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PRESENTS

IGCSE BIOLOGY

COMPLETE STUDY MAP

2026 Edition | Cambridge IGCSE Syllabus 0610

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Introduction to the IGCSE Biology Study Map

Welcome to the Eclassopedia IGCSE Biology Complete Study Map for 2026. This comprehensive guide has been meticulously crafted to help students navigate the Cambridge IGCSE Biology syllabus (0610) with confidence, clarity, and strategic focus. Whether you are just beginning your IGCSE journey or revising in the weeks before your examination, this study map provides a structured, topic-by-topic breakdown of everything you need to know.

The Cambridge IGCSE Biology course develops learners' knowledge and understanding of biological facts, concepts, and principles. It fosters an appreciation of the importance of biology in relation to everyday life, encourages a systematic approach to problem-solving, and prepares students for further study in the life sciences.

This study map is organised across all major topics of the syllabus, featuring key definitions, diagrams explained in words, comparison tables, exam tips, and practice question prompts. Each topic aligns with the Cambridge Assessment International Education (CAIE) 0610 syllabus objectives for the 2026 examination series.

Core Topics (Compulsory)	Extended Supplement Topics
Cell Structure & Organisation	Cell Cycle & Mitosis/Meiosis
Biological Molecules	DNA Structure & Protein Synthesis
Enzymes	Biotechnology & Genetic Engineering
Plant Nutrition	Hormonal Coordination (Extended)
Animal Nutrition	Excretion – Kidney Structure
Transport in Plants & Animals	Homeostasis – Detailed Mechanisms
Respiration	Genetic Crosses (Monohybrid & Dihybrid)
Excretion	Natural Selection & Evolution
Coordination & Response	Ecology – Energy Flow

Topic 1: Cell Structure and Organisation

Cells are the fundamental units of life. Understanding cell structure is the foundation for all other topics in IGCSE Biology. Students must distinguish between prokaryotic and eukaryotic cells and between plant and animal cells.

1.1 Animal vs Plant Cells

Animal Cell Features	Plant Cell Features (Additional)
Cell membrane	Cell wall (made of cellulose)
Cytoplasm	Large permanent vacuole (cell sap)
Nucleus (with nuclear membrane)	Chloroplasts (contain chlorophyll)
Mitochondria	Mitochondria
Ribosomes	Ribosomes
No cell wall	Cell membrane

1.2 Prokaryotic vs Eukaryotic Cells

Prokaryotic Cells (e.g. Bacteria)	Eukaryotic Cells (e.g. Plant, Animal, Fungi)
No membrane-bound nucleus	True nucleus with nuclear membrane
Circular DNA (no histones)	Linear DNA associated with histones
No mitochondria	Mitochondria present
Ribosomes (70S, smaller)	Ribosomes (80S, larger)
No endoplasmic reticulum	Endoplasmic reticulum present
Cell wall (peptidoglycan)	Cell wall (cellulose in plants)
Often have flagella and pili	Flagella less common

1.3 Cell Organisation Levels

Life is organised into increasing levels of complexity: cells → tissues → organs → organ systems → organisms.

- Cell: The basic unit of life (e.g. red blood cell, neurone)

- Tissue: A group of similar cells performing a specific function (e.g. muscle tissue, xylem tissue)
- Organ: A group of different tissues working together (e.g. heart, leaf, kidney)
- Organ System: A group of organs working together (e.g. digestive system, circulatory system)
- Organism: A complete living entity made of organ systems

EXAM TIP
Exam tip: You may be asked to identify whether a structure is a cell, tissue, organ, or organ system. Remember that the leaf is an organ of a plant — it contains epidermis tissue, mesophyll tissue, and vascular tissue.

1.4 Specialised Cells

Key Term	Definition
Red Blood Cell (Erythrocyte)	Biconcave shape, no nucleus — maximises surface area for oxygen transport; contains haemoglobin
Nerve Cell (Neurone)	Long axon to carry electrical impulses over distance; has myelin sheath for faster transmission
Palisade Mesophyll Cell	Column-shaped, packed with chloroplasts near top surface of leaf for maximum light absorption
Root Hair Cell	Long extension increases surface area for water and mineral ion absorption from soil
Sperm Cell	Long flagellum for motility; acrosome contains enzymes to penetrate egg; many mitochondria for energy
Egg Cell (Ovum)	Large cell with yolk for nourishment; zona pellucida membrane prevents multiple fertilisation

Topic 2: Biological Molecules

All living organisms are composed of chemical molecules. IGCSE Biology requires students to understand the structure, properties, and functions of the four major biological macromolecules: carbohydrates, lipids, proteins, and nucleic acids.

2.1 Carbohydrates

- Monosaccharides: Simple sugars — glucose (C6H12O6), fructose, galactose
- Disaccharides: Two monosaccharides joined by glycosidic bond (e.g. sucrose = glucose + fructose; maltose = glucose + glucose)
- Polysaccharides: Many monosaccharides joined — starch (storage in plants), glycogen (storage in animals), cellulose (structural in plant cell walls)

Testing for Carbohydrates:

Test	Positive Result	Substance Detected
Benedict's Test	Brick-red/orange precipitate	Reducing sugars (glucose, maltose)
Iodine Test	Blue-black colour	Starch
Fehling's Solution	Brick-red precipitate (on heating)	Reducing sugars

2.2 Lipids

Lipids include fats and oils. They are made of glycerol and fatty acids. Three fatty acids are joined to one glycerol by ester bonds (formed during condensation reactions) to form triglycerides.

- Functions: Energy storage (more than twice the energy per gram of carbohydrates), thermal insulation, protection of organs, component of cell membranes (phospholipids)
- Testing for lipids: Emulsion test — add ethanol and water; a milky-white emulsion indicates presence of lipid

2.3 Proteins

Proteins are polymers of amino acids linked by peptide bonds. The sequence of amino acids determines a protein's three-dimensional structure and function.

- Primary structure: Sequence of amino acids
- Secondary structure: Alpha helix or beta-pleated sheet (held by hydrogen bonds)
- Tertiary structure: 3D folded shape (maintained by disulphide bridges, hydrogen bonds, ionic bonds)
- Quaternary structure: Multiple polypeptide chains (e.g. haemoglobin = 4 subunits)

Functions of Proteins:

- Structural: Collagen (tendons, skin), keratin (hair, nails)
- Enzymatic: Amylase, pepsin, DNA polymerase
- Transport: Haemoglobin (oxygen transport), carrier proteins in membranes
- Hormonal: Insulin, glucagon
- Immune: Antibodies

Testing for proteins: Biuret test — add sodium hydroxide and copper sulphate; purple/lilac colour = protein present

2.4 Nucleic Acids

DNA (deoxyribonucleic acid) and RNA (ribonucleic acid) carry genetic information. DNA is double-stranded; RNA is single-stranded.

DNA Structure	RNA Structure
Double helix	Single strand
Deoxyribose sugar	Ribose sugar
Bases: A, T, G, C	Bases: A, U, G, C (Uracil replaces Thymine)
Found in nucleus (chromosomes)	Found in nucleus and cytoplasm
Carries genetic code	Carries code for protein synthesis

Topic 3: Enzymes

Enzymes are biological catalysts — proteins that speed up chemical reactions without being consumed. They are highly specific, each catalysing only one type of reaction (lock and key model / induced fit model).

3.1 Properties of Enzymes

- Protein in nature — denatured by high temperatures or extreme pH
- Specific — active site shape matches only one substrate
- Reusable — not consumed in the reaction
- Lower activation energy of reactions

3.2 Factors Affecting Enzyme Activity

Factor	Effect on Rate	Explanation
Temperature	Increases then drops sharply	More kinetic energy → more collisions; above optimum → denaturation (active site shape changes)
pH	Bell-shaped curve	Extreme pH alters ionic bonds → changes active site shape; each enzyme has optimum pH
Substrate Concentration	Increases then plateaus	More substrate → more enzyme-substrate complexes until all active sites are occupied
Enzyme Concentration	Increases proportionally	More enzymes = more active sites available (if substrate is not limiting)
Inhibitors	Decreases rate	Competitive inhibitors block active site; non-competitive inhibitors alter enzyme shape

EXAM TIP
Exam tip: When explaining denaturation, always say 'the active site changes shape so the substrate can no longer fit' — do NOT say the enzyme is 'killed'. Enzymes are not alive!

3.3 Key Enzyme Terminology

Key Term	Definition

Active site	The specific region of an enzyme where the substrate binds
Substrate	The molecule an enzyme acts on
Product	The molecule(s) formed after the enzyme-catalysed reaction
Enzyme-substrate complex	Temporary association between enzyme and substrate
Denaturation	Irreversible change in enzyme shape — active site no longer functions
Optimum temperature/pH	Conditions at which enzyme activity is highest
Competitive inhibitor	Molecule with similar shape to substrate that blocks the active site
Non-competitive inhibitor	Molecule that binds elsewhere on enzyme, altering active site shape

Topic 4: Plant Nutrition — Photosynthesis

Photosynthesis is the process by which plants convert light energy into chemical energy stored in glucose. It occurs in chloroplasts and requires light, carbon dioxide, and water.

The Equation for Photosynthesis

$$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$$

(light energy + chlorophyll required)

4.1 Factors Affecting Photosynthesis

- Light intensity: Increases rate up to a saturation point; beyond this, another factor limits rate
- Carbon dioxide concentration: Increases rate (as a substrate); can be a limiting factor
- Temperature: Increases rate up to optimum; above ~45°C, enzymes denature and rate drops
- Water availability: Essential substrate; deficiency closes stomata and reduces CO2 entry
- Chlorophyll content: More chlorophyll = greater light absorption

4.2 Leaf Structure and Adaptation for Photosynthesis

Key Term	Definition
Palisade mesophyll	Closely packed cells with many chloroplasts — site of most photosynthesis
Spongy mesophyll	Loose cells with air spaces — allow gas exchange (CO2 in, O2 out)
Stomata	Pores in lower epidermis — control CO2 entry and water vapour exit
Guard cells	Control opening and closing of stomata via changes in turgidity
Cuticle	Waxy layer on upper epidermis — reduces water loss
Vascular bundle (midrib)	Xylem delivers water; phloem carries away sucrose produced in photosynthesis

EXAM TIP
Exam tip: When drawing a graph of rate of photosynthesis vs light intensity, always explain the plateau by stating that 'another factor (CO2 or temperature) has become limiting'.

Topic 5: Animal Nutrition and Digestion

Nutrition in animals involves the ingestion, digestion, absorption, assimilation, and egestion of food. Humans have a complex alimentary canal that processes food mechanically and chemically.

5.1 The Human Digestive System — Organs and Functions

Organ	Secretion/Process	Function
Mouth (Buccal cavity)	Salivary amylase	Mechanical digestion; starch → maltose (chemical)
Oesophagus	Peristalsis (muscular contractions)	Moves bolus to stomach
Stomach	Pepsin, HCl, mucus	Protein digestion; HCl kills bacteria, activates pepsin
Small intestine (duodenum)	Bile, pancreatic enzymes	Bile emulsifies fats; enzymes digest all food groups
Small intestine (ileum)	Absorption via villi	Absorbs glucose, amino acids, fatty acids, glycerol
Large intestine	Water reabsorption	Absorbs water; forms faeces
Rectum & Anus	Egestion	Removes undigested material as faeces
Liver	Produces bile	Bile salts emulsify lipids; neutralises stomach acid
Pancreas	Amylase, lipase, protease	Produces digestive enzymes released into duodenum

5.2 Villi and Absorption

The small intestine is highly adapted for absorption. Its inner lining is covered in finger-like projections called villi, which are further covered in microvilli (brush border), dramatically increasing surface area.

- Glucose and amino acids: Absorbed by active transport and diffusion into capillaries → hepatic portal vein → liver
- Fatty acids and glycerol: Absorbed into lacteals (lymph vessels in villi) → lymphatic system → bloodstream

Adaptations of villi:

- Large surface area (due to finger-like shape and microvilli)
- Single layer of epithelial cells — short diffusion distance
- Rich blood capillary supply — maintains concentration gradient

- Lacteal for fat absorption

EXAM TIP
Exam tip: Always link adaptations to function. 'The single layer of epithelium provides a short diffusion path, so nutrients can be absorbed quickly into the blood.'

Topic 6: Transport in Plants and Animals

6.1 Transport in Plants — Xylem and Phloem

Xylem	Phloem
Transports water and mineral ions	Transports dissolved sugars (sucrose) and other organic molecules
Upward movement only (unidirectional)	Bidirectional (up and down the plant)
Dead cells with no cytoplasm	Living cells (sieve tube elements + companion cells)
Lignified walls — waterproof and strong	Non-lignified, flexible walls
Water moves by transpiration pull	Movement by translocation (active process)

6.2 Transpiration

Transpiration is the loss of water vapour from a plant, mainly through the stomata in leaves. The transpiration stream drives the movement of water from roots, up the xylem, to the leaves.

- Factors increasing transpiration: Higher light intensity, higher temperature, lower humidity, increased wind speed
- Experiment to measure: Potometer — measures rate of water uptake (indicator of transpiration rate)

6.3 The Human Circulatory System

Humans have a double circulatory system — the blood travels through the heart twice for each complete circuit of the body (pulmonary circulation: heart → lungs → heart; systemic circulation: heart → body → heart).

Blood Component	Structure	Function
Red blood cells	Biconcave, no nucleus, haemoglobin	Carry oxygen (as oxyhaemoglobin)
White blood cells	Have nucleus; some are phagocytes, some produce antibodies	Immune defence (phagocytosis and antibody production)
Platelets	Small cell fragments, no nucleus	Blood clotting (form fibrin mesh)
Plasma	Straw-coloured liquid	Transports glucose, hormones, urea, CO_2, heat

6.4 The Heart

- Four chambers: left atrium, right atrium, left ventricle, right ventricle
- Left ventricle has thickest wall — pumps blood to whole body (higher pressure needed)
- Bicuspid valve (left side) and tricuspid valve (right side) — prevent backflow
- Semilunar valves in aorta and pulmonary artery — prevent backflow after contraction
- Cardiac cycle: Diastole (filling) → Systole (contraction) → Diastole

EXAM TIP
Exam tip: Remember 'left side of heart = oxygenated blood, right side = deoxygenated blood'. The left ventricle wall is thicker because it must pump blood to the whole body — the right ventricle only pumps to the lungs (shorter distance).

Topic 7: Respiration

Respiration is the chemical process by which cells release energy from glucose. It occurs in all living cells, all the time. Do not confuse respiration with breathing (ventilation).

Aerobic Respiration	Anaerobic Respiration
Requires oxygen	Does not require oxygen
Produces CO2 and water	Produces lactic acid (animals) OR ethanol + CO2 (yeast/plants)
Releases large amount of ATP (~36-38 ATP per glucose)	Releases small amount of ATP (2 ATP per glucose)
Occurs in mitochondria (inner membrane)	Occurs in cytoplasm only
Sustainable long-term	Only sustainable short-term (builds oxygen debt)

Aerobic Respiration Equation

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

7.1 Breathing and Gas Exchange

- Inhaling: Diaphragm contracts (flattens), intercostal muscles contract, ribcage rises → thorax volume increases → pressure decreases → air flows in
- Exhaling: Diaphragm relaxes, intercostal muscles relax → thorax volume decreases → pressure increases → air flows out
- Gas exchange surface in lungs: Alveoli — thin walls (one cell thick), large surface area, moist, rich blood supply

Topic 8: Excretion

Excretion is the removal of metabolic waste products from the body. Key excretory organs include the kidneys (urea, excess water, mineral ions), lungs (CO_2 and water vapour), and skin (small amounts of urea in sweat).

8.1 The Kidneys

Each kidney contains approximately one million nephrons, which filter blood and produce urine through three main processes:

- Ultrafiltration: Blood filtered under high pressure at the glomerulus (Bowman's capsule). All small molecules pass into nephron — glucose, water, urea, mineral ions. Blood cells and large proteins remain in blood.
- Selective reabsorption: Useful substances (all glucose, some water, some mineral ions) reabsorbed back into blood as filtrate passes through proximal convoluted tubule and loop of Henle.
- Urine formation: Remaining filtrate (urea, excess water, excess mineral ions) passes to collecting duct → renal pelvis → ureter → bladder → expelled via urethra.

8.2 Osmoregulation

Kidneys regulate water content of blood (osmoregulation). This is controlled by ADH (antidiuretic hormone) released from the pituitary gland.

- Low water in blood → pituitary releases more ADH → collecting duct becomes more permeable → more water reabsorbed → concentrated (dark) urine
- High water in blood → less ADH released → collecting duct less permeable → less water reabsorbed → dilute (pale) urine

EXAM TIP
Exam tip: Remember: ADH = 'Anti-Diuretic Hormone' — it REDUCES urine production. More ADH = less (but more concentrated) urine.

Topic 9: Coordination and Response

9.1 The Nervous System

The nervous system allows rapid communication between receptors and effectors via electrical impulses.

Central Nervous System (CNS)	Peripheral Nervous System (PNS)
Brain and spinal cord	All nerves outside brain and spinal cord
Processes and coordinates information	Carries signals to and from CNS
Contains sensory and motor neurones + interneurones	Sensory neurones and motor neurones
Protected by skull and vertebral column	Not protected by bone

9.2 Reflex Arcs

A reflex is an automatic, rapid, involuntary response to a stimulus. The reflex arc pathway: Receptor → Sensory neurone → Relay (interneurone) in spinal cord → Motor neurone → Effector (muscle or gland)

9.3 The Endocrine System

Hormones are chemical messengers secreted by endocrine glands into the bloodstream. They travel to target organs and produce slower but longer-lasting responses than the nervous system.

Hormone	Gland	Function
Insulin	Pancreas (beta cells)	Lowers blood glucose — stimulates liver to convert glucose to glycogen
Glucagon	Pancreas (alpha cells)	Raises blood glucose — stimulates liver to convert glycogen to glucose
Adrenaline	Adrenal glands	Prepares body for 'fight or flight' — increases heart rate, dilates pupils
ADH	Pituitary gland	Increases water reabsorption in kidneys
Testosterone	Testes	Male secondary sex characteristics; sperm production

Oestrogen	Ovaries	Female secondary sex characteristics; thickens uterus lining
FSH / LH	Pituitary gland	Control menstrual cycle — stimulate egg development and ovulation

9.4 The Eye

- Cornea: Refracts light; most of the eye's focusing power
- Iris: Controls amount of light entering — circular muscles (dim light → pupil dilates) and radial muscles (bright light → pupil constricts)
- Lens: Fine focuses image onto retina; ciliary muscles and suspensory ligaments control lens shape
- Retina: Contains rod cells (low light, black/white) and cone cells (colour, bright light)
- Fovea: Highest concentration of cone cells — point of maximum visual acuity
- Blind spot: Where optic nerve exits — no photoreceptors

Topic 10: Homeostasis

Homeostasis is the maintenance of a constant internal environment. Key examples include thermoregulation (body temperature at 37°C) and blood glucose regulation.

10.1 Thermoregulation

The hypothalamus detects changes in blood temperature and sends signals to effectors in the skin.

Responses to Overheating	Responses to Being Too Cold
Vasodilation (widening of skin arterioles)	Vasoconstriction (narrowing of skin arterioles)
Sweating (evaporation cools skin)	Shivering (muscle contractions generate heat)
Hairs lie flat (less trapped air)	Hairs stand up (traps air — insulation)
Reduced metabolic rate	Increased metabolic rate

10.2 Blood Glucose Regulation

Blood glucose levels are regulated by insulin and glucagon — a negative feedback system.

- After a meal: Blood glucose rises → pancreas secretes insulin → liver converts glucose to glycogen → blood glucose falls
- Between meals/exercise: Blood glucose falls → pancreas secretes glucagon → liver converts glycogen to glucose → blood glucose rises
- Diabetes Type 1: Pancreas cannot produce insulin — managed by insulin injections
- Diabetes Type 2: Body cells become insensitive to insulin — managed by diet and medication

Topic 11: Reproduction

11.1 Sexual vs Asexual Reproduction

Sexual Reproduction	Asexual Reproduction
Involves two parents	Involves one parent
Gametes fuse (fertilisation)	No gametes; mitosis only
Genetic variation in offspring	Offspring genetically identical (clones)
Slower process	Rapid; large numbers of offspring
Examples: most animals, flowering plants	Examples: bacteria, hydra, potato (vegetative)

11.2 Human Reproductive System

Male: Testes (produce sperm and testosterone), epididymis (sperm maturation), vas deferens (sperm transport), seminal vesicles and prostate gland (produce seminal fluid), urethra (sperm and urine exit).

Female: Ovaries (produce eggs and oestrogen/progesterone), fallopian tubes/oviducts (egg transport; fertilisation occurs here), uterus (embryo implants and develops), cervix, vagina.

11.3 Menstrual Cycle

The menstrual cycle is approximately 28 days. Key events: Menstruation (day 1-5) → Uterus lining thickens (day 6-13, oestrogen) → Ovulation (day 14, triggered by LH surge) → Uterus maintained (day 15-28, progesterone) → If no fertilisation, progesterone drops and menstruation begins.

11.4 Fertilisation and Development

- Fertilisation: Sperm nucleus fuses with egg nucleus to form a zygote (in oviduct)
- Zygote divides by mitosis to form embryo → implants in uterine wall
- Placenta: Allows exchange of oxygen, glucose, urea, CO2 between maternal and fetal blood WITHOUT mixing
- Amnion: Fluid-filled sac — protects embryo from physical shock

Topic 12: Inheritance and Genetics

Genetics is the study of how characteristics are passed from parents to offspring through genes. IGCSE Biology covers monohybrid inheritance, codominance, sex-linked inheritance, and mutations.

12.1 Key Genetic Terminology

Key Term	Definition
Gene	A section of DNA that codes for a protein; determines a characteristic
Allele	A version of a gene (e.g. tall allele T, short allele t)
Genotype	The genetic makeup of an individual (e.g. TT, Tt, tt)
Phenotype	The observable characteristic expressed (e.g. tall, short)
Dominant	Allele that is expressed when only one copy is present (capital letter)
Recessive	Allele only expressed when two copies are present (lowercase letter)
Homozygous	Two identical alleles for a gene (TT or tt)
Heterozygous	Two different alleles for a gene (Tt)
Locus	The position of a gene on a chromosome
Codominance	Both alleles are expressed equally in the heterozygote (e.g. ABO blood group, sickle cell trait)

12.2 Monohybrid Cross Example — Pea Plant Height

Cross between two heterozygous tall plants (Tt x Tt):

Gametes	T	t
T	TT	Tt
t	Tt	tt

Result: 3 Tall (TT or Tt) : 1 Short (tt) — a 3:1 phenotypic ratio

12.3 Sex Determination and Sex-Linked Inheritance

- Females: XX chromosomes; Males: XY chromosomes
- Sex is determined by the sex chromosome carried in the sperm (X or Y)
- Sex-linked conditions are carried on the X chromosome — examples: colour blindness, haemophilia
- Females can be carriers (X^N X^n) without showing symptoms; males with X^n Y always show the condition

Topic 13: Variation and Natural Selection

13.1 Types of Variation

Continuous Variation	Discontinuous Variation
Range of values — no distinct categories	Distinct categories — no intermediate values
Controlled by many genes (polygenic) + environment	Controlled by one or few genes
Examples: height, weight, skin tone, intelligence	Examples: blood group, tongue rolling, attached/free earlobes
Normal distribution curve (bell-shaped)	Bar chart (distinct groups)

13.2 Darwin's Theory of Natural Selection

Darwin's theory of natural selection (evolution) rests on four key observations:

- Overproduction: Organisms produce more offspring than can survive
- Variation: Individuals within a population show variation in their characteristics
- Competition (Struggle for existence): Resources are limited; individuals compete for food, mates, and space
- Survival of the fittest: Individuals with advantageous traits are more likely to survive and reproduce
- Inheritance: Favourable traits are passed to offspring; over generations, the trait becomes more common in the population

EXAM TIP
Exam tip: When explaining natural selection, always include: variation exists → those with advantageous variation survive → they reproduce and pass on the allele → over generations, allele frequency increases.

13.3 Evidence for Evolution

- Fossil record: Shows gradual changes in organisms over millions of years
- Comparative anatomy: Homologous structures (same underlying structure, different function) suggest common ancestry
- DNA evidence: Closely related species share more DNA sequences than distantly related species
- Antibiotic resistance: Observable example of natural selection in action

Topic 14: Ecology and the Environment

Ecology is the study of how organisms interact with each other and their environment. Key concepts include food chains/webs, population dynamics, energy flow, and the carbon and nitrogen cycles.

14.1 Ecological Terminology

Key Term	Definition
Habitat	The place where an organism lives (e.g. pond, oak woodland, sandy soil)
Population	All the individuals of the same species in a given area at one time
Community	All the populations of different species living in a habitat
Ecosystem	A community of organisms and their non-living (abiotic) environment
Niche	The role of an organism in its ecosystem — what it eats, where it lives, when it is active
Producer	Organism that makes its own food by photosynthesis (e.g. plants, algae)
Consumer	Organism that obtains energy by eating other organisms
Decomposer	Organism that breaks down dead organic matter (e.g. bacteria, fungi)
Food chain	Linear sequence showing feeding relationships and energy flow
Food web	Complex, interconnected network of food chains

14.2 Energy Flow and Pyramids

Energy enters an ecosystem from the Sun via photosynthesis by producers. As energy passes along a food chain, most is lost at each trophic level as heat (from respiration), movement, and undigested material in faeces.

- Only approximately 10% of energy is transferred from one trophic level to the next
- This explains why food chains rarely exceed 4-5 links, and why pyramids of biomass and energy narrow at each level

14.3 The Carbon Cycle

- Carbon enters atmosphere as CO2
- Photosynthesis: Plants absorb CO2 and incorporate carbon into organic molecules
- Feeding: Carbon passes along food chains

- Respiration: All organisms release CO2 back to atmosphere
- Decomposition: Decomposers break down dead matter, releasing CO2
- Combustion: Burning fossil fuels releases CO2 stored millions of years ago

14.4 Human Impact on the Environment

Human Activity	Environmental Impact	Consequence
Burning fossil fuels	Increased CO2 in atmosphere	Global warming, climate change
Deforestation	Loss of carbon sinks; soil erosion; habitat loss	Biodiversity loss; flooding; CO2 increase
Pesticide use	Accumulates in food chains (bioaccumulation)	Harm to top predators (e.g. birds of prey)
Fertiliser run-off (eutrophication)	Excess nitrates/phosphates in water bodies	Algal bloom → decomposition → oxygen depletion → death of fish
Overfarming/monoculture	Soil degradation, reduced biodiversity	Unsustainable food production

Topic 15: Biotechnology and Genetic Engineering

This topic is part of the Extended syllabus for Cambridge IGCSE Biology 0610. Students must understand the principles and applications of genetic engineering and biotechnology.

15.1 Genetic Engineering — Steps

- Step 1 — Identify and isolate the desired gene: Use restriction enzymes to cut the gene from donor DNA; restriction enzymes cut at specific recognition sequences, leaving 'sticky ends'
- Step 2 — Insert into a vector: The gene is inserted into a bacterial plasmid (vector) using complementary sticky ends and DNA ligase seals the phosphodiester bonds
- Step 3 — Insert vector into host cell: The recombinant plasmid is inserted into a bacterium (e.g. E. coli) by transformation
- Step 4 — Express the gene: The bacterium divides and the gene is expressed — the desired protein is produced
- Step 5 — Harvesting the product: The protein is extracted and purified

15.2 Applications of Genetic Engineering

- Human insulin production: Insulin gene inserted into bacteria; bacteria produce human insulin for diabetics
- Golden rice: Beta-carotene genes inserted into rice to combat vitamin A deficiency
- Genetically modified crops: Pest resistance (Bt crops), herbicide tolerance, improved shelf-life
- Gene therapy: Correct faulty genes in somatic cells to treat genetic disorders (e.g. cystic fibrosis)

EXAM TIP
Exam tip: Remember the role of each enzyme: Restriction enzymes cut DNA; DNA ligase joins DNA strands. Plasmids are used as vectors because they replicate independently in bacteria.

15.3 Cloning

- Artificial cloning in plants: Cuttings, tissue culture (micropropagation) — produces many identical plants rapidly
- Animal cloning: Somatic cell nuclear transfer (SCNT) — nucleus from adult body cell transferred into enucleated egg cell
- Uses of cloning: Conservation of endangered species, organ transplant research, producing animals with desired traits

Examination Skills and Revision Strategies

Command Word Glossary

Understanding command words is critical for IGCSE Biology examinations. Here is a guide to the most common ones:

Command Word	What It Means	Example Response Structure
State	Give a brief, factual answer — no explanation needed	One sentence, no elaboration
Describe	Give a detailed account of what happens — no reason needed	What happens, in correct order
Explain	Give reasons — the 'why' and 'how'	Use 'because', 'therefore', 'this means'
Compare	Give similarities AND differences between two things	Use a table or 'whereas' / 'however'
Suggest	Apply knowledge to an unfamiliar situation	Reasonable scientific reasoning
Calculate	Give a numerical answer with working shown	Show formula, substitution, answer with units
Sketch	Draw a simple graph — no exact values needed	Label axes, correct trend, correct shape
Predict	State what will happen based on given information	Direct statement with reasoning

Common Exam Mistakes to Avoid

- Saying enzymes are 'killed' by high temperature — say 'denatured'
- Confusing respiration with breathing — respiration = cellular process; breathing = ventilation
- Saying 'the plant absorbs sunlight' in photosynthesis — chlorophyll absorbs light
- Mixing up mitosis and meiosis — mitosis: same chromosome number; meiosis: halves chromosome number
- Not giving units in calculations — always include units (e.g. mg/100cm3, beats per minute)
- Describing instead of explaining — when asked to 'explain', always give a reason
- Forgetting to include oxygen debt when discussing anaerobic respiration in muscles

Revision Tips from Eclassopedia

- Use active recall: Cover notes and try to write definitions from memory
- Draw diagrams and label them repeatedly — heart, kidney, eye, leaf cross-section
- Practise past papers under timed conditions — aim for at least 10 past papers before the exam
- Make flashcards for key terms — especially all the definitions in this study map
- Use the mark schemes to understand exactly what examiners are looking for
- For graph questions: always check the scale, label axes with units, use the full range of the paper
- For 6-mark extended response questions: plan your answer before writing; use scientific vocabulary