GCSE BIOLOGY - AQA AND PEARSON EDEXCEL

GCSE Biology revision handbook

Core biological knowledge, practical reasoning and original exam-style questions organised into six connected chapters.

Use the confirmed course

This handbook covers core ideas shared by AQA and Pearson Edexcel. Topic order, required practicals, tier content and equation sheets can differ. Always use the learner's current specification and teacher guidance as the final authority.

Inside this handbook

Each chapter gives the essential knowledge, a worked example and original exam-style practice. Complete the questions before using the answer section.

CHAPTER 1

Cells, microscopy and transport

Cells are the basic units of living organisms. Structure, scale and movement across membranes explain many later topics.

Coverage map

Animal, plant and bacterial cells; microscopy and magnification; cell differentiation; diffusion; osmosis; active transport; exchange surfaces.

Essential knowledge

- Animal and plant cells are eukaryotic; bacteria are prokaryotic and lack a nucleus.
- Magnification = image size ÷ actual size. Convert units before substituting.
- Diffusion is net movement down a concentration gradient; osmosis is water movement through a partially permeable membrane.
- Active transport moves substances against a concentration gradient using energy from respiration.
- Specialised cells have structures adapted to their functions.

Worked example	A cell image is 36 mm wide and the real cell is 60 micrometres wide. Convert 36 mm to 36,000 micrometres. Magnification = $36{,}000 / 60$ = x600.
Exam focus	Link each structural feature to a named function or transport process, using the direction of the concentration gradient accurately.
Common mistake to avoid	Osmosis is the net movement of water through a partially permeable membrane, not the movement of any dissolved substance.

CHAPTER 1 PRACTICE

Exam-style practice

1. Give two differences between a bacterial cell and a typical animal cell.

2. Explain why a root hair cell can absorb mineral ions when their concentration is lower in the soil than inside the cell.

3. A cell is 25 micrometres wide and appears 20 mm wide in an image. Calculate the magnification.

CHAPTER 2

Organisation, digestion and transport

Multicellular organisms contain specialised tissues, organs and systems that exchange and transport materials.

Coverage map

Cells to organ systems; enzymes; digestion; blood and vessels; the heart; gas exchange; plant tissues; transpiration and translocation.

Essential knowledge

- Enzymes are biological catalysts with active sites; temperature and pH affect their shape and rate.
- The digestive system breaks large insoluble molecules into small soluble molecules for absorption.
- The heart creates pressure for double circulation through lungs and body.
- Arteries, veins and capillaries have structures suited to pressure, return flow and exchange.
- Xylem transports water and mineral ions; phloem translocates dissolved sugars.

Worked example	At low temperature enzyme reactions are slow because particles have less kinetic energy. Above the optimum, bonds maintaining the active site's shape break, so the enzyme denatures and fewer substrates fit.
Exam focus	Trace a substance through the correct organs or vessels and explain how structure supports the rate of the process.
Common mistake to avoid	Bile is not an enzyme: it neutralises stomach acid and emulsifies fat, helping lipase work effectively.

CHAPTER 2 PRACTICE

Exam-style practice

1. Explain how the structure of a capillary supports exchange with tissues.

2. Describe the route of blood from the vena cava to the aorta.

3. Explain why the rate of transpiration usually increases on a warm, windy day.

CHAPTER 3

Infection, immunity and bioenergetics

Pathogens cause communicable disease, while immune responses and energy-transfer processes help organisms survive.

Coverage map

Pathogens and transmission; body defences; vaccination; antibiotics and drug development; photosynthesis; respiration; exercise and metabolism.

Essential knowledge

- Pathogens include bacteria, viruses, fungi and protists; transmission routes differ.
- White blood cells defend by phagocytosis, antibody production and antitoxin production.
- Vaccination creates memory cells, producing a faster secondary response.
- Photosynthesis transfers light energy into chemical energy stored in glucose.
- Aerobic respiration releases energy using oxygen; anaerobic pathways release less energy.

Worked example	Limiting-factor graphs level off when another factor becomes limiting. If increasing light no longer raises photosynthesis, carbon dioxide concentration or temperature may now limit the rate.
Exam focus	Separate the cause of a disease from its symptoms, and distinguish a rate-limiting factor from the process it affects.
Common mistake to avoid	Antibiotics act on bacteria, not viruses; vaccination prepares the immune response but does not directly kill a pathogen.

CHAPTER 3 PRACTICE

Exam-style practice

1. Explain why antibiotics do not treat a viral infection.

2. State the word equation for photosynthesis and explain one use of glucose in a plant.

3. Explain why breathing rate remains high for a period after vigorous exercise.

CHAPTER 4

Homeostasis, nerves and hormones

Homeostasis keeps internal conditions within limits through receptors, coordination centres and effectors.

Coverage map

Homeostasis and negative feedback; the nervous system; reflexes; the brain and eye; blood glucose; thermoregulation; kidneys and water balance; reproductive and plant hormones.

Essential knowledge

- Negative feedback reverses a change and returns a condition towards its normal range.
- The nervous system produces rapid, short-lived responses using electrical impulses.
- Hormones travel in blood and usually act more slowly but for longer.
- Insulin lowers blood glucose; glucagon raises it.
- Kidneys regulate water and ion balance and remove urea from blood.

Worked example	When blood glucose rises, the pancreas releases insulin. Body cells take up more glucose and liver and muscle cells convert glucose to glycogen, lowering the concentration towards normal.
Exam focus	Name the receptor, coordination centre and effector, then describe how the response reverses the original change.
Common mistake to avoid	Nervous responses use electrical impulses along neurones; hormonal responses use chemicals carried in the blood.

CHAPTER 4 PRACTICE

Exam-style practice

1. Describe the pathway of a reflex action from stimulus to response.

2. Explain how sweating and changes in skin blood flow cool the body.

3. Compare type 1 and type 2 diabetes.

CHAPTER 5

Inheritance, variation and evolution

DNA carries genetic information. Inheritance and environmental effects create variation on which natural selection can act.

Coverage map

DNA, genes and chromosomes; mitosis and meiosis; sexual and asexual reproduction; genetic crosses; variation; natural selection; selective breeding; genetic technologies.

Essential knowledge

- A gene is a section of DNA coding for a product; alleles are different versions of a gene.
- Mitosis produces genetically identical cells; meiosis produces genetically varied haploid gametes.
- A dominant allele is expressed with one copy; a recessive phenotype requires two recessive copies.
- Mutation creates new alleles and may be neutral, harmful or beneficial.
- Natural selection changes allele frequency when inherited variation affects survival and reproduction.

Worked example	Two heterozygous parents, Bb × Bb, produce genotype probabilities $^{1}/_{4}$ BB, $^{1}/_{2}$ Bb and $^{1}/_{4}$ bb. If b is recessive, the recessive phenotype probability is $^{1}/_{4}$.
Exam focus	Define alleles and genotypes before using a genetic diagram, and show how selection changes allele frequency over generations.
Common mistake to avoid	An organism does not evolve because it needs to; inherited variation already exists and selection acts across generations.

CHAPTER 5 PRACTICE

Exam-style practice

1. Explain why siblings from the same parents are genetically different.

2. A recessive disorder is caused by allele d. Two carriers have a child. Find the probability the child is unaffected but carries d.

3. Explain how antibiotic resistance can increase in a bacterial population.

CHAPTER 6

Ecology, cycles and human impact

Organisms interact with each other and their environment. Matter cycles while energy is transferred through food chains.

Coverage map

Communities and competition; adaptations; sampling; food chains and trophic levels; decomposition; carbon and water cycles; biodiversity; food security.

Essential knowledge

- A community contains interacting populations; an ecosystem includes the community and abiotic environment.
- Competition occurs for limited resources such as light, water, food, territory and mates.
- Energy transfer between trophic levels is inefficient because of respiration, movement, waste and uneaten material.
- Carbon and water are recycled through biological and physical processes.
- Biodiversity can be reduced by pollution, habitat loss and climate change, and supported through conservation.

Worked example	If producers store 20,000 kJ and primary consumers store 2,400 kJ, transfer efficiency = $2{,}^{400}\!/_{20}{,}000 \times 100 = 12\%$.
Exam focus	Connect an environmental change to population size through a resource, interaction or rate-limiting process.
Common mistake to avoid	Energy flows through ecosystems, whereas atoms such as carbon are recycled.

CHAPTER 6 PRACTICE

Exam-style practice

1. Explain how a quadrat and random coordinates can estimate plant abundance.

2. Calculate the biomass transfer efficiency from 4,800 kg of plants to 576 kg of herbivores.

3. Explain one benefit and one possible limitation of a conservation breeding programme.

ANSWERS AND WORKED METHODS

Check the reasoning as well as the final answer

Award credit only for a method that answers the question asked. Where a response is unclear, return to the matching chapter and correct it before trying a fresh question.

Chapter 1: Cells, microscopy and transport

1. A bacterial cell has no nucleus and its DNA is a circular loop in the cytoplasm; it may also have plasmids and a cell wall. An animal cell has a nucleus containing linear chromosomes and membrane-bound organelles such as mitochondria.

2. Mineral ions move against the concentration gradient by active transport. Carrier proteins in the membrane use energy released by respiration; the root hair projection provides a large surface area.

3. 20 mm = 20,000 micrometres. Magnification = $20{,}000 \div 25$ = x800.

Chapter 2: Organisation, digestion and transport

1. Capillaries have walls one cell thick, giving a short diffusion distance. Their narrow lumen keeps blood close to the wall, and extensive networks provide a large surface area.

2. Vena cava → right atrium → right ventricle → pulmonary artery → lungs → pulmonary vein → left atrium → left ventricle → aorta. Valves prevent backflow.

3. Higher temperature increases evaporation from mesophyll cell surfaces and diffusion of water vapour. Wind removes humid air around the leaf, maintaining a steep concentration gradient.

Chapter 3: Infection, immunity and bioenergetics

1. Antibiotics target bacterial structures or processes such as cell-wall formation or bacterial ribosomes. Viruses reproduce inside host cells and lack these targets.

2. Carbon dioxide + water → glucose + oxygen. Glucose may be respired, converted to starch for storage, made into cellulose, combined with nitrate ions to make amino acids, or converted to lipids.

3. Additional oxygen is needed to remove or process lactic acid produced during anaerobic respiration, restore normal conditions and replenish energy stores.

Chapter 4: Homeostasis, nerves and hormones

1. A receptor detects the stimulus. An impulse travels along a sensory neurone to the central nervous system, crosses synapses through a relay neurone, then travels along a motor neurone to an effector that produces the response.

2. Sweat evaporates from skin and transfers thermal energy to the surroundings. Vasodilation increases blood flow near the skin surface, increasing energy transfer to the environment.

3. Type 1 results from little or no insulin production and is commonly treated with insulin. Type 2 involves reduced response to insulin and is associated with genetic and lifestyle factors; treatment can include diet, activity and medication.

Chapter 5: Inheritance, variation and evolution

1. Meiosis produces different combinations of alleles through independent assortment and crossing over, and fertilisation randomly combines one gamete from each parent.

2. Dd × Dd gives DD, Dd, Dd and dd. Two of four outcomes are unaffected carriers, so the probability is $^{1}/_{2}$.

3. Random mutation creates resistance in some bacteria. Antibiotic use kills susceptible bacteria; resistant bacteria survive, reproduce and pass resistance alleles on, so their proportion increases.

Chapter 6: Ecology, cycles and human impact

1. Place quadrats at coordinates generated randomly across the area, count or estimate coverage in each, repeat enough times, then calculate a mean and scale it to the total area. Random placement reduces selection bias.

2. Efficiency = $^{576}/_{4}$,800 × 100 = 12%.

3. It can increase numbers of an endangered species and preserve genetic material. A small breeding population may have low genetic diversity, and release succeeds only if habitat and threats are also managed.