Course Companion

Pearson Edexcel · International GCSE · Biology

Every topic handout in one volume

全部专题讲义合集

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The nature and variety of living organisms

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What counts as alive?

A housefly and a maize plant could not look more different, yet both are alive in the same eight ways, and both are built from the same kind of cell. This first section gives you the words for that shared life – the characteristics every organism shows – and a map of life's variety: five groups of organisms plus the viruses, which are not alive at all but still infect every living thing.

Edexcel International GCSE Biology 4BI1, Section 1 is assessed in both papers; expect direct recall and "compare" questions from 1.1–1.4, often one mark for a feature and one for the named example.

The characteristics of life

Every living organism does all eight: it takes in **nutrition** 营养 (material for energy or growth), it **respires** 呼吸 (releases energy from food), it **excretes** 排泄 (removes waste), it **responds** 反应 to its surroundings, it **moves** 运动, it **controls its internal conditions** (keeps itself steady inside), it **reproduces** 繁殖, and it **grows and develops** 生长. The memory hook MRS GREN lists movement, reproduction, sensitivity, growth, respiration, excretion, nutrition – the "control of internal conditions" is the eighth that the hook leaves out, so name it separately.

A virus does none of these by itself – that is why it is not living.

Variety: the five groups and their give-away features

Plants 植物: multicellular; cells contain **chloroplasts** 叶绿体 and carry out **photosynthesis** 光合作用; walls of **cellulose** 纤维素; carbohydrate stored as **starch** 淀粉 or sucrose. Examples: a cereal (maize) and a herbaceous legume (peas or beans).

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A fungus: the fly agaric. Fungi feed by saprotrophic nutrition and have cell walls of chitin

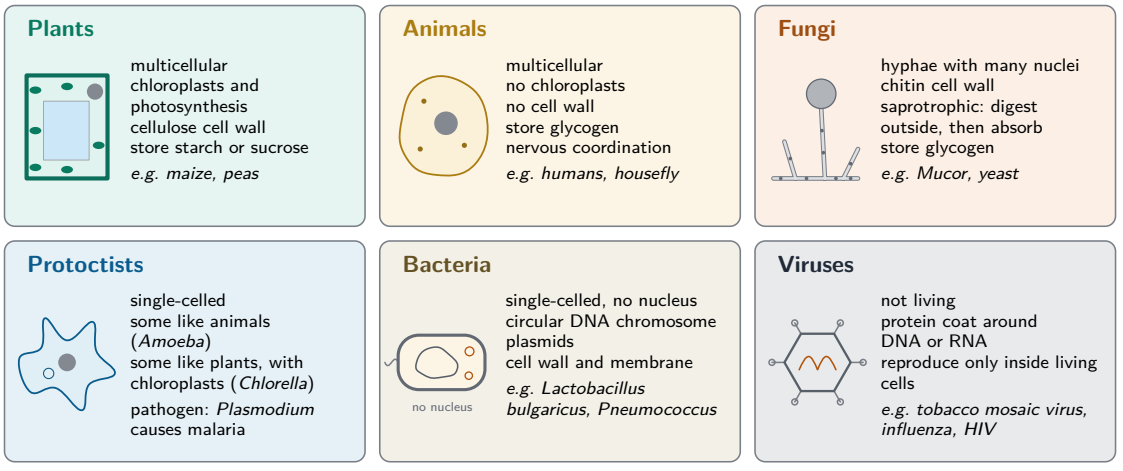
Animals 动物: multicellular; no chloroplasts, no photosynthesis; **no cell walls**; usually nervous coordination and movement from place to another; store carbohydrate as **glycogen** 糖原. Examples: mammals (humans) and insects (housefly, mosquito).

Fungi 真菌: no photosynthesis; body usually a **mycelium** 菌丝体 of thread-like **hyphae** 菌丝 containing **many nuclei**; some single-celled (yeast); walls of **chitin** 几丁质; feed by secreting digestive enzymes onto food outside the body and absorbing the products – **saprotrophic nutrition** 腐生营养; store glycogen. Examples: **Mucor** (typical hyphae) and **yeast** 酵母 (single-celled).

Protoctists 原生生物: microscopic **single-celled** organisms. *Amoeba* (pond water) is like an animal cell; *Chlorella* has chloroplasts and is like a plant. The pathogenic example is ***Plasmodium***, which causes **malaria** 疟疾.

Bacteria 细菌: microscopic single-celled organisms with a cell wall, cell membrane, cytoplasm and **plasmids** 质粒; they **lack a nucleus** but have a **circular chromosome of DNA** 环状 DNA. Some photosynthesise; most feed off living or dead organisms. Examples: ***Lactobacillus bulgaricus*** (rod-shaped, used to make yoghurt) and ***Pneumococcus*** (spherical, causes pneumonia 肺炎).

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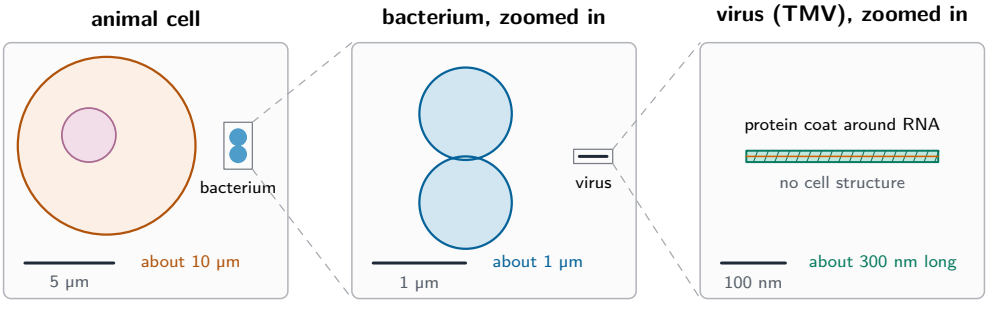
One panel per group with the features to recall and a named example for each.

The four-way comparison the examiners like: **cell wall material** (cellulose / none / chitin / bacterial wall), **nucleus** (yes / yes / yes / no), **chloroplasts** (plants and some protoctists only), **storage carbohydrate** (starch / glycogen / glycogen / –).

Pathogens and the viruses

A **pathogen** 病原体 is any organism or particle that causes disease – the specification allows fungi, bacteria, protoctists **or viruses**.

Viruses 病毒 are **not living organisms**: they are small particles (smaller than bacteria), **parasitic**, and can **reproduce only inside living cells**; they have **no cellular structure** – just a **protein coat** 蛋白质外壳 containing **one type of nucleic acid, DNA or RNA** (never both). Learn the three named examples with their diseases: **tobacco mosaic virus** 烟草花叶病毒 (discoloured tobacco leaves – it stops chloroplasts forming), **influenza virus** 流感病毒 (flu) and **HIV** 艾滋病毒 (AIDS).



Approximate sizes: a virus is far smaller than a bacterium, which is far smaller than a plant or animal cell.

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Common mistakes.

- Calling a virus a cell or a micro-organism. A virus has **no cellular structure**: only a protein coat around DNA or RNA, and it reproduces only inside living cells.
- Saying fungi photosynthesise or have cellulose walls. Fungi have **chitin** walls, no chloroplasts, and feed by **saprotrophic nutrition**: enzymes are secreted onto the food outside the body and the soluble products absorbed.
- Saying bacteria have a nucleus. Bacteria have a **circular chromosome** of DNA loose in the cytoplasm, plus small rings called plasmids.
- Writing "breathing" for respiration. **Respiration** is the release of energy from food inside cells; breathing only moves air.
- Giving a single example when the question asks for two named organisms. Learn the specification examples by name: maize and peas, housefly and mosquito, *Mucor* and yeast, *Amoeba*, *Chlorella* and *Plasmodium*, *Lactobacillus bulgaricus* and *Pneumococcus*.

Check yourself

1. List the eight characteristics shared by all living organisms.
2. Give two features of a plant cell that an animal cell lacks.
3. Which group stores carbohydrate as glycogen, and which as starch?
4. Describe saprotrophic nutrition in fungi, using the words hyphae, enzymes and absorb.
5. How does the genetic material of a bacterium differ from that of a plant cell?
6. Name the pathogenic protoctist and the disease it causes.
7. State three reasons why viruses are not classified as living organisms.
8. Which named virus prevents chloroplast formation, and what is the visible result?

Answers: 1 nutrition, respiration, excretion, response, movement, control of internal conditions, reproduction, growth; 2 chloroplasts and a cellulose cell wall; 3 animals and fungi store glycogen; plants store starch (or sucrose); 4 fungi secrete digestive enzymes from their hyphae onto dead food material, then absorb the soluble organic products; 5 a bacterium has no nucleus – circular DNA chromosome plus plasmids – while a plant cell keeps its DNA in a nucleus; 6 Plasmodium – malaria; 7 no cellular structure; reproduce only inside living cells; no life processes alone; 8 tobacco mosaic virus – discoloured, mosaic-patterned leaves.

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Structures and functions in living organisms

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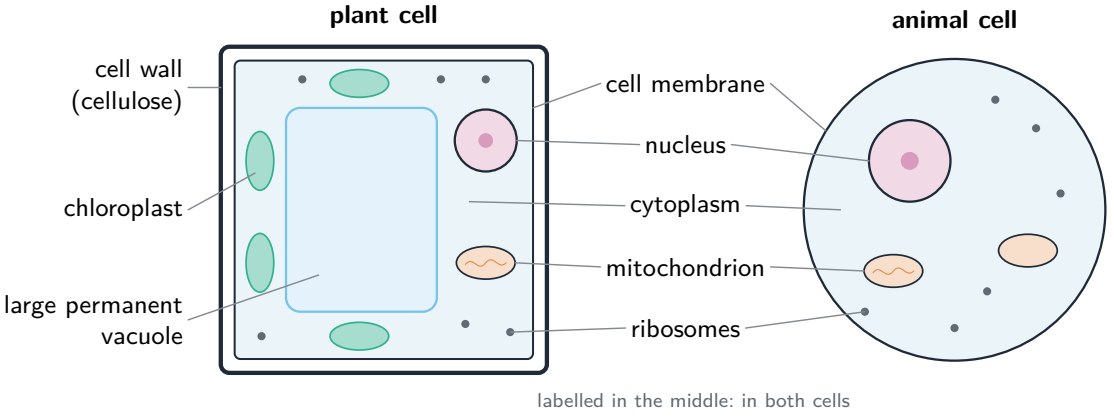
From cell to system

One cell became many; many cells became tissues, organs and systems; and every system serves the same three jobs – taking in what the body needs, moving it to where it is used, and removing what the body must not keep. This section is the core of IGCSE Biology: cells and molecules, how substances cross membranes, nutrition in plants and humans, respiration, gas exchange, transport, excretion and coordination.

Edexcel International GCSE Biology 4BI1, Section 2 (statements 2.1–2.95) is the largest section of the course and feeds every long question on both papers. B-suffixed statements are the separate-science (Biology-only) extension; double-award students learn the unlettered core.

Organisation and cells

Organisation runs upward: **organelles** 细胞器 → **cells** 细胞 → **tissues** 组织 → **organs** 器官 → **systems** 系统.



Structures labelled in the middle are in both cells; the cell wall, chloroplasts and large permanent vacuole are in plant cells only.

Structure	Function
Nucleus	contains DNA, controls the cell
Cytoplasm	where reactions happen
Cell membrane	controls what enters and leaves

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Structure	Function
Cell wall (plants)	strength (cellulose)
Mitochondria	release energy in respiration
Chloroplasts (plants)	absorb light for photosynthesis
Ribosomes	protein synthesis
Vacuole	stores water and dissolved substances (large and permanent in plants)

2.5B Specialised cells develop by **cell differentiation** 细胞分化; **2.6B** stem cells can replace damaged cells – advantages: treat conditions like paralysis or leukaemia; disadvantages: ethical concerns over embryos, risk of rejection and uncontrolled division.

Biological molecules and enzymes

Carbohydrates contain C, H, O; proteins add N; lipids are C, H, O with much less oxygen. Large molecules are chains of small units: **starch and glycogen from simple sugars**, **protein from amino acids**, **lipid from fatty acids and glycerol**. **2.9** Food tests: glucose – Benedict's (heated, blue → brick red); starch – iodine (yellow-brown → blue-black); protein – Biuret (blue → purple); fat – ethanol emulsion (cloudy white layer).



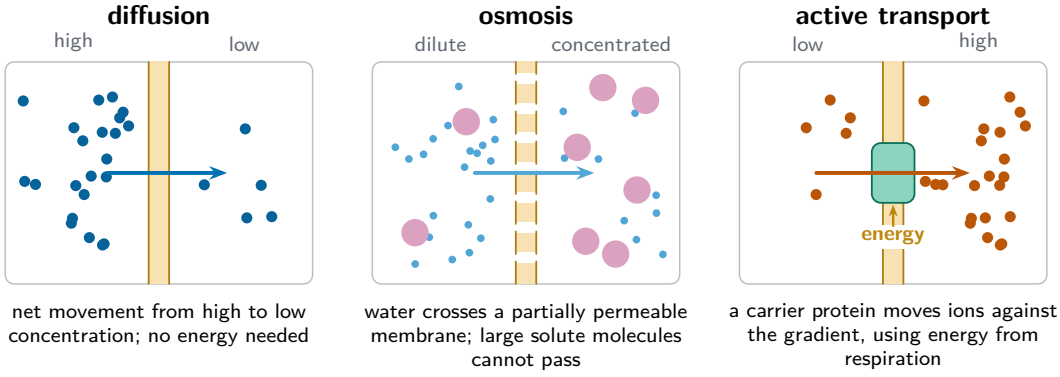
Biological washing powders contain enzymes that digest food stains at low temperatures

Enzymes 酶 are **biological catalysts** 生物催化剂: they speed metabolic reactions without being used up. Each has an **active site** 活性部位 the substrate must fit.

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Above an optimum temperature or away from the optimum pH, the active site changes shape (**denaturation** 变性) and the enzyme no longer works. Practical 2.12/2.14B follow amylase digesting starch at different temperatures or pH with iodine.

Movement into and out of cells



Diffusion and osmosis go down a gradient with no energy; active transport goes against it, using energy from respiration.

Diffusion 扩散 is the net movement of particles from a higher to a lower concentration (oxygen into blood). **Osmosis** 渗透 is the diffusion of **water** across a **partially permeable membrane** from a dilute to a more concentrated solution. **Active transport** 主动运输 moves substances **against** the gradient using energy from respiration (mineral ions into root hair cells). Rate increases with surface-area-to-volume ratio, concentration gradient and temperature, and decreases with distance.

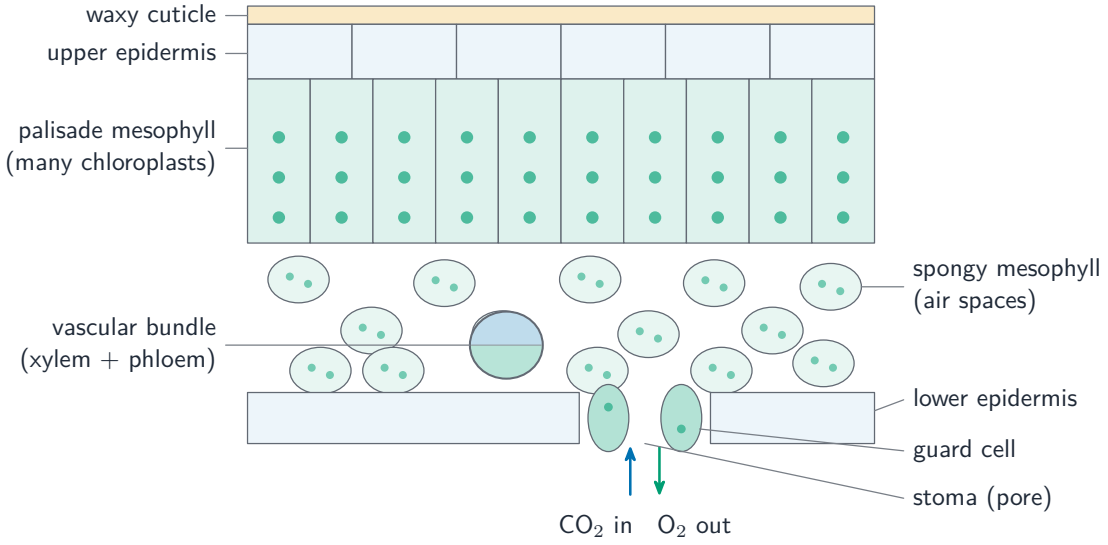
Nutrition

Flowering plants. Photosynthesis converts light energy into chemical energy stored in glucose:

$$6CO_2 + 6H_2O \xrightarrow{\text{light, chlorophyll}} C_6H_{12}O_6 + 6O_2$$

Limiting factors: **carbon dioxide concentration, light intensity, temperature** – each raises rate until another factor limits. **Magnesium ions** build chlorophyll (deficiency yellows leaves); **nitrate ions** build amino acids. 2.23: pondweed shows oxygen evolution; iodine tests a leaf for starch after blocking light, CO_2 or chlorophyll.

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Leaf cross-section with a palisade layer rich in chloroplasts and stomata below.

Humans. A balanced diet: carbohydrate, protein, lipid, vitamins A (night vision), C (connective tissue), D (calcium absorption), calcium (bones) and iron (haemoglobin), water, and dietary fibre. Energy needs rise with activity, growth (age) and pregnancy. The alimentary canal – mouth → oesophagus → stomach → duodenum and ileum → colon and rectum, with the pancreas supplying enzymes – moves food by **peristalsis** 蠕动. Digestion: amylase and maltase (starch → glucose), proteases (protein → amino acids), lipases (lipid → fatty acids + glycerol). **Bile** (made in the liver, stored in the gall bladder) **neutralises stomach acid** and **emulsifies lipids** into droplets. The ileum's wall is folded into **villi** 绒毛: huge surface area, one-cell-thick walls, dense capillary network – built for absorption.

Respiration and gas exchange

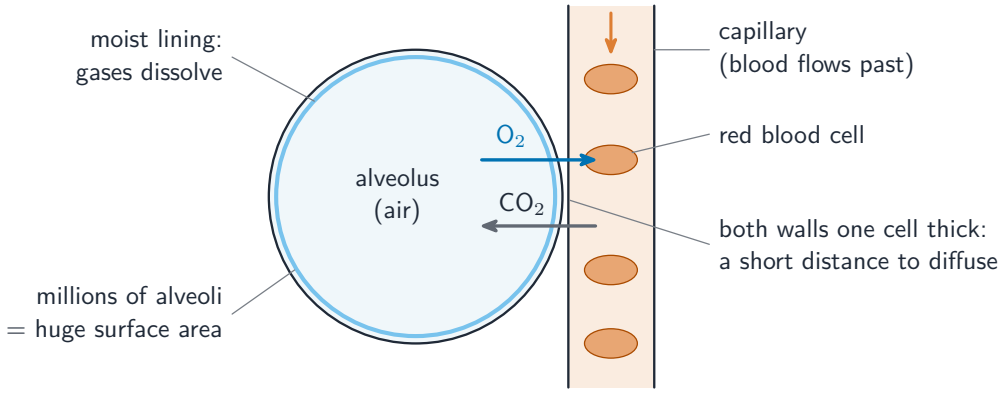
Respiration releases energy from glucose to make **ATP**, which supplies energy for muscle contraction, protein synthesis and active transport. **Aerobic**: glucose + oxygen → carbon dioxide + water (symbol equation: $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$). **Anaerobic** (without oxygen): in animals glucose → **lactic acid** (less energy, oxygen debt); in plants and yeast glucose → ethanol + carbon dioxide.

Plants (2.40B–2.45B). Gases move by **diffusion through stomata**; the leaf's flat shape, air spaces and thin, moist surfaces serve gas exchange as they serve photosynthesis. By day, photosynthesis outweighs respiration, so the **net** exchange is CO_2 in and O_2 out; at night only respiration continues (net O_2 in, CO_2 out). Hydrogencarbonate indicator shows this: orange → yellow with CO_2 (dark), orange → purple with less CO_2 (bright light).

Humans (2.46–2.50). The thorax: ribs, intercostal muscles, diaphragm, trachea → bronchi → bronchioles → **alveoli**, all in pleural membranes. Inhaling: intercostal

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muscles and diaphragm contract, the chest volume rises, pressure falls and air flows in. Smoking damages alveoli (emphysema), clogs arteries and raises coronary heart disease risk.



An alveolus with a one-cell-thick wall against a capillary: oxygen diffuses in, carbon dioxide out.

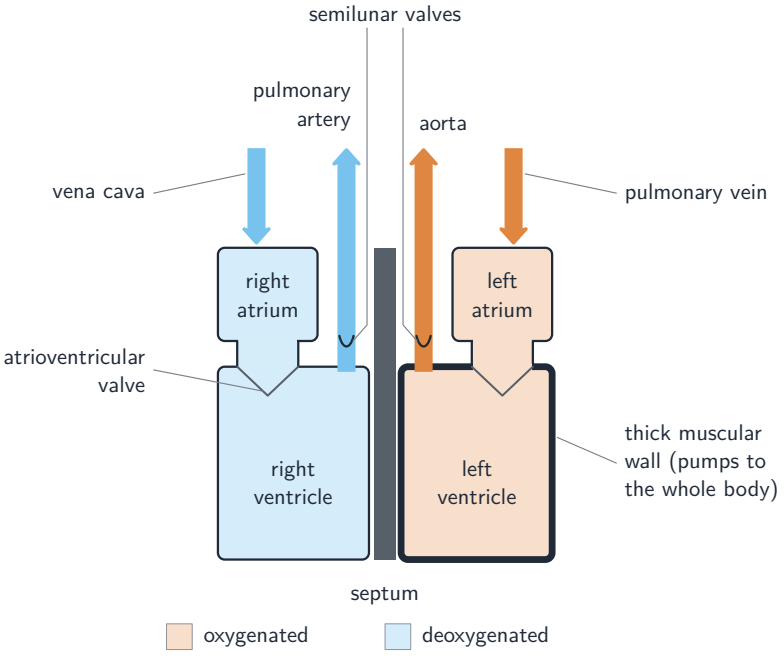
Transport

Unicellular organisms manage with diffusion alone – every part is close to the surface. Multicellular organisms need transport systems.

Plants. **Xylem** transports water and mineral ions from roots to leaves; **phloem** carries sucrose and amino acids between leaves and the rest of the plant. B-extension: root hair cells absorb water by osmosis; **transpiration** 蒸腾作用 is the evaporation of water from surfaces, mostly via stomata, faster in low humidity, high wind, high temperature and bright light.

Humans. Blood: **plasma** (carries CO_2, digested food, urea, hormones, heat), **red blood cells** (biconcave discs, no nucleus, full of **haemoglobin** 血红蛋白 – a large surface and short diffusion path for oxygen), **white blood cells** (**phagocytes** ingest pathogens; **lymphocytes** release specific **antibodies**), and **platelets** (clotting, B-extension; vaccination builds **memory cells**, B-extension).

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The four chambers of the heart with the vessels to and from lungs and body; the left ventricle has the thickest wall.

The heart's right side pumps blood to the lungs, the left side to the body; exercise and **adrenaline** raise heart rate. Arteries carry blood away at high pressure (thick, elastic walls), veins return it at low pressure (wide lumen, valves), capillaries exchange materials (one-cell-thick walls). Risk factors for **coronary heart disease** include smoking, high-fat diet and lack of exercise.

Excretion

Plants lose waste O_2 and CO_2 through stomata. Humans excrete CO_2 (lungs), urea + water + ions (kidneys – water and urea also in sweat). B-extension: the kidney **filters blood in nephrons** (ultrafiltration from the glomerulus into the Bowman's capsule; selective reabsorption of all glucose at the proximal convoluted tubule; water reabsorbed from the collecting duct under **ADH** – osmoregulation). Urine holds water, urea and ions; the urinary system runs kidneys → ureters → bladder → urethra.

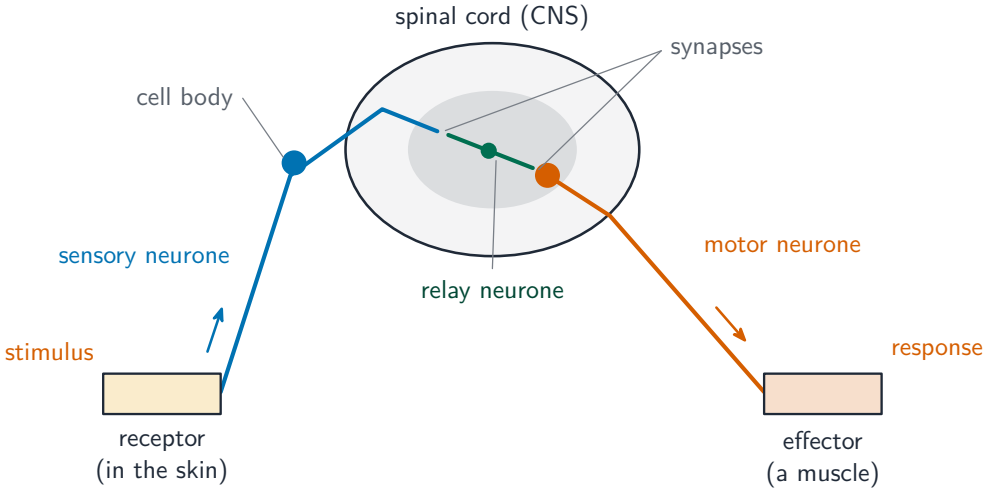
Coordination and response

Homeostasis 稳态 keeps the internal environment constant (water content, temperature). A coordinated response needs **stimulus → receptor → coordinator → effector**. Plants respond to light (**phototropism** 向光性) and gravity (**geotropism**) – shoots grow towards light, roots downwards – controlled by **auxin** 生长素 accumulating on the shaded side of a shoot.

Nervous control is electrical, fast and short-lived; **hormonal** control is chemical in

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the blood, slower and longer-lasting. The CNS (brain and spinal cord) links to sense organs by nerves; at a **synapse** 突触 a **neurotransmitter** 神经递质 passes the signal between neurones.



The reflex arc from stimulus to effector, through sensory neurone, relay neurone in the CNS and motor neurone.

The eye focuses by changing lens shape (near: more curved) and responds to light via the pupil. Skin temperature control: **sweating** cools by evaporation; **vasodilation** loses heat; **vasoconstriction** conserves it. Hormones: **adrenaline** (adrenal glands – fight or flight), **insulin** (pancreas – lowers blood glucose), **testosterone** (testes), **progesterone** and **oestrogen** (ovaries); B-extension adds **ADH** (pituitary), **FSH** and **LH** (pituitary – menstrual cycle).

Common mistakes.

- Saying enzymes are killed at high temperature. Enzymes are not alive: the **active site changes shape** (the enzyme is denatured), so the substrate no longer fits.
- Saying water moves in osmosis from a concentrated to a dilute solution. Water moves from a **dilute** solution (more water) to a **more concentrated** one, across a partially permeable membrane.
- Saying plants photosynthesise by day and respire only at night. Plants **respire all the time**; by day photosynthesis is faster, so the net gas exchange is CO_2 in and O_2 out.
- Saying the lungs suck air in. When you breathe in, the intercostal muscles and diaphragm **contract**, the volume of the thorax rises and the pressure falls, so air is **pushed** in by the higher pressure outside.
- Saying arteries carry oxygenated blood and veins deoxygenated blood. Arteries carry blood **away from** the heart, veins **towards** it; the pulmonary artery carries deoxygenated blood.

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- Saying red blood cells have no nucleus "to carry oxygen". Name the benefit: it leaves **more room for haemoglobin**, so each cell carries more oxygen.
- Mixing up nerves and hormones. **Nervous** responses are electrical, fast and short-lived; **hormonal** responses travel in the blood, are slower and last longer.
- Saying auxin makes the shoot bend by growing on the light side. Auxin collects on the **shaded** side, cells there elongate more, and the shoot bends **towards** the light.

Check yourself

1. Put in order of size: cell, organ, organelle, system, tissue.
2. Give two structures a plant cell has that an animal cell lacks, and two structures both cells have.
3. Name the small units that build proteins, starch and lipids.
4. State the colour changes for Benedict's, iodine and Biuret tests.
5. Why does heating an enzyme far above its optimum stop it working?
6. Distinguish diffusion, osmosis and active transport in one sentence each.
7. Write the balanced symbol equation for photosynthesis and for aerobic respiration.
8. Give two adaptations of the leaf for photosynthesis and two of the alveolus for gas exchange.
9. Why can a single-celled organism survive without a transport system?
10. Compare arteries, veins and capillaries by wall thickness, lumen size and function.
11. Outline what happens to glucose, water and urea as liquid passes along a nephron (B).
12. State the pathway of a reflex arc, and give one advantage of reflexes.

Answers: 1 organelle → cell → tissue → organ → system; 2 cellulose wall and chloroplasts (and a large permanent vacuole); both have a nucleus, cytoplasm, cell membrane, mitochondria and ribosomes (any two); 3 amino acids; simple sugars; fatty acids and glycerol; 4 Benedict's blue → brick red (with glucose, heated); iodine yellow-brown → blue-black (with starch); Biuret blue → purple (with protein); 5 the active site changes shape (denaturation) so the substrate no longer fits; 6 diffusion – net movement down a concentration gradient; osmosis – water only, across a partially permeable membrane; active transport – against the gradient, using energy; 7 $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$ (light, chlorophyll); $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$; 8 leaf: broad flat surface and palisade cells packed with chloroplasts (or air spaces/stomata); alveolus: one-cell-thin walls and enormous surface area (moist surface, capillary network); 9 its surface area is large compared with its volume, so diffusion reaches every part quickly enough; 10 arteries – thick muscular walls, narrow lumen, carry blood away at high pressure; veins – thin walls, wide lumen,

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valves, return blood at low pressure; capillaries – one-cell-thick walls, exchange materials; 11 (B) all glucose is selectively reabsorbed into the blood at the proximal convoluted tubule; water is reabsorbed from the collecting duct (controlled by ADH); urea is not reabsorbed and leaves in the urine with water and ions; 12 stimulus → receptor → sensory neurone → relay neurone (CNS) → motor neurone → effector; reflexes are rapid and automatic, protecting the body before harm is done.

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Reproduction and inheritance

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Passing it on

Every living thing gets one chance to pass its genes on. Flowers do it with petals and pollen, humans with gametes and cycles of hormones – and the packets of information that pass are chromosomes, shuffled by meiosis and recombined at fertilisation. This section runs from flower structure to monohybrid crosses, from Darwin's finches to antibiotic-resistant bacteria.

Edexcel International GCSE Biology 4BI1, Section 3 (statements 3.1–3.39) is the genetics and reproduction section. Crosses and pedigrees carry reliable marks for students who lay out a genetic diagram properly.

Reproduction

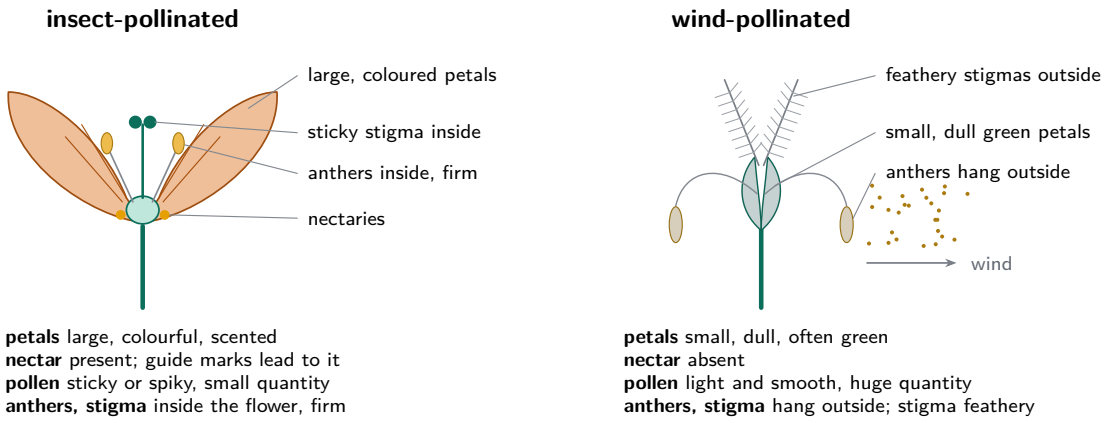
Sexual reproduction needs two gametes; the offspring are genetically different. **Asexual** reproduction needs one parent; the offspring are genetically identical clones.



A bee carries pollen from flower to flower: insect pollination

Flowering plants. Insect-pollinated flowers have large colourful petals, scent and nectar; wind-pollinated flowers are small and green, with light smooth pollen in huge quantities, anthers hanging outside and feathery stigmas.

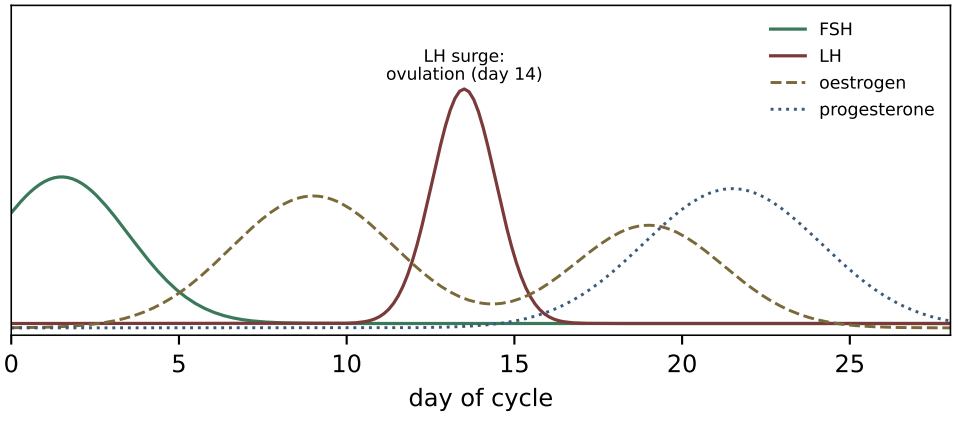
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Insect- and wind-pollinated flowers compared (schematic, not to scale).

After **pollination** 传粉 the pollen grain grows a **pollen tube** 花粉管 down the style; **fertilisation** 受精 follows, and the ovule becomes the **seed** while the ovary becomes the **fruit**. Germinating seeds live on their stored food reserves until the seedling can photosynthesise. Plants reproduce asexually by **runners** and artificially by **cuttings**.

Humans. The menstrual cycle: **FSH** 促卵泡激素 matures an egg in the ovary; the mature follicle releases **oestrogen** 雌激素, which thickens the uterus lining and triggers the **LH surge** that causes **ovulation** at about day 14; the empty follicle becomes a corpus luteum releasing **progesterone** 孕酮, holding the lining thick until day 28, when the falling hormone levels bring menstruation (B: FSH and LH from the pituitary).

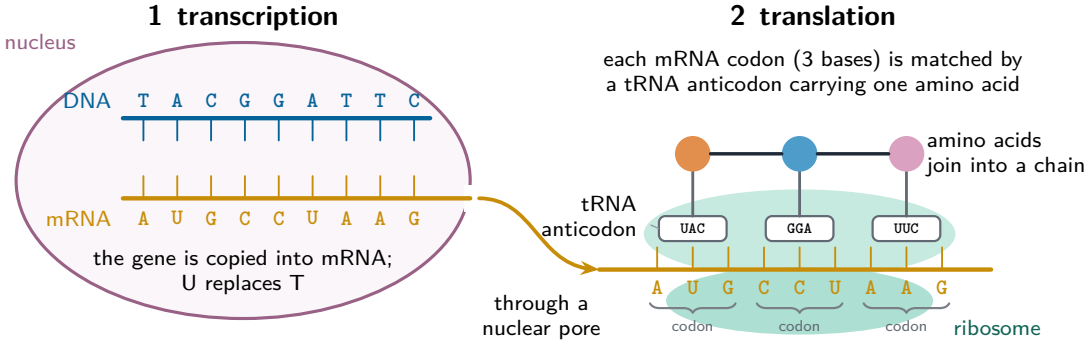


The four hormones of one cycle: FSH early, the LH surge at ovulation, oestrogen then progesterone through the second half.

The **placenta** supplies the embryo with oxygen and nutrients and removes waste; **amniotic fluid** protects it. **Oestrogen** and **testosterone** 睾酮 drive the development of secondary sexual characteristics.

Inheritance

The **genome** 基因组 is all an organism's DNA; a **gene** is a section of a DNA molecule coding for one protein. Genes sit on **chromosomes** in the nucleus. (B) DNA is a **double helix** 双螺旋 with paired bases – A–T and C–G; **RNA** is single-stranded with **U replacing T**. (B) Protein synthesis: **transcription** 转录 copies the gene to mRNA in the nucleus; **translation** 翻译 at the ribosome reads **codons** 密码子, each matched by a **tRNA anticodon** carrying its amino acid, building the chain.



Transcription copies the gene into mRNA in the nucleus; translation at a ribosome matches each codon with a tRNA anticodon and joins the amino acids.

Alleles 等位基因 are alternative forms of a gene. Vocabulary: **dominant** 显性 (shows if one copy present), **recessive** 隐性 (needs two), **homozygous** 纯合, **heterozygous** 杂合, **genotype** 基因型, **phenotype** 表型; (B) **codominance** 共显性 – both alleles expressed. Most features are **polygenic**, not single-gene.

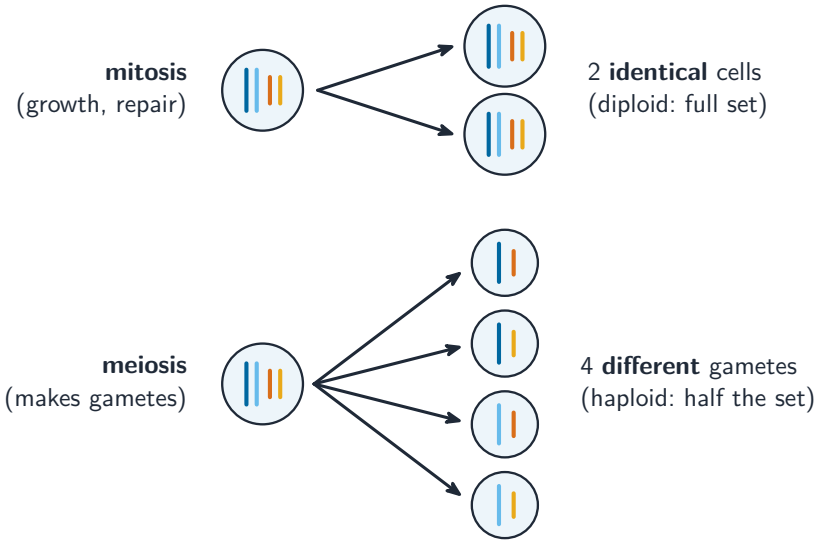
A monohybrid cross, laid out to earn its marks: parents' genotypes → gametes → Punnett grid → phenotype ratio.

Worked check. Cystic fibrosis (cf, recessive): both parents heterozygous Cc × Cc. Gametes C or c. Offspring CC, Cc, Cc, cc – 3 unaffected : 1 affected; a 1-in-4 chance per child, the same chance every child.

Sex determination: XX female, XY male. Mother always gives X; father gives X or Y – a genetic diagram of X×X, X×Y gametes gives 1:1 female:male, and the father's gamete decides the sex.

Mitosis 有丝分裂 makes two cells with **identical** chromosomes – growth, repair, cloning, asexual reproduction. **Meiosis** 减数分裂 makes four genetically different **haploid** 单倍体 gametes (human diploid 46 → haploid 23), and **random fertilisation** of any sperm with any egg creates further variation.

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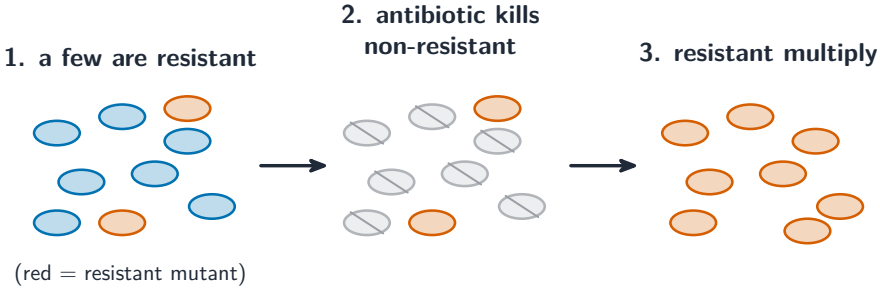


Variation can be genetic, environmental, or both. **Mutation** 突变 is a rare, random change in DNA that can be inherited – mostly harmless, occasionally significant (B: a changed base can alter one amino acid and the protein's shape); ionising radiation and chemical mutagens such as tobacco chemicals raise mutation rates.

Evolution

Darwin's natural selection 自然选择, step by step: organisms produce more offspring than survive; **variation** exists within a species; those with characteristics best suited to the environment survive and **reproduce**, passing the alleles on; over generations the advantageous characteristic becomes more common.

Antibiotic resistance is selection in action: a random mutation makes one bacterium resistant; antibiotics kill the non-resistant majority; the resistant bacterium survives and reproduces – completing courses of antibiotics and avoiding overuse slows the spread, and resistant infections become hard to control.



The mutation was already there; the antibiotic only selects it.

Common mistakes.

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- Mixing up pollination and fertilisation. **Pollination** is the transfer of pollen to a stigma; **fertilisation** is the fusion of the male nucleus with the egg nucleus in the ovule, after the pollen tube has grown.
- Saying the ovule becomes the fruit. The **ovule** becomes the seed; the **ovary** becomes the fruit.
- Saying the mother decides a baby's sex. Every egg carries an X; the **sperm** carries X or Y, so the father's gamete decides.
- Reading a 3 : 1 ratio as an exact count. It gives the **chance** for each child: 1 in 4 for every child, whatever happened before.
- Leaving the gametes out of a genetic diagram. The marks need **parents' genotypes → gametes → Punnett grid → offspring genotypes and phenotypes**.
- Saying bacteria become resistant because they get used to the antibiotic. A random **mutation** was already present; the antibiotic kills the others, so the resistant bacteria survive and reproduce.
- Saying meiosis makes identical cells. **Mitosis** makes identical diploid cells; **meiosis** makes four genetically different haploid gametes.

Check yourself

1. Give two differences between sexual and asexual reproduction.
2. State two adaptations of a wind-pollinated flower.
3. What happens after the pollen tube reaches the ovule?
4. Which hormone surges at day 14, and what does it cause?
5. Define gene, allele and genome.
6. (B) Name the base that replaces thymine in RNA, and where translation happens.
7. Cross Cc × cc and give the phenotype ratio.
8. Why does the father's gamete determine the sex of a child?
9. Give two differences between mitosis and meiosis.
10. Explain antibiotic resistance by natural selection in three steps.

Answers: 1 sexual – two parents, genetically different offspring; asexual – one parent, genetically identical offspring; 2 light smooth pollen in large quantity; anthers hanging outside the flower with a feathery stigma (small dull petals, no nectar); 3 the male gamete fuses with the ovule's egg cell – fertilisation; the ovule becomes a seed and the ovary a fruit; 4 LH – ovulation (release of the egg); 5 gene – a DNA section coding for one protein; allele – an alternative form of a gene; genome – all the organism's DNA; 6 (B) uracil; at a ribosome; 7 gametes C, c and c, c → Cc, Cc, cc, cc – 1 unaffected : 1 affected; 8 the mother's egg always carries X; the sperm carries X or Y, so XX (female) or XY (male) depends on the sperm; 9 mitosis – two cells, identical, same (diploid) chromosome number, for growth/repair/asexual re-

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production; meiosis – four cells, genetically different, half the number (haploid), for gametes; 10 a mutation gives one bacterium resistance; the antibiotic kills the non-resistant bacteria; the resistant one survives and reproduces, so resistance spreads.

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Ecology and the environment

Pearson Edexcel · International GCSE · Biology

Who lives where, and what eats whom

A pond holds more than water: populations that feed each other, cycle carbon and nitrogen, and respond – sometimes catastrophically – to what humans add. Ecology asks four questions: who lives here (population, community, habitat, ecosystem), who eats whom (food chains, webs, pyramids), what goes round (the carbon and nitrogen cycles), and what we are doing to it (pollution, greenhouse gases, eutrophication, deforestation).

Edexcel International GCSE Biology 4BI1, Section 4 (statements 4.1–4.18B) rewards precise definitions and the carbon cycle drawn from memory.

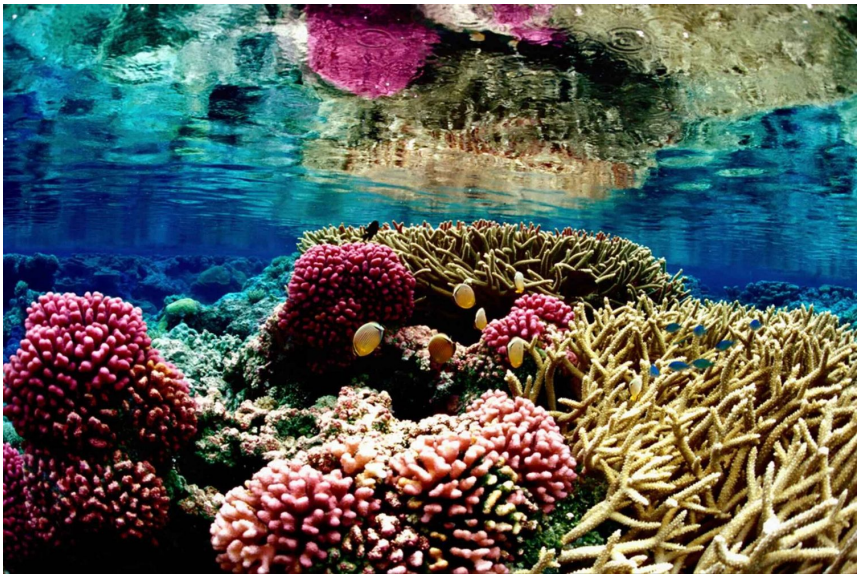
The organism in the environment

A **population** 种群 is all the organisms of one species in a habitat; a **community** 群落 is all the populations in that habitat; a **habitat** 栖息地 is the place; an **ecosystem** 生态系统 is the community plus its non-living surroundings. Population size is set by **abiotic** 非生物 factors (light, water, temperature) and **biotic** 生物 factors (food, predators, disease, competition). Quadrat practicals estimate population size (mean per quadrat × total area ÷ quadrat area), and (B) quadrats along a transect show distribution and **biodiversity** 生物多样性.

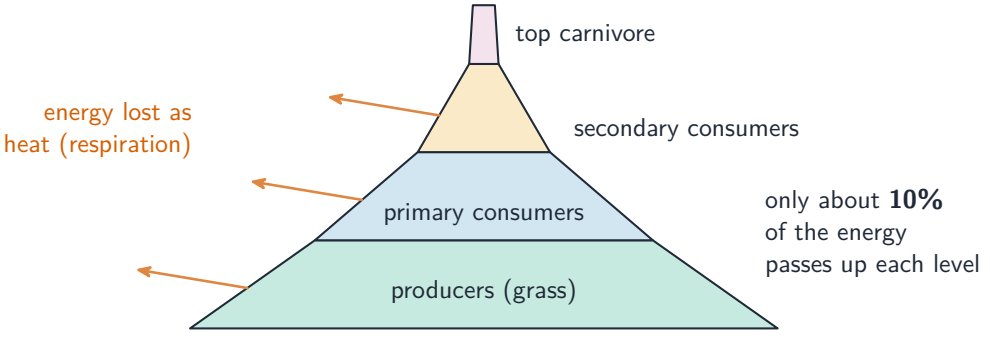
Feeding relationships

Producers 生产者 (plants) capture light energy; **primary consumers** 初级消费者 eat producers; **secondary** and **tertiary consumers** follow; **decomposers** 分解者 break down dead material. Arrows in a food chain point from eaten to eater – the direction energy flows. **Pyramids of number** can invert (one tree, many insects), but **pyramids of energy transfer** always narrow upward, and **pyramids of biomass** almost always do (a few water ecosystems, with fast-reproducing plankton, are the exception) – because only about **10 %** of the energy at one level passes to the next: the rest is lost in respiration, movement and excretion, and as heat.

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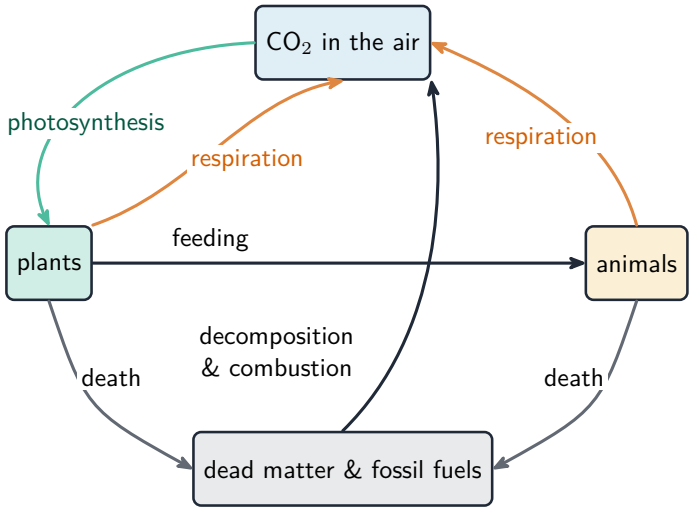
A coral reef: many food chains link into one food web



A pyramid of energy: only about 10% of the energy passes up each level; the rest is lost, mostly as heat from respiration.

Cycles within ecosystems

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The carbon cycle with photosynthesis, feeding, respiration, decomposition and combustion.

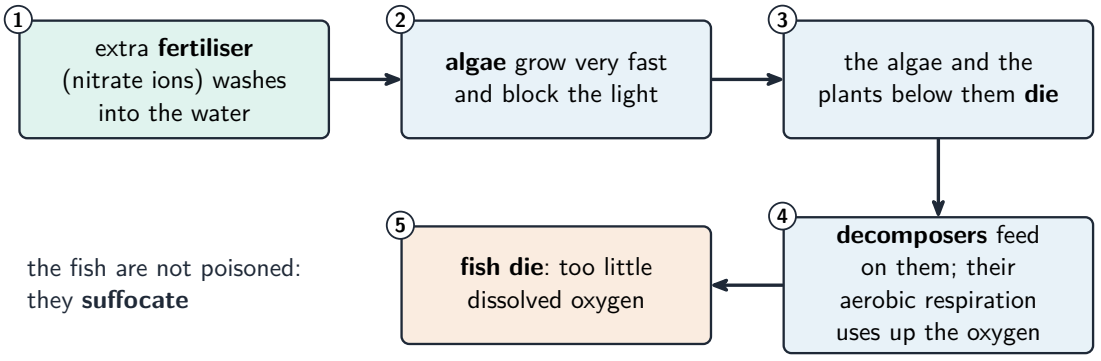
Carbon: photosynthesis removes CO_2 from the air; feeding passes carbon along chains; **respiration** 呼吸 (all organisms) and **decomposition** 分解 return it; **combustion** 燃烧 of fossil fuels releases carbon stored for millions of years.

(B) Nitrogen: nitrogen-fixing bacteria make nitrogen compounds from atmospheric N_2; decomposers break dead matter into ammonia; nitrifying bacteria convert ammonia to nitrates plants absorb; denitrifying bacteria return nitrogen to the air.

Human influences

Air pollution: sulfur dioxide dissolves in rain to form acid rain (damages leaves, lakes, buildings); carbon monoxide binds haemoglobin, cutting the oxygen blood can carry. **Greenhouse gases** 温室气体 – water vapour, carbon dioxide, nitrous oxide, methane and CFCs – trap outgoing radiation; burning fossil fuels, deforestation, agriculture and industry add them, thickening the blanket (the **enhanced greenhouse effect**), bringing global warming with rising sea levels and shifting climates. **Sewage** in water feeds microbes that consume oxygen. **Eutrophication** 富营养化: fertiliser leaches into water, algae bloom, die, and decomposers strip the oxygen – fish suffocate.

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The eutrophication sequence from leached fertiliser to oxygen-starved fish.

(B) Deforestation removes roots and canopy: rain leaches soil minerals away, soil erodes, evapotranspiration falls (less cloud and rain), and stored carbon returns to the air, unbalancing atmospheric gases.

Check yourself

1. Define population, community, habitat and ecosystem.
2. Why can a pyramid of number be inverted when a biomass pyramid almost never is?
3. Explain why only about 10 % of energy passes between trophic levels.
4. Name the four processes of the carbon cycle.
5. (B) Which bacteria convert ammonia to nitrates, and which return nitrogen to the air?
6. Why does carbon monoxide kill?
7. Name the five greenhouse gases.
8. Describe the eutrophication sequence in four steps.
9. (B) Give two consequences of deforestation for the carbon cycle and two for the soil.

Answers: 1 population – all organisms of one species in a habitat; community – all populations in a habitat; habitat – the place where organisms live; ecosystem – community plus its environment; 2 number counts individuals – one huge tree can feed many insects, inverting the shape – while biomass measures total mass, which almost always falls with each level; 3 energy is lost at each step through respiration (heat), movement, and egestion/excretion of uneaten parts; 4 photosynthesis, respiration, decomposition, combustion; 5 (B) nitrifying bacteria; denitrifying bacteria; 6 it binds to haemoglobin more strongly than oxygen, so blood carries less oxygen to tissues; 7 water vapour, carbon dioxide, nitrous oxide, methane, CFCs; 8 fertiliser runs into water → algal bloom → algae die and decomposers multiply → decomposers respire, using the oxygen, so fish and other organisms die; 9 (B) carbon: fewer trees photosynthesise, and burning releases stored carbon; soil: leaching of minerals

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and erosion without roots, with less evapotranspiration.

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Use of biological resources

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Using life to feed and to heal

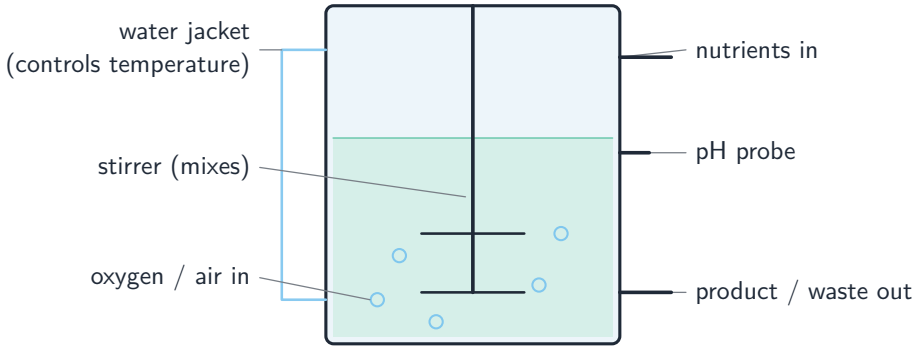
Bread rises, yoghurt thickens, insulin saves lives – all products of organisms put to work. This last section covers how humans increase yields (glasshouses, fertiliser, pest control), grow micro-organisms at scale (fermenters), and change organisms deliberately: selective breeding, genetic modification and cloning.

Edexcel International GCSE Biology 4BI1, Section 5 (statements 5.1–5.20B) completes the course. The B-suffixed statements (fish farming, micropropagation, mammal cloning) are Biology-only.

Food production

Crop plants. Glasshouses and polythene tunnels trap heat and shelter crops, letting farmers control light, temperature, CO_2 and water; raising CO_2 and temperature toward the optimum lifts the photosynthesis rate and yield. **Fertilisers** replace mineral ions (nitrate for amino acids, magnesium for chlorophyll) the soil loses with each harvest. **Pest control**: pesticides kill pests quickly and completely but risk **bioaccumulation** 生物累积, harming other species and leaving residues; **biological control** 生物防治 (introducing a pest's predator) is self-sustaining and specific but slow and less controllable if the control species itself spreads.

Micro-organisms. Yeast 酵母 ferments sugar: anaerobically it produces carbon dioxide (which raises bread) and ethanol; *Lactobacillus* converts milk sugar to lactic acid, thickening yoghurt. An **industrial fermenter** 工业发酵罐 keeps micro-organisms at their optimum: **aseptic precautions** (no contamination), **nutrients**, **optimum temperature and pH**, **oxygenation** (air supply for aerobic cultures) and **agitation** (stirring spreads heat and nutrients evenly).



An industrial fermenter with nutrient and air inlets, a stirrer, a temperature-controlling water jacket, a pH probe and a product outlet.

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(B) Fish farming provides protein efficiently: maintain water quality, control predation (intraspecific – among the fish – and interspecific), control disease, remove waste, control feeding quality and frequency, and selectively breed fast-growing strains.

Selective breeding

Choose parents with the desired characteristics → breed them → select the best offspring → repeat over generations. It develops plants with higher yield, disease resistance or hardiness, and animals with more meat, milk or docility – but it narrows the gene pool, increasing vulnerability to disease, and takes many generations.

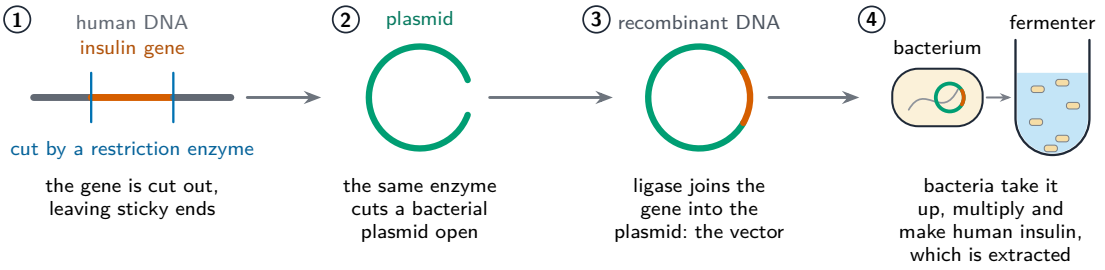
Genetic modification (genetic engineering)

Restriction enzymes 限制性内切酶 cut DNA at specific sites; **ligase** 连接酶 joins pieces of DNA together. A **plasmid** 质粒 (or a virus) acts as a **vector** 载体: the human insulin gene is cut out, inserted into an opened plasmid, and the **recombinant DNA** is taken up by bacteria, which multiply in a fermenter producing **human insulin**. GM plants can resist pests or herbicides or make more food. An organism receiving genes from a different species is **transgenic** 转基因.



Insect-resistant GM cotton (left) beside an ordinary plant eaten by pests (right)

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Genetic engineering of insulin in four steps from cutting the gene to harvesting from the fermenter.

Cloning (B)

Micropropagation 微繁殖 (tissue culture): a small **explant** 外植体 is grown **in vitro** 体外 on a nutrient medium with growth hormones, producing genetically identical plantlets – commercial quantities of plants with desirable characteristics, disease-free and fast. **Mammal cloning**: a **diploid nucleus from a mature cell** is inserted into an **enucleated egg cell** (its own nucleus removed); the cell divides into an embryo placed in a surrogate – Dolly the sheep. Cloned **transgenic** animals can produce human proteins in their milk.

Check yourself

1. Give two ways a glasshouse raises crop yield.
2. State one advantage and one disadvantage of biological control.
3. Why does *Lactobacillus* thicken milk?
4. List the five conditions a fermenter maintains.
5. (B) Name two methods of controlling predation in fish farming.
6. Give two drawbacks of selective breeding.
7. Name the enzyme that cuts DNA and the one that joins it.
8. What is a vector in genetic engineering?
9. Explain why bacteria with the human insulin gene make useful medicine.
10. (B) Outline the stages of cloning a mammal.

Answers: 1 Traps heat near the optimum; CO_2, light and water controlled (any two); 2 Advantage – self-sustaining, no residues; disadvantage – slow, and the control species may spread; 3 It converts lactose to lactic acid, which coagulates the milk protein; 4 aseptic conditions, nutrients, optimum temperature and pH, oxygenation, agitation; 5 (B) nets or covers keep out other species (interspecific predation); fish of different sizes or ages are kept apart, so the large do not eat the small (intraspecific predation); 6 narrows the gene pool, so disease spreads easily; takes many generations.

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Answers continued: 7 Restriction enzymes cut; ligase joins; 8 a plasmid or virus carrying recombinant DNA into a cell; 9 they multiply fast in a fermenter, secreting human insulin – safe and producible at scale; 10 (B) Diploid nucleus from a mature cell → enucleated egg → divides into an embryo → implanted in a surrogate.

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