9th Class Biology Notes - Complete Chapter-Wise Study Notes for Punjab Students (2026-27)

9th Class - Punjab Board - Session 2026-27

Original study notes by Zahid Notes for revision. These are summaries, not the official textbook.

Chapter titles follow the revised PCTB Biology book (2023 curriculum). Students should check chapter titles against their issued book.

Introduction

These biology class 9 notes are written to help a class 9 student revise the whole Biology book chapter by chapter, in simple words. Each chapter below gives a short summary of the main ideas, the key definitions to remember, important short questions with brief answers, important long questions with fuller answers, and a set of practice MCQs with an answer key. The notes explain ideas in the student's own study language and do not reproduce the textbook.

How to use these biology class 9 notes: read the summary of a chapter first, then cover the answers and try the short questions on your own, and finally test yourself with the MCQs. Biology becomes easier when you connect each idea to something you can picture - for example, a leaf making food in sunlight, or a single cell dividing into two. Work through one chapter at a time rather than trying to memorise the whole book at once. These biology class 9 notes are Punjab-wide only: no board-specific claims are made anywhere in these notes.

Chapter 1: The Science of Biology

Summary

Biology is the scientific study of life and living things. The word comes from two Greek words: "bios" (life) and "logos" (study). Biology is divided into three major divisions: zoology (animals), botany (plants) and microbiology (microorganisms). It is further divided into branches that study one aspect of life: morphology studies form and structure, anatomy studies internal structure, physiology studies functions, cytology studies cells, histology studies tissues, genetics studies inheritance, ecology studies relations between organisms and their environment, and biotechnology applies living things for human benefit.

Living things show several levels of organization, from small to large: atoms join into molecules, molecules form organelles, organelles work together in cells, similar cells form tissues, tissues form organs, organs form organ systems, and organ systems work together in an organism. Beyond the individual, organisms of one kind form a population, populations of different kinds form a community, and a community together with its non-living environment forms an ecosystem. All ecosystems together make the biosphere.

Biology is linked with other sciences. Biophysics applies physics to living things, biochemistry studies the chemistry of life, biomathematics uses mathematics in biology, and biogeography studies where organisms live. Biology also offers careers in medicine, agriculture, teaching, research, fisheries, forestry and biotechnology. The chapter also includes a section on the Quran and the study of life, noting that observing nature is encouraged.

Science works through the scientific method: a problem is recognised, observations are made, a hypothesis (a testable possible explanation) is proposed, experiments test it, and a conclusion is drawn. A theory is a well-tested explanation supported by much evidence, while a law describes a pattern in nature. A famous example of the biological method is the study of malaria: observations linked the disease with mosquitoes, and experiments showed that the female Anopheles mosquito carries the malarial parasite, Plasmodium, from one person to another.

Key definitions and concepts

- **Biology:** The scientific study of life and living things.
- **Zoology / Botany / Microbiology:** The study of animals / plants / microorganisms.
- **Morphology:** The study of the form and structure of organisms.
- **Anatomy:** The study of the internal structures of organisms.
- **Physiology:** The study of the functions of living things and their parts.
- **Genetics:** The study of genes and inheritance.
- **Ecology:** The study of relations between organisms and their environment.
- **Hypothesis:** A testable possible explanation for an observation.
- **Theory:** A well-tested explanation supported by a large body of evidence.
- **Law:** A statement describing a regular pattern observed in nature.
- **Biosphere:** The part of the Earth where life exists, including all ecosystems.

Important short questions

Q1. What is biology, and what are its three major divisions?

Biology is the scientific study of life. Its three major divisions are zoology (animals), botany (plants) and microbiology (microorganisms).

Q2. Arrange these levels of organization from smallest to largest: organ, cell, tissue, organism.

Cell, tissue, organ, organism. Cells group into tissues, tissues into organs, and organs work together in an organism.

Q3. What is the difference between a hypothesis and a theory?

A hypothesis is a testable possible explanation proposed before experiments. A theory is an explanation that has been tested many times and is supported by much evidence.

Q4. How is biology related to physics and chemistry?

Biophysics applies the principles of physics to living things, and biochemistry studies the chemical substances and reactions of life. Both show that biology works together with other sciences.

Important long questions

Q1. Describe the levels of biological organization from atom to biosphere.

Atoms join to form molecules, and molecules assemble into organelles, the working parts inside cells. Cells are the basic units of life. Similar cells working together form a tissue, different tissues form an organ, and organs working together form an organ system, such as the digestive system. All organ systems together make an organism. Organisms of the same kind in one area form a population, different populations together form a community, and a community plus its non-living surroundings forms an ecosystem. All the ecosystems of the Earth together make the biosphere.

Q2. Explain the steps of the scientific method using the example of malaria.

First a problem is recognised: people in some areas suffer from malaria. Observations show that the disease is common where mosquitoes are common. A hypothesis is made: mosquitoes spread malaria. Experiments are done: mosquitoes are allowed to bite healthy people after biting malaria patients, and the patients fall ill, while people protected from mosquitoes stay healthy. The conclusion is that the female Anopheles mosquito carries the malarial parasite Plasmodium. Further work confirms the explanation, which is why controlling mosquitoes controls malaria.

MCQs

1. The study of microorganisms is called:

a) Zoology b) Botany c) Microbiology d) Morphology

2. Which level of organization comes directly after "tissue"?

a) Cell b) Organ c) Organism d) Organelle

3. A testable possible explanation for an observation is called a:

a) Law b) Theory c) Hypothesis d) Fact

4. The malarial parasite is called:

a) Plasmodium b) Anopheles c) Amoeba d) Paramecium

Answer key (Ch. 1): 1-c, 2-b, 3-c, 4-a.

Chapter 2: Biodiversity

Summary

Biodiversity means the variety of life on Earth - the variety of genes within a species, the variety of species, and the variety of ecosystems. Life is enormously varied: organisms differ in size, shape, colour, habitat and way of life. To study this variety, biologists classify organisms, that is, they arrange them into groups based on similarities and differences. The branch that deals with naming and classifying organisms is called taxonomy, and the system of classification is called systematics.

The modern system of naming gives every species a scientific name made of two parts: the genus name (written first, with a capital letter) and the species name (written second, in small letters). This is called binomial nomenclature, introduced by the Swedish scientist Carolus Linnaeus. Scientific names are written in italics in print and underlined when handwritten, so that scientists everywhere use the same name for the same organism.

The most widely used classification divides living things into five kingdoms, proposed by Robert Whittaker: Monera (single-celled organisms without a true nucleus, such as bacteria), Protista (mostly single-celled organisms with a true nucleus, such as Amoeba), Fungi (organisms such as mushrooms and moulds that absorb food), Plantae (multicellular organisms that make their own food by photosynthesis) and Animalia (multicellular organisms that take in food). Viruses are not placed in any kingdom because they are not made of cells; they are particles of genetic material in a protein coat that can only reproduce inside a living host cell.

Biodiversity is threatened by habitat destruction, hunting, pollution and the introduction of new species into an area. When a species disappears completely it is extinct, and species at risk of disappearing are called endangered. Conservation means protecting species and their habitats, for example through national parks, wildlife sanctuaries and laws against hunting.

Key definitions and concepts

- **Biodiversity:** The variety of genes, species and ecosystems in an area or on Earth.
- **Taxonomy:** The branch of biology that names and classifies organisms.
- **Binomial nomenclature:** The two-part scientific naming system: genus name + species name.
- **Genus:** A group of closely related species.
- **Species:** A group of similar organisms that can interbreed and produce fertile offspring.
- **Kingdom:** The largest group in classification, such as Plantae or Animalia.
- **Extinct species:** A species that no longer exists anywhere on Earth.
- **Endangered species:** A species at serious risk of becoming extinct.
- **Conservation:** The protection and careful management of species and their habitats.

Important short questions

Q1. What is biodiversity? Name its three levels.

Biodiversity is the variety of life. Its three levels are genetic diversity, species diversity and ecosystem diversity.

Q2. Write the rules of binomial nomenclature.

Each species gets two names: the genus name first (capital letter) and the species name second (small letters). The name is italicised in print and underlined in handwriting.

Q3. Name the five kingdoms and give one example of each.

Monera (bacteria), Protista (Amoeba), Fungi (mushroom), Plantae (rose plant), Animalia (human).

Q4. Why are viruses not placed in any kingdom?

Viruses are not made of cells, so they do not fit the cell-based kingdom system. They are particles of genetic material in a protein coat that reproduce only inside a host cell.

Important long questions

Q1. Explain binomial nomenclature and why scientists use it.

Common names differ from place to place and language to language, so one organism may have many local names. Binomial nomenclature gives every species one scientific name understood worldwide. The name has two parts: the genus, a group of closely related species, and the species itself. For example, the scientific name of the human is Homo sapiens, where Homo is the genus and sapiens the species. The system was introduced by Linnaeus and avoids confusion in scientific work.

Q2. Compare the five kingdoms on the basis of cell type, cell number and mode of nutrition.

Monera are single-celled organisms without a true nucleus; bacteria make their own food or absorb it. Protista are mostly single-celled organisms with a true nucleus; some photosynthesise and some take in food. Fungi are mostly multicellular organisms with a true nucleus that absorb food from dead or living matter. Plantae are multicellular organisms with a true nucleus that make food by photosynthesis. Animalia are multicellular organisms with a true nucleus that take in food by eating other organisms.

MCQs

1. The two-part naming system of organisms is called:

a) Taxonomy b) Binomial nomenclature c) Classification d) Systematics

2. Which kingdom contains bacteria?

a) Protista b) Fungi c) Monera d) Plantae

3. In a scientific name, the genus name is written:

a) In small letters b) With a capital letter c) In numbers d) Last

4. A species that no longer exists anywhere is called:

a) Endangered b) Extinct c) Rare d) Protected

Answer key (Ch. 2): 1-b, 2-c, 3-b, 4-b.

Chapter 3: The Cell

Summary

The cell is the basic structural and functional unit of all living things. The idea comes from cell theory: all living things are made of one or more cells, the cell is the basic unit of life, and all cells arise from pre-existing cells. Cells were first seen by Robert Hooke in 1665, when he looked at thin slices of cork under a microscope and saw small box-like compartments, which he called cells. Later, Schleiden and Schwann proposed that plants and animals are made of cells, and Virchow added that new cells come from existing cells.

Cells are of two main types. Prokaryotic cells have no true nucleus and no membrane-bound organelles; their genetic material lies free in the cytoplasm. Bacteria are prokaryotic. Eukaryotic cells have a true nucleus and membrane-bound organelles; plants, animals, fungi and protists are eukaryotic.

A eukaryotic cell has several organelles, each with a job. The cell membrane controls what enters and leaves the cell. The cytoplasm is the jelly-like fluid where organelles sit and many reactions happen. The nucleus controls the cell and holds the genetic material. Mitochondria release energy from food and are called the powerhouse of the cell. Ribosomes make proteins. The endoplasmic reticulum transports materials (rough ER has ribosomes, smooth ER does not). The Golgi apparatus packs and sends out proteins. Lysosomes digest worn-out parts and unwanted material. Plant cells also have a cell wall for support, chloroplasts for photosynthesis, and a large central vacuole for storage; animal cells have small vacuoles or none.

Key definitions and concepts

- **Cell:** The basic structural and functional unit of life.
- **Cell theory:** All living things are made of cells; the cell is the basic unit of life; all cells arise from pre-existing cells.
- **Prokaryotic cell:** A cell without a true nucleus or membrane-bound organelles.
- **Eukaryotic cell:** A cell with a true nucleus and membrane-bound organelles.
- **Organelle:** A small structure inside a cell that carries out a particular job.
- **Cell membrane:** The boundary of the cell that controls the passage of materials.
- **Nucleus:** The organelle that controls the cell and contains genetic material.
- **Mitochondrion:** The organelle that releases energy from food by respiration.
- **Ribosome:** The organelle where proteins are made.

Important short questions

Q1. State the three points of cell theory.

All living things are made of one or more cells; the cell is the basic unit of life; all cells arise from pre-existing cells.

Q2. What is the difference between a prokaryotic and a eukaryotic cell?

A prokaryotic cell has no true nucleus and no membrane-bound organelles, while a eukaryotic cell has a true nucleus and membrane-bound organelles.

Q3. Which organelle is called the powerhouse of the cell, and why?

The mitochondrion, because it releases energy from food during respiration.

Q4. Name three structures found in plant cells but not in animal cells.

Cell wall, chloroplasts and a large central vacuole.

Important long questions

Q1. Compare plant and animal cells.

Both plant and animal cells have a cell membrane, cytoplasm, nucleus, mitochondria, ribosomes, endoplasmic reticulum and Golgi apparatus. Plant cells additionally have a rigid cell wall outside the membrane, chloroplasts that carry out photosynthesis, and a large central vacuole that stores sap and keeps the cell firm. Animal cells lack a cell wall and chloroplasts, and have only small vacuoles or none. Plant cells are usually regular in shape because of the wall, while animal cells vary in shape.

Q2. Describe the functions of the main organelles of a eukaryotic cell.

The nucleus controls all cell activities and holds the genetic material. The cell membrane controls what enters and leaves the cell. The cytoplasm is the site of many chemical reactions and holds the organelles. Mitochondria release energy from food. Ribosomes build proteins. The endoplasmic reticulum transports materials within the cell. The Golgi apparatus modifies, packs and sends out proteins. Lysosomes digest unwanted material and worn-out organelles. In plant cells, chloroplasts trap sunlight for photosynthesis and the vacuole stores water and substances.

MCQs

1. Who first observed cells in cork in 1665?

   a) Schwann b) Hooke c) Virchow d) Schleiden

2. Which cell type has no true nucleus?

   a) Eukaryotic b) Prokaryotic c) Plant cell d) Animal cell

3. Proteins are made in the:

   a) Mitochondria b) Nucleus c) Ribosomes d) Lysosomes

4. Which organelle digests worn-out cell parts?

   a) Golgi apparatus b) Lysosome c) Vacuole d) Ribosome

Answer key (Ch. 3): 1-b, 2-b, 3-c, 4-b.

Chapter 4: Cell Cycle

Summary

The cell cycle is the series of events by which a cell grows, copies its genetic material and divides into two daughter cells. It has two main parts: interphase, the long growing and copying stage, and the mitotic phase, the shorter dividing stage. Interphase itself has three stages: G1, when the cell grows and makes proteins; S, when the DNA is copied so that each new cell will get a full set; and G2, when the cell grows more and prepares to divide.

Mitosis is the division of the nucleus that produces two daughter cells genetically identical to the parent cell. It has four stages. In prophase, the chromosomes become visible and the nuclear membrane starts to disappear. In metaphase, the chromosomes line up in the middle of the cell. In anaphase, the sister chromatids are pulled apart to opposite ends of the cell. In telophase, a nuclear membrane forms around each set of chromosomes. After the nucleus divides, the cytoplasm divides (cytokinesis), giving two daughter cells. Mitosis is used for growth, repair and replacement of worn-out cells.

Meiosis is a different kind of division that produces sex cells (gametes) with half the number of chromosomes. It has two divisions: meiosis I separates homologous chromosomes, and meiosis II separates sister chromatids, giving four haploid cells. During meiosis I, crossing over happens: homologous chromosomes exchange pieces, which creates new combinations of genes. This is why children differ from their parents and from each other. Mistakes in cell division control can lead to uncontrolled growth, which may form a tumour.

Key definitions and concepts

- **Cell cycle:** The sequence of growth, DNA copying and division in a cell's life.
- **Interphase:** The stage of the cell cycle when the cell grows and copies its DNA.
- **Mitosis:** Nuclear division producing two genetically identical daughter cells.
- **Meiosis:** Division producing four haploid cells, used to make gametes.
- **Chromosome:** A structure of DNA and protein carrying genes.
- **Chromatid:** One of the two identical copies of a chromosome after DNA copying.
- **Homologous chromosomes:** A pair of chromosomes, one from each parent, carrying genes for the same traits.
- **Crossing over:** Exchange of pieces between homologous chromosomes during meiosis.
- **Haploid:** Having a single set of chromosomes, as in gametes.
- **Cytokinesis:** Division of the cytoplasm after nuclear division.

Important short questions

Q1. What are the two main parts of the cell cycle?

Interphase (growth and DNA copying) and the mitotic phase (division).

Q2. What happens during the S stage of interphase?

The DNA is copied, so that each daughter cell will receive a complete set of genetic material.

Q3. Name the four stages of mitosis in order.

Prophase, metaphase, anaphase, telophase.

Q4. What is crossing over, and why is it important?

Crossing over is the exchange of pieces between homologous chromosomes during meiosis I. It creates new gene combinations and so produces variation among offspring.

Important long questions

Q1. Describe the stages of mitosis and its importance.

In prophase, chromosomes shorten and become visible, and the nuclear membrane begins to disappear. In metaphase, chromosomes line up across the middle of the cell. In anaphase, sister chromatids separate and move to opposite ends. In telophase, nuclear membranes form around each set of chromosomes, and then cytokinesis divides the cytoplasm, giving two daughter cells. Mitosis is important because it produces genetically identical cells for growth, for replacing worn-out cells and for repairing damaged tissues.

Q2. Compare mitosis and meiosis.

Mitosis has one division and produces two daughter cells that are genetically identical to the parent and have the full chromosome number. Meiosis has two divisions and produces four daughter cells that are genetically different from the parent and have half the chromosome number. Mitosis is used for growth and repair in body cells, while meiosis produces gametes for sexual reproduction. Crossing over happens in meiosis but not in mitosis, which is why meiosis creates variation.

MCQs

1. DNA is copied during which stage of interphase?

   a) G1 b) S c) G2 d) M

2. In which stage of mitosis do chromosomes line up in the middle of the cell?

   a) Prophase b) Metaphase c) Anaphase d) Telophase

3. Meiosis produces how many daughter cells?

   a) Two b) Four c) One d) Eight

4. Crossing over takes place during:

   a) Mitosis b) Meiosis I c) Cytokinesis d) Interphase

Answer key (Ch. 4): 1-b, 2-b, 3-b, 4-b.

Chapter 5: Tissues, Organs, and Organ Systems

Summary

In multicellular organisms, cells do not work alone. A tissue is a group of similar cells that work together to perform a particular function. Different tissues combine to form an organ, such as a leaf or the heart, and different organs working together form an organ system, such as the shoot system of a plant or the digestive system of an animal.

Plant tissues are of two main kinds. Meristematic tissues are made of young, dividing cells found at growing tips: apical meristems at root and shoot tips make the plant grow longer, lateral meristems make stems and roots grow thicker, and intercalary meristems occur at the base of leaves and internodes in grasses. Permanent tissues are made of cells that have stopped dividing. Simple permanent tissues are parenchyma (soft, thin-walled cells for storage and photosynthesis), collenchyma (cells with thickened corners that support young parts) and sclerenchyma (thick-walled dead cells that give strength). Complex permanent tissues are xylem, which carries water and minerals upward, and phloem, which carries food from leaves to other parts.

Animal tissues are of four kinds. Epithelial tissue covers surfaces and lines organs and cavities, protecting them. Connective tissue joins and supports other tissues; blood, bone, cartilage and tendons are connective tissues. Muscular tissue contracts to produce movement; there are skeletal muscles (under conscious control), smooth muscles (in internal organs) and cardiac muscle (in the heart). Nervous tissue carries messages: it is made of nerve cells (neurons) supported by other cells.

Organs are built from tissues, and organ systems from organs. In a flowering plant, the root system anchors the plant and absorbs water, while the shoot system (stem, leaves, flowers) makes food and reproduces. In animals, systems include the digestive system (breaks down food), circulatory system (transports substances), respiratory system (gas exchange), nervous system (control and coordination) and excretory system (removal of wastes).

Key definitions and concepts

- **Tissue:** A group of similar cells working together for a particular function.
- **Organ:** A structure made of different tissues working together for a function.
- **Organ system:** A group of organs working together for a major function.
- **Meristematic tissue:** Plant tissue of dividing cells at growing regions.
- **Parenchyma:** Soft plant tissue of thin-walled cells, used for storage and photosynthesis.
- **Sclerenchyma:** Plant tissue of thick-walled cells that gives strength and support.
- **Xylem:** Plant tissue that transports water and dissolved minerals upward.
- **Phloem:** Plant tissue that transports food from leaves to other parts.
- **Epithelial tissue:** Animal tissue covering surfaces and lining organs.
- **Neuron:** A nerve cell that carries messages in the form of impulses.

Important short questions

Q1. What is a tissue? Give one plant and one animal example.

A tissue is a group of similar cells working together for a function. Parenchyma is a plant tissue; epithelial tissue is an animal tissue.

Q2. What is the difference between meristematic and permanent tissue?

Meristematic tissue is made of dividing cells at growing regions, while permanent tissue is made of cells that have stopped dividing and taken on a fixed function.

Q3. What are the functions of xylem and phloem?

Xylem carries water and dissolved minerals from roots upward. Phloem carries food made in leaves to other parts of the plant.

Q4. Name the four types of animal tissue.

Epithelial, connective, muscular and nervous tissue.

Important long questions

Q1. Describe the types of plant tissue and their functions.

Meristematic tissues are dividing tissues at growing tips: apical meristems lengthen roots and shoots, lateral meristems thicken stems and roots, and intercalary meristems grow the base of leaves and internodes. Permanent tissues have stopped dividing. Simple permanent tissues are parenchyma for storage and photosynthesis, collenchyma for support in young parts, and sclerenchyma for strength. Complex permanent tissues are xylem for carrying water and minerals upward and phloem for carrying food from leaves to the rest of the plant.

Q2. Explain how cells, tissues, organs and organ systems are related, with examples.

Similar cells working together form a tissue, for example muscle cells form muscular tissue. Different tissues together form an organ, for example the heart is made of muscular, connective, nervous and epithelial tissue and pumps blood. Organs working together form an organ system, for example the heart, blood vessels and blood form the circulatory system, which transports substances around the body. In plants, root, stem and leaf tissues form organs, and the root system and shoot system together make the whole plant body.

MCQs

1. Which plant tissue carries water upward?

   a) Phloem b) Xylem c) Parenchyma d) Collenchyma

2. Apical meristems are found at:

   a) Leaf bases b) Root and shoot tips c) Stem sides d) Flower centres

3. Blood is an example of which animal tissue?

   a) Epithelial b) Muscular c) Connective d) Nervous

4. Cardiac muscle is found in the:

a) Stomach b) Heart c) Skin d) Bones

Answer key (Ch. 5): 1-b, 2-b, 3-c, 4-b.

Chapter 6: Biomolecules

Summary

Biomolecules are the large, carbon-based molecules that make up living things. The four main classes are carbohydrates, proteins, lipids and nucleic acids, and water is also essential for life. Carbon is central because each carbon atom can form four bonds, allowing long chains and rings of many shapes.

Carbohydrates are made of carbon, hydrogen and oxygen and are the main quick source of energy. Simple sugars (monosaccharides) such as glucose and fructose are single units. Two units joined make a disaccharide, such as sucrose (table sugar) and lactose (milk sugar). Many units joined make a polysaccharide: starch stores energy in plants, glycogen stores energy in animals, and cellulose forms plant cell walls and gives fibre in the diet.

Proteins are made of amino acids joined by peptide bonds into long chains that fold into particular shapes. Their shape decides their job. Some proteins build structures (such as collagen in skin and keratin in hair), some carry substances (haemoglobin carries oxygen in blood), some defend the body (antibodies), and some speed up reactions (enzymes). Proteins are needed for growth and repair.

Lipids include fats and oils. They are made of fatty acids and glycerol. Fats store more energy per gram than carbohydrates, insulate the body, and protect organs. Phospholipids form cell membranes, with a water-loving head and water-fearing tails. Steroids, such as cholesterol and some hormones, are also lipids.

Nucleic acids store and pass on hereditary information. DNA (deoxyribonucleic acid) is double-stranded and holds the instructions for making proteins; RNA (ribonucleic acid) is usually single-stranded and helps build proteins. Both are made of units called nucleotides, each with a sugar, a phosphate group and a nitrogenous base. Water is the medium in which most life reactions happen: it dissolves substances, carries materials, and helps control temperature because it heats and cools slowly.

Key definitions and concepts

- **Biomolecule:** A carbon-based molecule produced by living things.
- **Monosaccharide:** A single sugar unit, such as glucose.
- **Disaccharide:** Two sugar units joined, such as sucrose.
- **Polysaccharide:** Many sugar units joined, such as starch or cellulose.
- **Amino acid:** The building unit of proteins.
- **Peptide bond:** The bond joining two amino acids.
- **Lipid:** A fat-like molecule, including fats, oils, phospholipids and steroids.
- **Nucleotide:** The building unit of nucleic acids: sugar + phosphate + base.
- **DNA:** The double-stranded nucleic acid that stores hereditary instructions.
- **RNA:** The usually single-stranded nucleic acid that helps make proteins.

Important short questions

Q1. Name the four main classes of biomolecules.

Carbohydrates, proteins, lipids and nucleic acids.

Q2. What is the difference between starch, glycogen and cellulose?

Starch stores energy in plants, glycogen stores energy in animals, and cellulose forms plant cell walls and is dietary fibre. All three are polysaccharides of glucose units.

Q3. Why is the shape of a protein important?

A protein's shape decides its job: a wrong shape cannot bind its target or carry out its function, just as a wrongly shaped key cannot open a lock.

Q4. What are nucleotides made of?

A sugar, a phosphate group and a nitrogenous base.

Important long questions

Q1. Describe carbohydrates and their roles, from monosaccharides to polysaccharides.

Monosaccharides are single sugar units such as glucose and fructose; glucose is the main fuel of cells. Two monosaccharides join to form a disaccharide, such as sucrose in table sugar and lactose in milk. Many monosaccharides join to form polysaccharides: starch is the energy store of plants, glycogen is the energy store of animals (kept mainly in liver and muscle), and cellulose builds plant cell walls and provides fibre that helps digestion. So carbohydrates give quick energy as sugars and stored energy as starch and glycogen, and also build structures as cellulose.

Q2. Compare the functions of proteins, lipids and nucleic acids.

Proteins are built from amino acids and do most of the work of the cell: they build structures (collagen, keratin), carry substances (haemoglobin), defend the body (antibodies) and speed up reactions (enzymes). Lipids store the most energy per gram, insulate the body, protect organs, and form cell membranes as phospholipids. Nucleic acids store hereditary information: DNA holds the instructions for the organism, and RNA helps turn those instructions into proteins. Together they cover structure, energy, control and inheritance.

MCQs

1. Which of these is a monosaccharide?

a) Sucrose b) Starch c) Glucose d) Cellulose

2. Glycogen is the energy store of:

a) Plants b) Animals c) Fungi only d) Bacteria only

3. Proteins are made of:

a) Fatty acids b) Nucleotides c) Amino acids d) Sugars

4. The double-stranded nucleic acid is:

a) RNA b) DNA c) ATP d) ADP

Answer key (Ch. 6): 1-c, 2-b, 3-c, 4-b.

Chapter 7: Enzymes

Summary

Enzymes are biological catalysts: they speed up chemical reactions in living things without being used up themselves. Most enzymes are proteins, and each enzyme has a specially shaped region called the active site, where its substrate (the substance it acts on) fits. The enzyme and substrate join briefly to form an enzyme-substrate complex, the reaction happens, products are released, and the enzyme is free to work again.

Enzymes are specific: each enzyme usually works on only one substrate or a small group of similar substrates. Two models explain the fit. In the lock-and-key model, the substrate fits the active site exactly, like a key in a lock. In the induced-fit model, the active site changes shape slightly to grip the substrate better, like a glove moulding to a hand.

Several factors affect how fast an enzyme works. Temperature: as temperature rises, molecules move faster and the reaction speeds up, but above an optimum temperature the enzyme's shape breaks down (denaturation) and it stops working. pH: each enzyme works best at its own optimum pH, and strong acids or alkalis denature it. Substrate concentration: more substrate means a faster reaction, until all active sites are busy and the rate levels off. Enzyme concentration: more enzyme means a faster reaction, as long as substrate is available. Some enzymes need helpers: cofactors are non-protein helpers such as metal ions, and coenzymes are organic helpers such as many vitamins. Inhibitors slow enzymes down, either by blocking the active site or by changing the enzyme's shape from elsewhere.

Enzymes are used in everyday life and industry: in biological washing powders to break down stains, in food making (for example, in baking and cheese making), and in medicine, where enzyme tests help diagnose disease.

Key definitions and concepts

- **Enzyme:** A biological catalyst, usually a protein, that speeds up a reaction without being used up.
- **Catalyst:** A substance that speeds up a reaction without being changed by it.
- **Substrate:** The substance an enzyme acts on.
- **Active site:** The specially shaped region of an enzyme where the substrate fits.
- **Enzyme-substrate complex:** The temporary joining of enzyme and substrate during a reaction.
- **Specificity:** The property by which an enzyme works on only one substrate or a few similar ones.
- **Denaturation:** Loss of an enzyme's shape (and so its function) caused by heat, extreme pH or other harsh conditions.
- **Optimum temperature / pH:** The temperature / pH at which an enzyme works fastest.
- **Cofactor / Coenzyme:** A non-protein helper / organic helper needed by some enzymes.
- **Inhibitor:** A substance that slows down or stops an enzyme.

Important short questions

Q1. What is an enzyme, and why is it called a biological catalyst?

> An enzyme is a substance, usually a protein, that speeds up a reaction in a living thing without being used up in the reaction. That is exactly what a catalyst does, so enzymes are biological catalysts.

Q2. What is the active site?

The active site is the specially shaped region of an enzyme where the substrate fits and the reaction takes place.

Q3. What happens to an enzyme at very high temperature?

Its shape breaks down (denaturation), so the substrate no longer fits the active site and the enzyme stops working.

Q4. What is the difference between the lock-and-key and induced-fit models?

In lock-and-key, the substrate fits the active site exactly without change. In induced-fit, the active site changes shape slightly to grip the substrate better.

Important long questions

Q1. Explain how an enzyme works, using the enzyme-substrate complex.

The substrate fits into the enzyme's active site, forming a temporary enzyme-substrate complex. While joined, the reaction takes place more easily than it would on its own - bonds may be broken or new bonds formed. The products are then released, and the enzyme is unchanged and free to act on another substrate molecule. Because the enzyme is not used up, one enzyme molecule can catalyse many reactions. The fit is specific: only a substrate with the right shape can enter the active site, which is why each enzyme works on few substrates.

Q2. Describe how temperature, pH, substrate concentration and enzyme concentration affect enzyme activity.

Raising temperature speeds up molecular movement and so the reaction, up to an optimum; beyond it, the enzyme denatures and activity falls sharply. Each enzyme has an optimum pH, and moving far from it denatures the enzyme and lowers activity. Raising substrate concentration increases the rate until all active sites are occupied, after which the rate levels off. Raising enzyme concentration increases the rate, because more active sites are available, as long as there is enough substrate.

MCQs

1. Most enzymes are made of:

   a) Carbohydrate b) Protein c) Lipid d) Nucleic acid

2. The part of an enzyme where the substrate fits is the:

   a) Active site b) Cofactor c) Product d) Inhibitor

3. An enzyme denatured by heat has lost its:

   a) Substrate b) Shape c) Cofactor d) Products

4. As substrate concentration rises, the reaction rate first rises and then:

   a) Falls to zero b) Levels off c) Doubles each time d) Stops at once

Answer key (Ch. 7): 1-b, 2-a, 3-b, 4-b.

Chapter 8: Bioenergetics

Summary

Bioenergetics is the study of how living things obtain, store and use energy. The energy currency of the cell is ATP (adenosine triphosphate). ATP stores energy in its phosphate bonds; when the last phosphate is removed, energy is released for cell work, and ATP becomes ADP. Cells constantly rebuild ATP from ADP using energy from food.

Plants obtain energy from sunlight through photosynthesis, which takes place in chloroplasts. In words: carbon dioxide + water, in the presence of sunlight and chlorophyll, gives glucose + oxygen. Photosynthesis has two stages. The light-dependent reactions happen in the thylakoids (grana) of the chloroplast: light energy splits water, releasing oxygen, and produces energy carriers (ATP and NADPH). The light-independent reactions (Calvin cycle) happen in the stroma: carbon dioxide is fixed into glucose using the energy carriers. Factors that limit photosynthesis are light intensity, carbon dioxide concentration and temperature: raising any one increases the rate only until another factor becomes limiting.

All living things release energy from food through cellular respiration. Aerobic respiration uses oxygen and gives the most energy: glucose + oxygen gives carbon dioxide + water + energy (ATP). It happens in three stages: glycolysis in the cytoplasm (glucose split into pyruvate), the Krebs cycle in mitochondria, and the electron transport chain in mitochondria, which makes most of the ATP. Anaerobic respiration happens without oxygen and gives much less energy; in yeast it produces ethanol and carbon dioxide (fermentation, used in baking and brewing), and in muscle cells during hard exercise it produces lactic acid, which causes tiredness and cramps.

Key definitions and concepts

- **Bioenergetics:** The study of energy flow in living things.
- **ATP:** Adenosine triphosphate, the energy currency of the cell.
- **ADP:** Adenosine diphosphate, formed when ATP releases energy.
- **Photosynthesis:** The process by which plants use sunlight to make glucose from carbon dioxide and water.
- **Chlorophyll:** The green pigment that traps light energy for photosynthesis.
- **Light-dependent reactions:** The stage of photosynthesis needing light, producing oxygen, ATP and NADPH.
- **Calvin cycle:** The light-independent stage fixing carbon dioxide into glucose.
- **Cellular respiration:** The breakdown of food to release energy as ATP.
- **Aerobic respiration:** Respiration using oxygen, giving carbon dioxide, water and much ATP.
- **Anaerobic respiration:** Respiration without oxygen, giving little ATP plus ethanol or lactic acid.
- **Fermentation:** Anaerobic breakdown of glucose, for example by yeast into ethanol and carbon dioxide.

Important short questions

Q1. What is ATP, and why is it called the energy currency of the cell?

ATP is adenosine triphosphate. It stores energy in its phosphate bonds and releases it when a phosphate is removed, so cells use it to pay for energy-requiring work, like money in trade.

Q2. Write the word equation for photosynthesis.

Carbon dioxide + water, in sunlight and chlorophyll, gives glucose + oxygen.

Q3. Where do the two stages of photosynthesis take place?

Light-dependent reactions take place in the thylakoids (grana) of the chloroplast, and the Calvin cycle takes place in the stroma.

Q4. What is the difference between aerobic and anaerobic respiration?

Aerobic respiration uses oxygen and releases much energy plus carbon dioxide and water. Anaerobic respiration works without oxygen and releases little energy plus ethanol (yeast) or lactic acid (muscle).

Important long questions

Q1. Describe the two stages of photosynthesis.

In the light-dependent reactions, which happen in the thylakoids, chlorophyll traps light energy. The energy splits water into hydrogen and oxygen; oxygen is released, and the energy is stored as ATP and NADPH. In the light-independent reactions (Calvin cycle), which happen in the stroma and do not need light directly, carbon dioxide is fixed and combined with hydrogen from NADPH, using ATP energy, to build glucose. So light energy is first captured and then used to make food.

Q2. Describe aerobic respiration and compare it with anaerobic respiration.

Aerobic respiration starts with glycolysis in the cytoplasm, where glucose is split into pyruvate with a small ATP gain. Pyruvate then enters the mitochondria, where the Krebs cycle and the electron transport chain release carbon dioxide and water and make most of the ATP. Anaerobic respiration stops after glycolysis: in yeast, pyruvate becomes ethanol and carbon dioxide; in hard-working muscle, it becomes lactic acid. Aerobic respiration gives far more ATP per glucose molecule, which is why organisms prefer it when oxygen is available.

MCQs

1. The energy currency of the cell is:

   a) DNA b) ATP c) Glucose d) NADPH

2. Oxygen in photosynthesis comes from the splitting of:

   a) Carbon dioxide b) Glucose c) Water d) Chlorophyll

3. The Calvin cycle takes place in the:

   a) Grana b) Stroma c) Nucleus d) Mitochondrion

4. Anaerobic respiration in yeast produces:

   a) Lactic acid only b) Ethanol and carbon dioxide c) Oxygen d) Glucose

Answer key (Ch. 8): 1-b, 2-c, 3-b, 4-b.

Chapter 9: Plant Physiology

Summary

Plant physiology is the study of how plants work: how they take in water and minerals, how they move substances around, how they feed, and how they respond to their surroundings. This chapter brings together plant nutrition and transport, which in older books were separate topics.

Water enters a plant through root hairs by osmosis: water moves from a region of higher water concentration (the soil) into the root cells. Dissolved minerals enter by diffusion and active transport. Once inside, water and minerals travel upward through the xylem to stems and leaves. The upward movement is helped by transpiration pull: water evaporates from leaves through stomata (transpiration), pulling more water up behind it, like sucking through a straw. Transpiration is faster in bright light, warm temperature, wind and low humidity, and slower in dim light, cold, still and humid air. Plants control water loss by opening and closing their stomata: guard cells swell to open the pore and shrink to close it.

Food made in leaves by photosynthesis moves through the phloem to all parts of the plant. This is translocation. Food moves from a source (usually a leaf) to a sink (a growing part, a root or a storing organ). Unlike xylem flow, which is mainly upward, phloem flow can go up or down, depending on where food is needed.

Plants also need mineral nutrients. Macronutrients are needed in larger amounts and include nitrogen (for proteins and chlorophyll), phosphorus (for energy transfer and roots) and potassium (for stomata and disease resistance). Micronutrients are needed in tiny amounts, such as iron and zinc. Lack of a nutrient causes poor growth and yellowing leaves, but this chapter does not give medical-style deficiency charts; the key point is that minerals come from the soil and are essential for healthy growth.

Plants respond to stimuli with movements. Tropisms are growth movements towards or away from a stimulus: phototropism is growth towards light (shoots bend towards light), and geotropism is growth in response to gravity (roots grow down, shoots grow up). Plant hormones control growth: auxins promote cell elongation and bending towards light, gibberellins promote stem growth and seed germination, cytokinins promote cell division, abscisic acid promotes dormancy and closes stomata in dry conditions, and ethene promotes fruit ripening.

Key definitions and concepts

- **Plant physiology:** The study of the functions and processes of plants.
- **Osmosis:** Movement of water across a partially permeable membrane from higher to lower water concentration.
- **Transpiration:** Loss of water vapour from a plant, mainly through leaf stomata.
- **Transpiration pull:** The upward pull on xylem water caused by transpiration from leaves.
- **Stomata:** Tiny pores on leaves, each guarded by two guard cells, controlling gas exchange and water loss.
- **Translocation:** Movement of food through phloem from source to sink.
- **Source / Sink:** The place food is made or stored for export / the place food is used or stored.
- **Macronutrient:** A mineral nutrient needed by plants in larger amounts.
- **Tropism:** A growth movement towards or away from a stimulus.
- **Phototropism / Geotropism:** Growth towards light / in response to gravity.
- **Plant hormone:** A chemical messenger controlling plant growth and responses.

Important short questions

Q1. How does water enter a plant root?

Through root hairs by osmosis: water moves from the soil, where its concentration is higher, into the root cells.

Q2. What is transpiration pull?

It is the upward pull on water in the xylem caused by water evaporating from leaves, which draws more water up behind it.

Q3. What is translocation, and which tissue carries it out?

Translocation is the movement of food from source to sink, and it is carried out by the phloem.

Q4. Name two plant hormones and one function of each.

Auxins promote cell elongation and bending towards light; gibberellins promote stem growth and seed germination.

Important long questions

Q1. Explain how water moves from soil to leaf, and how transpiration helps.

Water enters root hairs by osmosis from the soil. It passes through root tissues into the xylem, which carries it up the stem to the leaves. In the leaves, water evaporates through the stomata as transpiration. This loss creates a pull, called transpiration pull, which draws more water up the xylem, much like sucking through a straw. The process also brings dissolved minerals up with the water and cools the leaf. Guard cells control the stomata, opening them for photosynthesis and closing them to save water when conditions are dry.

Q2. Describe tropisms and the role of plant hormones in them.

Tropisms are growth movements towards or away from a stimulus. In phototropism, a shoot bends towards light because auxin moves to the shaded side, where it promotes faster cell elongation, bending the shoot towards the light. In geotropism, roots grow downward and shoots grow upward in response to gravity, guided by auxin distribution. Other hormones control other growth: gibberellins lengthen stems and wake dormant seeds, cytokinins drive cell division, abscisic acid keeps buds and seeds dormant and closes stomata in drought, and ethene ripens fruit. Together, hormones let the plant adjust growth to its surroundings.

MCQs

1. Water enters root hairs mainly by:

a) Active transport only b) Osmosis c) Translocation d) Photosynthesis

2. Transpiration is fastest in:

a) Cold, still, humid air b) Warm, windy, dry air c) Dim light d) Night time

3. Food is translocated through the:

a) Xylem b) Phloem c) Cambium d) Epidermis

4. Shoots bending towards light is called:

a) Geotropism b) Phototropism c) Thigmotropism d) Chemotropism

Answer key (Ch. 9): 1-b, 2-b, 3-b, 4-b.

Chapter 10: Reproduction in Plants

Summary

Reproduction is the production of new individuals of the same kind, which keeps a species alive. Plants reproduce in two ways: asexually, without gametes, and sexually, with gametes.

In asexual reproduction, the new plant comes from one parent and is genetically identical to it. Common natural methods are vegetative propagation: runners (such as strawberry stems that root at nodes), bulbs (such as onion), tubers (such as potato, where each eye can grow a new plant), and rhizomes (underground stems such as ginger). Some plants also reproduce by spores. Farmers and gardeners use artificial propagation: cuttings (a stem piece planted to root), layering (a stem bent to the ground to root while still attached), grafting (joining a shoot of one plant onto the rootstock of another) and tissue culture (growing many small plants from a few cells in a laboratory).

Sexual reproduction in flowering plants takes place in the flower. A typical flower has sepals (protecting the bud), petals (attracting insects), stamens (the male parts: anther making pollen, and filament) and carpels (the female parts: stigma receiving pollen, style, and ovary containing ovules). Pollination is the transfer of pollen from anther to stigma. In self-pollination, pollen goes to a flower of the same plant; in cross-pollination, it goes to another plant of the same species. Pollination is carried out by wind, water, insects and other animals.

After pollination, a pollen tube grows down the style to the ovule, and fertilisation happens: one male gamete joins the egg to form a zygote, and a second male gamete joins other nuclei to form the endosperm, which feeds the embryo. This double fertilisation is special to flowering plants. The ovule becomes a seed, containing the embryo, stored food and a protective coat (testa), and the ovary becomes a fruit. Seeds are dispersed by wind, water, animals or explosion, so new plants do not crowd the parent. Germination needs water, oxygen and a suitable temperature; the seed absorbs water, the embryo grows, and the young root and shoot emerge.

Key definitions and concepts

- **Reproduction:** Production of new individuals of the same kind.
- **Asexual reproduction:** Reproduction from one parent without gametes, giving genetically identical offspring.
- **Vegetative propagation:** Asexual reproduction using plant parts such as runners, bulbs, tubers or rhizomes.
- **Pollination:** Transfer of pollen from anther to stigma.
- **Self-pollination / Cross-pollination:** Pollination within the same plant / between different plants of the same species.
- **Fertilisation:** Fusion of male and female gametes to form a zygote.
- **Double fertilisation:** In flowering plants, one male gamete forms the zygote and a second forms the endosperm.
- **Seed:** A fertilised ovule containing an embryo, stored food and a protective coat.
- **Germination:** Growth of the embryo in a seed into a young plant, needing water, oxygen and suitable temperature.
- **Dispersal:** Spreading of seeds away from the parent plant.

Important short questions

Q1. What is the difference between asexual and sexual reproduction in plants?

Asexual reproduction uses one parent and no gametes, giving identical offspring. Sexual reproduction uses male and female gametes, giving offspring that differ from the parents.

Q2. Give two natural methods of vegetative propagation with examples.

Runners, such as strawberry; tubers, such as potato (each eye can grow a new plant).

Q3. What is pollination, and how do self-pollination and cross-pollination differ?

Pollination is the transfer of pollen from anther to stigma. In self-pollination the pollen comes from the same plant, while in cross-pollination it comes from another plant of the same species.

Q4. What three things does a seed need to germinate?

Water, oxygen and a suitable temperature.

Important long questions

Q1. Describe sexual reproduction in a flowering plant, from pollination to seed formation.

Pollination transfers pollen from the anther to the stigma, by wind, insects or other agents. A pollen tube grows down the style carrying two male gametes to the ovule. Double fertilisation follows: one male gamete fuses with the egg to form the zygote, which grows into the embryo, and the second fuses with other nuclei to form the endosperm, which stores food for the embryo. The ovule develops into a seed with a protective testa, and the ovary develops into a fruit. The seed is then dispersed and, given water, oxygen and suitable temperature, germinates into a new plant.

Q2. Compare natural and artificial vegetative propagation, and explain why farmers use artificial methods.

Natural vegetative propagation happens on its own: runners root at nodes, bulbs and tubers store food and sprout, and rhizomes spread underground. Artificial methods are done by people: cuttings are planted to root, layering roots a stem while it is still attached, grafting joins a good fruiting shoot onto strong roots, and tissue culture grows many plants from a few cells. Farmers use artificial methods because they are fast, produce many plants identical to a good parent (same fruit quality), and can combine the best shoot with the best roots.

MCQs

1. Potato reproduces vegetatively by its:

   a) Bulbs b) Runners c) Tubers d) Seeds

2. Pollen is produced in the:

   a) Ovary b) Stigma c) Anther d) Style

3. Double fertilisation is special to:

   a) Mosses b) Ferns c) Flowering plants d) Algae

4. Which of these is needed for germination?

   a) Light only b) Water, oxygen and suitable temperature c) Soil only d) Fertiliser only

Answer key (Ch. 10): 1-c, 2-c, 3-c, 4-b.

Chapter 11: Biostatistics

Summary

Biostatistics is the use of statistics in biology: collecting, organising and interpreting numerical data from living things. Biologists count and measure things - for example, the heights of plants, the number of seeds in pods, or the pulse rates of students - and then use simple statistics to describe the data and draw fair conclusions. Without statistics, a single unusual measurement could mislead; with statistics, patterns become clear.

Data can be of two kinds. Qualitative data describes qualities, such as flower colour or blood group. Quantitative data is numerical, such as height or mass. Quantitative data is further divided into discrete data (whole numbers only, such as the number of petals) and continuous data (any value in a range, such as height in centimetres). A population is the whole group being studied, while a sample is a smaller part of it chosen for study; a good sample must fairly represent the population.

Raw data is organised into a frequency table, which shows how often each value occurs. From a set of values, three averages are commonly found. The mean is found by adding all values and dividing by how many there are. The median is the middle value when values are arranged in order (for an even number of values, it is the average of the two middle values). The mode is the value that occurs most often. The range (highest value minus lowest value) shows how spread out the data is.

Worked example (practice numbers only, made up for this exercise): five seedlings have heights 4 cm, 6 cm, 6 cm, 8 cm and 11 cm. Mean = (4 + 6 + 6 + 8 + 11) ÷ 5 = 35 ÷ 5 = 7 cm. Median: arranged in order (4, 6, 6, 8, 11), the middle value is 6 cm. Mode: 6 cm, because it occurs twice, more than any other value. Range: 11 - 4 = 7 cm.

Data is also shown as graphs. A bar chart uses bars to compare categories, such as the number of each flower colour. A histogram uses touching bars for grouped continuous data, such as heights grouped in ranges. A line graph joins points to show change over time, such as plant growth over weeks. Choosing the right graph, labelling axes, and giving a title make data honest and easy to read. Statistics helps biologists compare groups (for example, plants grown in light versus darkness), test whether a difference is real, and present results clearly.

Key definitions and concepts

- **Biostatistics:** The application of statistics to biological data.
- **Data:** Recorded observations or measurements.
- **Qualitative data:** Data describing qualities, such as colour or type.
- **Quantitative data:** Numerical data, such as height or mass.
- **Discrete data:** Numerical data taking whole-number values only.
- **Continuous data:** Numerical data that can take any value in a range.
- **Population:** The whole group being studied.
- **Sample:** A smaller part of a population chosen for study.
- **Frequency table:** A table showing how often each value occurs.
- **Mean:** Sum of values divided by the number of values.
- **Median:** The middle value of ordered data.
- **Mode:** The most frequently occurring value.
- **Range:** Highest value minus lowest value.

Important short questions

Q1. What is biostatistics?

Biostatistics is the use of statistics in biology: collecting, organising, presenting and interpreting numerical data from living things.

Q2. What is the difference between qualitative and quantitative data? Give one example of each.

Qualitative data describes qualities, such as flower colour. Quantitative data is numerical, such as plant height in centimetres.

Q3. What is the difference between a population and a sample?

A population is the whole group being studied, while a sample is a smaller part of it chosen to represent the whole group.

Q4. Find the mean of 2, 4, 4, 6 and 9.

Mean = (2 + 4 + 4 + 6 + 9) ÷ 5 = 25 ÷ 5 = 5.

Important long questions

Q1. Find the mean, median, mode and range of: 4, 6, 6, 8, 11. Explain each step.

Mean: add the values (4 + 6 + 6 + 8 + 11 = 35) and divide by how many there are (5), giving 7. Median: arrange in order (4, 6, 6, 8, 11) and take the middle value, which is 6. Mode: the value occurring most often, which is 6 (it occurs twice). Range: highest minus lowest, 11 - 4 = 7. So the data is centred near 6-7 and spread over 7 units.

Q2. When would you use a bar chart, a histogram and a line graph? Give a biology example of each.

A bar chart compares separate categories: for example, the number of flowers of each colour in a garden. A histogram shows grouped continuous data with touching bars: for example, the heights of seedlings grouped in ranges such as 0-5 cm, 5-10 cm and 10-15 cm. A line graph shows change over time: for example, the height of one plant measured each week for six weeks. Each graph must have a title and labelled axes so the reader can understand it without extra explanation.

MCQs

1. Data describing flower colour is:

a) Quantitative b) Qualitative c) Continuous d) Discrete

2. The middle value of ordered data is the:

a) Mean b) Mode c) Median d) Range

3. For the values 3, 5, 5, 7, the mode is:

a) 3 b) 5 c) 7 d) 4

4. A histogram is best for:

a) Comparing categories b) Grouped continuous data c) Change over time d) Single values

Answer key (Ch. 11): 1-b, 2-c, 3-b, 4-b.