does not occur
D) Implantation of the embryo

✔ **Answer: (C)** Each month the uterine lining thickens with blood supply, ready to receive a fertilised egg. If fertilisation does NOT occur, the egg lives for about a day and the lining is not needed. The thickened lining slowly breaks down and is expelled as blood and mucous through the vagina over 2–8 days — this is menstruation.

Q6. The malarial parasite (Plasmodium) reproduces by: *[1 mark]*

A) Binary fission
B) Budding
C) Multiple fission
D) Fragmentation

✔ **Answer: (C)** Plasmodium (cause of malaria) undergoes MULTIPLE FISSION — the nucleus divides many times, and then the cell divides simultaneously into many daughter cells. This is why malaria symptoms come in waves — Plasmodium releases many cells at once into the blood. Leishmania uses binary fission in a definite plane. Amoeba uses binary fission in any plane.

Q7. Which of the following is a method of vegetative propagation? *[1 mark]*

A) Spore formation in Rhizopus
B) Binary fission in bacteria
C) Leaf buds in Bryophyllum
D) Budding in yeast

✔ **Answer: (C)** Vegetative propagation is asexual reproduction using plant parts (root, stem, or leaf). Bryophyllum (Kalanchoe) produces tiny plantlets in the notches along its leaf margins. When these fall on moist soil, they grow into new plants. Options A, B, and D are reproductive methods of microorganisms, not vegetative propagation.

Q8. The special tissue that provides nutrition from mother to embryo in the uterus is: *[1 mark]*

A) Amnion
B) Placenta
C) Fallopian tube
D) Cervix

✔ **Answer: (B)** The placenta is a disc-shaped structure embedded in the uterine wall. On the embryo's side, it has finger-like villi. On the mother's side, blood spaces surround the villi, providing a large surface area for exchange. Glucose and oxygen pass from mother to embryo; waste products pass from embryo to mother's blood through the placenta.

Q9. Why are testes located outside the abdominal cavity in the scrotum? *[1 mark]*

A) For easy access during sexual reproduction
B) To protect them from mechanical damage
C) Sperm formation requires a temperature lower than normal body temperature
D) To increase blood supply to the testes

✔ **Answer: (C)** Sperm formation (spermatogenesis) requires a temperature about 2°C LOWER than the normal body temperature (37°C). The scrotum (outside the body) provides this cooler environment. This is why testes descend from the abdomen into the scrotum before birth — if they remain inside (undescended testes), infertility can result.

Q10. Reproduction in Spirogyra takes place by: *[1 mark]*

A) Budding
B) Fragmentation
C) Binary fission
D) Spore formation

✔ **Answer: (B)** Spirogyra (a filamentous green alga found in ponds) reproduces asexually by FRAGMENTATION. The filament breaks into smaller pieces upon maturation, and each fragment (piece) grows into a new individual. This works because Spirogyra has a relatively simple body organisation without specialised tissues.

Q11. Self-pollination means transfer of pollen from: *[1 mark]*

A) One plant to another of the same species
B) One species to another species
C) The anther to the stigma of the SAME flower
D) The stigma to the anther of the same flower

✔ **Answer: (C)** Self-pollination: pollen is transferred from the anther to the stigma of THE SAME flower (or the same plant). Cross-pollination: pollen transferred from the anther of one flower to the stigma of ANOTHER flower — achieved by agents like wind, water, insects, or birds. Cross-pollination promotes genetic variation.

Q12. Regeneration as seen in Hydra and Planaria is: *[1 mark]*

A) Always the normal method of reproduction
B) A method of sexual reproduction
C) Carried out by specialised cells that can differentiate into all cell types
D) Possible only in vertebrate animals

✔ **Answer: (C)** Regeneration in Hydra/Planaria is carried out by specialised, undifferentiated cells. When the organism is cut, these cells proliferate, make large numbers of cells, and then differentiate in an organised sequence to form all the different cell types and tissues needed to grow a complete new organism. Regeneration is not the normal mode of reproduction — it is a response to injury.

Q13. Which of the following prevents both STDs and unwanted pregnancy? *[1 mark]*

A) Copper-T
B) Oral contraceptive pills
C) Condom
D) Surgical methods

✔ **Answer: (C)** A condom (barrier method) is the ONLY contraceptive that protects against BOTH sexually transmitted diseases (STDs) AND unwanted pregnancy. It prevents the exchange of bodily fluids and direct skin contact. Copper-T, pills, and surgical methods prevent pregnancy but do NOT protect against STDs.

Q14. DNA copying occurs during reproduction to ensure: *[1 mark]*

A) The new organism is genetically identical to the parent
B) The information for body design is passed to the next generation
C) Faster growth of the new organism
D) Resistance to diseases in the next generation

✔ **Answer: (B)** The primary purpose of DNA copying in reproduction is to pass on the BLUEPRINT for body design (genetic information) to the next generation. Without copying the DNA, the new cell would have no instructions for building and maintaining its body. Note: copies are similar but NOT identical due to small variations — these variations are the basis of evolution.

Q15. In a flower, after fertilisation, the ovule develops into a ___ and the ovary develops into a ___. *[1 mark]*

A) Seed; Fruit
B) Fruit; Seed
C) Embryo; Seed

D) Seed; Pollen

✔ **Answer: (A)** After fertilisation: The ZYGOTE divides to form an EMBRYO inside the OVULE → OVULE develops a tough coat and becomes a SEED. The OVARY grows, ripens, and becomes the FRUIT. The seed contains the embryo (future plant). Meanwhile, sepals, petals, stamens, style, and stigma usually wither and fall off.

Q16. Germ cells (sex cells) in sexually reproducing organisms contain: *[1 mark]*

A) Twice the number of chromosomes of body cells
B) The same number of chromosomes as body cells
C) Half the number of chromosomes of body cells
D) No chromosomes at all

✔ **Answer: (C)** Germ cells (sperm and egg) contain HALF the number of chromosomes (haploid, n) compared to normal body cells (diploid, 2n). This is achieved through a special type of cell division called MEIOSIS. When two gametes fuse during fertilisation, the normal chromosome number (2n) is restored in the zygote. Without this, the chromosome number would double with each generation.

Q17. Which plant produces plantlets in the notches along its leaf margins? *[1 mark]*

A) Money plant
B) Bryophyllum (Kalanchoe)
C) Potato
D) Rose

✔ **Answer: (B)** Bryophyllum (also called Kalanchoe/sprout leaf plant) is famous for vegetative reproduction via its leaves. Tiny plantlets (complete with roots and shoots) develop in the notches (margins) of its leaves. When these fall on moist soil, they grow into new plants. This is a natural form of vegetative propagation from leaves.

Q18. The prostate gland and seminal vesicles in males: *[1 mark]*

A) Produce sperms
B) Add secretions that nourish sperms and facilitate their transport
C) Store eggs for fertilisation
D) Produce testosterone hormone

✔ **Answer: (B)** The prostate gland and seminal vesicles are accessory glands in the male reproductive system. They add their secretions to sperms as they travel through the vas deferens. These secretions form the seminal fluid (semen), which provides nutrition for sperms (fructose energy), maintains their pH, and makes their transport easier. Sperms are produced in the TESTES; testosterone is also produced by testes.

Q19. HIV-AIDS is classified as a: *[1 mark]*

A) Bacterial STD
B) Viral STD
C) Parasitic STD
D) Fungal STD

✔ **Answer: (B)** HIV (Human Immunodeficiency Virus) is a VIRUS that causes AIDS (Acquired Immunodeficiency Syndrome). It is a sexually transmitted disease (STD). Bacterial STDs include gonorrhoea and syphilis (can be cured with antibiotics). Viral STDs (HIV, warts/HPV) have no complete cure — condoms significantly reduce (but don't eliminate) the risk of transmission.

Q20. Tissue culture technique involves: *[1 mark]*

A) Growing plants from seeds in artificial conditions
B) Grafting of two different plants
C) Growing new plants from plant cells/tissue placed in nutrient medium
D) Crossing two plant species to produce hybrid seeds

✔ **Answer: (C)** Tissue culture is an advanced vegetative propagation technique. Cells or tissue (usually from the growing tip) are removed and placed in an artificial nutrient medium. They divide rapidly to form a callus (mass of undifferentiated cells), which is then transferred to a medium with growth hormones to form plantlets. These are transferred to soil to grow into full plants. It produces disease-free plants in large numbers from one parent.

SECTION B | *Assertion–Reason Questions* | *1 Mark Each*

Directions: Select the correct option:

(A) Both A and R are true, and R is the correct explanation of A.
(B) Both A and R are true, but R is NOT the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

Q1. *[1 mark]*

Assertion (A): Sexual reproduction produces more variation than asexual reproduction.

Reason (R): Sexual reproduction combines DNA from two different individuals, creating new combinations of genetic traits in each generation.

✔ **Answer: (A)** Both A and R are true, and R correctly explains A. In sexual reproduction, each parent contributes half their chromosomes, and the combination is unique every time (two individuals with different accumulated variations). Asexual reproduction produces genetically identical copies (clones), so variations arise only from occasional copying errors in DNA.

Q2. *[1 mark]*

Assertion (A): The embryo gets nutrition from the mother through the placenta.

Reason (R): Placenta contains villi on the embryo's side surrounded by mother's blood spaces, providing a large surface area for exchange of glucose, oxygen, and waste products.

✔ **Answer: (A)** Both A and R are true, and R correctly explains A. The placenta is the nutritional bridge between mother and embryo. Villi increase surface area enormously; glucose and oxygen diffuse from mother's blood into embryo's blood; CO_2 and nitrogenous waste pass in the reverse direction. The mother's blood and embryo's blood do NOT directly mix.

Q3. *[1 mark]*

Assertion (A): Spirogyra can reproduce by regeneration like Hydra and Planaria.

Reason (R): Spirogyra reproduces by fragmentation, which involves breaking into smaller pieces that grow into new individuals, unlike regeneration which is a response to injury in complex organisms.

✔ **Answer: (D)** A is false — Spirogyra does NOT reproduce by regeneration. It uses FRAGMENTATION (breaking into pieces on maturation). R is true and correctly distinguishes fragmentation from regeneration. Regeneration occurs in organisms like Hydra and Planaria when pieces of their body (cut by injury or experimentally) can grow into complete organisms using specialised cells.

Q4. *[1 mark]*

Assertion (A): Cross-pollination leads to more genetic variation than self-pollination.

Reason (R): In cross-pollination, pollen from one plant combines with gametes from another plant of the same species, mixing two different sets of genetic material.

✔ **Answer: (A)** Both A and R are true, and R correctly explains A. Self-pollination uses pollen from the same plant, so offspring are genetically very similar to the parent. Cross-pollination combines genetic material from two separate plants, producing offspring with new combinations of traits and therefore greater genetic diversity — better for adaptation and evolution.

Q5. *[1 mark]*

Assertion (A): If a woman uses a copper-T, she is also protected from sexually transmitted diseases.

Reason (R): The copper-T acts as a physical barrier that prevents sperms from reaching the egg and also prevents pathogen entry.

✔ **Answer: (C)** A is false. A copper-T (IUD — Intrauterine Device) prevents pregnancy by creating an unfavourable environment in the uterus for the fertilised egg to implant (or by interfering with sperm movement). It does NOT protect against STDs. R is also false — it is NOT a barrier that prevents pathogen entry. Only condoms provide protection against both pregnancy AND STDs.

Q6. *[1 mark]*

Assertion (A): Vegetative propagation is advantageous because it produces plants identical to the parent.

Reason (R): Vegetative propagation is a form of asexual reproduction where new plants arise from vegetative parts (roots, stems, leaves), so there is no genetic recombination and offspring are genetically identical to the parent.

✔ **Answer: (A)** Both A and R are true, and R correctly explains A. Since vegetative propagation involves no gamete formation or fertilisation, the offspring are genetically identical clones of the parent. This is an advantage when the parent plant has desirable traits (good fruit quality, disease resistance). However, it means all plants are equally vulnerable to the same disease or environmental change.

Q7. *[1 mark]*

Assertion (A): The egg released from the ovary lives for only about one day if not fertilised.

Reason (R): Menstruation occurs every month because the uterine lining is shed as the unfertilised egg cannot survive for long.

✔ **Answer: (B)** Both A and R are true, but R does not correctly explain A. The egg surviving for only one day is an independent fact about the egg's viability. Menstruation occurs because the uterine lining — which was built up to nourish a potential embryo — is no longer needed if fertilisation does not happen. The egg's short lifespan and menstruation are related events but R does not explain WHY the egg lives only one day.

Q8. *[1 mark]*

Assertion (A): In flowering plants, the pollen tube grows from the pollen grain on the stigma to the ovule in the ovary.

Reason (R): The male germ cell needs to travel through the style to reach the female gamete (egg) inside the ovule for fertilisation to occur.

✔ **Answer: (A)** Both A and R are true, and R correctly explains A. After the pollen grain lands on the stigma, it germinates and grows a pollen tube downward through the style. The tube carries the male gamete (from the pollen grain) to the ovule where fertilisation occurs. This is how fertilisation happens in flowering plants without sperm needing to swim in water (unlike mosses and ferns).

SECTION C | *Short Answer Questions* | *2 Marks Each*

Write precise, point-form answers. 2 marks each.

Q1. What is the difference between binary fission and multiple fission? Give one example of each. *[2 marks]*

Answer:

Binary fission: The parent cell divides into TWO equal daughter cells. It is the simplest form of asexual reproduction. Example: Amoeba (splits in any plane), Leishmania (splits in a definite plane related to its whip-like structure), bacteria.

Multiple fission: The nucleus divides MANY TIMES, then the cell divides simultaneously into MANY daughter cells. Example: Plasmodium (the malarial parasite) — this is how it multiplies rapidly inside a human host, causing waves of fever.

Key difference: Binary = 1 parent → 2 offspring. Multiple = 1 parent → many offspring simultaneously.

Q2. What are the advantages of vegetative propagation? Give two examples of plants where it is used. *[2 marks]*

Answer:

Advantages of vegetative propagation: ① Plants produced bear flowers and fruits EARLIER than those grown from seeds. ② All offspring are genetically similar to the parent, preserving desirable traits. ③ It allows propagation of plants that have LOST THE ABILITY to produce seeds (e.g., banana, orange, seedless grapes). ④ Faster multiplication of plants.

Examples: ① Sugarcane — propagated by stem cuttings (each piece with a bud grows into a new plant). ② Rose/Grapes — propagated by layering or grafting. ③ Banana — propagated by suckers from the base. ④ Potato — by planting pieces with "eyes" (buds). ⑤ Bryophyllum — by leaf buds.

Q3. Why does menstruation occur? How long does it typically last? *[2 marks]*

Answer:

Every month, one ovary releases a mature egg. The uterine lining thickens and becomes richly supplied with blood, preparing to nourish a potential embryo.

If the egg is NOT fertilised, it lives for about ONE DAY. The prepared uterine lining is then no longer needed.

The lining slowly breaks down and is shed as BLOOD AND MUCOUS through the vagina. This is menstruation.

It occurs roughly every 28 days (monthly cycle) and typically lasts 2–8 days.

Q4. What is the role of the placenta? Where is it located? *[2 marks]*

Answer:

The placenta is a disc-shaped, spongy structure EMBEDDED IN THE UTERINE WALL (inside the uterus) during pregnancy.

Functions: ① Nutrition: Glucose and oxygen from the mother's blood pass to the embryo through the villi of the placenta. ② Excretion: CO_2 and nitrogenous waste from the embryo pass into the mother's blood for removal. ③ Acts as a barrier between mother's and embryo's blood (they do NOT directly mix).

Structure: Has villi (finger-like projections) on the embryo's side → increase surface area. Mother's blood spaces surround the villi.

Q5. What happens to the ovule and the ovary after fertilisation in a flowering plant? *[2 marks]*

Answer:

After fertilisation: The ZYGOTE (fertilised egg) divides repeatedly to form an EMBRYO inside the OVULE.

The OVULE: develops a TOUGH PROTECTIVE COAT and gradually transforms into a SEED. The seed contains the embryo (future plant) and stored food.

The OVARY: grows rapidly, its walls thicken, and it ripens to become the FRUIT.

Meanwhile: sepals, petals, stamens, style, and stigma usually wither and fall off. The seed, when mature and under suitable conditions (warmth, moisture, air), germinates to produce a new seedling.

Q6. What is spore formation? Name the organism in which it is seen and describe the structure. *[2 marks]*

Answer:

Spore formation is an asexual method of reproduction seen in fungi like Rhizopus (bread mould).

Structure: The thread-like structures (hyphae) of Rhizopus produce tiny blob-on-a-stick structures called sporangia (singular: sporangium). The sporangia are the reproductive structures that contain hundreds of tiny cells called SPORES.

Process: When the sporangia burst, spores are released into the air. Spores have THICK, RESISTANT WALLS that protect them from unfavourable conditions. When spores land on a moist surface with nutrients, they germinate and grow into new Rhizopus organisms.

Advantage: Thick walls allow spores to survive heat, dryness, and other harsh conditions until conditions improve.

Q7. What is the difference between self-pollination and cross-pollination? *[2 marks]*

Answer:

Self-pollination: Transfer of pollen from the ANTHER to the STIGMA of the SAME FLOWER (or same plant). Example: Wheat, rice, pea.

Result: Offspring are genetically similar to the parent. No variation introduced. Reliable even when pollinators are absent.

Cross-pollination: Transfer of pollen from the anther of ONE FLOWER to the stigma of a DIFFERENT FLOWER (usually on a different plant of the same species). Achieved by agents: wind, water, insects (bees), birds, bats. Example: Mustard, sunflower, maize.

Result: Offspring have NEW COMBINATIONS of traits from two parents. Increases genetic diversity. Better for adaptation and evolution.

Q8. List any FOUR contraceptive methods and briefly explain how each works. *[2 marks]*

Answer:

① Condom (barrier method): A physical covering for the penis (or similar for vagina) that prevents sperm from entering the female reproductive tract. Also protects against STDs.

② Oral contraceptive pills (hormonal): Contain synthetic hormones that prevent ovulation (egg release). Taken daily. Can have side effects due to hormonal changes.

③ Copper-T / Loop (IUD — Intrauterine Device): A small device placed inside the uterus by a doctor. Prevents implantation of the fertilised egg. Does NOT prevent STDs.

④ Surgical methods — Vasectomy (male): Vas deferens is cut and tied, preventing sperm from reaching the semen. Tubectomy (female): Fallopian tube is cut and tied, preventing egg from reaching uterus. Both are permanent methods.

⑤ (Bonus) Emergency pill: Taken within 72 hours of unprotected sex; prevents implantation.

Q9. What changes occur in boys and girls during puberty? *[2 marks]*

Answer:

Changes common to BOTH boys and girls: ① Growth of thick hair in armpits and genital area ② Thinner hair on legs, arms, and face ③ Skin becomes oily; development of pimples ④ New body awareness and sensations.

Changes specific to GIRLS: ① Increase in breast size with darkening of nipple skin ② Beginning of MENSTRUATION ③ Widening of hips ④ Growth in height.

Changes specific to BOYS: ① Growth of thick hair on the FACE (beard/moustache) ② Voice becomes deeper and may "crack" ③ Enlargement and erection of penis ④ Development of broader shoulders and greater muscle mass.

These changes are caused by the hormones testosterone (in boys) and oestrogen (in girls), and mark the beginning of reproductive maturity — puberty.

Q10. What is regeneration? Is it the same as reproduction? Explain with an example. *[2 marks]*

Answer:

Regeneration: The ability of an organism to regrow lost or damaged body parts. If an organism is cut into pieces, each piece can develop into a new, complete individual.

Example: PLANARIA — if cut into two pieces, each piece grows into a separate complete worm. Similarly, HYDRA can regenerate from small cut pieces.

Mechanism: Carried out by SPECIALISED (undifferentiated) CELLS that proliferate and then differentiate in an organised sequence (called DEVELOPMENT) into all required cell and tissue types.

Is it the same as reproduction? NO. Regeneration is NOT reproduction. Reproduction is a normally occurring process for creating offspring. Regeneration is primarily a response to injury. Most organisms do not normally get cut up to reproduce — it is a remarkable survival ability but is not a regular reproductive strategy.

Q11. What is the significance of variations during reproduction? *[2 marks]*

Answer:

Variations are small differences in the DNA copies produced during reproduction.

Why variations are significant: ① They are the basis of EVOLUTION — organisms with beneficial variations are more likely to survive and pass them on. ② They ensure SURVIVAL OF THE SPECIES when the environment changes. If all individuals were genetically identical and the environment changed drastically, the entire population could be wiped out. ③ Individuals with a rare variation suited to the new conditions would survive and reproduce.

Example: If water temperature rises due to global warming, most bacteria in a temperate lake would die — but the FEW VARIANTS with heat resistance would survive and multiply. Thus the species survives.

Note: Variations benefit the SPECIES but not necessarily the individual (an individual with a bad variation may die).

SECTION D | *Short Answer Questions* | *3 Marks Each*

Write structured answers covering all key points. 3 marks each.

Q1. Compare asexual and sexual reproduction. What are the advantages of sexual reproduction over asexual reproduction? [3 marks]

Comparison Table:

Feature | Asexual Reproduction | Sexual Reproduction

Number of parents | ONE parent only | TWO parents required
Gametes formed | No gametes (no meiosis) | Gametes formed by meiosis
Genetic variation | Very little (offspring are clones) | High (new gene combinations each generation)
Speed | Fast; large numbers quickly | Slower; fewer offspring
Energy needed | Less energy | More energy
Examples | Amoeba, yeast, Spirogyra, Hydra | Humans, flowering plants, most animals

Advantages of sexual reproduction over asexual: [1 mark each — 3 marks total]

① MORE GENETIC VARIATION: Sexual reproduction combines DNA from two different individuals. Each offspring gets a unique combination of traits. This variation is the raw material for evolution.

② BETTER SURVIVAL OF SPECIES: Because offspring differ from each other, some may have traits that help them survive in changed environments. If a disease attacks a population, genetically diverse individuals are more likely to have some members with natural resistance.

③ ELIMINATION OF BAD MUTATIONS: Over generations, harmful mutations (bad DNA changes) can be reduced because organisms with bad mutations are less likely to survive and reproduce. In asexual reproduction, harmful mutations accumulate in all clones.

Q2. Describe the male reproductive system in human beings. Name its organs and state the function of each. [3 marks]

The male reproductive system produces sperms (male gametes) and delivers them to the site of fertilisation.

Organs and their functions:

① TESTES (singular: testis):
• Location: Outside the abdominal cavity in a sac called the SCROTUM (cooler temperature needed for sperm formation — about 2°C below body temperature).
• Functions: (a) PRODUCE SPERMS (spermatogenesis) (b) Secrete TESTOSTERONE hormone (controls male secondary sexual characters + regulates sperm formation).

② VAS DEFERENS (sperm duct):
• Carries sperms from the testes upward toward the urethra.
• Passes through the abdominal cavity.

③ SEMINAL VESICLES and PROSTATE GLAND:
• Accessory glands that add secretions (seminal fluid/semen) to the sperms.
• Functions of secretions: Provide NUTRITION (fructose) to sperms, maintain pH, and facilitate transport of sperms.

④ URETHRA:
• A common passage for both URINE (from bladder) and SEMEN (sperms + fluid) to leave the body through the penis.

⑤ PENIS:
• The male copulatory organ that delivers sperms into the vagina during sexual intercourse.
• Contains the urethra.

Structure of a sperm:
• Tiny cell consisting mainly of GENETIC MATERIAL (nucleus with DNA).
• Has a long TAIL for swimming toward the egg.
• Mitochondria in the middle piece provide energy for swimming.

Q3. Describe the female reproductive system in human beings. Explain what happens from egg release to implantation. [3 marks]

Organs of the female reproductive system and their functions:

① OVARIES (pair):
• Produce EGGS (female gametes) — one egg per month from one ovary alternately.
• Also produce hormones (oestrogen, progesterone).
• At birth, ovaries contain thousands of immature eggs; they start maturing at puberty.

② FALLOPIAN TUBE (Oviduct) (pair):
• Carries the egg from the ovary to the uterus.
• SITE OF FERTILISATION — sperms travel up from the vagina and meet the egg here.

③ UTERUS (Womb):
• A hollow, elastic, pear-shaped muscular organ.
• Site where the embryo implants and develops for ~9 months.
• Lining (endometrium) thickens monthly in preparation for a fertilised egg.

④ CERVIX:
• The narrow lower part of the uterus that opens into the vagina.
• Acts as a passage for sperms entering and for the baby during birth.

⑤ VAGINA:
• Birth canal through which the baby is born.
• Entry point for sperms during sexual intercourse.

Pathway from egg release to implantation:
Step 1: Ovary releases a mature egg (OVULATION) every ~28 days.
Step 2: Egg is picked up by the fallopian tube.
Step 3: Sperms enter through the vagina → travel through cervix → uterus → fallopian tube.
Step 4: FERTILISATION occurs in the fallopian tube → ZYGOTE is formed.
Step 5: Zygote divides repeatedly (mitosis) to form a ball of cells → EMBRYO.
Step 6: Embryo travels to the uterus and IMPLANTS in the thickened uterine lining → continues developing → becomes foetus → baby born after ~9 months.

Q4. Describe the process of sexual reproduction in flowering plants from pollination to seed formation. [3 marks]

Sexual reproduction in flowering plants involves:

STEP 1 — POLLINATION:
• Transfer of pollen grains from the ANTHER (male part) to the STIGMA (female part).
• Types: (i) Self-pollination — same flower or plant; (ii) Cross-pollination — pollen from another flower of the same species, carried by wind, water, insects, birds.

STEP 2 — POLLEN TUBE GROWTH:
• After landing on a suitable stigma, the pollen grain germinates.
• A POLLEN TUBE grows out of the pollen grain, travels DOWN through the STYLE, and reaches the OVARY.
• The male germ cell is carried in this pollen tube.

STEP 3 — FERTILISATION:
• The male germ cell from the pollen tube fuses with the FEMALE GAMETE (egg cell) inside the OVULE.
• This fusion produces a ZYGOTE.

STEP 4 — SEED FORMATION:
• The zygote divides many times to form an EMBRYO inside the ovule.
• The ovule develops a tough coat → becomes a SEED (which contains the embryo + stored food).

STEP 5 — FRUIT FORMATION:
• The OVARY grows rapidly, ripens, and becomes the FRUIT.
• Sepals, petals, stamens, style, and stigma usually wither and fall off.
• The seed germinates under suitable conditions (moisture, warmth, air) to grow into a new plant — this is called GERMINATION.

Q5. What are sexually transmitted diseases (STDs)? Name any four and classify them. How can transmission be prevented? [3 marks]

Sexually Transmitted Diseases (STDs) are infections passed from one person to another through sexual contact (exchange of bodily fluids or skin-to-skin contact in the genital area).

Classification:

BACTERIAL STDs (caused by bacteria — can often be cured with antibiotics):
① Gonorrhoea — caused by bacteria Neisseria gonorrhoeae; causes burning urination, discharge.
② Syphilis — caused by Treponema pallidum; progresses in stages; can damage heart and brain if untreated.

VIRAL STDs (caused by viruses — NO complete cure; can be managed but not eliminated):
③ HIV-AIDS — caused by the Human Immunodeficiency Virus (HIV); destroys the immune system; currently no cure but antiretroviral therapy (ART) manages it.
④ Genital Warts — caused by Human Papillomavirus (HPV); may increase risk of cervical cancer.

Prevention:
① CONDOMS: The most effective protection — physical barrier prevents exchange of fluids and direct contact. Reduces risk significantly (not 100%).
② MUTUAL MONOGAMY: Having one uninfected partner.
③ Avoiding sharing needles (for HIV).
④ Regular STD testing and early treatment.
⑤ Vaccination: HPV vaccine now available to prevent genital warts and cervical cancer.

Note: Copper-T, oral pills, and surgical methods do NOT protect against STDs.

Q6. Compare the different modes of asexual reproduction. Give examples. [3 marks]

Table: Modes of Asexual Reproduction

Mode | Description | Example
Binary fission | Parent splits into TWO equal cells | Amoeba (any plane), Leishmania (definite plane), Bacteria
Multiple fission | Nucleus divides many times → cell splits into MANY daughter cells simultaneously | Plasmodium (malarial parasite)
Budding | Small outgrowth (bud) forms → detaches as new individual | Yeast (unicellular), Hydra (multicellular)
Fragmentation | Organism breaks into pieces; each grows into a new individual | Spirogyra (filamentous alga)
Regeneration | Cut pieces of body regenerate into complete organisms via specialised cells | Hydra, Planaria
Vegetative propagation | Roots, stems, or leaves develop into new plants | Bryophyllum (leaf), Potato (stem), Money plant (stem cutting), Rose (stem)
Spore formation | Spores (in sporangia) protected by thick walls; germinate under favourable conditions | Rhizopus (bread mould)

Key point: All asexual reproduction involves a SINGLE PARENT and produces offspring that are genetically identical to the parent (clones). It is faster but produces less variation.

SECTION E | *Case-Based / Competency Questions | 4 Marks Each*

Read each passage carefully and answer ALL sub-questions.

Case Study 1: The Monthly Cycle

> *Meera is a 14-year-old girl who has recently experienced her first menstruation. She is confused and worried. Her school teacher explains that menstruation is a completely normal biological process. The teacher explains the monthly cycle: an egg is released, the uterus prepares, and if the egg is not fertilised, the lining breaks down. The teacher also tells her that both boys and girls undergo changes during puberty triggered by hormones.*

(i) What triggers the onset of puberty in girls and what hormone is responsible? [1 mark]

Puberty is triggered by the maturation of the reproductive system, which occurs as the body's general growth rate slows down. In girls, the OVARIES begin to secrete OESTROGEN hormone, which causes all the changes of puberty: breast development, menstruation, widening of hips, and growth of hair in new areas. (Progesterone also plays a role in regulating the menstrual cycle.)

(ii) What exactly happens during the menstrual cycle to cause menstruation? Explain step by step. [1 mark]

Step 1: OVULATION — the ovary releases a mature egg.

Step 2: The uterine lining thickens and becomes richly supplied with blood — preparing to receive a fertilised egg (embryo).

Step 3: The egg lives for about ONE DAY. If it is NOT fertilised, it degenerates.

Step 4: The thickened uterine lining is no longer needed → it breaks down slowly and is expelled as BLOOD AND MUCOUS through the vagina.

This cycle repeats roughly every 28 days; bleeding lasts 2–8 days.

(iii) What changes are common to BOTH boys and girls during puberty? [1 mark]

Changes common to both: ① Growth of thick hair in the ARMPITS and GENITAL AREA (between thighs), which may also become darker. ② Thinner hair on legs, arms, and face. ③ Skin becomes oily and PIMPLES may develop. ④ Increased body awareness and new sensations. ⑤ Rapid increase in height (growth spurt). These common changes are caused by hormones from adrenal glands active in both sexes.

(iv) If fertilisation occurs, what happens to the uterine lining? What is the significance of the placenta? [1 mark]

If fertilisation occurs: The embryo travels to the uterus and IMPLANTS in the thickened uterine lining. The lining does NOT break down — it continues to develop and nourish the embryo.

The PLACENTA develops at the site of implantation. It connects the embryo's blood supply with the mother's blood supply:

• Glucose + oxygen flow from mother → embryo (nutrition)

• CO_2 + waste flow from embryo → mother (excretion)

The mother's and embryo's blood do not actually mix. Placenta provides the only connection for 9 months of development.

Case Study 2: The Garden Experiment

> *A biology student, Arjun, wants to grow many plants quickly from one parent plant. He tries three methods: (A) He plants seeds collected from the parent plant. (B) He cuts stems of the parent plant with a leaf and places them in water until roots form, then plants them in soil. (C) He scrapes cells from the tip of a shoot and places them in a nutrient medium in the lab. After a few weeks, he has: Method A — some plants but they look*

different from the parent. Method B — plants identical to the parent. Method C — many identical plantlets on a small scale.

(i) What type of reproduction is Arjun using in Method A and Method B? What is the key difference in the offspring? [1 mark]

Method A (seeds): SEXUAL REPRODUCTION (seeds form from fertilisation of gametes). Offspring show variation — they look different from the parent because seeds contain new combinations of genes from both parents.

Method B (stem cuttings): ASEXUAL REPRODUCTION / Vegetative propagation. Offspring are genetically IDENTICAL to the parent (clones) because no fertilisation occurs and all cells are derived from one parent's DNA. This is why Arjun's Method B plants look like the parent.

(ii) What technique is Method C called? What are its advantages? [1 mark]

Method C is TISSUE CULTURE.

Process: Cells/tissue from the shoot tip are placed in a sterile artificial nutrient medium → cells divide to form a CALLUS (unorganised cell mass) → transferred to medium with hormones → plantlets form → transferred to soil.

Advantages: ① Produces LARGE NUMBERS of plants from a SMALL AMOUNT of parent tissue. ② Plants are DISEASE-FREE (grown in sterile conditions). ③ Preserves rare or endangered species. ④ Genetically identical to parent. ⑤ Can be done year-round regardless of season.

(iii) Why do some plants lose their ability to produce seeds? How does vegetative propagation help them? [1 mark]

Some plants have been selectively cultivated for so long (e.g., banana, orange, seedless grapes) that they have LOST THE ABILITY TO PRODUCE VIABLE SEEDS through selective breeding or genetic modification. Without seeds, they cannot reproduce sexually.

Vegetative propagation helps because: These plants can still be multiplied using other plant parts (stems, roots, leaves, or suckers). E.g., banana is grown from suckers; orange from grafting; seedless grapes from cuttings. This ensures the species (and its desirable traits) continues even without seed formation.

(iv) Arjun notices that all the plants from Method A have slight differences, while Methods B and C produce identical plants. How does this relate to the importance of variation? [1 mark]

Sexual reproduction (Method A seeds) produces variation because it combines genetic material from two parents → new gene combinations in every offspring → some differences in appearance, growth, disease resistance.

This variation is IMPORTANT because: If the environment changes (new disease, temperature change), some variant plants may have traits that help them survive → the species survives.

Asexual reproduction (B and C) produces clones with NO variation. This is an advantage for quickly multiplying a good variety, but a risk — if a disease attacks ONE plant, it can attack ALL identical plants equally. Example: The Cavendish banana (today's most common variety) is a clone, and a single fungal disease (Panama disease) threatens ALL banana plants worldwide because there are no resistant variants.

Case Study 3: Reproductive Health Awareness

A school health educator is teaching Class 10 students about reproductive health. She explains: "Pregnancy has major physical and emotional demands on a woman's body. There are several safe ways to prevent pregnancy. However, not all methods protect against infections passed during sexual contact. Some diseases can be caused by bacteria and can be treated; others are caused by viruses and have no cure. Understanding these facts helps young people make informed health decisions."

(i) Name two bacterial and two viral sexually transmitted diseases (STDs). Which can be cured with medicines? [1 mark]

Bacterial STDs (treatable with antibiotics): ① GONORRHOEA ② SYPHILIS

Viral STDs (no complete cure — can only be managed): ① HIV-AIDS ② Genital WARTS (caused by HPV — Human Papillomavirus)

Bacterial STDs can be completely cured with proper antibiotic treatment if detected early. Viral STDs like HIV-AIDS have NO cure but can be managed with antiretroviral therapy (ART). HPV can be prevented with a vaccine.

(ii) A girl uses oral contraceptive pills. Does this protect her from STDs? Explain why/why not. [1 mark]

NO. Oral contraceptive pills (OCPs) do NOT protect against STDs.

Why: OCPs work by releasing synthetic hormones (like oestrogen and progesterone) that prevent OVULATION (egg release). Without an egg, fertilisation cannot occur and pregnancy is prevented.

However, OCPs do nothing to block the exchange of bodily fluids or prevent skin-to-skin contact during sex. They create NO PHYSICAL BARRIER against pathogens (viruses or bacteria). ONLY CONDOMS provide a physical barrier that reduces the risk of both pregnancy AND STDs.

(iii) What is sex-selective abortion? Why is it illegal and harmful to society? [1 mark]

Sex-selective abortion is the ILLEGAL act of aborting a foetus specifically because it is female (female foeticide), based on prenatal sex determination (ultrasound scanning to determine foetal sex).

Why it is illegal: Prenatal sex determination and sex-selective abortion are BANNED by law in India (Pre-Conception and Pre-Natal Diagnostic Techniques Act, PC-PNDT Act).

Why it is harmful: ① It causes a dangerous decline in the CHILD SEX RATIO (fewer girls per 1000 boys). ② It violates the right to life of female foetuses. ③ A skewed sex ratio creates social problems. ④ It reflects and reinforces gender discrimination. For a healthy society, the female-male sex ratio MUST be maintained.

(iv) Why should pregnancy not occur too early in a teenage girl, even if she has started menstruation? [1 mark]

Menstruation beginning means a girl is capable of conceiving, but this does NOT mean her body or mind is ready for pregnancy.

Reasons why early pregnancy is harmful: ① Physical unreadiness: A teenage girl's body (especially the pelvis, uterus, and hormonal system) is still developing. Pregnancy creates enormous physical demands — a body that is still growing may not cope safely. ② Risk to health: Early pregnancy significantly increases risks of complications (anaemia, high blood pressure, obstructed labour). ③ Mental unreadiness: Adolescents are still developing emotionally and psychologically; parenting demands extreme emotional maturity. ④ Educational impact: Early pregnancy often ends girls' education. ⑤ Sexual maturation is a gradual process and some degree of it does not automatically mean readiness for parenthood.

SECTION F | *Long Answer Questions* | *5 Marks Each*

Write detailed, structured answers. 5 marks each.

Q1. (a) Draw a labelled diagram of the longitudinal section of a flower and name its parts. (b) Describe the events from pollination to fruit formation. [5 marks]

(a) Parts of a flower — Labels for diagram [2 marks]:

[Draw a longitudinal section of a bisexual flower. Label:]

• RECEPTACLE — base on which all flower parts are attached

• SEPALS (Calyx) — outermost green leaf-like parts; protect bud

• PETALS (Corolla) — coloured parts; attract pollinators

• STAMEN (male part): ANTHER (produces pollen grains) + FILAMENT (stalk)

• PISTIL/CARPEL (female part): STIGMA (sticky top, receives pollen) + STYLE (tube) + OVARY (swollen base, contains OVULES with EGG CELLS)

Flower types:

• Bisexual (perfect): Has both stamen and pistil (e.g., Hibiscus, mustard)

• Unisexual: Has either stamen or pistil (e.g., papaya, watermelon)

(b) Events from Pollination to Fruit Formation [3 marks]:

① POLLINATION: Pollen grains transfer from anther → stigma (of same or different flower). Agents: wind, water, insects (bees, butterflies), birds. Pollen sticks to the stigma (which is often sticky).

② POLLEN TUBE GROWTH: The pollen grain germinates on the stigma. A pollen tube grows downward through the style, carrying the male germ cell toward the ovule in the ovary.

③ FERTILISATION: Male germ cell from the pollen tube fuses with the female gamete (egg cell) inside the ovule → ZYGOTE formed.

④ EMBRYO DEVELOPMENT: Zygote divides repeatedly → EMBRYO forms inside the ovule. The ovule develops a tough coat → becomes SEED (contains embryo + stored food).

⑤ FRUIT FORMATION: The ovary wall grows, thickens, and ripens → becomes FRUIT. Other flower parts (sepals, petals, stamens, style, stigma) usually wither and fall off.

⑥ GERMINATION: Seed disperses (wind, animals, water). Under suitable conditions (moisture, warmth, O_2), seed germinates → new seedling grows.

Q2. (a) Describe the human female reproductive system with a diagram. (b) Explain what happens if the egg is fertilised and if it is not fertilised. (c) What is the role of placenta? [5 marks]

(a) Female Reproductive System — Organs and Functions [2 marks]:

[Draw female reproductive system. Label: Ovaries, Fallopian tubes (oviduct), Uterus, Cervix, Vagina]

• OVARIES (pair — left and right): Produce mature eggs (one per month, alternately); secrete oestrogen and progesterone hormones. At birth, ovaries contain thousands of immature eggs.

• FALLOPIAN TUBES / OVIDUCTS (pair): Transport egg from ovary to uterus. Site of fertilisation. Lined with cilia that sweep the egg along.

• UTERUS (womb): Muscular, pear-shaped elastic organ. Site where embryo implants and develops. Monthly lining (endometrium) builds up and sheds.

• CERVIX: Narrow lower end of uterus; opens into vagina. Passage for sperms entering upward and for baby during birth.

• VAGINA: Opening of female reproductive tract to outside. Entry for sperms; exit for menstrual blood and baby at birth.

(b) If egg IS fertilised [1.5 marks]:
• Sperm meets egg in the fallopian tube → FERTILISATION → ZYGOTE formed.
• Zygote divides → EMBRYO (ball of cells) → travels to uterus.
• IMPLANTATION: Embryo embeds in the thickened uterine lining (endometrium).
• Embryo develops organs → becomes FOETUS.
• Development continues for approximately 9 MONTHS (gestation period).
• At term, rhythmic contractions of the uterus → BIRTH of the baby.

If egg is NOT fertilised [0.5 marks]:
• Egg lives for about ONE DAY and degenerates.
• Uterine lining breaks down → shed as blood and mucous → MENSTRUATION (2–8 days).
• Cycle repeats approximately every 28 days.

(c) Role of the Placenta [1 mark]:

• The placenta is a DISC-SHAPED TISSUE embedded in the uterine wall.
• Structure: Villi (finger-like projections) on embryo's side; mother's blood spaces surrounding villi → large surface area for exchange.
• Functions:
— Supplies GLUCOSE and OXYGEN from mother's blood to embryo.
— Removes CO_2 and NITROGENOUS WASTE from embryo to mother's blood.
• Important: Mother's blood and embryo's blood NEVER DIRECTLY MIX — exchange is across the placental membrane.
• Also acts as a barrier to some infections and harmful substances.

Q3. (a) What is asexual reproduction? Describe any FIVE methods of asexual reproduction with examples. (b) Why can complex multicellular organisms NOT rely on regeneration for reproduction? [5 marks]

(a) Asexual Reproduction — Definition and 5 Methods [4 marks]:

Asexual reproduction is a mode of reproduction involving ONLY ONE PARENT, producing offspring that are genetically identical to the parent (clones), WITHOUT formation of gametes or fertilisation.

Method 1 — BINARY FISSION (1 mark):
Parent cell divides into TWO EQUAL daughter cells.
Examples: Amoeba (in any plane), Leishmania (in a definite orientation), most bacteria.
Note: In Leishmania, the split is always in a specific direction because of its whip-like tail (flagellum).

Method 2 — MULTIPLE FISSION (1 mark):
The nucleus divides MANY TIMES, then the cell divides simultaneously into MANY daughter cells.
Example: Plasmodium (malarial parasite) — causes waves of fever as many cells are released at once.

Method 3 — BUDDING (1 mark):
A small outgrowth (BUD) forms due to cell division at one spot → develops into a miniature individual → detaches and becomes independent.
Examples: Yeast (unicellular), Hydra (multicellular).

Method 4 — FRAGMENTATION (0.5 mark):
Organism breaks into pieces; each piece grows into a new complete individual.
Example: Spirogyra (a filamentous alga in ponds) — breaks up on maturation into fragments that grow individually.

Method 5 — SPORE FORMATION (0.5 mark):
Special reproductive cells (SPORES) enclosed in a sporangium (spore case) are released. Spores have THICK WALLS for protection against harsh conditions (drought, heat). They germinate on a suitable moist surface.
Example: Rhizopus (bread mould) — develops sporangia (blob-on-a-stick structures) on its hyphae.

(b) Why complex organisms cannot rely on regeneration [1 mark]:
Complex multicellular organisms (humans, cats, birds) have:
• Highly specialised tissues and organs placed at VERY SPECIFIC POSITIONS in the body.
• Cells are NOT a random collection — they are organised in a precise, hierarchical manner (cells → tissues → organs → systems).
• Cell-by-cell regeneration into a complete organism would require rebuilding this entire complex architecture from scratch — which is practically impossible.
• In simple organisms like Hydra and Planaria, the body organisation is much simpler, and the specialised regenerative cells can more easily reform all required structures.
• Additionally, complex animals have IMMUNE SYSTEMS that would interfere with uncontrolled regeneration.
• Conclusion: As body complexity increases, the ability to regenerate a whole organism from a piece decreases.

Q4. (a) Why is sexual reproduction important for generating variation? (b) Explain how meiosis solves the problem of chromosome doubling in sexual reproduction. (c) Distinguish between male and female gametes. [5 marks]

(a) Sexual Reproduction and Variation [2 marks]:

Why sexual reproduction generates MORE variation:

① Two DIFFERENT individuals each contribute their own unique set of DNA (accumulated over many generations of variation). Combining these two sets creates ENTIRELY NEW COMBINATIONS of traits — novel in every offspring.

② DNA copying, while quite reliable, produces small errors (mutations). Over generations, each individual in a population accumulates different sets of mutations. When two individuals mate, their DIFFERENT SETS of variations COMBINE — the possibilities are virtually limitless.

③ The random process of which gametes from each parent combine during fertilisation adds another layer of randomness and variation.

Why this matters: In asexual reproduction, all offspring are clones — identical to the parent and to each other. Variations arise only from rare DNA copying errors. Sexual reproduction speeds up the generation of variation ENORMOUSLY. More variation = better chance that SOME individuals can survive environmental changes = species survival.

(b) Meiosis and the Chromosome Problem [2 marks]:

The problem: If two individuals each contribute a complete set of chromosomes (say 46 each in humans), the offspring would have 92 chromosomes — DOUBLE the normal. The next generation would have 184, then 368, and so on. This would make the DNA uncontrollable.

Solution — MEIOSIS:
• Special cell division called MEIOSIS occurs in reproductive organs (testes in males, ovaries in females).
• In meiosis, cells undergo TWO rounds of division, reducing the chromosome number by HALF.
• Human body cells: 46 chromosomes (DIPLOID — 2n).
• After meiosis, germ cells (sperm/egg): 23 chromosomes each (HAPLOID — n).
• At FERTILISATION: Sperm (23) + Egg (23) = Zygote with 46 chromosomes (2n) — NORMAL!
• This restores the correct chromosome number in every generation.

(c) Male vs Female Gametes [1 mark]:

Male gamete (SPERM):
• Small in size.
• MOTILE — has a long tail (flagellum) for swimming.
• Carries LITTLE or NO food store — moves fast but requires energy from seminal fluid.
• Produced in large numbers (millions per ejaculation).
• Contains 23 chromosomes (n).

Female gamete (EGG/OVUM):
• LARGE in size compared to sperm.
• NON-MOTILE — cannot move on its own.
• Contains LARGE FOOD STORES (yolk/cytoplasm nutrients) to nourish the developing embryo.
• One released per month.
• Contains 23 chromosomes (n).

As organisms become more complex, the differences between male and female gametes become more pronounced — the egg grows larger (more food stores), the sperm becomes more specialised for motility.

SECTION G | *Very Short Answer (VSA) | 1 Mark Each | Rapid Fire Round*

One-line answers. Directly asked in CBSE papers 2019–2025.

Q1. Define: Reproduction.

Ans: The biological process by which living organisms produce new individuals of the same species, ensuring the continuation of the species.

Q2. Name the organism that shows binary fission in a definite orientation.

Ans: Leishmania (which causes kala-azar). Its binary fission is oriented in relation to its whip-like flagellum.

Q3. What is a sporangium?

Ans: A sporangium is a blob-like reproductive structure found in Rhizopus (bread mould) that contains and releases spores for asexual reproduction.

Q4. What are the three parts of the pistil?

Ans: Stigma (sticky top — receives pollen), Style (middle elongated tube), Ovary (swollen base — contains ovules with egg cells).

Q5. Where does fertilisation occur in human beings?

Ans: In the FALLOPIAN TUBE (oviduct). Sperms travel up from the vagina and meet the egg in the fallopian tube.

Q6. What is germination?

Ans: Germination is the process by which a seed develops into a new plant seedling under suitable conditions of moisture, warmth, and air.

Q7. Why do testes lie in the scrotum outside the body?

Ans: Because sperm formation requires a temperature lower than normal body temperature (~2°C below). The scrotum provides this cooler environment.

Q8. What is the gestation period in human beings?

Ans: Approximately 9 months (about 280 days / 40 weeks) from fertilisation to birth.

Q9. Name any two methods of artificial vegetative propagation.

Ans: ① Grafting (e.g., mango, apple) ② Layering (e.g., jasmine, roses) — also: stem cuttings, tissue culture.

Q10. What is the function of the vas deferens?

Ans: The vas deferens (sperm duct) carries sperms from the testes to the urethra for ejaculation.

Q11. Why is variation important for a species?

Ans: Variation ensures some individuals in a population can survive environmental changes (e.g., disease outbreak, climate change), preventing the extinction of the entire species.

Q12. What type of cell division produces gametes?

Ans: MEIOSIS — a specialised cell division that halves the chromosome number (from 2n to n) to produce haploid gametes (sperm and egg).

Q13. Name the male and female reproductive organs in a flower.

Ans: Male: STAMEN (consisting of anther + filament). Female: PISTIL or CARPEL (consisting of stigma + style + ovary).

Q14. What is the function of the uterus?

Ans: The uterus (womb) is where the embryo implants and develops during pregnancy. Its lining (endometrium) provides nutrition; its muscular walls contract during childbirth.

Q15. Name two STDs caused by viruses.

Ans: ① HIV-AIDS ② Genital warts (caused by HPV — Human Papillomavirus)

Q16. What is tubectomy?

Ans: A surgical method of contraception in females where the fallopian tubes are cut and tied, preventing the egg from reaching the uterus and thus preventing fertilisation.

Q17. What happens to the ovary after fertilisation?

Ans: The ovary grows rapidly, ripens, and becomes the FRUIT. Simultaneously, the ovule inside becomes the SEED.

Q18. Name the hormone that regulates sperm formation in males.

Ans: TESTOSTERONE (produced by the testes). It also controls secondary sexual characters in males during puberty.

Q19. What is meant by pollination?

Ans: Pollination is the transfer of pollen grains from the anther (male part) to the stigma (female part) of a flower, enabling fertilisation.

Q20. What is the function of the placenta?

Ans: Placenta provides nutrition (glucose, O_2) from mother to embryo and removes waste (CO_2, nitrogenous waste) from embryo to mother, without mixing their blood directly.

⚡ QUICK REVISION | KEY FACTS & TABLES | *Chapter 7: How do Organisms Reproduce?*

Asexual Reproduction — Quick Reference

Method	Example(s)	Key Feature
Binary fission	Amoeba, Leishmania, Bacteria	1 parent → 2 equal daughter cells
Multiple fission	Plasmodium	1 parent → many daughter cells simultaneously
Budding	Yeast, Hydra	Outgrowth (bud) forms → detaches
Fragmentation	Spirogyra	Breaks into pieces; each grows into new individual
Regeneration	Hydra, Planaria	Cut pieces grow into complete organisms via specialised cells
Spore formation	Rhizopus (bread mould)	Spores in sporangia; thick-walled; resistant to harsh conditions
Vegetative propagation	Bryophyllum, Potato, Rose	Roots, stems, or leaves produce new plants

Key Facts to Remember

Fact	Detail
Fertilisation site (humans)	Fallopian tube (oviduct)
Gestation period	Approximately 9 months
Menstrual cycle duration	Approximately 28 days; bleeding lasts 2–8 days
Egg lifespan (unfertilised)	About 1 day

Testes location	Scrotum (outside body — cooler temperature for sperm)
Chromosome number in gametes	Haploid (n) — half of body cells — due to meiosis
Pollen → Pistil pathway	Stigma → Pollen tube through Style → Ovary → Ovule → Egg
Ovule → Seed	Ovule + embryo + tough coat = Seed
Ovary → Fruit	Ovary wall ripens = Fruit
STD prevention	ONLY condoms protect against BOTH pregnancy AND STDs
Copper-T	Prevents implantation; does NOT prevent STDs
Oral pills	Prevent ovulation; hormonal; can have side effects; no STD protection
Vasectomy (male)	Vas deferens cut; surgical; permanent contraception
Tubectomy (female)	Fallopian tube cut; surgical; permanent contraception
Tissue culture advantage	Large numbers; disease-free; year-round; from small tissue sample

C H A P T E R

8

Heredity

Mendel's Laws • Punnett Squares • Dominant & Recessive • Sex Determination

★★★★★ **Marks Weightage: High**

Sections: A (MCQ) • B (Assertion-Reason) • C–D (Short Answer) • E (Case-Based) • F (Long Answer) • VSA • Quick Revision

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CBSE Class 10 | Science (Biology)

CHAPTER 8

HEREDITY

Master Question Bank ● Board Exam 2027 Pattern

CBSE EXAM TREND ANALYSIS (2019–2026) | *Chapter 8: Heredity*

Topic-wise Prediction for 2027

Topic	Marks Asked/Year	Format	Prediction 2027
Mendel's Monohybrid Cross (F1 & F2)	3–5 marks	Cross + Ratio + Explain	★★★★★ Very High
Dominant & Recessive Traits	1–3 marks	Define + Example / MCQ	★★★★★ Very High
Sex Determination in Humans (XX/XY)	2–3 marks	Explain + Diagram / AR	★★★★★ Very High
Punnett Square Problems	3–5 marks	Draw + Work out offspring ratio	★★★★★ Very High
Dihybrid Cross (9:3:3:1)	3–5 marks	F2 ratio + Explain independent assortment	★★★★☆ High
Gene, DNA, Chromosome Relationship	2–3 marks	Define & Relate / MCQ	★★★★☆ High
Genotype vs Phenotype	1–2 marks	Define + Examples / MCQ	★★★★☆ High
Importance of Variation	1–2 marks	VSA / AR / MCQ	★★★☆☆ Medium
Mendel's Contributions (Biography)	1 mark	MCQ / VSA	★★★☆☆ Medium

✦ Punnett squares are the MOST important skill — practise drawing them for both monohybrid and dihybrid crosses.
✦ The 3:1 (F2 monohybrid) and 9:3:3:1 (F2 dihybrid) ratios are asked in EVERY board paper since 2018.
✦ Sex determination diagram showing X and Y from both parents is a consistent 2-3 mark question.
✦ Genotype vs phenotype, and homozygous vs heterozygous definitions appear in MCQ and AR questions.
✦ The logic of why the father determines the sex of the child is commonly tested in case-based questions.

SECTION A | *Multiple Choice Questions* | *1 Mark Each*

Instructions: Choose the BEST option. All questions carry 1 mark.

Q1. Gregor Johann Mendel conducted his heredity experiments on: *[1 mark]*

A) Maize (corn) plants
B) Garden pea (Pisum sativum) plants
C) Drosophila (fruit fly)
D) Snapdragon flowers

✔ **Answer: (B)** Mendel chose garden pea plants (Pisum sativum) because they have many clearly contrasting traits (tall/short, round/wrinkled seeds, violet/white flowers), have a short life cycle, can self-pollinate easily, and can also be cross-pollinated manually. He worked in his monastery garden in Brno (now Czech Republic) in the 1860s.

Q2. When Mendel crossed tall pea plants (TT) with short pea plants (tt), ALL plants in the F1 generation were tall. This shows that: *[1 mark]*

A) Shortness trait was lost permanently
B) Tallness is a dominant trait; shortness is recessive
C) Both traits were blended together
D) The F1 generation had a mixed genotype

✔ **Answer: (B)** When TT × tt, all F1 offspring are Tt (heterozygous). They are ALL TALL because T (tallness) is dominant over t (shortness). The shortness trait (t) is recessive — it is not lost, merely "hidden." It reappears in the F2 generation when two Tt plants self-pollinate, producing 1TT:2Tt:1tt (3 tall:1 short).

Q3. In Mendel's monohybrid cross experiment, the ratio of tall to short plants in the F2 generation was: *[1 mark]*

A) 1:1
B) 2:1
C) 3:1
D) 9:3:3:1

✔ **Answer: (C)** When Tt × Tt (F1 self-pollination): offspring are TT, Tt, Tt, tt in a 1:2:1 GENOTYPE ratio. Since TT and Tt are both tall, and only tt is short, the PHENOTYPE ratio is 3 tall : 1 short. This 3:1 ratio is one of the most important findings in genetics — it showed that traits are inherited as discrete units (genes).

Q4. An organism with genotype Tt is called: *[1 mark]*

A) Homozygous dominant
B) Homozygous recessive
C) Heterozygous
D) Hemizygous

✔ **Answer: (C)** Heterozygous means having TWO DIFFERENT alleles for a gene (one dominant, one recessive). Tt = one dominant allele (T) and one recessive allele (t). The organism is PHENOTYPICALLY TALL (because T is dominant) but GENOTYPICALLY HETEROZYGOUS. Homozygous dominant = TT; Homozygous recessive = tt.

Q5. Which of the following genotypes would produce a SHORT pea plant? *[1 mark]*

A) TT
B) Tt
C) tT
D) tt

✔ **Answer: (D)** Only tt (homozygous recessive) produces a short plant because both copies of the gene are the recessive allele (t). A single copy of T (dominant) in TT or Tt is enough to express tallness. Note: tT and Tt are the same genotype — order doesn't matter.

Q6. In a dihybrid cross between RrYy × RrYy pea plants, the ratio of round yellow : round green : wrinkled yellow : wrinkled green seeds in F2 is: *[1 mark]*

A) 1:2:1
B) 3:1
C) 1:1:1:1
D) 9:3:3:1

✔ **Answer: (D)** In a dihybrid cross (two traits), the F2 phenotype ratio is 9:3:3:1. This means: 9 round yellow (R_Y_) : 3 round green (R_yy) : 3 wrinkled yellow (rrY_) : 1 wrinkled green (rryy). The 9:3:3:1 ratio proves that the two traits (seed shape and seed colour) are inherited INDEPENDENTLY of each other — Mendel's Law of Independent Assortment.

Q7. The sex of a human child is determined by: *[1 mark]*

A) The age of the mother at conception
B) The chromosome contributed by the mother
C) The chromosome contributed by the father
D) The nutritional status of the mother

✔ **Answer: (C)** The father determines the sex. Females are XX — they can only contribute X chromosome to the child. Males are XY — they can contribute either X or Y. If the father's X combines with mother's X → girl (XX). If the father's Y combines with mother's X → boy (XY). So the sex depends entirely on which chromosome the FATHER passes on.

Q8. Women have sex chromosomes: *[1 mark]*

A) XY
B) YY
C) XX

D) XO

✔ **Answer: (C)** Human females have a matching pair of sex chromosomes — both are X, so females are XX. Males have one X chromosome (normal sized) and one Y chromosome (small), making them XY. The Y chromosome carries genes for male sex determination. The 22 other chromosome pairs (autosomes) are the same in males and females.

Q9. A section of DNA that provides information for making ONE protein is called a: *[1 mark]*

A) Chromosome
B) Gene
C) Nucleus
D) Allele

✔ **Answer: (B)** A GENE is a specific segment of DNA that codes for (provides instructions for making) one protein. Genes control traits because proteins are the molecules that carry out all biological functions. For example, a gene for an enzyme involved in hormone production controls how tall a plant grows. An ALLELE is one version of a gene (e.g., T and t are two alleles of the height gene).

Q10. In Mendel's cross between round yellow (RRYY) × wrinkled green (rryy) pea plants, the F1 generation would be: *[1 mark]*

A) All round green (RRyy)
B) All wrinkled yellow (rrYY)
C) All round yellow (RrYy)
D) 1:1:1:1 ratio of four types

✔ **Answer: (C)** RRYY × rryy → all F1 offspring are RrYy. They are ALL ROUND AND YELLOW because: R (round) is dominant over r (wrinkled) and Y (yellow) is dominant over y (green). In F1, each plant gets one R from the round parent and one r from the wrinkled parent, and one Y from the yellow parent and one y from the green parent.

Q11. Which of the following represents a PHENOTYPE? *[1 mark]*

A) TT
B) Tt
C) tt
D) Tall plant

✔ **Answer: (D)** PHENOTYPE is the OBSERVABLE physical appearance of an organism (what you can see). "Tall plant" is a phenotype. GENOTYPE is the genetic makeup written in terms of alleles (TT, Tt, tt). Both TT and Tt have the SAME phenotype (tall) but different genotypes. Phenotype depends on genotype but also on environmental factors.

Q12. In Mendel's experiment, traits like tallness that are expressed even when only one copy is present are called: *[1 mark]*

A) Recessive traits
B) Co-dominant traits
C) Dominant traits
D) Latent traits

✔ **Answer: (C)** DOMINANT traits are expressed even when only ONE copy (allele) is present — as in heterozygous Tt plants which are tall. RECESSIVE traits are only expressed when BOTH copies are the recessive allele — as in tt plants which are short. Mendel identified dominant and recessive traits by observing that certain traits "disappeared" in F1 but reappeared in F2.

Q13. In humans, both males and females have: *[1 mark]*

A) 22 pairs of sex chromosomes
B) 44 autosomes + 2 sex chromosomes (total 46)
C) 23 sex chromosomes
D) XY combination

✔ **Answer: (B)** Humans have 46 chromosomes total: 44 autosomes (22 pairs) + 2 sex chromosomes (1 pair). Females: 44 autosomes + XX = 46; Males: 44 autosomes + XY = 46. The sex chromosomes differ between males and females; the 22 pairs of autosomes are the same. This was confirmed by karyotyping of human cells.

Q14. Which of the following correctly describes what happens when two heterozygous tall pea plants (Tt) are crossed? *[1 mark]*

A) All offspring will be tall
B) 1/4 of offspring will be tall, 3/4 will be short
C) 3/4 of offspring will be tall, 1/4 will be short
D) Half will be TT and half will be tt

✔ **Answer: (C)** Tt × Tt → TT : Tt : Tt : tt (1:2:1 genotype ratio). TT and Tt are both tall → 3 tall : tt is short → 1 short. So 3/4 (75%) will be tall and 1/4 (25%) will be short. This 3:1 ratio was Mendel's KEY DISCOVERY and is known as the F2 monohybrid ratio. Genotype breakdown: 1TT + 2Tt (tall) + 1tt (short).

Q15. If a trait A exists in 10% of an asexually reproducing population and trait B exists in 60% of the same population, which trait arose EARLIER? *[1 mark]*

A) Trait A (10%)
B) Trait B (60%)
C) Both arose at the same time
D) Cannot be determined

✔ **Answer: (B)** In asexually reproducing populations, all individuals are clones of the original parent. A new variation arises in ONE individual. Over time, as that individual and its clones multiply, the frequency of that variant increases. Trait B at 60% has had MORE TIME to spread through the population → it arose EARLIER. Trait A at 10% is more recent, having had less time to accumulate.

Q16. Which statement about alleles is CORRECT? *[1 mark]*

A) Alleles are always identical copies of a gene
B) Alleles are different versions of the same gene, located at the same position on homologous chromosomes
C) Alleles are found only in gametes
D) A single gene can have only two possible alleles in a species

✔ **Answer: (B)** ALLELES are alternative forms (versions) of the same gene. They occupy the same location (locus) on homologous chromosomes. For example, T (tall) and t (short) are alleles of the height gene in peas. An organism can have two identical alleles (TT or tt — homozygous) or two different alleles (Tt — heterozygous). Some genes may have more than two alleles in a population (multiple alleles).

Q17. Which cross would give all tall offspring? *[1 mark]*

A) TT × Tt
B) Tt × Tt
C) Tt × tt
D) tt × tt

✔ **Answer: (A)** TT × Tt: T from TT and T or t from Tt. Possible offspring: TT and Tt — ALL TALL (50% TT + 50% Tt). Tt × Tt gives 3:1 (75% tall, 25% short). Tt × tt gives 1:1 (50% tall Tt, 50% short tt). tt × tt gives all short (tt). Only TT × TT or TT × Tt can give all tall offspring.

Q18. The variation between offspring and parents that can be inherited is due to: *[1 mark]*

A) Environmental factors only
B) Errors in DNA copying during reproduction
C) Acquired characteristics (like muscles developed by exercise)
D) The food eaten by the parents

✔ **Answer: (B)** Heritable variations arise from small errors (mutations) in DNA copying during reproduction. Each DNA copy is SIMILAR but not IDENTICAL to the original. These changes in DNA lead to changes in proteins, which may alter traits. Non-heritable variations (acquired characteristics) like bigger muscles from exercise are NOT passed to offspring because they don't change the DNA in germ cells.

Q19. Why did Mendel's F1 tall plants NOT breed true (i.e., they gave short offspring in F2)? *[1 mark]*

A) Because they were exposed to different environmental conditions
B) Because they had only one copy of the tallness allele (Tt), also carrying a hidden shortness allele
C) Because tall plants spontaneously mutate to short plants
D) Because F1 plants self-pollinated with short plants

✔ **Answer: (B)** F1 tall plants are Tt (heterozygous). They appear tall because T is dominant, but they also carry a recessive t allele (shortness). When Tt × Tt (F1 self-pollination), the offspring include tt — these SHORT plants

reveal the hidden recessive allele. This is why Mendel said F1 tall plants did not breed true. TT (parental tall) would breed true since they don't carry t.

Q20. In which type of organism is sex determined by environmental temperature rather than genetics? *[1 mark]*

A) Humans
B) Some reptiles (like turtles)
C) Birds
D) Flowering plants

✔ **Answer: (B)** In some reptiles, including sea turtles and some lizards, the sex of offspring is determined by the INCUBATION TEMPERATURE of the eggs (Environmental Sex Determination). In contrast, humans, birds, and most mammals have GENETIC sex determination via sex chromosomes (XX/XY in humans). Snails can even CHANGE SEX, showing that sex is not always fixed genetically.

Q21. Mendel concluded that traits are controlled by discrete "factors" that are passed unchanged from parents to offspring. Today, these "factors" are called: *[1 mark]*

A) Chromosomes
B) Proteins
C) Genes
D) Alleles only

✔ **Answer: (C)** Mendel's "factors" are today called GENES. A gene is a specific segment of DNA on a chromosome that codes for a particular protein, which ultimately controls a trait. Mendel did not know about DNA or chromosomes (discovered later), but his experiments correctly predicted that hereditary units are discrete, come in pairs, and are passed intact from parent to offspring.

SECTION B | *Assertion–Reason Questions | 1 Mark Each*

Directions: Select the correct option:

(A) Both A and R are true, and R is the correct explanation of A.
(B) Both A and R are true, but R is NOT the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

Q1. *[1 mark]*

Assertion (A): In Mendel's F2 generation, both tall and short traits appeared in a 3:1 ratio.
Reason (R): The F1 tall plants (Tt) were heterozygous and carried the hidden recessive shortness allele (t), which was expressed when two Tt plants were crossed.

✔ **Answer: (A)** Both A and R are true, and R correctly explains A. The F1 plants (Tt) appeared tall but carried the hidden t allele. When Tt × Tt: offspring are 1TT:2Tt:1tt. TT and Tt are tall (dominant), tt is short. So 3:1 phenotype ratio appears in F2, revealing the hidden recessive trait.

Q2. *[1 mark]*

Assertion (A): The sex of a child is determined by the father, not the mother.
Reason (R): Mothers always contribute an X chromosome (since females are XX), while fathers can contribute either X or Y. If the child gets Y from the father, it is a boy; X from the father gives a girl.

✔ **Answer: (A)** Both A and R are true, and R correctly explains A. This is one of the most important facts in genetics. Since mothers are XX, they can ONLY give X. The father (XY) gives either X (daughter) or Y (son). Therefore, the sex of the child is entirely determined by which chromosome the FATHER contributes — making the practice of blaming mothers for the sex of the child scientifically incorrect.

Q3. *[1 mark]*

Assertion (A): Dominant traits always appear in greater frequency in a population than recessive traits.
Reason (R): A dominant trait is expressed whenever at least one dominant allele is present (in both TT and Tt individuals), while recessive traits only appear in homozygous recessive individuals (tt).

✔ **Answer: (C)** A is false — dominant traits do NOT always appear more frequently in a population. A recessive trait can be very common if the allele is frequent in the population (e.g., normal blood clotting is recessive to haemophilia in some interpretations; many common traits are recessive). R is true — the definition of dominant (expressed in Tt) vs recessive (expressed only in tt) is correct. However, frequency in a population depends on the frequency of alleles, not just dominance.

Q4. *[1 mark]*

Assertion (A): Mendel's dihybrid cross showed a 9:3:3:1 ratio in the F2 generation.

Reason (R): The two traits (seed shape and seed colour) are inherited independently of each other because they are located on SEPARATE chromosomes.

✔ **Answer: (A)** Both A and R are true, and R correctly explains A. The 9:3:3:1 ratio results because the two gene pairs (R/r for shape and Y/y for colour) assort independently during gamete formation. Since they are on separate chromosomes, the inheritance of one trait does not affect the inheritance of the other — this is Mendel's Law of Independent Assortment.

Q5. *[1 mark]*

Assertion (A): Both TT and Tt plants look identical (tall) in terms of phenotype.

Reason (R): The genotype of an organism determines its phenotype. Since TT and Tt have different genotypes, they must have different phenotypes.

✔ **Answer: (C)** A is true — TT and Tt plants BOTH appear tall (same phenotype) because T is dominant and masks the effect of t in Tt. R is false — it incorrectly states that different genotypes must give different phenotypes. This is wrong: TT and Tt have DIFFERENT genotypes but the SAME phenotype (tall). The dominant allele masks the recessive allele. R contains a conceptual error.

Q6. *[1 mark]*

Assertion (A): Genes are sections of DNA that provide information for making proteins.

Reason (R): Different proteins control different biological traits. An enzyme that produces growth hormones efficiently will make a plant tall; an inefficient enzyme produces less hormone, making the plant short.

✔ **Answer: (A)** Both A and R are true and R correctly explains A. The gene → protein → trait pathway: DNA (gene) provides code → ribosome makes protein (enzyme) → enzyme controls a biochemical process (e.g., hormone synthesis) → the amount of hormone produced determines the trait (tall/short). This is how Mendel's genetic factors ultimately control physical characteristics.

Q7. *[1 mark]*

Assertion (A): In asexual reproduction, variations among offspring are fewer than in sexual reproduction.

Reason (R): Sexual reproduction combines DNA from two different individuals, creating entirely new combinations of traits. Asexual reproduction copies DNA from only one parent.

✔ **Answer: (A)** Both A and R are true and R correctly explains A. Asexual reproduction produces genetic copies (clones) — variations arise only from rare DNA copying errors. Sexual reproduction creates new genetic combinations with every offspring (by combining DNA from two different individuals via meiosis and fertilisation), dramatically accelerating the rate of variation.

Q8. *[1 mark]*

Assertion (A): Each human germ cell (sperm or egg) contains 46 chromosomes.

Reason (R): Germ cells are produced by meiosis, which halves the chromosome number from 46 (diploid, 2n) to 23 (haploid, n) so that fertilisation restores the normal number.

✔ **Answer: (D)** A is false — human germ cells contain 23 chromosomes (haploid, n), NOT 46. Normal body cells contain 46 (diploid, 2n). R is true — meiosis produces haploid germ cells. This is essential: if germ cells had 46 chromosomes, fertilisation would give 92, then 184, etc. — doubling each generation. Meiosis prevents this chromosome doubling problem.

SECTION C | *Short Answer Questions* | *2 Marks Each*

Write precise answers. 2 marks each.

Q1. What is heredity? What is the basic rule of inheritance? *[2 marks]*

Answer:

Heredity is the transmission of genetic traits (characteristics) from parents to offspring through generations. It explains why offspring resemble their parents.

Basic rule: Both parents contribute EQUAL amounts of genetic material to the offspring (the child). This means each trait is influenced by genetic information from BOTH parents — the child receives one allele from the father and one from the mother for each gene.

Q2. Distinguish between dominant and recessive traits with examples from Mendel's experiments. *[2 marks]*

Answer:

DOMINANT TRAIT: A trait that is expressed (visible) even when only ONE copy of the allele is present (in heterozygous condition). It masks the recessive trait.

Example: Tallness (T) in pea plants — Tt plants are tall. Round seeds (R), violet flowers are dominant.

RECESSIVE TRAIT: A trait that is expressed ONLY when BOTH copies of the allele are the recessive form (homozygous recessive condition).

Example: Shortness (t) in pea plants — only tt plants are short. Wrinkled seeds (r), white flowers are recessive.

Memory trick: Dominant = expressed always when present. Recessive = hidden in heterozygotes, visible only in homozygotes.

Q3. What is a Punnett square? Use one to show the offspring of a cross between two heterozygous tall pea plants (Tt × Tt). State the phenotypic ratio. *[2 marks]*

Answer:

A Punnett square is a diagram used to predict the genotypes and phenotypes of offspring from a genetic cross.

Cross: Tt × Tt

Punnett square shows: TT, Tt, Tt, tt

Genotype ratio: 1 TT : 2 Tt : 1 tt

Phenotype: TT = Tall, Tt = Tall (T dominant), tt = Short

Phenotype ratio: 3 TALL : 1 SHORT

This 3:1 ratio is Mendel's monohybrid F2 ratio — one of the most important ratios in genetics.

Q4. How does sex determination work in human beings? What is the role of the father? *[2 marks]*

Answer:

Humans have 23 pairs of chromosomes. 22 pairs are autosomes (same in males and females). The 23rd pair is the SEX CHROMOSOMES:

FEMALES: XX (both sex chromosomes are X — a matched pair)

MALES: XY (one X chromosome and one smaller Y chromosome — mismatched pair)

How sex is determined:

• Mother (XX) can ONLY produce eggs with X chromosome.

• Father (XY) produces sperm with EITHER X OR Y chromosome.

• If X sperm fertilises the egg: X + X = XX = GIRL

• If Y sperm fertilises the egg: X + Y = XY = BOY

The FATHER'S chromosome (X or Y) determines the sex of the child. Each child has a 50% chance of being male or female.

Q5. What is the difference between genotype and phenotype? Give examples. *[2 marks]*

Answer:

GENOTYPE: The actual genetic makeup (combination of alleles) of an organism, written as allele symbols. It cannot be seen directly — only revealed by testing.

Examples: TT, Tt, tt are genotypes for the height gene in peas.

PHENOTYPE: The observable physical appearance or characteristics of an organism — what you can see, measure, or detect.

Examples: "Tall plant" and "short plant" are phenotypes.

Key relationship: TT and Tt have DIFFERENT genotypes but the SAME phenotype (both are tall). tt has a different genotype AND different phenotype (short).

Formula: Phenotype = Genotype + Environmental Influence

Q6. Explain with an example how a gene controls a trait. *[2 marks]*

Answer:

A GENE is a section of DNA that provides the code for making one specific PROTEIN.

How it works (using plant height as an example):

① A gene codes for a specific ENZYME needed to produce a growth hormone (like gibberellin) in pea plants.

② If the gene version (T allele) makes an EFFICIENT enzyme → a lot of hormone is produced → plant grows TALL.

③ If the gene version (t allele) makes an INEFFICIENT enzyme → less hormone produced → plant stays SHORT.

So: Gene (T or t) → Enzyme (efficient or inefficient) → Hormone level (high or low) → Trait (tall or short)

This shows that genes control traits by controlling the PROTEINS (especially enzymes) that carry out biological processes in cells.

Q7. What are the contrasting traits Mendel studied in garden pea plants? Name any four pairs. *[2 marks]*

Answer:

Mendel studied 7 pairs of contrasting (visible) traits in garden pea plants (Pisum sativum). Four important ones:

① Plant height: TALL (T) — dominant vs SHORT (t) — recessive

② Seed shape: ROUND (R) — dominant vs WRINKLED (r) — recessive

③ Seed colour: YELLOW (Y) — dominant vs GREEN (y) — recessive

④ Flower colour: VIOLET (V) — dominant vs WHITE (v) — recessive

(Bonus: ⑤ Pod colour: Green (dominant) vs Yellow. ⑥ Pod shape: Inflated vs Constricted. ⑦ Flower position: Axial vs Terminal)

Mendel chose pea plants because they have a short life cycle, many well-defined contrasting traits, and can be easily cross-pollinated.

Q8. Why are some traits dominant and others recessive at the molecular level? *[2 marks]*

Answer:

At the molecular level, dominance and recessiveness are explained by how gene alleles make proteins:

DOMINANT allele (T): Makes a FUNCTIONAL, EFFICIENT version of an enzyme/protein. Even ONE copy produces enough protein to carry out its job and express the trait.

RECESSIVE allele (t): Makes an INEFFICIENT or NON-FUNCTIONAL version of the same enzyme. When both copies are recessive (tt), there is NO functional protein → trait changes (e.g., less hormone → short plant).

In a heterozygote (Tt): The single T allele makes ENOUGH functional enzyme to produce the normal trait. The t allele's non-functional enzyme does not interfere. So T "dominates."

Key insight: Dominance is NOT about one allele suppressing another — it is about whether ONE COPY of a functional gene is ENOUGH to produce the normal trait.

Q9. What did Mendel's dihybrid cross experiment demonstrate? *[2 marks]*

Answer:

Mendel crossed pea plants with TWO different traits: round yellow seeds (RRYY) × wrinkled green seeds (rryy).

F1 generation: All plants were Round and Yellow (RrYy) — showing R and Y are dominant.

F2 generation (RrYy × RrYy self-pollination): Produced 4 TYPES of offspring in 9:3:3:1 ratio:

• 9 Round Yellow (R_Y_) : 3 Round Green (R_yy) : 3 Wrinkled Yellow (rrY_) : 1 Wrinkled Green (rryy)

SIGNIFICANCE — Law of Independent Assortment:

The 9:3:3:1 ratio proves that the two traits (seed shape and seed colour) are inherited INDEPENDENTLY of each other. They do not travel together. The offspring include NEW COMBINATIONS never seen in parents (round green, wrinkled yellow), showing that genes on different chromosomes assort independently during gamete formation.

Q10. How does the accumulation of variations over generations promote survival of species? *[2 marks]*

Answer:

Every time DNA is copied, small errors (variations/mutations) occur. These accumulate over generations.

Why it helps survival: The environment is NEVER constant — temperatures change, new diseases appear, food sources vary. If ALL individuals were genetically identical (no variation), a single change in the environment could kill the entire population.

With VARIATION: Some individuals will have traits that help them survive the change. These individuals survive and reproduce, passing their advantageous variant to offspring.

Example: If a heat wave hits a population of bacteria, most die — but bacteria with a heat-resistant variation survive and multiply.

Conclusion: Variation is the raw material for NATURAL SELECTION and EVOLUTION. It benefits the SPECIES (ensures survival across generations) even if individual variants may not survive.

SECTION D | *Short Answer Questions* | *3 Marks Each*

Write structured answers covering all key points. 3 marks each.

Q1. Describe Mendel's monohybrid cross experiment with pea plants. What conclusions did he draw about inheritance? [3 marks]

Mendel's Monohybrid Cross (One Trait at a Time) [3 marks]:

EXPERIMENT SETUP:
• Mendel selected two PURE BREEDING (true-breeding) varieties of pea plants:
— Tall plants (TT) × Short plants (tt)
• He performed controlled cross-pollination.

RESULTS:

F1 Generation (First Filial generation):
• All F1 plants were TALL — NO short plants, NO medium-height plants.
• Conclusion: Tallness is DOMINANT over shortness. Shortness trait is NOT lost — just hidden.
• All F1 plants have genotype Tt (heterozygous).

F2 Generation (Second Filial generation):
• Mendel allowed F1 plants to self-pollinate: Tt × Tt.
• Result: 3 TALL : 1 SHORT (3:1 ratio) — SHORT plants REAPPEARED.
• Genotype breakdown: 1 TT : 2 Tt : 1 tt

Punnett square for Tt × Tt:
Parent gametes: T and t from each parent
Offspring: TT, Tt, Tt, tt

Conclusions — Mendel's Laws:
① Traits are controlled by discrete "factors" (now called GENES) — not by blending.
② Each organism has TWO copies of each gene (one from each parent).
③ One allele can be DOMINANT (expressed even in one copy) and the other RECESSIVE (expressed only in two copies).
④ The two alleles separate during gamete formation so each gamete gets only ONE allele — Law of Segregation.

Q2. A tall pea plant (TT) is crossed with a short pea plant (tt). (a) What will be the genotype and phenotype of F1 offspring? (b) If two F1 plants are crossed, what genotype ratio and phenotype ratio will appear in F2? Show using a Punnett square. [3 marks]

(a) F1 Cross: TT × tt [1 mark]

Gametes from TT parent: T only
Gametes from tt parent: t only

All F1 offspring genotype: Tt
All F1 offspring phenotype: TALL (because T is dominant — one T allele is enough for tallness)
F1 phenotype ratio: 100% Tall (no short plants in F1)

(b) F2 Cross: Tt × Tt [2 marks]

Gametes from each Tt parent: T or t

Punnett square (Tt × Tt):

	T	t
T:	TT	Tt
t:	Tt	tt

Offspring:
• TT (1) = Tall (homozygous dominant)
• Tt (2) = Tall (heterozygous — T dominant)
• tt (1) = Short (homozygous recessive)

F2 Genotype ratio: 1 TT : 2 Tt : 1 tt
F2 Phenotype ratio: 3 TALL (TT + Tt) : 1 SHORT (tt)

KEY OBSERVATION: The short trait REAPPEARED in F2 from F1 tall plants. This proves that recessive traits are not lost in F1 — they are present but HIDDEN, only appearing when two recessive alleles come together (tt).

Q3. Explain the dihybrid cross experiment. What is the significance of the 9:3:3:1 ratio? [3 marks]

Mendel's Dihybrid Cross (Two Traits at a Time) [3 marks]:

CROSS: Round Yellow seeds (RRYY) × Wrinkled Green seeds (rryy)
(R = Round, dominant; r = wrinkled; Y = Yellow, dominant; y = green)

F1 Generation:
• All offspring: RrYy (Round Yellow) — BOTH dominant traits expressed.
• F1 phenotype: 100% Round and Yellow.

F2 Generation: RrYy × RrYy (F1 self-pollination)
• Gametes produced by RrYy: RY, Ry, rY, ry (4 types)
• Total F2 combinations: 4 × 4 = 16 (use 4×4 Punnett square)

F2 PHENOTYPE RATIO:
• 9 Round Yellow (R_Y_) — both dominant traits
• 3 Round Green (R_yy) — one dominant, one recessive
• 3 Wrinkled Yellow (rrY_) — one recessive, one dominant
• 1 Wrinkled Green (rryy) — both recessive traits
RATIO = 9 : 3 : 3 : 1

NEW COMBINATIONS observed: Round Green and Wrinkled Yellow — these were NOT in the original parents!

SIGNIFICANCE — Law of Independent Assortment:
The 9:3:3:1 ratio proves that the two traits (seed shape and seed colour) are inherited INDEPENDENTLY. Genes on SEPARATE CHROMOSOMES assort (distribute) into gametes independently of each other. This creates NEW COMBINATIONS of traits in every generation — a major source of genetic variation.

Q4. Explain how sex is determined in human beings. Why is it scientifically incorrect to blame the mother for the sex of the child? [3 marks]

Sex Determination in Human Beings [3 marks]:

CHROMOSOME BASIS:
• Humans have 46 chromosomes in 23 pairs.
• 22 pairs = AUTOSOMES (same in males and females)
• 1 pair = SEX CHROMOSOMES (different)

FEMALES: XX (both sex chromosomes are X — a perfect pair)
MALES: XY (one X + one smaller Y chromosome — mismatched pair)

HOW SEX IS DETERMINED:

Mother (XX):
• During meiosis, eggs formed: ALL carry X chromosome only.
• Mother can ONLY give X to the child.

Father (XY):
• During meiosis, sperms formed: 50% carry X, 50% carry Y chromosome.

At Fertilisation:
• X egg + X sperm (from father) = XX = DAUGHTER
• X egg + Y sperm (from father) = XY = SON

Punnett square for sex determination:

	Father's gametes	
	X	Y
Mother:		
X:	XX (Girl)	XY (Boy)
X:	XX (Girl)	XY (Boy)

Result: 50% boys and 50% girls — equal probability in large populations.

WHY BLAMING MOTHER IS SCIENTIFICALLY WRONG:
The mother always contributes an X chromosome — she CANNOT contribute Y. The sex of the child is entirely determined by WHETHER THE FATHER contributes X or Y. Therefore, blaming the mother for the birth of a girl (or practising female foeticide because of it) is not only wrong morally but also scientifically baseless.

Q5. What is the relationship between genes, chromosomes, and DNA? How do these carry hereditary information? [3 marks]

The Gene–Chromosome–DNA Relationship [3 marks]:

DNA (Deoxyribonucleic Acid): [1 mark]
• DNA is the molecule that carries all the genetic information of a cell.
• It is a long, double-stranded molecule twisted into a double helix.

• DNA is the "master blueprint" — instructions for making all the proteins of the organism.
• DNA is found in the NUCLEUS of every cell.

GENE: [1 mark]
• A GENE is a specific SEGMENT of DNA that codes for (provides instructions for making) ONE PROTEIN.
• Different proteins control different traits.
• Example: The gene for height codes for an enzyme involved in hormone synthesis. T allele = efficient enzyme; t allele = inefficient enzyme.
• Humans have about 20,000–25,000 genes.

CHROMOSOME: [1 mark]
• DNA does not exist as one long continuous thread. It is packaged into separate, compact structures called CHROMOSOMES.
• Each CHROMOSOME is essentially a very long, tightly coiled DNA molecule (with proteins called histones).
• A chromosome contains MANY GENES along its length.
• Humans have 46 chromosomes (23 pairs).
• Each pair of chromosomes contains matching gene sets — one from father, one from mother.
• Germ cells (sperm/egg) have only 23 chromosomes (one from each pair) — this ensures that after fertilisation, the offspring has the correct 46.

Summary:
DNA → organised into → Chromosomes → contain → Genes → code for → Proteins → control → Traits

Q6. Describe how Mendel's experiments showed that: (a) traits may be dominant or recessive, and (b) traits are inherited independently of each other. [3 marks]

(a) Dominant and Recessive Traits — Monohybrid Cross Evidence [1.5 marks]:

Mendel crossed TRUE BREEDING TALL (TT) × TRUE BREEDING SHORT (tt) pea plants.

Observation 1 — F1 generation: ALL plants were TALL. No short plants appeared, no medium-height plants. → This showed that one trait (tallness) DOMINATED over the other (shortness). The shortness trait was not visible — not blended.

Observation 2 — F2 generation (Tt × Tt): SHORT plants REAPPEARED in 1/4 of offspring (3 tall : 1 short ratio). → This proved that the shortness trait was NOT LOST in F1 — it was present but HIDDEN (recessive). It only appeared when two recessive alleles (tt) came together.

Conclusion: Traits can be DOMINANT (expressed in one copy — T) or RECESSIVE (expressed only in two copies — tt). Both exist as separate factors (genes) in the organism.

(b) Independent Inheritance — Dihybrid Cross Evidence [1.5 marks]:

Mendel crossed round yellow (RRYY) × wrinkled green (rryy) plants.

F1: All Round Yellow (RrYy) — both dominant.

F2 (RrYy × RrYy): Produced FOUR types including NEW COMBINATIONS:
• Round Green and Wrinkled Yellow — these combinations were NOT in the original parents!

If the two traits were LINKED (inherited together), we would never see new combinations. The appearance of round green (Ryy) and wrinkled yellow (rrY) plants PROVES that:
• Seed shape gene and seed colour gene are inherited INDEPENDENTLY.
• Each trait "shuffles" independently into gametes (because they are on separate chromosomes).

Conclusion: Mendel's Law of Independent Assortment — genes on different chromosomes assort independently, creating new combinations in offspring.

SECTION E | *Punnett Square Practice Problems | 3 Marks Each*

CBSE EXAM ESSENTIAL: Work out each cross completely — gametes, Punnett square, ratio, and inference.

Q1. A homozygous tall pea plant (TT) is crossed with a heterozygous tall pea plant (Tt). (a) Write all possible gametes for each parent. (b) Draw a Punnett square. (c) State the genotype ratio and phenotype ratio. [3 marks]

(a) Gametes: TT parent → T and T (only T gametes). Tt parent → T and t (T or t gametes).

(b) Punnett square: (see table below)

(c) Genotype ratio: 1TT : 1Tt (50%:50%)

(d) Phenotype ratio: ALL TALL (100%) — because TT is tall (homozygous dominant) and Tt is tall (T dominant). No short plants.

Inference: When a homozygous dominant is crossed with a heterozygous, ALL offspring show the dominant phenotype. But 50% are true-breeding (TT) and 50% are non-true-breeding (Tt).

Punnett Square: TT × Tt

	T (from TT)	T (from TT)
T (from Tt)	TT	TT
t (from Tt)	Tt	Tt

Q2. A heterozygous tall pea plant (Tt) is crossed with a short pea plant (tt) — this is called a TEST CROSS. (a) Draw a Punnett square. (b) Give the genotype and phenotype ratio. (c) Why is a test cross important? [3 marks]

(a) Cross: Tt × tt. Gametes: Tt → T or t; tt → t only.

(b) Punnett square: (see table below)

Genotype ratio: 1 Tt : 1 tt (1:1)

Phenotype ratio: 1 TALL (Tt) : 1 SHORT (tt) → 1:1 ratio

(c) Why test cross is important: A tall plant could be TT (true-breeding) or Tt (heterozygous) — we cannot tell by looking. If we cross it with a short plant (tt):

— If ALL offspring are tall → original plant was TT (homozygous dominant)

— If HALF offspring are tall and half short → original plant was Tt (heterozygous)

A test cross with a homozygous recessive organism reveals the UNKNOWN GENOTYPE of an organism showing the dominant phenotype. This is used in plant and animal breeding.

Test Cross: Tt × tt

	T (from Tt)	t (from Tt)
t (from tt)	Tt (Tall)	tt (Short)
t (from tt)	Tt (Tall)	tt (Short)

Q3. In humans, X-linked colour blindness (c) is recessive, while normal vision (C) is dominant. A woman who is a carrier for colour blindness (X^C X^c) marries a man with normal vision (X^C Y). Show using a Punnett square the probability of their children being colour blind. [3 marks]

Cross: X^C X^c (carrier female) × X^C Y (normal male)
Gametes: Female → X^C or X^c ; Male → X^C or Y
Punnett square: (see table below)
Offspring analysis:
① X^C X^C = Normal daughter (25%)
② X^C X^c = Carrier daughter — looks normal but carries colour blindness (25%)
③ X^C Y = Normal son (25%)
④ X^c Y = COLOUR BLIND SON (25%)
Phenotype analysis:
• Daughters: All appear to have normal vision (50% normal, 50% carriers) — none are colour blind.
• Sons: 50% normal vision, 50% colour blind.
INFERENCE: X-linked recessive diseases appear MORE FREQUENTLY in males because males have only ONE X chromosome. If that single X carries the recessive allele, the disease is expressed (no second X to mask it). Females need TWO copies of the recessive allele to be affected.

X-linked Colour Blindness Cross

	X^C (from mother)	**X^c (from mother)**
X^C (from father)	X^C X^C (Normal girl)	X^C X^c (Carrier girl)
Y (from father)	X^C Y (Normal boy)	X^c Y (Colour blind boy)

SECTION F | *Case-Based / Competency Questions* | *4 Marks Each*

Read each passage carefully and answer ALL sub-questions.

Case Study 1: The Royal Family Mystery

> *Haemophilia is a genetic condition where the blood cannot clot normally, causing uncontrolled bleeding from even minor injuries. It is caused by a recessive allele (h) on the X chromosome; the dominant allele (H) codes for normal clotting. Queen Victoria of England carried the gene for haemophilia on one of her X chromosomes (X^H X^h) — she was a carrier. She passed this gene to some of her children and grandchildren, affecting royal families across Europe. Her carrier daughters married into royal families, and some of their sons were haemophilic. The disease was known as the "Royal Disease."*

(i) What is the genotype of Queen Victoria? Was she haemophilic? Why or why not? [1 mark]

Queen Victoria's genotype: X^H X^h (carrier female).
She was NOT haemophilic. She had ONE normal allele (X^H) which produces enough clotting factor (a protein) to prevent haemophilia. The disease is X-linked RECESSIVE — females need TWO copies of the recessive allele (X^h X^h) to be affected. One dominant X^H masks the effect of X^h. She was a CARRIER — not affected but able to pass the allele to children.

(ii) If Queen Victoria's carrier daughter (X^H X^h) married a normal man (X^H Y), what is the probability of their son being haemophilic? Show using a Punnett square. [1 mark]

Cross: X^H X^h (carrier mother) × X^H Y (normal father)
Gametes: Mother → X^H or X^h ; Father → X^H or Y
Punnett square:
X^H (Father) | Y (Father)
X^H (Mother): X^H X^H (Normal girl) | X^H Y (Normal boy)
X^h (Mother): X^H X^h (Carrier girl) | X^h Y (Haemophilic boy)

Probability of haemophilic son: 1 out of 4 total children = 25% overall, or 1 out of 2 sons = 50% of sons are haemophilic.

(iii) Why do daughters rarely show haemophilia while sons are more commonly affected? [1 mark]

Because haemophilia is X-LINKED RECESSIVE:

FEMALES (XX): Need TWO recessive alleles (X^h X^h) to be haemophilic. Since fathers contribute X^H (normal), daughters of normal fathers always get at least one X^H → they are protected. Daughters can only be haemophilic if both father AND mother carry/have the recessive allele.

MALES (XY): Have only ONE X chromosome. If that X carries the recessive allele (X^h), there is NO second X to mask it → they ARE haemophilic. Males are said to be HEMIZYGOUS for X-linked traits.

(iv) What does this case study reveal about the importance of knowing genetics before marriage? [1 mark]

This case shows that: ① Carrier individuals (like Queen Victoria) appear completely healthy but can pass genetic diseases to children without knowing. ② Genetic counselling before marriage helps identify carrier status — especially for X-linked conditions like haemophilia, Duchenne muscular dystrophy, and colour blindness. ③ Knowing the genotype of parents allows calculation of the probability of affected children. ④ It also illustrates that genetic diseases cross all social boundaries — even royal families are affected. Modern genetic testing (carrier testing, prenatal diagnosis) can help families make informed reproductive decisions.

Case Study 2: The School Genetics Project

> *Students in Class 10 are studying earlobes. They observe that some students have FREE earlobes (hang away from the face) and some have ATTACHED earlobes (connected directly to the face). They find that the free earlobe trait (F) is dominant over the attached earlobe trait (f). They also notice that students' earlobe types often match one of their parents. Two students, Anu and Binu, both have free earlobes. However, their child (in a hypothetical scenario for the project) has attached earlobes.*

(i) What must Anu's and Binu's genotypes be? Explain your reasoning. [1 mark]

Both Anu and Binu must be HETEROZYGOUS (Ff) for the earlobe gene.

Reasoning: They both have FREE earlobes → they must have at least one F allele. Their child has ATTACHED earlobes (ff) → the child got an f allele from EACH parent. Since Anu and Binu are both free-eared but can pass an f allele, they must EACH have one F and one f allele → genotype Ff (heterozygous).

(ii) If Anu and Binu have four children, how many would you expect to have attached earlobes? Draw a Punnett square to support your answer. [1 mark]

Cross: Ff × Ff

Punnett square:

	F	f
F:	FF	Ff
f:	Ff	ff

Ratio: 1FF : 2Ff : 1ff → 3 Free : 1 Attached

For 4 children: Expected 3 with free earlobes and 1 with attached earlobes.

IMPORTANT: This is a PROBABILITY, not a certainty. The actual result might differ — genetics tells us the probability, not the exact outcome.

(iii) A new student joins the class with attached earlobes. Can you tell their genotype just by looking? Explain. [1 mark]

YES — a student with ATTACHED earlobes (recessive phenotype) must be HOMOZYGOUS RECESSIVE (ff). There is no other possibility — both alleles MUST be f because if any F allele were present, the student would have free earlobes (F is dominant). For RECESSIVE phenotypes, we can always determine the exact genotype (ff). For dominant phenotypes (free earlobes), we CANNOT tell if the genotype is FF or Ff just by looking — this is why test crosses are needed.

(iv) The students learn that earlobes are inherited but skin tanning from sun exposure is NOT inherited. Explain the difference between heritable and non-heritable variations. [1 mark]

HERITABLE VARIATION (like earlobe type): Caused by changes in the DNA (in genes) of the organism. These changes are present in ALL cells including germ cells (sperm/egg). Therefore, they CAN be passed to offspring. Example: earlobe shape, eye colour, blood group.

NON-HERITABLE VARIATION (acquired characteristics): Caused by environmental factors during the organism's lifetime. They change the BODY but do NOT change the DNA in germ cells. Therefore, they CANNOT be passed to offspring. Example: tanned skin from sun, muscles built by exercise, a scar from an injury.

Key principle: Only changes in DNA of germ cells can be inherited.

Case Study 3: The Genetics Counsellor

Rajan and Priya visit a genetics counsellor. Rajan has blood group A (genotype I^A i — heterozygous), and Priya has blood group B (genotype I^B i — heterozygous). Blood group is determined by alleles I^A (produces A antigen), I^B (produces B antigen), and i (produces no antigen). I^A and I^B are co-dominant; i is recessive to both. The counsellor explains the possible blood groups their children might have.

(i) List all four possible blood groups their children could have. [1 mark]

Cross: I^A i × I^B i

Possible offspring genotypes:

① I^A I^B = Blood group AB (co-dominant — both A and B antigens expressed)

② I^A i = Blood group A

③ I^B i = Blood group B

④ ii = Blood group O (no antigen)

All four blood groups (A, B, AB, and O) are possible in equal probability (25% each).

This is an example of CO-DOMINANCE (I^A and I^B are equally expressed when both present) and MULTIPLE ALLELES (three alleles: I^A, I^B, i for one gene).

(ii) Explain what co-dominance means, using blood group as an example. [1 mark]

CO-DOMINANCE: When two alleles are BOTH fully expressed in a heterozygous individual — neither allele is dominant or recessive over the other.

Blood group example: In a person with genotype I^A I^B:

• I^A allele produces A antigens on red blood cells.

• I^B allele produces B antigens on red blood cells.

• BOTH antigens are produced — the person has blood group AB.

Neither I^A suppresses I^B nor vice versa. Both are equally expressed. This is different from simple dominance where one allele completely masks the other.

(iii) Rajan's parents have blood groups A and O. Is this information enough to confirm that Rajan's genotype is I^A i? [1 mark]

YES, this IS enough to confirm Rajan's genotype is I^A i.

Reasoning:

• Blood group O parent has genotype ii.

• They can ONLY pass allele i to Rajan.

• Rajan has blood group A → he has at least one I^A allele.

• Since one allele came as i from the O-parent, and his phenotype is A (not AB or O), his genotype MUST be I^A i.

If Rajan were I^A I^A, his O-parent could not have given an I^A — impossible. If he were ii, his phenotype would be O. The logic of Mendelian genetics allows us to deduce genotypes from phenotypes and family history.

(iv) The counsellor tells them that blood group is NOT influenced by environmental factors like diet or climate. What does this tell us about the nature of inherited traits? [1 mark]

This tells us that GENETICALLY DETERMINED TRAITS are not altered by environmental factors that affect the body during life. Blood group is fixed at fertilisation (determined by the alleles inherited from both parents) and remains constant throughout life regardless of diet, climate, disease, or lifestyle.

This is the fundamental principle of Mendelian inheritance: GENETIC INFORMATION (DNA) is passed INTACT from parents to offspring. Environmental changes to the body (phenotype) are NOT inherited (Lamarck was wrong about acquired characteristics). True heritable traits are those encoded in the DNA of germ cells and remain stable across generations.

SECTION G | *Long Answer Questions | 5 Marks Each*

Write detailed, structured answers. 5 marks each.

Q1. (a) Who was Gregor Mendel and what were his contributions to genetics? (b) Describe the monohybrid cross in detail with a Punnett square. (c) What do the laws of segregation and independent assortment state? [5 marks]

(a) Gregor Johann Mendel (1822–1884) — Father of Genetics [1 mark]:
• Austrian monk and scientist who laid the foundation of modern genetics.
• Studied at the University of Vienna (science and mathematics).
• Conducted meticulous experiments on garden pea plants in his monastery garden.
• Key innovation: He was the FIRST to COUNT the number of individuals showing each trait in each generation (quantitative approach to biology).
• Kept careful records over 8 years, studying thousands of plants.
• Published his findings in 1866, but they were largely ignored until rediscovered in 1900.
• His "factors" (now called genes) correctly predicted discrete units of inheritance long before DNA was discovered.

(b) Monohybrid Cross — Detailed Description [3 marks]:
Cross: Pure tall (TT) × Pure short (tt)

Step 1 — Parental (P) generation:
• Tall plants (TT) produce only T gametes.
• Short plants (tt) produce only t gametes.

Step 2 — F1 generation (TT × tt):
All offspring: Tt (heterozygous)
Phenotype: ALL TALL (T is dominant, t is recessive and hidden)

Step 3 — F2 generation (Tt × Tt self-pollination):
Gametes from Tt: T or t

Punnett square:

	T	t
T:	TT	Tt
t:	Tt	tt

F2 Genotype ratio: 1 TT : 2 Tt : 1 tt
F2 Phenotype ratio: 3 TALL (TT + Tt) : 1 SHORT (tt)

Important observations:
• SHORT trait reappeared in F2 (1/4 of plants) after disappearing in F1 → proved the recessive trait is NOT lost.
• F1 plants (Tt) appeared tall but were NOT identical to parental TT plants — they were heterozygous.
• The 3:1 ratio is one of the most important ratios in biology.

(c) Mendel's Laws [1 mark]:

Law 1 — LAW OF SEGREGATION (Monohybrid cross):
During gamete formation, the TWO ALLELES for each trait SEPARATE (segregate) from each other. Each gamete receives ONLY ONE allele for each gene. The two alleles come back together at fertilisation.

Law 2 — LAW OF INDEPENDENT ASSORTMENT (Dihybrid cross):
When two or more traits are inherited simultaneously, the alleles for EACH TRAIT assort (distribute) into gametes INDEPENDENTLY of the alleles for other traits (provided the genes are on different chromosomes). This creates new combinations of traits in offspring.

Q2. (a) Explain sex determination in humans with a diagram. (b) What social impact has the misunderstanding of sex determination had on society? (c) Briefly describe how sex is determined in snails and reptiles differently from humans. [5 marks]

(a) Sex Determination in Humans [2 marks]:

Human Sex Chromosomes:
• Females: 44 autosomes + XX = 46 chromosomes total
• Males: 44 autosomes + XY = 46 chromosomes total
• The Y chromosome is smaller than X and carries fewer genes.

Mechanism:
• Mother (XX) → produces eggs, ALL containing X chromosome only.
• Father (XY) → produces sperms: 50% contain X, 50% contain Y.

Cross diagram:
Mother (XX) × Father (XY)
Gametes: X (eggs only) × X or Y (sperms)

Offspring:
• X (egg) + X (sperm from dad) = XX = DAUGHTER
• X (egg) + Y (sperm from dad) = XY = SON

Each pregnancy: 50% probability of boy, 50% of girl.
SEX IS DETERMINED BY THE FATHER (which sperm fertilises the egg).

(b) Social Impact of Misunderstanding Sex Determination [2 marks]:

The scientific FACT is that the father determines the sex of the child. Yet, in many societies, mothers have been:
① BLAMED for not producing sons (despite the science showing fathers determine sex)
② Subject to DOMESTIC ABUSE, dowry demands, and social discrimination because of the sex of children
③ Subjected to SEX-SELECTIVE ABORTION (female foeticide) because families want sons — even though the mother has no genetic control over this
④ Denied equal rights in marriages and families based on superstition

Consequences of female foeticide:
• Dangerously declining CHILD SEX RATIO in some regions of India
• Social imbalance (fewer women in the population)
• Violation of the right to life of female foetuses
• India has banned prenatal sex determination (PC-PNDT Act) to combat this

Understanding genetics is therefore not just academic — it directly impacts social justice and human rights.

(c) Sex Determination in Other Species [1 mark]:

In SNAILS: Individuals can CHANGE SEX — they may be male at one life stage and female at another. Sex is not fixed genetically — it can be altered by social or environmental factors. This shows sex determination is not always chromosomal.

In REPTILES (some, e.g., sea turtles, many lizards):
Sex is determined by the TEMPERATURE at which eggs are incubated (Environmental Sex Determination / ESD).
• Higher temperatures may produce mainly females.
• Lower temperatures may produce mainly males.
• No sex chromosomes are involved.
This makes these species vulnerable to climate change — rising temperatures may skew sex ratios.

Conclusion: Different organisms use completely different strategies for sex determination — genetic (XX/XY like humans), environmental (reptiles), or changeable (snails). Humans use one of the most well-studied genetic mechanisms.

SECTION H | *Very Short Answer (VSA) | 1 Mark Each | Rapid Fire Round*

One-line answers. Directly asked in CBSE papers 2019–2025.

Q1. Who is known as the "Father of Genetics"?

Ans: Gregor Johann Mendel (1822–1884), an Austrian monk who studied heredity in garden pea plants.

Q2. What plant did Mendel use for his experiments?

Ans: Garden pea plant — Pisum sativum.

Q3. Define: Gene.

Ans: A gene is a specific segment of DNA that provides information (code) for making one protein, which controls a particular trait.

Q4. What is the phenotype ratio in F2 of a monohybrid cross?

Ans: 3 : 1 (3 dominant phenotype : 1 recessive phenotype), e.g., 3 tall : 1 short.

Q5. What is the genotype ratio in F2 of a monohybrid cross (Tt × Tt)?

Ans: 1 TT : 2 Tt : 1 tt

Q6. What is the sex chromosome combination in human males and females?

Ans: Females: XX. Males: XY. (Total chromosomes = 46 in both; 22 pairs autosomes + 1 pair sex chromosomes)

Q7. Who determines the sex of the child — father or mother?

Ans: The FATHER. Mothers (XX) can only give X; fathers (XY) can give X (producing a girl) or Y (producing a boy).

Q8. What is the phenotype ratio in F2 of a dihybrid cross?

Ans: 9 : 3 : 3 : 1 (e.g., 9 round yellow : 3 round green : 3 wrinkled yellow : 1 wrinkled green)

Q9. What is a dominant trait? Give an example.

Ans: A trait expressed even when only one copy of the allele is present. Example: Tallness (T) in pea plants — Tt plants are tall.

Q10. What is a recessive trait? Give an example.

Ans: A trait expressed ONLY when both copies of the allele are recessive. Example: Shortness (t) — only tt plants are short.

Q11. Define: Homozygous and Heterozygous.

Ans: Homozygous: Both alleles are identical (TT or tt). Heterozygous: Two different alleles (Tt).

Q12. What is a test cross?

Ans: Crossing an organism of unknown genotype (showing dominant phenotype) with a homozygous recessive organism (tt) to determine if it is TT or Tt.

Q13. What is the genotype of a short (recessive) pea plant?

Ans: tt (homozygous recessive) — only possible genotype for a short plant.

Q14. What is independent assortment?

Ans: Mendel's Law: Genes on different chromosomes are inherited independently of each other, creating new trait combinations in offspring.

Q15. If a trait B exists in 60% of an asexually reproducing population, did it arise before or after a trait at 10%?

Ans: Trait B (60%) arose EARLIER — it has had more time to spread through the population by being copied into more offspring.

Q16. What is a chromosome?

Ans: A chromosome is a compact, organised structure of DNA and proteins found in the nucleus. Each chromosome contains many genes. Humans have 46 chromosomes (23 pairs).

Q17. How many pairs of chromosomes do humans have? How many are sex chromosomes?

Ans: 23 pairs (46 total). 22 pairs are autosomes. 1 pair are sex chromosomes (XX in females, XY in males).

Q18. Name any two contrasting traits Mendel studied in pea plants.

Ans: ① Tall vs Short plant height (T dominant over t). ② Round vs Wrinkled seed shape (R dominant over r). (Also: Yellow vs Green seeds, Violet vs White flowers)

Q19. What is the difference between genotype and phenotype?

Ans: Genotype: Genetic makeup written as alleles (TT, Tt, tt). Phenotype: Observable physical appearance (tall or short plant). TT and Tt have different genotypes but same phenotype.

Q20. Why are variations important for the survival of a species?

Ans: Variations ensure that when the environment changes (disease, climate), some individuals have traits that allow them to survive and reproduce, preventing extinction of the entire species.

⚡ QUICK REVISION | KEY FORMULAS & FACTS | *Chapter 8: Heredity*

Mendel's Cross Results — Quick Reference

Cross	F1 Genotype	F2 Genotype Ratio	F2 Phenotype Ratio
TT × tt (Monohybrid)	All Tt	1TT : 2Tt : 1tt	3 Tall : 1 Short
Tt × Tt (F1 self)	—	1TT : 2Tt : 1tt	3 Dominant : 1 Recessive
TT × Tt	50% TT, 50% Tt	—	All Tall (100%)
Tt × tt (Test cross)	50% Tt, 50% tt	—	1 Tall : 1 Short
tt × tt	All tt	—	All Short (100%)
RrYy × RrYy (Dihybrid)	—	16 combinations	9:3:3:1

Key Terms — Quick Definitions

Term	Definition
Gene	Segment of DNA coding for one protein; controls one trait
Allele	Alternative form of a gene (e.g., T and t are alleles of height gene)

Dominant	Expressed even with one copy — masks recessive in heterozygote
Recessive	Expressed ONLY when both alleles are recessive (homozygous recessive)
Homozygous	Both alleles identical — TT (dominant) or tt (recessive)
Heterozygous	Two different alleles — Tt
Genotype	Genetic makeup (allele combination) — TT, Tt, tt
Phenotype	Observable appearance — tall, short, round, wrinkled
F1 generation	First filial generation — offspring of two parent plants
F2 generation	Second filial generation — offspring of F1 plants (by self-pollination)
Test cross	Cross with homozygous recessive to determine unknown genotype
Sex chromosomes	Chromosomes determining sex — XX (female), XY (male) in humans
Autosomes	Non-sex chromosomes — 22 pairs in humans (same in both sexes)
Law of Segregation	Two alleles for each gene separate during gamete formation
Independent Assortment	Genes on different chromosomes are inherited independently

Sex Determination Across Species

Organism	Sex Determination Method	Details
Humans (Mammals)	Genetic — XX/XY	XX = Female; XY = Male. Father determines sex.
Birds	Genetic — ZW/ZZ	Female = ZW; Male = ZZ (opposite of mammals)
Some Reptiles (turtles)	Environmental — Temperature	Incubation temp of eggs determines sex; no sex chromosomes
Snails	Changeable	Can change sex; sex not fixed genetically