HOLIDAY HOMEWORK 假期作业

AP Biology

Exercise sheets, topic by topic.

每个单元：练习卷。

For class or self-study • no answer keys included.

Contents 目录

1 Water and the molecules of life – Part 1

Name: _____ Class: _____ Date: _____

Vocabulary 词汇

Write each word three times. 把每个单词抄写三遍。

English	中文	Write it 3 times (English)		
polar	极性			
hydrogen bonds	氢键			
Carbon	碳			
macromolecules	大分子			
polymers	聚合物			
monomers	单体			
dehydration synthesis	脱水缩合			
hydrolysis	水解			
Carbohydrates	碳水化合物			
cellulose	纤维素			
Lipids	脂质			
hydrophobic	疏水			

Recall

You already know some biology chemistry:

- Living things are built mostly from a few elements –carbon, hydrogen, oxygen, nitro-

gen.

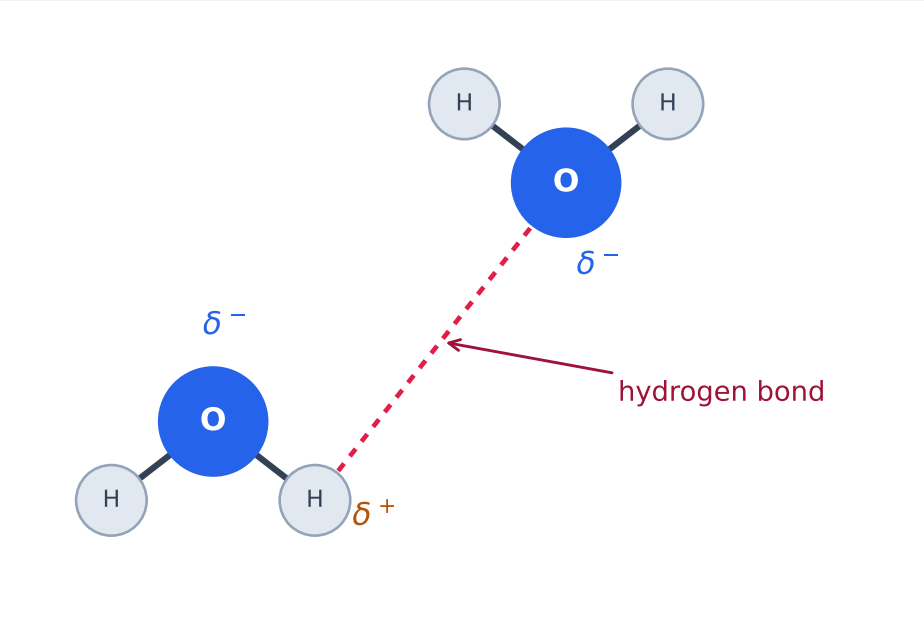
- Water is everywhere in life, inside and around cells.
- You have met carbohydrates, fats, and proteins as the main food molecules.

This sheet lines up why these molecules matter. Each idea has a short worked example.

New ideas

1 Water is special

Water is **polar** 极性: its oxygen pulls electrons a little more than its hydrogens, so one end is slightly negative and the other slightly positive. This lets water molecules form **hydrogen bonds** 氢键 with each other.



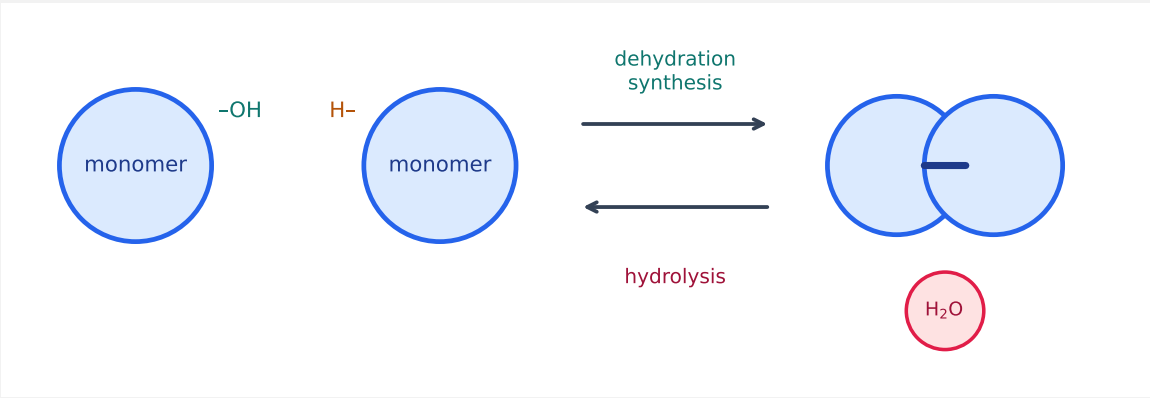
These bonds give water its life-supporting properties: it sticks together, dissolves many substances, and resists temperature change.

2 Carbon builds life

Carbon 碳 can form four bonds, so it builds long chains and rings –the skeletons of all biological molecules.

3 Building and breaking big molecules

Large molecules (**macromolecules** 大分子) are **polymers** 聚合物 built from repeating units called **monomers** 单体. Cells join monomers by **dehydration synthesis** 脱水缩合 (removing water) and break them by **hydrolysis** 水解 (adding water).



4 Carbohydrates and lipids

- **Carbohydrates** 碳水化合物 (sugars) store energy and give structure (like **cellulose** 纤维素 in plants).
- **Lipids** 脂质 (fats) are **hydrophobic** 疏水 (they do not mix with water); they store energy and build cell membranes.

Watch out: all of water's helpful properties –sticking together, dissolving things, resisting temperature change –come from the **hydrogen bonds** between its molecules.

Practice

Try these in order. The methods are all above.

2.1 Explain why a water molecule is described as polar. [2]

2.2 State why carbon is able to build such a wide variety of large molecules. [2]

2.3 Name the process that (a) joins monomers into a polymer, (b) breaks a polymer apart. [2]

2.4 Give one function of carbohydrates and one function of lipids in living things. [2]

2.5 State what ”hydrophobic” means and give one example of a hydrophobic molecule.[2]

1 Proteins and nucleic acids – Part 2

Name: _____ Class: _____ Date: _____

Vocabulary 词汇

Write each word three times. 把每个单词抄写三遍。

English	中文	Write it 3 times (English)		
Proteins	蛋白质			
amino acids	氨基酸			
peptide bonds	肽键			
denature	变性			
Nucleic acids	核酸			
nucleotides	核苷酸			

Recall

In Part A you met the idea that big biological molecules are polymers of small units. Two of them run all of life:

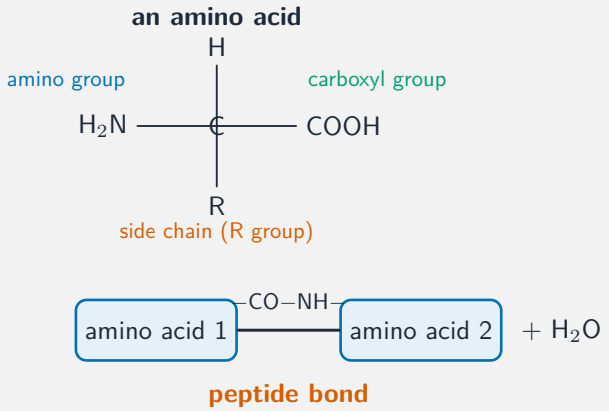
- **Proteins** do most of the work in cells (enzymes, muscle, structure).
- **DNA** carries the genetic instructions.

Each idea has a short worked example before the Practice.

New ideas

■ 1 Proteins

Proteins 蛋白质 are long chains of **amino acids** 氨基酸 joined by **peptide bonds** 肽键. There are 20 different amino acids, so a huge variety of proteins is possible.



condensation removes one water for each peptide bond

2 Shape decides function

A protein chain folds into a specific 3-D shape, and **its shape decides its job** –as an enzyme, a transporter, or a structural part.

primary (1°)	**secondary (2°)**	**tertiary (3°)**	**quaternary (4°)**
order of amino acids	α-helix & β-sheet (hydrogen bonds)	folded into a precise 3-D shape	two or more chains together

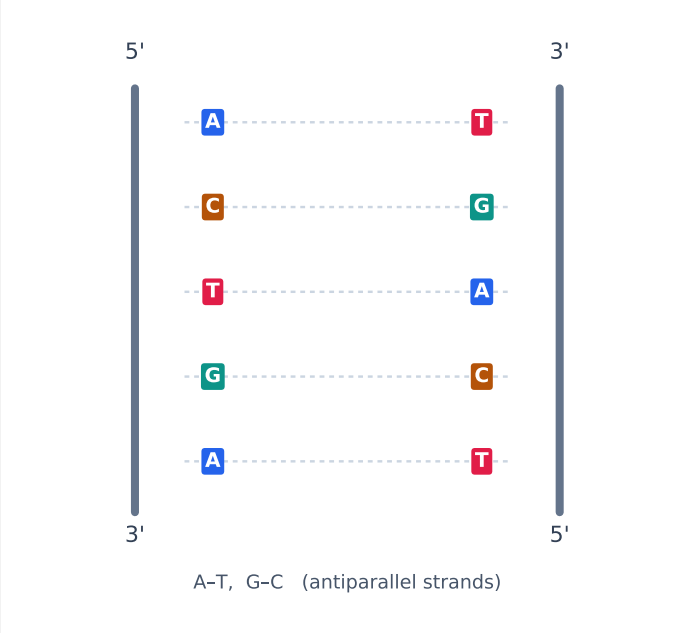
Heat or a change in pH can **denature** 变性 a protein –unfold it –which stops it working.

3 Nucleic acids

Nucleic acids 核酸 (DNA and RNA) store and carry genetic information. They are built from units called **nucleotides** 核苷酸, each a sugar, a phosphate, and a base.

4 DNA base pairing

DNA is two strands held together by pairing of the bases: A pairs with T, and C pairs with G.



Watch out: a protein's job depends completely on its **shape**. If heat or acid denatures (unfolds) it, the protein stops working –which is why high fever or the wrong pH is dangerous for enzymes.

Practice

Try these in order. The methods are all above.

2.1 State the small units that make up a protein, and the bond that joins them. [2]

2.2 Explain why a protein's shape is so important. [2]

2.3 State what "denature" means and give one thing that can cause it. [2]

2.4 Name the two nucleic acids and state what they do. [2]

2.5 In DNA, state which base pairs with (a) A, (b) C. [2]

2 Cells and their membranes – Part 1

Name: _____ Class: _____ Date: _____

Vocabulary 词汇

Write each word three times. 把每个单词抄写三遍。

English	中文	Write it 3 times (English)		
organelles	细胞器			
nucleus	细胞核			
mitochondria	线粒体			
chloroplasts	叶绿体			
surface-area-to-volume ratio	表面积与体积比			
phospholipid bilayer	磷脂双分子层			
fluid mosaic model	流动镶嵌模型			
selectively permeable	选择透过性			

Recall

You already know that cells are the building blocks of life:

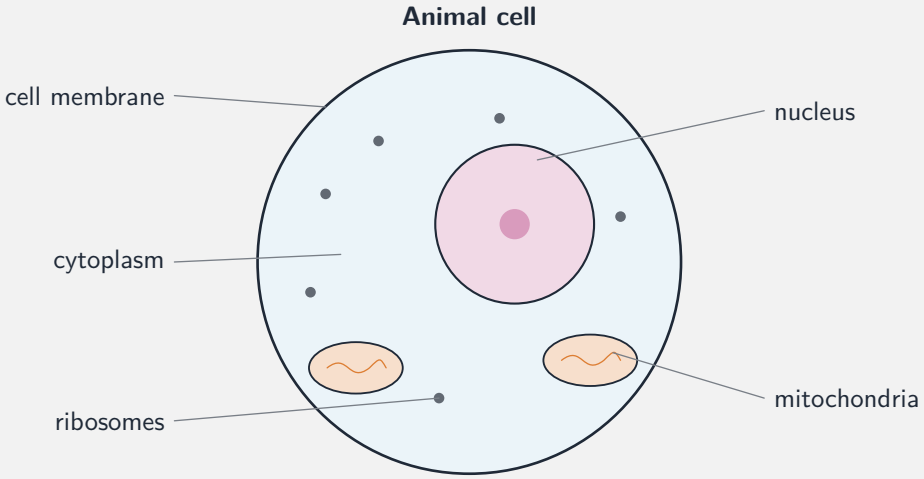
- You have seen animal and plant cells and named their parts.
- A **nucleus** holds the DNA; **mitochondria** release energy; plant cells have **chloroplasts**.
- A membrane surrounds every cell.

This sheet lines up cell structure for AP. Each idea has a short worked example.

New ideas

1 Organelles

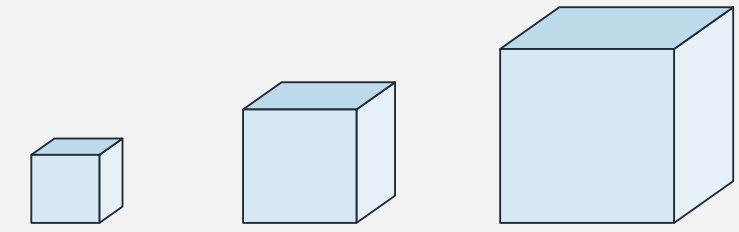
A cell divides its work among **organelles** 细胞器:



- the **nucleus** 细胞核 holds the DNA,
- **mitochondria** 线粒体 carry out respiration (release energy),
- **chloroplasts** 叶绿体 carry out photosynthesis (in plants).

2 Why cells stay small

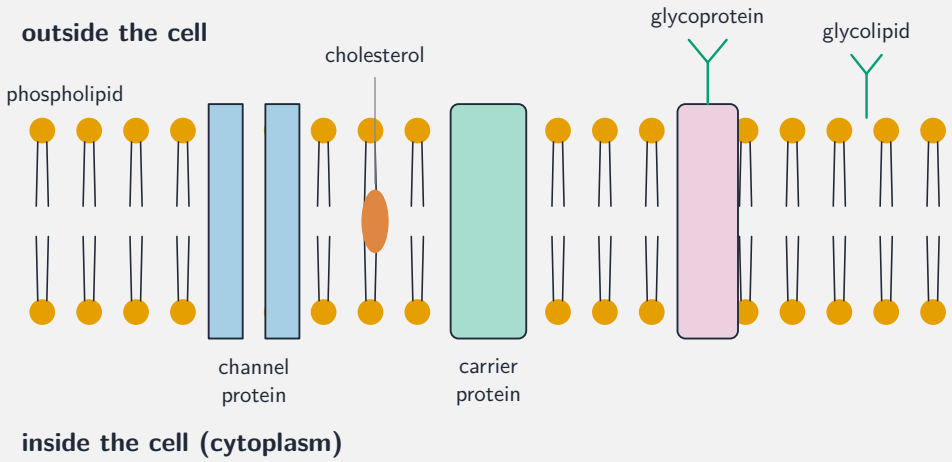
As a cell grows, its volume rises faster than its surface area, so its **surface-area-to-volume ratio** 表面积与体积比 falls. A small cell has enough surface to exchange materials fast enough for its inside.



a bigger cube (or cell) has a **smaller** surface area : volume ratio

3 The cell membrane

The membrane is a **phospholipid bilayer** 磷脂双分子层–a double sheet with water-loving heads outside and water-hating tails inside –studded with proteins. This **fluid mosaic model** 流动镶嵌模型 pictures it as a fluid sheet in which the parts drift.



4 A selective barrier

The membrane is **selectively permeable** 选择透过性: small non-polar molecules pass easily, but large or charged particles need help. This lets the cell control what goes in and out.

Watch out: a bigger cell is worse at exchange, not better –its volume grows faster than its surface, so the surface-area-to-volume ratio drops and it cannot supply its interior fast enough.

Practice

Try these in order. The methods are all above.

2.1 State the job of (a) the nucleus, (b) the mitochondria. [2]

2.2 Explain why cells stay small, using the surface-area-to-volume ratio. [2]

2.3 Name the type of molecule that makes up most of the cell membrane. [1]

2.4 State what ”selectively permeable” means. [2]

2.5 Name one organelle found in a plant cell but not an animal cell, and state its job.[2]

2 Moving substances across the membrane – Part 2

Name: _____ Class: _____ Date: _____

Vocabulary 词汇

Write each word three times. 把每个单词抄写三遍。

English	中文	Write it 3 times (English)		
Diffusion	扩散			
Osmosis	渗透			
tonicity	张力			
Active transport	主动运输			
endocytosis	内吞			
exocytosis	外排			

Recall

In Part A you met the selectively permeable cell membrane. Now see how things cross it:

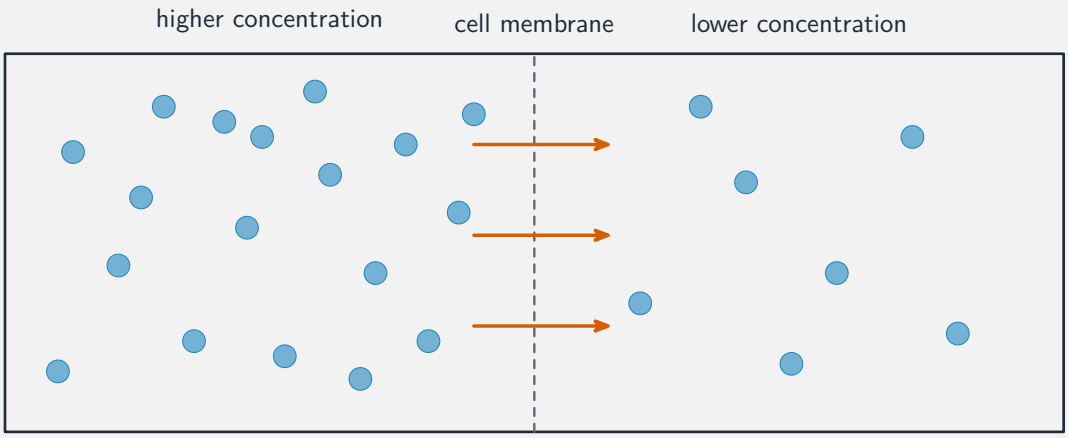
- You have watched a drop of dye spread through water (diffusion).
- You know water moves in and out of cells (osmosis).
- Some things need energy to move; others move on their own.

Each idea has a short worked example before the Practice.

New ideas

■ 1 Diffusion

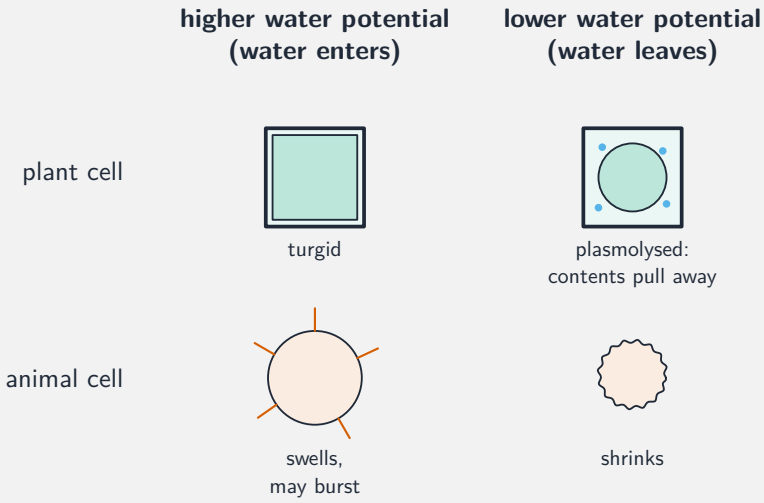
Diffusion 扩散 is the spreading of particles from where they are **crowded** (high concentration) to where they are **spread out** (low concentration). It needs **no energy**.



net movement of particles down the concentration gradient

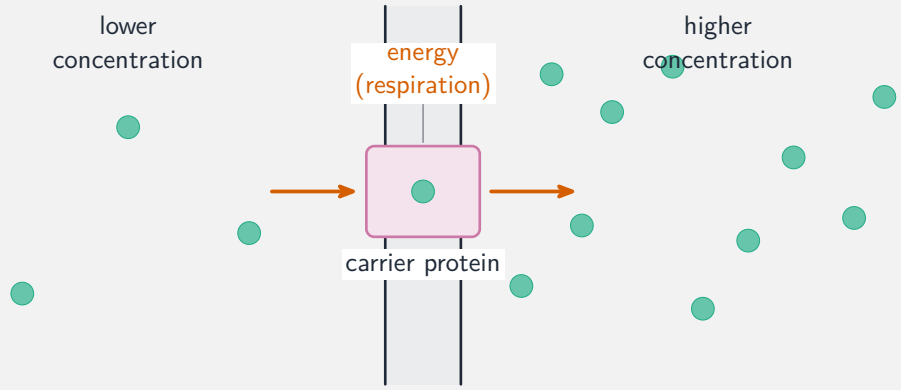
2 Osmosis and tonicity

Osmosis 渗透 is the diffusion of **water** across a membrane. Comparing the solution's strength (**tonicity** 张力): in a weaker (hypotonic) solution a cell gains water; in a stronger (hypertonic) one it loses water.



3 Active transport

Active transport 主动运输 moves particles the "wrong" way –from low to high concentration –so it needs **energy** (ATP) and a carrier protein.



particles moved against the gradient, using energy

4 Moving big things

Very large items cross in bulk: **endocytosis** 内吞 brings material **in** (the membrane wraps around it), and **exocytosis** 外排 sends material **out**.

Watch out: diffusion and osmosis need **no** energy (particles move down their gradient on their own); active transport needs energy because it pushes particles **against** the gradient.

Practice

Try these in order. The methods are all above.

2.1 State the direction (high to low, or low to high) that particles move during diffusion. [1]

2.2 Explain what osmosis is. [2]

2.3 A cell is placed in a very strong (hypertonic) sugar solution. State what happens to it and why. [2]

2.4 State the two things active transport needs that diffusion does not. [2]

2.5 Name the process that a cell uses to take in a large particle from outside. [1]

3 Enzymes – Part 1

Name: _____ Class: _____ Date: _____

Vocabulary 词汇

Write each word three times. 把每个单词抄写三遍。

English	**中文**	**Write it 3 times** (English)		
enzyme	酶			
catalyst	催化剂			
lowering the activation energy	活化能			
active site	活性位点			
substrate	底物			
denatures	变性			
inhibitor	抑制剂			

Recall

You already know that living things use enzymes:

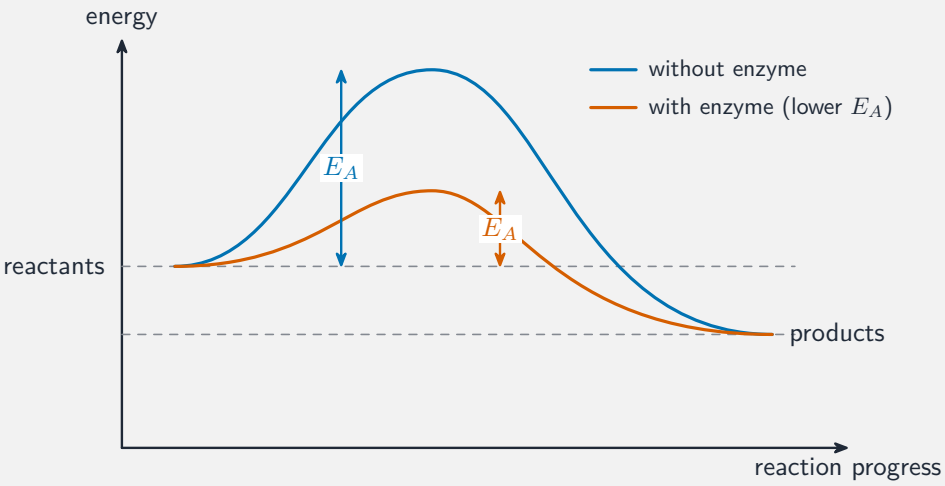
- Enzymes speed up the reactions in your body, like digesting food.
- They work best at a certain temperature (about body temperature) and pH.
- Too much heat ”kills” an enzyme.

This sheet makes enzyme action exact. Each idea has a short worked example.

New ideas

■ 1 Enzymes lower the barrier

An **enzyme** 酶 is a protein **catalyst** 催化剂: it speeds up a reaction by **lowering the activation energy** 活化能, and is not used up.

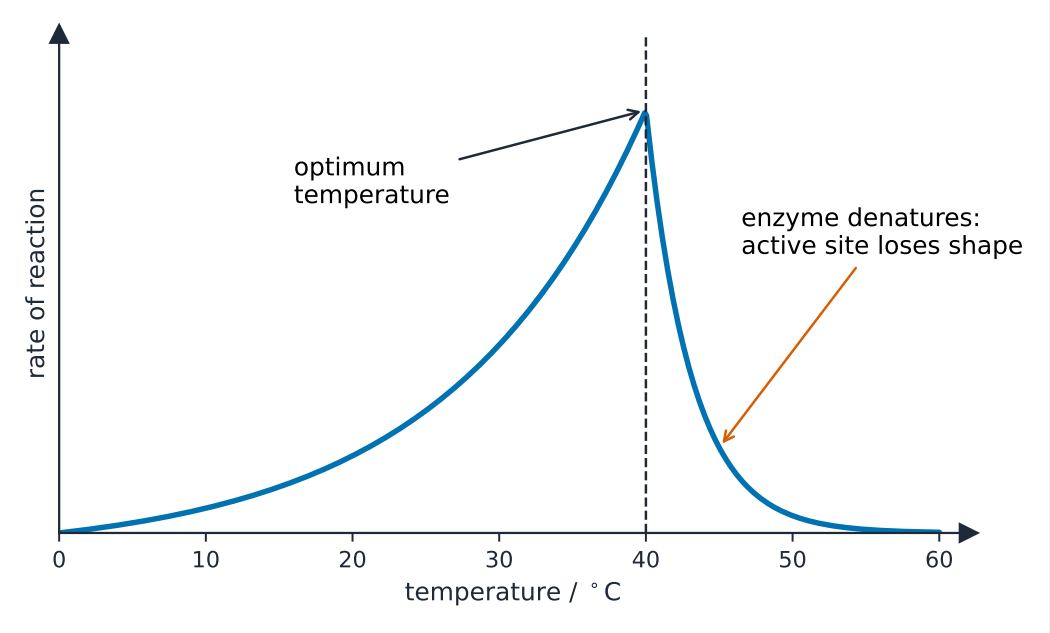


2 The active site

Each enzyme has an **active site** 活性位点 shaped to fit one particular **substrate** 底物–like a lock and key. This makes each enzyme highly **specific** to its reaction.

3 Temperature and pH

Each enzyme has an **optimum** temperature and pH where it works fastest. Beyond that, the protein **denatures** 变性 (loses its shape) and stops working.



4 Inhibitors

An **inhibitor** 抑制剂 slows an enzyme down –by blocking the active site, or by changing the enzyme's shape.

Watch out: raising the temperature speeds an enzyme up only **up to its optimum**. Past that, the heat denatures the enzyme and the rate **drops** –unlike an ordinary reaction, which just keeps speeding up.

Practice

Try these in order. The methods are all above.

2.1 State how an enzyme speeds up a reaction. [2]

2.2 Explain why each enzyme only works on one particular substrate. [2]

2.3 State what happens to an enzyme when it is heated well above its optimum temperature. [2]

2.4 Sketch in words how the rate of an enzyme reaction changes as temperature rises from cold to very hot. [2]

2.5 State what an enzyme inhibitor does. [1]

3 ATP, photosynthesis, and respiration – Part 2

Name: _____ Class: _____ Date: _____

Vocabulary 词汇

Write each word three times. 把每个单词抄写三遍。

English	**中文**	**Write it 3 times** (English)
Photosynthesis	光合作用	
Cellular respiration	细胞呼吸	

Recall

You already know the two great energy processes of life:

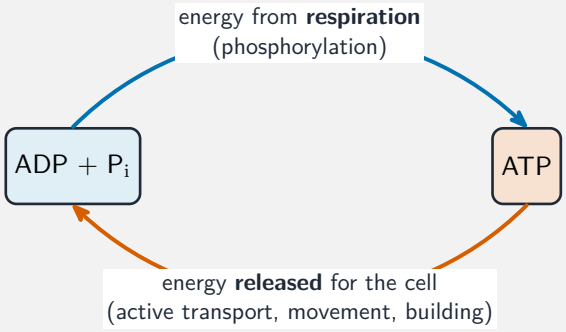
- Plants make food from sunlight –**photosynthesis**.
- All living things release energy from food –**respiration**.
- Your cells need a constant supply of energy to work.

This sheet lines up how cells store and release energy. Each idea has a short worked example.

New ideas

■ 1 ATP –the energy currency

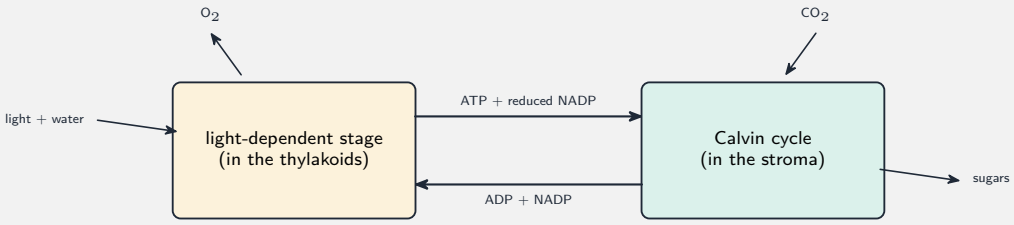
ATP is the molecule cells use to carry energy. Breaking off one of its phosphate groups (ATP → ADP) **releases** energy to power the cell's work; adding it back **stores** energy.



2 Photosynthesis

Photosynthesis 光合作用 captures light energy to build glucose from carbon dioxide and water, releasing oxygen:

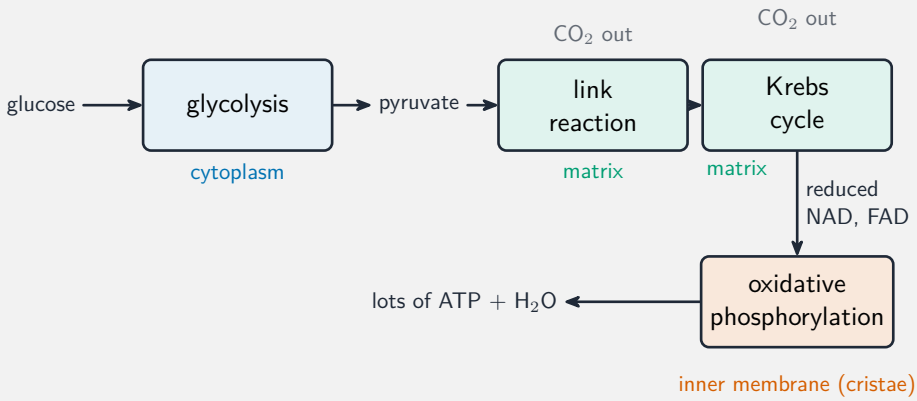
$$\mathrm{CO_2} + \text{water} \xrightarrow{\text{light}} \text{glucose} + \mathrm{O_2}.$$



3 Cellular respiration

Cellular respiration 细胞呼吸 releases the energy stored in glucose to make ATP, usually using oxygen:

$$\text{glucose} + \mathrm{O_2} \to \mathrm{CO_2} + \text{water} + \text{ATP}.$$



■ 4 Two sides of one coin

Photosynthesis and respiration are **complementary**: the products of one are the reactants of the other. Plants do both; animals only respire.

Watch out: photosynthesis *stores* energy (building glucose) while respiration *releases* it (breaking glucose down). They are opposite processes, not the same thing run twice.

Practice

Try these in order. The methods are all above.

2.1 State what happens to energy when ATP is broken down into ADP. [1]

2.2 Write, in words, the overall equation for photosynthesis. [2]

2.3 Write, in words, the overall equation for aerobic respiration. [2]

2.4 State one way photosynthesis and respiration are opposite processes. [2]

2.5 State which of the two processes an animal cell can carry out. [1]

4 Cell communication and feedback – Part 1

Name: _____ Class: _____ Date: _____

Vocabulary 词汇

Write each word three times. 把每个单词抄写三遍。

English	中文	Write it 3 times (English)		
signals	信号			
ligand	配体			
receptor	受体			
hormones	激素			
Signal transduction	信号转导			
Negative feedback	负反馈			
homeostasis	稳态			
Positive feedback	正反馈			

Recall

You already know that the body's cells work together:

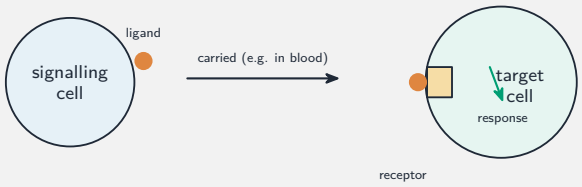
- Hormones carry chemical messages through the blood.
- Your body keeps a steady temperature and blood sugar.
- Nerves and chemicals let cells "talk" to one another.

This sheet lines up how cells communicate. Each idea has a short worked example.

New ideas

1 Cell signals

Cells send chemical **signals** 信号 to each other. A signalling cell releases a **ligand** 配体 (a signal molecule), which binds to a matching **receptor** 受体 on the target cell.



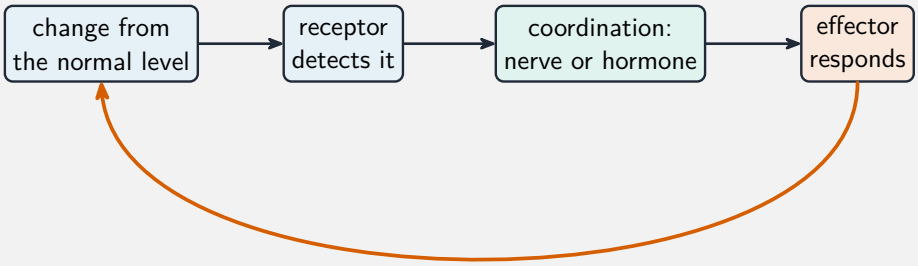
Long-distance signals are **hormones** 激素, carried in the blood.

2 Signal transduction

Signal transduction 信号转导 turns an outside signal into a response, in three steps: **reception** (ligand binds receptor), **transduction** (a relay inside the cell), and **response** (the cell changes what it does).

3 Negative feedback

Negative feedback 负反馈 reverses a change to return to a set point –like a thermostat. It keeps conditions steady, which is **homeostasis** 稳态.



the response pushes the level back to normal (negative feedback)

4 Positive feedback

Positive feedback 正反馈 does the opposite: it **amplifies** a change to push a process to completion, like the contractions of childbirth or blood clotting.

Watch out: "negative" feedback does not mean bad –it means the response **opposes** the change, bringing the system back to normal. It is what keeps you stable.

Practice

Try these in order. The methods are all above.

2.1 State what a ligand and a receptor are. [2]

2.2 Name the three stages of signal transduction. [2]

2.3 Explain how negative feedback keeps body temperature steady. [2]

2.4 State the main difference between negative and positive feedback. [2]

2.5 Give one example of a process controlled by positive feedback. [1]

4 The cell cycle and its control – Part 2

Name: _____ Class: _____ Date: _____

Vocabulary 词汇

Write each word three times. 把每个单词抄写三遍。

English	中文	Write it 3 times (English)		
cell cycle	细胞周期			
interphase	间期			
mitosis	有丝分裂			
checkpoints	检查点			
cancer	癌症			

Recall

You already know that cells divide:

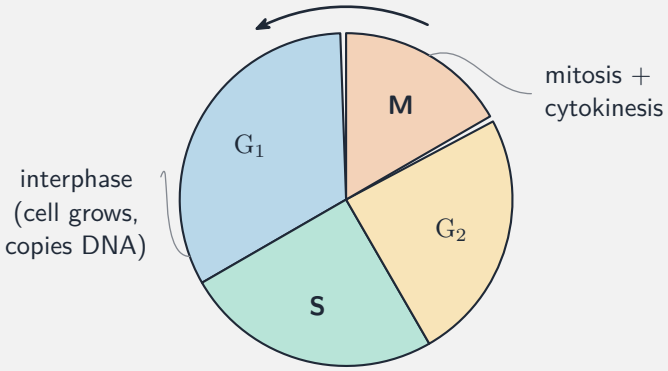
- Your body makes new cells to grow and to repair injuries.
- **Mitosis** produces two identical cells from one.
- You have heard that cancer is cells dividing out of control.

This sheet lines up how a cell's life and division are controlled. Each idea has a short worked example.

New ideas

■ 1 The cell cycle

The **cell cycle** 细胞周期 is the life of a cell from one division to the next. It has two main parts:



- **interphase** 间期–the cell grows and copies its DNA,
- **mitosis** 有丝分裂–the cell divides into two identical daughter cells.

■ 2 DNA is copied once

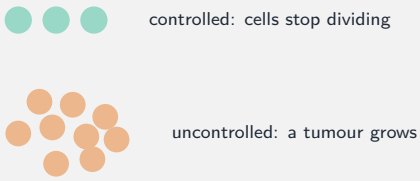
The DNA is copied only during the S phase of interphase, so each daughter cell gets a complete, identical copy.

■ 3 Checkpoints

The cycle is controlled at **checkpoints** 检查点 that check conditions before the cell continues (Is the DNA undamaged? Are the chromosomes ready?). If something is wrong, the cycle pauses.

■ 4 When control fails

If the checkpoints fail –often through a mutation –cells divide uncontrollably, forming a tumour. This is the basis of **cancer** 癌症.



Watch out: mitosis makes two **identical** daughter cells, each with a full copy of the DNA –not half each. The DNA is copied first (in interphase) so nothing is lost.

Practice

Try these in order. The methods are all above.

2.1 Name the two main parts of the cell cycle and state what happens in each. [2]

2.2 State when in the cell cycle the DNA is copied, and why this matters. [2]

2.3 State what checkpoints do in the cell cycle. [2]

2.4 Explain how a failure of cell-cycle control can lead to cancer. [2]

2.5 State how many daughter cells mitosis produces, and whether they are identical. [1]

5 Meiosis and genetic variation – Part 1

Name: _____ Class: _____ Date: _____

Vocabulary 词汇

Write each word three times. 把每个单词抄写三遍。

English	**中文**	**Write it 3 times** (English)
Meiosis	减数分裂	
gametes	配子	
crossing over	交叉互换	
independent assortment	自由组合	

Recall

You already know that offspring resemble their parents but are not identical:

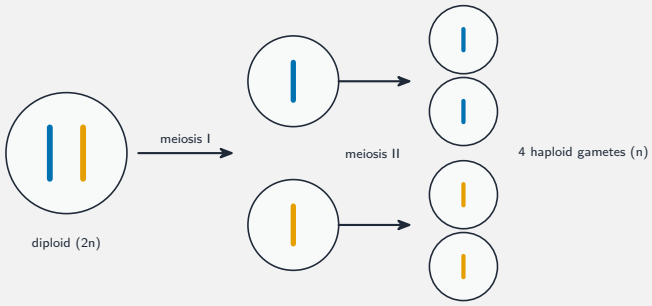
- Body cells divide by mitosis to make identical copies.
- Sex cells (eggs and sperm) are made a different way.
- Brothers and sisters differ, even with the same parents.

This sheet explains where that variety comes from. Each idea has a short worked example.

New ideas

■ 1 Meiosis

Meiosis 减数分裂 makes sex cells, called **gametes** 配子 (eggs and sperm), with **half** the number of chromosomes. One cell divides **twice** to give four cells.

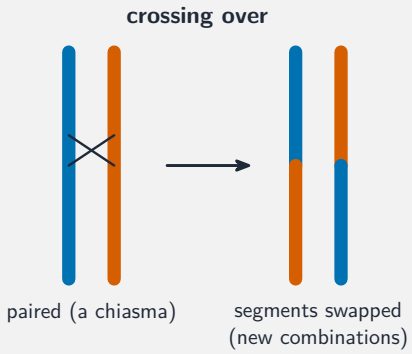


2 Fertilisation restores the number

When an egg and sperm join at fertilisation, the full chromosome number is restored –half from each parent.

3 Shuffling the genes

Meiosis mixes the genes so each gamete is different:



- **crossing over** 交叉互换–homologous chromosomes swap pieces,
- **independent assortment** 自由组合–each chromosome pair lines up randomly.

4 Random fertilisation

On top of that, any sperm can meet any egg –**random fertilisation** adds even more variety.

Watch out: meiosis makes **four** cells that are **not identical**, each with **half** the chromosomes. This is different from mitosis, which makes **two identical** cells with the **full** number.

Practice

Try these in order. The methods are all above.

2.1 State what meiosis produces and how many chromosomes those cells have compared with a body cell. [2]

2.2 Explain why the chromosome number is restored at fertilisation. [2]

2.3 Name two ways meiosis mixes the genes to create variety. [2]

2.4 State two differences between meiosis and mitosis. [2]

2.5 Explain why brothers and sisters are not genetically identical (unless they are identical twins). [2]

5 Genetics and Punnett squares – Part 2

Name: _____ Class: _____ Date: _____

Vocabulary 词汇

Write each word three times. 把每个单词抄写三遍。

English	中文	Write it 3 times (English)		
alleles	等位基因			
genotype	基因型			
phenotype	表型			
dominant	显性			
recessive	隐性			
homozygous	纯合			
heterozygous	杂合			
Punnett square	庞纳特方格			

Recall

You already know some genetics:

- Genes come in different versions, and some are dominant, some recessive.
- You have used a Punnett square to predict offspring.
- Traits like eye colour are passed from parents to children.

This sheet lines up how inheritance works. Each idea has a short worked example.

New ideas

■

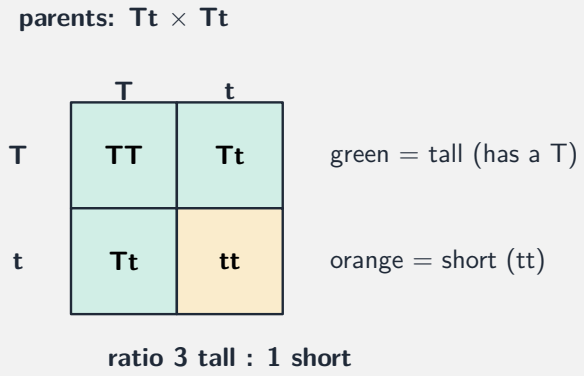
A gene's different versions are **alleles** 等位基因. An organism's **genotype** 基因型 (its alleles) produces its **phenotype** 表型 (its visible traits).

■ 2 Dominant and recessive

A **dominant** 显性 allele shows even if only one copy is present; a **recessive** 隐性 allele shows only with two copies. Two identical alleles is **homozygous** 纯合; two different is **heterozygous** 杂合.

■ 3 Punnett squares

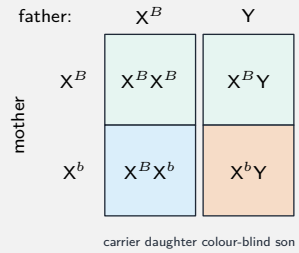
A **Punnett square** 庞纳特方格 predicts offspring ratios. Crossing two heterozygotes ($Aa \times Aa$) gives a 3 : 1 ratio of dominant to recessive.



Worked example. $Aa \times Aa$ gives offspring AA, Aa, Aa, aa –so 3 show the dominant trait and 1 shows the recessive, a 3 : 1 ratio.

■ 4 Not always so simple

Some traits break the simple rule –**incomplete dominance** (a blend, red × white → pink), **codominance** (both show, like blood group AB), and **sex-linked** genes on the X chromosome.



Watch out: the **genotype** is the alleles an organism has; the **phenotype** is what you actually see. Two organisms can look the same (phenotype) but have different genotypes (AA and Aa both show the dominant trait).

Practice

Try these in order. The methods are all above.

2.1 State the difference between an organism's genotype and its phenotype. [2]

2.2 State what "homozygous" and "heterozygous" mean. [2]

2.3 A cross is $Aa \times Aa$. State the ratio of dominant to recessive offspring. [2]

2.4 A homozygous dominant (AA) is crossed with a homozygous recessive (aa). State the genotype of all the offspring. [2]

2.5 Two purple flowers produce some white offspring. Explain how this is possible. [2]

6 DNA and making proteins – Part 1

Name: _____ Class: _____ Date: _____

Vocabulary 词汇

Write each word three times. 把每个单词抄写三遍。

English	中文	Write it 3 times (English)		
double helix	双螺旋			
complementary base pairing	互补配对			
semiconservative replication	半保留复制			
Transcription	转录			
Translation	翻译			
ribosome	核糖体			
codons	密码子			

Recall

You already know the basics of DNA:

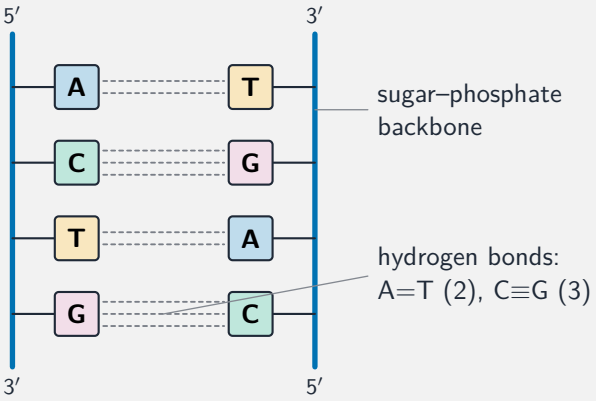
- DNA carries the genetic instructions, in a shape called the **double helix**.
- Its bases pair in a fixed way: A with T, and C with G.
- DNA codes for proteins.

This sheet lines up how a cell reads DNA to build proteins. Each idea has a short worked example.

New ideas

■

DNA is a **double helix** 双螺旋 of two strands. The bases pair by rule –A with T, C with G –called **complementary base pairing** 互补配对. So one strand tells you the other.



the two strands run in opposite directions (antiparallel)

■ 2 DNA replication

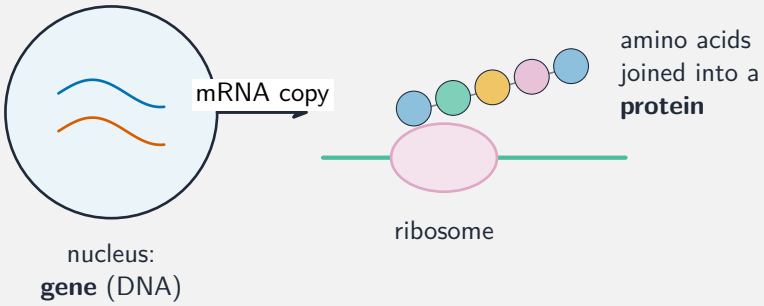
Before a cell divides, DNA is copied by **semiconservative replication** 半保留复制: the helix unwinds and each old strand acts as a template for a new one, so each new helix has one old and one new strand.

■ 3 Transcription

Transcription 转录 copies a gene from DNA into a messenger molecule, mRNA. Note that RNA uses the base U (uracil) in place of T, and is single-stranded.

■ 4 Translation

Translation 翻译 builds a protein from the mRNA at the **ribosome** 核糖体. The mRNA is read in three-base groups called **codons** 密码子, each choosing one amino acid. The overall flow is the "central dogma": DNA → RNA → protein.



Watch out: RNA is **single-stranded** and uses **U** (uracil) instead of the T found in DNA. Don't carry the DNA rules straight over to RNA.

Practice

Try these in order. The methods are all above.

2.1 In DNA, state which base pairs with (a) A, (b) G. [2]

2.2 A DNA strand reads A–T–C–G. Write the sequence of the complementary strand. [2]

2.3 State what happens during transcription. [2]

2.4 State what a codon is and what it codes for. [2]

2.5 State two ways RNA differs from DNA. [2]

6 Gene regulation, mutations, and biotechnology – Part 2

Name: _____ Class: _____ Date: _____

Vocabulary 词汇

Write each word three times. 把每个单词抄写三遍。

English	中文	Write it 3 times (English)		
operon	操纵子			
differential gene expression	差异表达			
mutation	突变			
PCR	聚合酶链反应			
gel electrophoresis	凝胶电泳			

Recall

In Part A you saw how a cell reads DNA to make proteins. Now two important extras:

- Every cell has the same DNA, yet a muscle cell and a nerve cell are very different.
- DNA can change –a mutation –and scientists can now read and copy DNA.

Each idea has a short worked example before the Practice.

New ideas

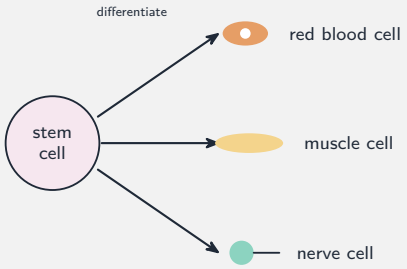
■ 1 Controlling genes

Cells control **which** genes are switched on and when –so they use only the genes they need. In bacteria, an **operon** 操纵子 switches a group of genes on or off together.

■ 2 Why cells differ

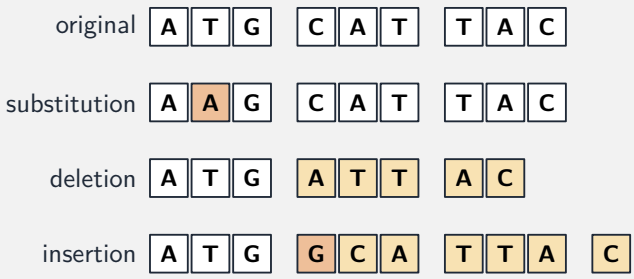
Every cell in your body has the **same** DNA, but different cells switch on **different** genes –**differential gene expression** 差异表达. This is how one fertilised egg builds

muscle, nerve, and skin cells.



3 Mutations

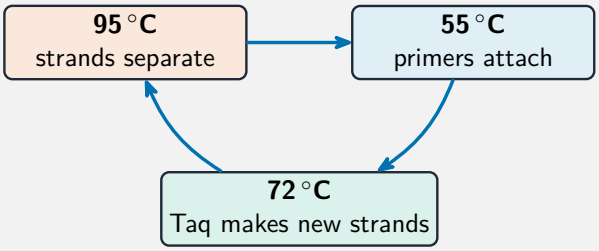
A **mutation** 突变 is a change in the DNA sequence. It may be harmful, neutral, or beneficial –and beneficial ones give the variation that natural selection acts on.



red = changed base; shaded = shifted by a frameshift (deletion or insertion)

4 Biotechnology

Scientists can work with DNA directly: **PCR** 聚合酶链反应 copies DNA many times, and **gel electrophoresis** 凝胶电泳 separates DNA pieces by size.



each cycle **doubles** the DNA → millions of copies

Watch out: all your cells share the **same** DNA –a skin cell and a brain cell differ only because they switch on **different genes**, not because they have different DNA.

Practice

Try these in order. The methods are all above.

2.1 Explain why a muscle cell and a nerve cell are different, even though they have the same DNA. [2]

2.2 State what a mutation is. [1]

2.3 State whether a mutation is always harmful, and explain. [2]

2.4 State what PCR is used for. [1]

2.5 State what gel electrophoresis separates DNA pieces by. [1]

7 Natural selection and evolution – Part 1

Name: _____ Class: _____ Date: _____

Vocabulary 词汇

Write each word three times. 把每个单词抄写三遍。

English	**中文**	**Write it 3 times** (English)		
Evolution	进化			
natural selection	自然选择			
variation	变异			
Fitness	适合度			
adaptation	适应			
artificial selection	人工选择			

Recall

You have likely met Darwin's big idea already:

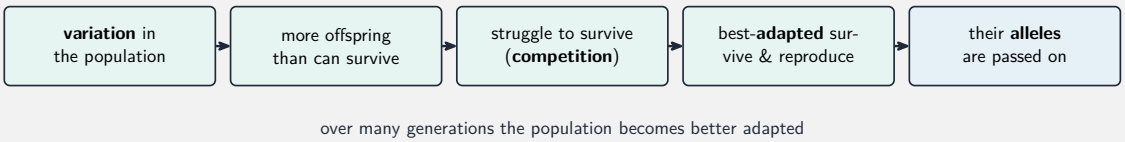
- Living things vary –no two are exactly alike.
- Those best suited to their environment tend to survive and have more offspring.
- Farmers breed animals and plants for the features they want.

This sheet lines up how evolution works. Each idea has a short worked example.

New ideas

■ 1 Natural selection

Evolution 进化 is a change in a population's inherited traits over generations. Its main cause is **natural selection** 自然选择:



- individuals show **variation** 变异,
- some variations survive and reproduce better,
- those helpful traits become more common over time.

■ 2 Fitness and adaptation

Fitness 适合度 means reproductive success –how many offspring an individual leaves, not how strong it is. A well-suited trait is an **adaptation** 适应.

■ 3 Selection changes populations

Over many generations, natural selection makes helpful traits common and harmful ones rare, reshaping the whole population.

■ 4 Artificial selection

In **artificial selection** 人工选择, humans (not nature) choose which individuals breed –for bigger crops, faster horses, or friendlier dogs.

Watch out: "fitness" in biology means **reproductive success**, not being strong or healthy. An animal that survives but leaves no offspring has zero fitness.

Practice

Try these in order. The methods are all above.

2.1 State the three key parts of natural selection. [3]

2.2 State what "fitness" means in biology. [1]

2.3 State the difference between natural selection and artificial selection. [2]

2.4 Explain why a helpful trait becomes more common in a population over time. [2]

2.5 Give one example of a trait produced by artificial selection. [1]

7 Populations, speciation, and evidence – Part 2

Name: _____ Class: _____ Date: _____

Vocabulary 词汇

Write each word three times. 把每个单词抄写三遍。

English	中文	Write it 3 times (English)		
allele frequency	等位基因频率			
gene flow	基因流			
genetic drift	遗传漂变			
Speciation	物种形成			
reproductively isolated	生殖隔离			

Recall

In Part A you met natural selection. Now see it acting on whole populations:

- Bacteria can become resistant to antibiotics.
- Over long times, populations can split into new species.
- Fossils and DNA give evidence for evolution.

Each idea has a short worked example before the Practice.

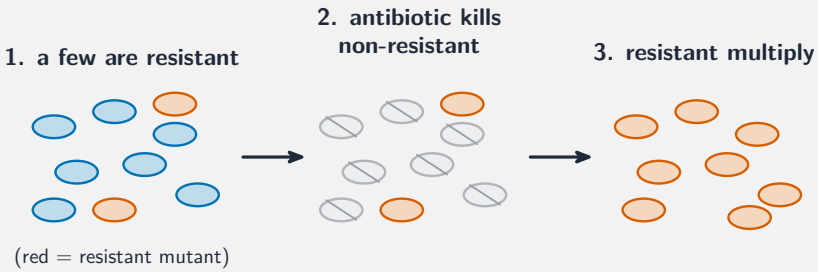
New ideas

■ 1 Evolution changes allele frequencies

A population's gene pool holds many **alleles**. Evolution is a change in how common each allele is –its **allele frequency** 等位基因频率. Besides natural selection, this changes through mutation, **gene flow** 基因流 (migration), and **genetic drift** 遗传漂变 (random change, strongest in small populations).

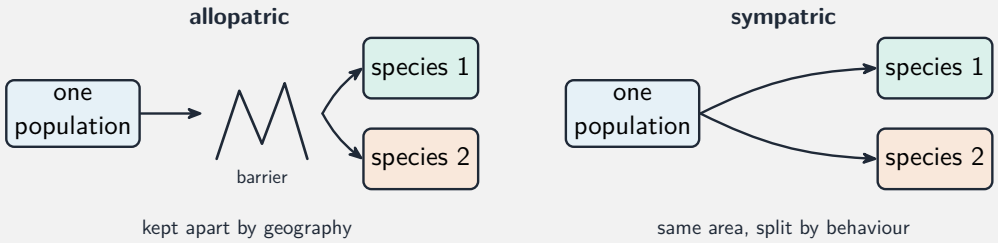
2 Antibiotic resistance

Antibiotic resistance is natural selection in fast-forward: a few bacteria happen to survive the drug, then reproduce, so the whole population becomes resistant.



3 Speciation

Speciation 物种形成 is the origin of a new species. It usually happens when populations become **reproductively isolated** 生殖隔离 (often by a geographic barrier) and slowly diverge until they can no longer interbreed.



4 Evidence for evolution

Many independent lines support evolution: the fossil record, shared anatomy between related species, and matching DNA sequences.

Watch out: individuals do **not** evolve –**populations** do. A single bacterium doesn't "become resistant"; rather, resistant ones survive and multiply, shifting the whole population.

Practice

Try these in order. The methods are all above.

2.1 State what evolution is, in terms of alleles in a population. [2]

2.2 Explain how a population of bacteria becomes resistant to an antibiotic. [3]

2.3 State what usually must happen for two populations to become separate species. [2]

2.4 Give two kinds of evidence that support evolution. [2]

2.5 Explain why it is wrong to say a single individual "evolves". [2]

8 Energy flow and populations – Part 1

Name: _____ Class: _____ Date: _____

Vocabulary 词汇

Write each word three times. 把每个单词抄写三遍。

English	中文	Write it 3 times (English)		
ecosystem	生态系统			
producers	生产者			
consumers	消费者			
food chain	食物链			
trophic level	营养级			
population	种群			
carrying capacity	环境容纳量			

Recall

You already know how living things depend on one another:

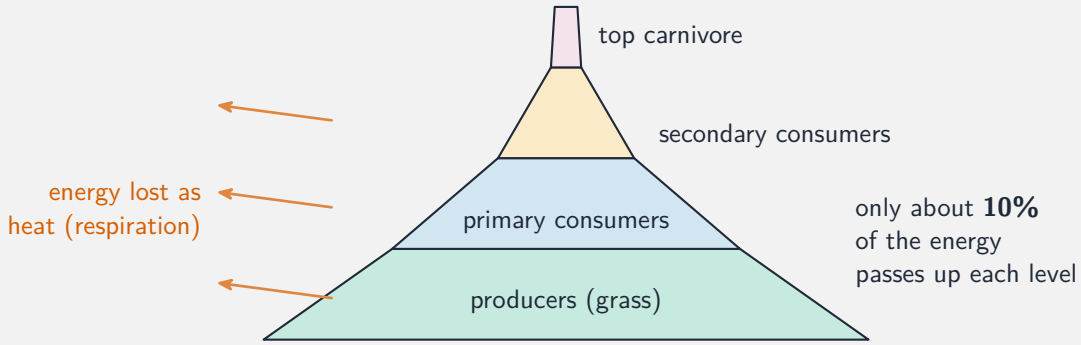
- Food chains show who eats whom, starting with plants.
- Energy from the Sun flows through an ecosystem.
- A population can grow, then level off when resources run low.

This sheet lines up energy flow and population growth. Each idea has a short worked example.

New ideas

■

Energy enters an **ecosystem** 生态系统 as sunlight, captured by **producers** 生产者 (plants), then passes to **consumers** 消费者 along a **food chain** 食物链. Each step is a **trophic level** 营养级.



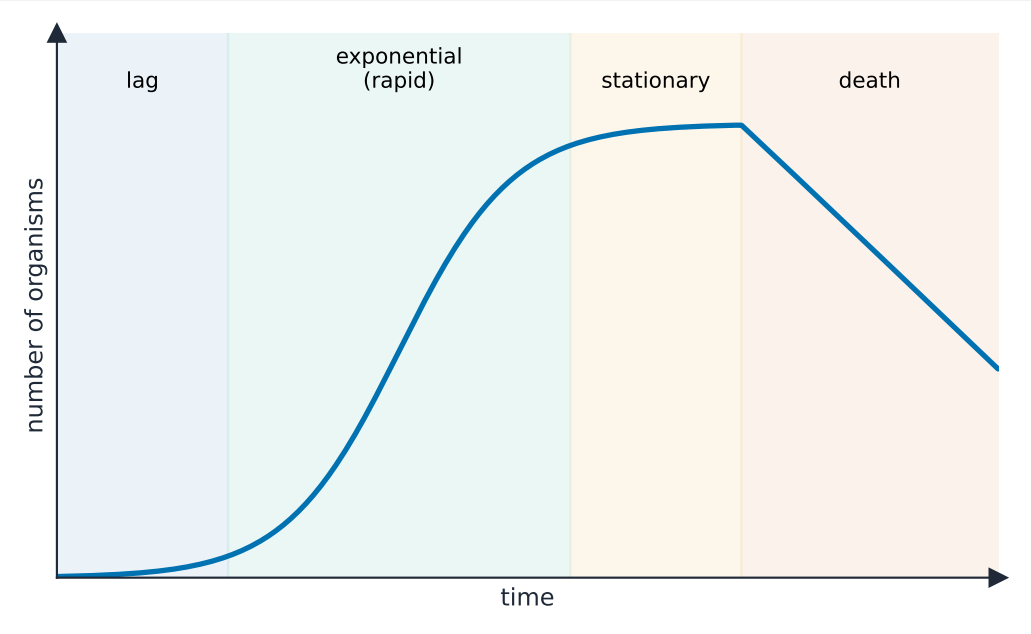
■ 2 The 10% rule

Only about **10%** of the energy passes from one trophic level to the next –the rest is lost as heat. This is why food chains are short and top predators are few.

Worked example. If plants capture 10,000 units of energy, the next level gets about 1,000, then 100, then just 10 –losing 90% at each step.

■ 3 Population growth

A **population** 种群 grows quickly when resources are plenty, then slows and levels off at the **carrying capacity** 环境容纳量–the most the environment can support.



■ 4 What limits a population

Food, water, space, disease, and predators are **limiting factors** that stop a population growing without end.

> **Watch out:** so much energy is lost between levels (about 90% each step) that a food chain rarely has more than four or five links –there is simply not enough energy left to support another predator.

Practice

Try these in order. The methods are all above.

2.1 State where the energy in an ecosystem originally comes from, and which organisms capture it. [2]

2.2 About what percentage of energy passes to the next trophic level? [1]

2.3 A plant level holds 8,000 units of energy. Estimate the energy at the next two levels. [2]

2.4 State what ”carrying capacity” means. [2]

2.5 Give two factors that can limit the growth of a population. [2]

8 Communities and ecosystems – Part 2

Name: _____ Class: _____ Date: _____

Vocabulary 词汇

Write each word three times. 把每个单词抄写三遍。

English	中文	Write it 3 times (English)		
community	群落			
competition	竞争			
predation	捕食			
symbiosis	共生			
Biodiversity	生物多样性			
keystone species	关键种			

Recall

In Part A you followed energy through an ecosystem. Now look at how species live together:

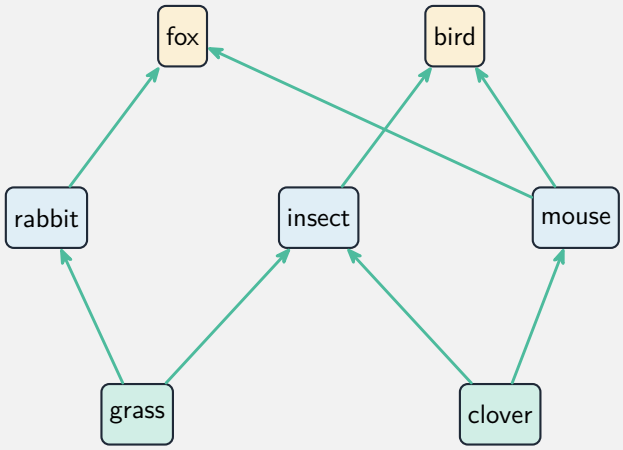
- Animals compete for food and space, hunt each other, and sometimes help each other.
- A variety of living things makes an ecosystem healthier.
- Human activity can damage ecosystems.

Each idea has a short worked example before the Practice.

New ideas

■ 1 Community interactions

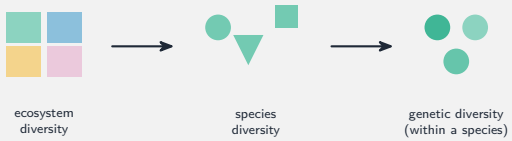
A **community** 群落 is all the species living together in an area. They interact by:



- **competition** 竞争–for shared food, water, or space,
- **predation** 捕食–one animal hunting another,
- **symbiosis** 共生–living closely together (both may benefit, or one may harm the other).

2 Biodiversity

Biodiversity 生物多样性 is the variety of living things –genes, species, and habitats. Higher biodiversity usually makes an ecosystem more able to recover from disturbance.



3 Keystone species

A **keystone species** 关键种 has an outsized effect on its community –removing it can cause the whole system to collapse.

4 Human impact

Human actions –habitat loss, pollution, over-hunting, and climate change –reduce biodiversity and disturb ecosystems, and because species are linked, a change to one can ripple through many.

Watch out: because species are connected in a food web, harming one species (especially a keystone species) can affect many others –not just that one.

Practice

Try these in order. The methods are all above.

2.1 Name three ways species in a community interact. [3]

2.2 State what biodiversity means. [2]

2.3 Explain why higher biodiversity usually makes an ecosystem more resilient. [2]

2.4 State what a keystone species is. [2]

2.5 Give two ways human activity can reduce biodiversity. [2]