HOLIDAY HOMEWORK 假期作业

AS-Level Biology

Exercise sheets and past-paper practice, topic by topic.

每个单元：练习卷 + 历年真题。

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

Contents 目录

1 Cell structure – 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)		
microscope	显微镜			
light microscope	光学显微镜			
electron microscope	电子显微镜			
resolution	分辨率			
Magnification	放大倍数			
eukaryotic cells	真核细胞			
nucleus	细胞核			
organelles	细胞器			
cytoplasm	细胞质			
mitochondria	线粒体			
respiration	呼吸作用			
ribosomes	核糖体			
proteins	蛋白质			

Recall

At IGCSE you saw plant and animal cells and used a microscope. Bring this with you:

- a cell is the basic unit of life, far too small to see with your eyes;
- plant and animal cells share many parts (membrane, cytoplasm, nucleus).

At AS we look more closely: how we **measure** cells, and the tiny **organelles** inside them.

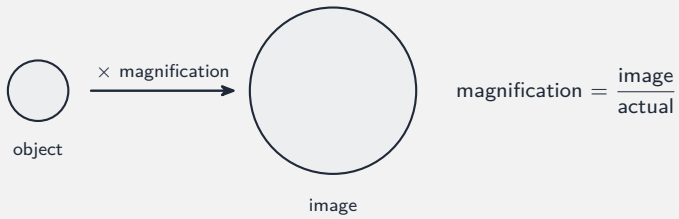
New ideas

1 Studying cells: magnification and resolution

A **microscope** 显微镜 makes a bigger image. A **light microscope** 光学显微镜 uses light; an **electron microscope** 电子显微镜 uses electrons, giving far higher **resolution** 分辨率 (the smallest distance at which two points still look separate).

Magnification 放大倍数 is how many times bigger the image is than the real object:

$$\text{magnification} = \frac{\text{image size}}{\text{actual size}}.$$



Worked example. An image is 25 mm across at magnification 5000: actual size $= \dfrac{25}{5000} = 0.005$ mm $= 5$ µm.

Micro-check. An image is 40 mm at magnification 2000. Find the actual size in mm. [1]

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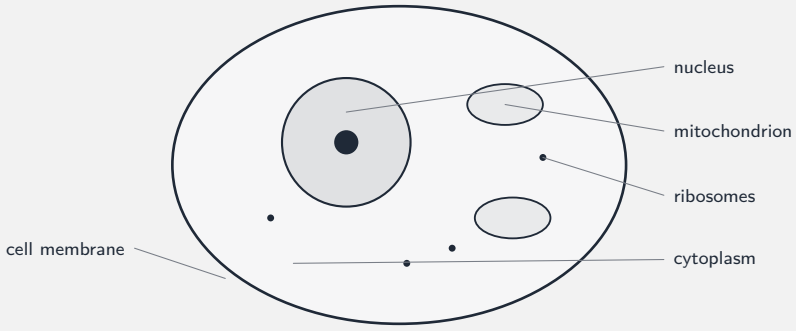
2 Eukaryotic cells and their organelles

Plant and animal cells are **eukaryotic cells** 真核细胞: their DNA is held inside a **nucleus** 细胞核. The cell is full of tiny **organelles** 细胞器 floating in the jelly-like **cytoplasm** 细胞质. Key ones:

- the **nucleus** holds the DNA and controls the cell;
- **mitochondria** 线粒体 carry out **respiration** 呼吸作用 to release energy (as ATP);
- **ribosomes** 核糖体 join amino acids to make **proteins** 蛋白质.



Micro-check. Which organelle carries out **respiration**? [1]

Watch out: magnification and resolution are not the same —magnification just enlarges the image, while resolution sets the *real* limit on detail. A light microscope cannot resolve tiny organelles (like ribosomes) however much you magnify.

Practice

1.1 An image of a cell is 30 mm long at magnification 1500. Find the actual length in mm. [2]

1.2 State the difference between **magnification** and **resolution**. [2]

1.3 State the function of (a) the nucleus, (b) mitochondria, (c) ribosomes. [3]

1.4 State what is meant by a **eukaryotic** cell. [1]

1.5 State which type of microscope (light or electron) gives the higher resolution, and

why. [2]

1.6 Challenge. A student magnifies a light-microscope image of a cell more and more, but the ribosomes still look like a blur. Explain why, using the idea of resolution. [2]

1 In a photomicrograph of magnification ×5000, a chloroplast measures 25 mm in diameter.

What is the actual diameter of the chloroplast?

A 0.2 μm **B** 0.5 μm **C** 2 μm **D** 5 μm

2 What is a function of Golgi bodies?

A formation of vesicles for endocytosis

B modification of proteins for secretion

C synthesis of ATP

D synthesis of polypeptides

1 Which structures are visible in an appropriately stained plant cell using a high power (×400) light microscope?

	centrioles	mitochondria	starch grains
A	✓	✗	✓
B	✓	✗	✗
C	✗	✓	✗
D	✗	✓	✓

key

✓ = visible

✗ = **not** visible

1 Cell structure – 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 wall	细胞壁			
cellulose	纤维素			
chloroplasts	叶绿体			
photosynthesis	光合作用			
vacuole	液泡			
prokaryotic cell	原核细胞			
bacterium	细菌			
peptidoglycan	肽聚糖			
virus	病毒			
nucleic acid	核酸			
capsid	衣壳			
host	宿主			

Recall

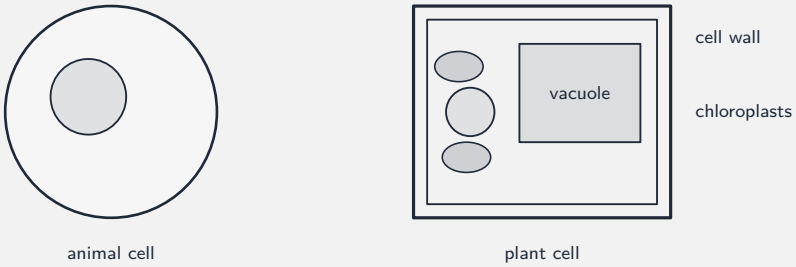
In **Part 1** you met magnification, resolution, and eukaryotic cells with their organelles. Part 2 looks at how plant and animal cells differ, and at two simpler kinds of life — **bacteria** and **viruses**.

New ideas

1 Plant and animal cells

Both plant and animal cells have a cell surface membrane, cytoplasm, a nucleus, mitochondria and ribosomes. But **only plant cells** have three extra features:

- a **cell wall** 细胞壁 made of **cellulose** 纤维素, which supports the cell and stops it bursting;
- **chloroplasts** 叶绿体, the site of **photosynthesis** 光合作用;
- a large permanent **vacuole** 液泡 that stores water and keeps the cell firm.



Micro-check. Name **one** feature a plant cell has that an animal cell does not. [1]

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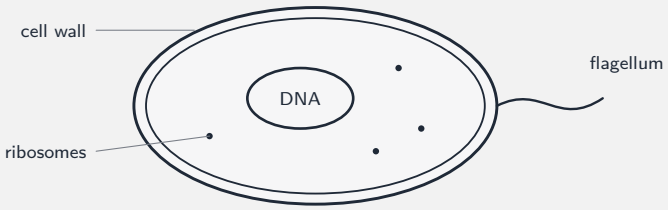
2 Prokaryotic cells

A **prokaryotic cell** 原核细胞, such as a **bacterium** 细菌, is much smaller and simpler. It has **no nucleus** —its DNA is a single circular loop lying free in the cytoplasm. It also has a cell wall (made of **peptidoglycan** 肽聚糖, not cellulose), smaller ribosomes, and **no** membrane-bound organelles (so no mitochondria).



Micro-check. State one way a prokaryotic cell differs from a eukaryotic cell. [1]

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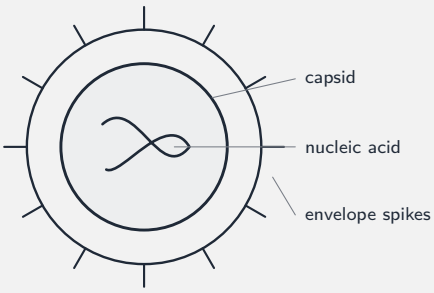
3 Viruses

A **virus** 病毒 is **non-cellular** —it is not made of cells at all. It is just a core of **nucleic acid** 核酸 (either DNA or RNA) inside a protein coat called a **capsid** 衣壳, sometimes with an outer envelope.

A virus has no cytoplasm and no ribosomes, so it cannot make its own proteins. It

can only copy itself **inside** a living **host** 宿主 cell.



Micro-check. Why can a virus only reproduce inside a host cell? [1]

Watch out: a prokaryote has *no* nucleus and *no* membrane-bound organelles (its DNA is a free loop). A virus is *non-cellular* —it is not a cell at all, so never call it one.

Practice

1.1 Name the **three** features that a plant cell has but an animal cell does not. [3]

1.2 State **one** way a prokaryotic cell is different from a eukaryotic cell. [2]

1.3 Name the two or three parts of a virus. [2]

1.4 Explain why a virus is described as **non-cellular**. [1]

1.5 Explain why a virus cannot reproduce on its own. [2]

1.6 Challenge. Antibiotics kill many bacteria but have no effect on viruses. Suggest why, using the difference between a bacterium and a virus. [2]

2 Which structures will be present in a cell that causes cholera?

1 circular DNA

2 cytoplasmic DNA

3 70S ribosomes

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

3 Which organelles have a partially permeable membrane?

1 Golgi apparatus

2 lysosome

3 mitochondrion

4 ribosome

A 1, 2 and 3 **B** 1, 2 and 4 **C** 1, 3 and 4 **D** 2, 3 and 4

5 Some features of cells are listed.

1 cytoplasm

2 cell surface membrane

3 ribosomes

Which features are found in animal cells and also in prokaryotic cells?

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

2 Biological molecules – 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)		
carbohydrates	碳水化合物			
lipids	脂质			
proteins	蛋白质			
molecule	分子			
reducing sugar	还原糖			
starch	淀粉			
biuret	双缩脲			
emulsion	乳浊液			
monomer	单体			
polymer	聚合物			
monosaccharide	单糖			
glucose	葡萄糖			
disaccharide	二糖			
maltose	麦芽糖			
polysaccharide	多糖			

English	中文	Write it 3 times (English)		
glycosidic bond	糖苷键			
condensation	缩合			
hydrolysis	水解			
amylose	直链淀粉			
amylopectin	支链淀粉			
glycogen	糖原			
cellulose	纤维素			
cell wall	细胞壁			
insoluble	不溶			

Recall

You met these ideas at IGCSE. Bring them with you:

- Living things contain **carbohydrates** 碳水化合物, **lipids** 脂质, **proteins** 蛋白质 and water.
- You used food tests before —the iodine test for starch, and Benedict's test for sugar.
- "Big molecules are built from small ones" —that simple idea runs through this whole sheet.

Nothing here is harder than IGCSE. It just lines up the chemistry the AS course starts with.

New ideas

Read these first. Each has a short worked example. Then do the Practice below.

■ 1 Four food tests

A **molecule** 分子 is a group of atoms joined together. Simple tests show which kinds are present in a sample.

Test	Finds	Positive result
Benedict's test	**reducing sugar** 还原糖	blue → green → orange → brick-red
iodine test	**starch** 淀粉	orange-brown → blue-black
biuret 双缩脲 test	protein	blue → purple
emulsion test	lipid	white cloudy **emulsion** 乳浊液

Worked example. You add Benedict's solution to a juice and heat it. It turns brick-red. So the juice contains a reducing sugar.

2 Monomers and polymers

- a **monomer** 单体 is a small single unit.
- a **polymer** 聚合物 is a long molecule made of many monomers joined up.

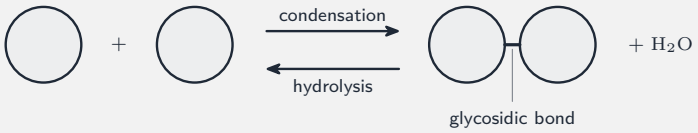
Sugars come in three sizes:

- a **monosaccharide** 单糖 is one sugar unit, such as **glucose** 葡萄糖.
- a **disaccharide** 二糖 is two units joined, such as **maltose** 麦芽糖.
- a **polysaccharide** 多糖 is many units joined into a polymer.

3 Joining and breaking (condensation and hydrolysis)

When two monomers join, a strong **glycosidic bond** 糖苷键 forms and **one water molecule is removed**. This is **condensation** 缩合.

The reverse adds water to break the bond. This is **hydrolysis** 水解.



Worked example. Sucrose + water → glucose + fructose. Adding water breaks one bond, so this is hydrolysis.

4 Storage and structure polysaccharides

All three are polymers of glucose, but their **shape fits their job**:

- **starch** is the store in plants —made of a coiled chain (**amylose** 直链淀粉) and a branched chain (**amylopectin** 支链淀粉).
- **glycogen** 糖原 is the store in animals —like amylopectin but **more branched**, so it breaks down fast.
- **cellulose** 纤维素 is made of straight chains held side by side; they pack into strong fibres that build the plant **cell wall** 细胞壁.

Stores like starch and glycogen are useful because they are compact and **insoluble** 不溶 (so they stay in the cell).

amylose (coiled) glycogen (branched) cellulose (straight)

Watch out: condensation *removes* water (joining monomers); hydrolysis *adds* water (breaking them apart). Starch, glycogen and cellulose are *all* glucose polymers —it is their different *shapes* that suit their different jobs.

Practice

Try these in order. The methods are all above.

2.1 Name the test for (a) starch, (b) protein, (c) a reducing sugar. [3]

2.2 A sample turns Benedict's solution brick-red. What does this tell you? [1]

2.3 Define (a) a monomer, (b) a polymer. [2]

2.4 Two monosaccharides join to form a disaccharide. (a) Name the bond formed. (b) Name this type of reaction. (c) What small molecule is removed? [3]

2.5 Glycogen and cellulose are both polymers of glucose, but do different jobs. State one use of each. [2]

2.6 Explain why starch is a good storage molecule in a cell. [2]

2.7 Challenge. Cellulose and starch are both made only of glucose, yet cellulose builds strong cell walls while starch is a store. Explain how their different structures suit these different jobs. [2]

8 The diagram shows some steps in a laboratory method used to identify the presence of non-reducing sugars in a food sample.

Some terms are missing.

Which terms are correct for the expected result for a very low concentration of non-reducing sugar?

	X	Y	Z
A	acid hydrolysis	Benedict's test	orange
B	Benedict's test	acid hydrolysis	orange
C	acid hydrolysis	Benedict's test	green
D	Benedict's test	acid hydrolysis	green

6 Trehalose is a non-reducing disaccharide.

Separate samples of a mixture of fructose and trehalose were tested with Benedict's solution before and after acid hydrolysis.

What will be the results of these Benedict's tests?

	before acid hydrolysis	after acid hydrolysis
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

key

✓ = positive result with Benedict's test

✗ = negative result with Benedict's test

2 Biological molecules – 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)		
condensation	缩合			
hydrolysis	水解			
triglyceride	甘油三酯			
glycerol	甘油			
fatty acids	脂肪酸			
ester bonds	酯键			
hydrophobic	疏水			
saturated	饱和			
unsaturated	不饱和			
phospholipid	磷脂			
phosphate	磷酸			
hydrophilic	亲水			
bilayer	双层			
amino acids	氨基酸			
peptide bond	肽键			

English	中文	Write it 3 times (English)		
polypeptide	多肽			
primary structure	一级结构			
secondary structure	二级结构			
tertiary structure	三级结构			
Globular proteins	球状蛋白质			
fibrous proteins	纤维状蛋白质			
collagen	胶原蛋白			
polar	极性			
hydrogen bonds	氢键			
solvent	溶剂			
specific heat capacity	比热容			

Recall

From Part 1 you know that big biological molecules are built from small ones by **condensation** 缩合 (removing water) and broken by **hydrolysis** 水解 (adding water). The same idea returns here for fats and proteins.

- You met fats and proteins in food at IGCSE.
- Now we look at what they are actually made of, and why their shape matters.

New ideas

Read these first, then do the Practice.

■ 1 Triglycerides (fats and oils)

A **triglyceride** 甘油三酯 is the main fat or oil. It is one **glycerol** 甘油 molecule joined to three **fatty acids** 脂肪酸 by **ester bonds** 酯键. It is **hydrophobic** 疏水 (does not mix with water).

Fatty acids are of two kinds:

- **saturated** 饱和—no carbon–carbon double bonds; usually solid fats.
- **unsaturated** 不饱和—one or more double bonds (a ”kink”); usually liquid oils.

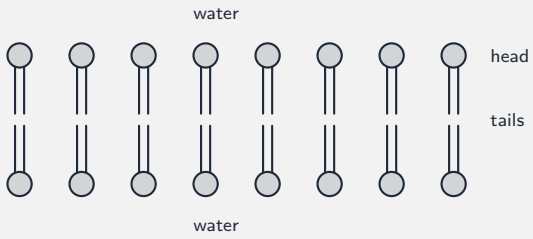
Worked example. A triglyceride releases about **twice** as much energy per gram as a carbohydrate, so it makes a good long-term energy store.

■ 2 Phospholipids and the bilayer

A **phospholipid** 磷脂 is like a triglyceride, but one fatty acid is swapped for a **phosphate** 磷酸 group. This gives it two ends:

- a **hydrophilic** 亲水 (”water-loving”) head.
- two hydrophobic (”water-fearing”) tails.

In water, phospholipids line up into a **bilayer** 双层—heads facing the water, tails hidden inside. This is the basis of every cell membrane.



■ 3 Proteins and the peptide bond

Proteins are polymers of **amino acids** 氨基酸. Two amino acids join by condensation, forming a **peptide bond** 肽键 and removing water. A long chain is a **polypeptide** 多肽.

A protein folds into a precise 3-D shape, described in levels:

- **primary structure** 一级结构—the order of amino acids.
- **secondary structure** 二级结构—local coils and folds held by hydrogen bonds.
- **tertiary structure** 三级结构—the whole chain folded into one shape.

The shape decides the job. **Globular proteins** 球状蛋白质 (like enzymes) are rounded and soluble; **fibrous proteins** 纤维状蛋白质 (like **collagen** 胶原蛋白) are long, strong strands.

4 Water —small but special

Water is a **polar** 极性 molecule: the oxygen end is slightly negative, the hydrogen ends slightly positive. So water molecules attract each other by weak **hydrogen bonds** 氢键. This explains:

- water is a good **solvent** 溶剂 (so substances dissolve and can be carried).
- water has a high **specific heat capacity** 比热容 (so its temperature stays steady).

Watch out: a phospholipid has *both* a hydrophilic head and hydrophobic tails —that split is *why* it forms a bilayer. And a protein's *shape* (set by its amino-acid order) is what decides its job.

Practice

Try these in order.

2.1 Name the parts that join to make a triglyceride. [2]

2.2 State one difference between a saturated and an unsaturated fatty acid. [1]

2.3 A phospholipid has a hydrophilic head and hydrophobic tails. Explain how this makes phospholipids form a bilayer in water. [2]

2.4 Name the bond that joins two amino acids, and the small molecule removed when it forms. [2]

2.5 State what is meant by the *primary structure* of a protein. [1]

2.6 Water has a high specific heat capacity. Explain why this is useful to living things. [2]

2.7 Challenge. A phospholipid forms a bilayer in water, but a triglyceride does not. Explain why, using their structures. [2]

9 Which feature of storage polysaccharides means they do **not** change the water potential of cells?

A They are easily hydrolysed.

B They are compact.

C They are insoluble.

D They are branched molecules.

12 What is a feature of triglyceride molecules?

A They are hydrophobic molecules.

B They are molecules with a single ester bond.

C They are polar molecules.

D They are water-soluble molecules.

13 An unsaturated fatty acid molecule has 17 carbon atoms in the tail which is attached to its carboxyl group. The tail contains three double bonds.

How many hydrogen atoms does the tail contain?

A 29 **B** 31 **C** 33 **D** 35

7 Which molecules have a structural formula that contains C=O bonds?

1 glucose

2 glycerol

3 protein

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

11 In some people a mutation can affect the beta chains in their haemoglobin molecules. As a result polar amino acids on the outer surfaces of the chains are replaced by non-polar amino acids.

What will be the effect on haemoglobin?

A Haemoglobin will become less soluble.

B Haemoglobin will become more soluble.

C Hydrophobic interactions between amino acids will decrease.

D More hydrogen bonds will form in the molecule.

10 Which bonds between amino acids hold the shape of the secondary structure and also the tertiary structure of proteins?

A peptide bonds

B disulfide bonds

C hydrogen bonds

D ionic bonds

11 Resilin is a protein found in the wings of insects. It is an elastic, fibrous protein and scientists have suggested that it may have an important role in allowing the wings of an insect to fold and unfold without damage.

Peptidyl transferase is an enzyme which catalyses the condensation of amino acids during translation to form resilin.

Which statements are correct?

1 Peptidyl transferase and resilin have structural roles in the insect.

2 Peptidyl transferase is a globular protein.

3 Peptidyl transferase is soluble in water.

A 1 and 2 **B** 1 and 3 **C** 1 only **D** 2 and 3

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)		
biological catalysts	生物催化剂			
enzyme	酶			
globular protein	球状蛋白质			
catalyses	催化			
intracellular	细胞内			
catalase	过氧化氢酶			
extracellular	细胞外			
secreted	分泌			
amylase	淀粉酶			
active site	活性位点			
substrate	底物			
enzyme–substrate complex	酶底物复合物			
products	产物			
specific	专一			
complementary	互补			

English	中文	Write it 3 times (English)		
lock-and-key	锁钥学说			
induced fit	诱导契合			
activation energy	活化能			
temperature	温度			

Recall

You met enzymes at IGCSE:

- Enzymes are **biological catalysts** 生物催化剂—they speed up reactions in living things.
- They are not used up, so one enzyme works again and again.
- You saw that heat and the wrong **pH** can stop an enzyme working.

This sheet sharpens those ideas ready for AS. Nothing here is harder than IGCSE.

New ideas

Read these first, then do the Practice.

1 What an enzyme is

An **enzyme** 酶 is a **globular protein** 球状蛋白质 (a rounded, soluble protein) that **catalyses** 催化 (speeds up) a reaction. Enzymes work in two places:

- **intracellular** 细胞内—inside the cell that made it (e.g. **catalase** 过氧化氢酶).
- **extracellular** 细胞外—**secreted** 分泌 to work outside the cell (e.g. **amylase** 淀粉酶 in the gut).

2 The active site and the substrate

Each enzyme has a pocket called the **active site** 活性位点. The molecule it acts on is the **substrate** 底物. The substrate fits into the active site to form an **enzyme–substrate complex** 酶底物复合物. The reaction happens, and the **products** 产物 leave.

An enzyme is **specific** 专一—it usually works on only one substrate, because the active site shape is **complementary** 互补 (a matching fit) to that substrate only.

3 Lock-and-key and induced fit

Two ideas explain the fit:

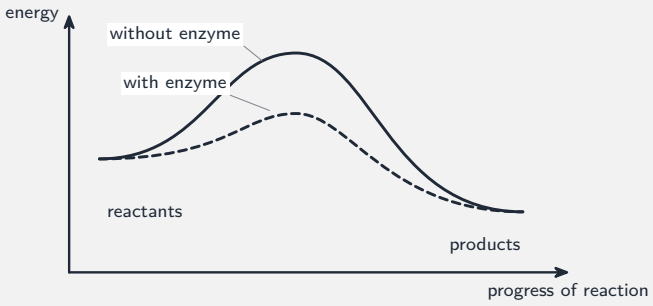
- **lock-and-key** 锁钥学说—the active site is a fixed shape; only the matching

substrate fits, like a key in a lock.

- **induced fit** 诱导契合—the active site changes shape slightly to grip the substrate as it binds. This fits the evidence better.

■ 4 Lowering activation energy

Every reaction needs a small push of energy to start —the **activation energy** 活化能. An enzyme **lowers** the activation energy, so the reaction goes quickly at the cell's normal **temperature** 温度 instead of needing high heat.



Worked example. The enzyme does not change the reactants or products —only the size of the "hill" between them.

Watch out: an enzyme *lowers* the activation energy but does *not* change the reactants, products or overall energy change —only the size of the "hill". Enzymes are *specific* because the active-site shape is complementary to just one substrate.

Practice

Try these in order.

3.1 What type of molecule are all enzymes? [1]

3.2 State the difference between an *intracellular* and an *extracellular* enzyme. [2]

3.3 Name (a) the pocket where the substrate binds, (b) the structure formed when substrate binds. [2]

3.4 Explain why an enzyme usually works on only one substrate. [2]

3.5 State one way the *induced-fit* model differs from the *lock-and-key* model. [1]

3.6 Explain how an enzyme speeds up a reaction, using the idea of activation energy. [2]

3.7 Challenge. A poison binds permanently inside an enzyme's active site so the substrate can no longer fit. Explain why this stops the enzyme working. [2]

13 What is the effect of an enzyme in an enzyme-catalysed reaction?

A decreases the activation energy and decreases the energy yield

B decreases the activation energy and has **no** effect on the energy yield

C increases the activation energy and increases the energy yield

D decreases the activation energy and increases the energy yield

13 Which statements describe the action of an extracellular enzyme?

1 synthesis of a polynucleotide in the nucleus during DNA replication

2 digestion of macromolecules in the lumen of the small intestine

3 synthesis of ATP molecules in the mitochondria

A 1 and 2 **B** 1 and 3 **C** 2 and 3 **D** 2 only

14 Which statement about the induced-fit hypothesis of enzyme action is correct?

A An enzyme that uses the induced-fit mechanism will increase the activation energy of a reaction.

B The binding of a substrate causes conformational changes in an enzyme.

C The active site of an enzyme changes to become the same shape as the substrate.

D An enzyme that uses an induced-fit mechanism has decreased specificity to the substrate.

3 Enzymes – 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)		
enzyme	酶			
active site	活性位点			
substrate	底物			
rate	速率			
kinetic energy	动能			
collide	碰撞			
optimum temperature	最适温度			
denatures	变性			
optimum pH	最适			
buffer solution	缓冲液			
Michaelis–Menten constant	米氏常数			
high affinity	亲和力			
inhibitor	抑制剂			
competitive inhibitor	竞争性抑制剂			
non-competitive inhibitor	非竞争性抑制剂			

English	中文	Write it 3 times (English)		
immobilised enzyme	固定化酶			

Recall

From Part 1 you know an **enzyme** 酶 has an **active site** 活性位点 that fits its **substrate** 底物. Here we look at what changes the **rate** 速率 of an enzyme reaction.

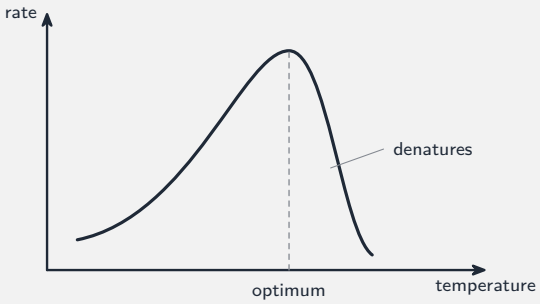
- At IGCSE you saw enzymes have a best (optimum) temperature and pH.
- Now we add the idea of *denaturing* and how to read the graphs.

New ideas

Read these first, then do the Practice.

1 Temperature

As temperature rises, molecules gain **kinetic energy** 动能 and **collide** 碰撞 more often, so the rate rises. But above the **optimum temperature** 最适温度 the heat breaks the bonds holding the enzyme's shape —it **denatures** 变性. The active site changes, the substrate no longer fits, and the rate falls fast.



2 pH

Each enzyme has an **optimum pH** 最适 pH. Move the pH too far from it and the enzyme denatures, so the rate drops. A **buffer solution** 缓冲液 is used to keep pH steady in an experiment.

3 Concentration

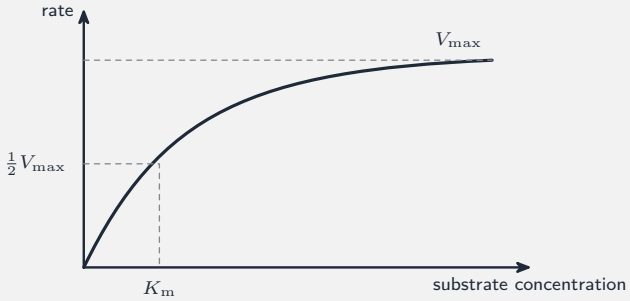
- more **enzyme** (with plenty of substrate) → more active sites → faster, in proportion.
- more **substrate** → faster at first, then it levels off once every active site is busy.

4 V_max and K_m

The levelling-off rate, when all active sites are full, is the maximum rate, $V_{\max}$.

The **Michaelis–Menten constant** 米氏常数 (K_{m}) is the substrate concentration

that gives **half** of V_{max}. A **low** K_m means a **high affinity** 亲和力 (the enzyme grips its substrate strongly).



5 Inhibitors

An **inhibitor** 抑制剂 slows an enzyme. Two reversible types:

- **competitive inhibitor** 竞争性抑制剂—binds in the active site; more substrate out-competes it.
- **non-competitive inhibitor** 非竞争性抑制剂—binds elsewhere and changes the active site; more substrate does not help.

An **immobilised enzyme** 固定化酶 is fixed in place (e.g. trapped in beads) so it can be reused and is not washed away.

Watch out: above the optimum, heat *denatures* the enzyme —the shape change is *permanent*, so the rate does *not* recover on cooling. A competitive inhibitor (in the active site) is overcome by *more* substrate; a non-competitive one is not.

Practice

Try these in order.

3.1 Explain why an enzyme reaction speeds up as temperature rises from 10 °C to its optimum. [2]

3.2 What is meant by *denature*? [1]

3.3 Why is a buffer solution used when studying the effect of temperature on an en-

zyme? [1]

3.4 Adding more substrate speeds the reaction at first, then has no effect. Explain why it has no effect at high concentration. [2]

3.5 Define the Michaelis–Menten constant, K_{m}. [1]

3.6 State where (a) a competitive and (b) a non-competitive inhibitor bind on an enzyme. [2]

3.7 Challenge. Adding more substrate reverses the effect of a competitive inhibitor, but not a non-competitive one. Explain why. [2]

14 How is the Michaelis–Menten constant (K_m) used?

A to determine the number of collisions between the enzyme and substrate

B to compare the affinity of enzymes for their substrates

C to find the maximum velocity of an enzyme (V_{max})

D to find the optimum rate of reaction

16 Which statements are correct for a non-competitive inhibitor of enzyme action?

1 Increasing the concentration of the enzyme's substrate will reduce its effect.

2 It reduces the activation energy required for a reaction to take place.

3 It reduces the maximum rate of reaction.

A 1 and 3 **B** 1 only **C** 2 and 3 **D** 3 only

17 The rate of enzyme-catalysed reactions in human cells is regulated.

What may be involved in this regulation?

1 a change in enzyme concentration

2 a change in substrate concentration

3 inhibition by the final product of the reaction

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

4 Cell 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)		
cell membrane	细胞膜			
partially permeable	半透			
phospholipids	磷脂			
fluid mosaic model	流动镶嵌模型			
bilayer	双层			
hydrophilic	亲水			
hydrophobic	疏水			
proteins	蛋白质			
channel proteins	通道蛋白			
carrier proteins	载体蛋白			
cholesterol	胆固醇			
fluidity	流动性			
glycoproteins	糖蛋白			
cell signalling	细胞信号传递			
ligand	配体			

English	中文	Write it 3 times (English)		
hormone	激素			
target cell	靶细胞			
receptor	受体			

Recall

At IGCSE you learned that a **cell membrane** 细胞膜 controls what enters and leaves a cell. Now we look at what it is built from and how it is arranged.

- The membrane is **partially permeable** 半透—it lets some things through and blocks others.
- It is mostly made of **phospholipids** 磷脂 (Part 1 of the Biological molecules sheet).

Nothing here is harder than IGCSE —it just adds detail and the right words.

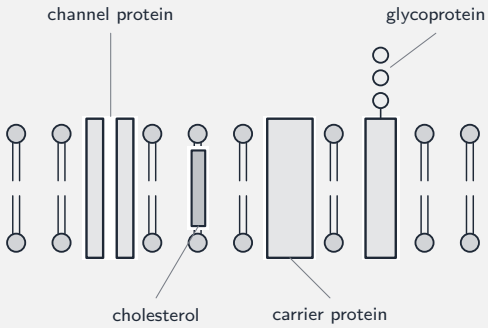
New ideas

Read these first, then do the Practice.

■ 1 The fluid mosaic model

We describe the membrane with the **fluid mosaic model** 流动镶嵌模型. The phospholipids form a **bilayer** 双层: **hydrophilic** 亲水 heads face the water on each side, **hydrophobic** 疏水 tails hide in the middle.

- ”fluid” —the phospholipids slide past each other, so the membrane can bend.
- ”mosaic” —many **proteins** 蛋白质 are dotted through it, like tiles in a picture.



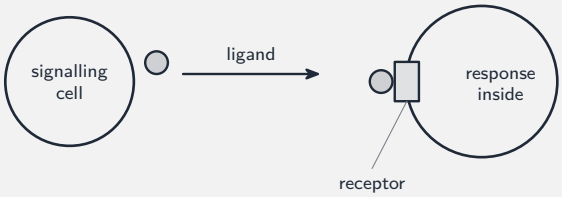
2 What floats in the membrane

Part	Role
channel proteins 通道蛋白	water-filled pores that let ions pass
carrier proteins 载体蛋白	carry specific molecules across
cholesterol 胆固醇	controls **fluidity** 流动性 and adds strength
glycoproteins 糖蛋白	carbohydrate chains for cell recognition

3 Cell signalling

Cells talk to each other by **cell signalling** 细胞信号传递:

1. a cell releases a signal chemical called a **ligand** 配体 (for example a **hormone** 激素).
2. the ligand travels (often in the blood) to a **target cell** 靶细胞.
3. it binds a **receptor** 受体 of matching shape on the target cell, which triggers a response inside.



Worked example. The receptor shape fits one ligand only, so **only** cells with that receptor respond to the signal.

Watch out: the hydrophilic heads face the water on *both* sides and the hydrophobic tails hide *inside* —so charged or large molecules cannot cross the tails and must use proteins. A receptor fits *one* ligand shape, so only target cells respond.

Practice

Try these in order.

4.1 Name the model used to describe membrane structure. [1]

4.2 Explain why the model is described as (a) *fluid* and (b) a *mosaic*. [2]

4.3 State the role of (a) a channel protein, (b) cholesterol. [2]

4.4 In the bilayer, where are the hydrophobic tails found, and why? [2]

4.5 Put the stages of cell signalling in order: A the ligand binds a receptor, B a cell releases a ligand, C a response is triggered inside the target cell. [1]

4.6 A hormone travels in the blood but affects only some cells. Explain why. [2]

4.7 Challenge. Oxygen crosses the membrane straight through the bilayer, but glucose needs a transport protein. Explain why, using the structure of the bilayer. [2]

15 What are the main roles of glycolipids in cell surface membranes?

1 to help cells to attach to each other to form tissues

2 to act as antigens for cell-to-cell recognition

3 to increase fluidity for the cell surface membrane

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

17 What can increase the fluidity of the cell surface membrane at low temperatures?

1 double bonds between carbon atoms in the fatty acid chains

2 cholesterol

3 fatty acids having shorter chains

A 1, 2 and 3 **B** 1 and 3 only **C** 1 only **D** 2 and 3 only

18 Which statements about the proteins and glycoproteins in cell surface membranes are correct?

1 They can allow cells to bond together to form tissues.

2 They can recognise messenger molecules like hormones.

3 They can be antigens and allow cell-to-cell recognition.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

14 Which statement about phospholipids in the bilayer of a cell surface membrane is correct?

A The non-polar phosphate heads face outwards and the polar fatty acid tails face inwards.

B The polar phosphate heads face outwards and the non-polar fatty acid tails face inwards.

C The non-polar fatty acid tails face outwards and the polar phosphate heads face inwards.

D The polar fatty acid tails face outwards and the non-polar phosphate heads face inwards.

4 Cell membranes – 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)		
partially permeable	半透			
diffusion	扩散			
osmosis	渗透			
simple diffusion	简单扩散			
oxygen	氧气			
concentration gradient	浓度梯度			
facilitated diffusion	易化扩散			
ions	离子			
glucose	葡萄糖			
water potential	水势			
Active transport	主动运输			
endocytosis	胞吞			
exocytosis	胞吐			
volume	体积			
surface area	表面积			

English	中文	Write it 3 times (English)		
turgid	膨胀			
plasmolysis	质壁分离			

Recall

From Part 1 you know the membrane is **partially permeable** 半透. Here we look at the ways substances cross it, and why cell size matters.

- At IGCSE you met **diffusion** 扩散 and **osmosis** 渗透.
- Now we add *facilitated diffusion*, *active transport*, and the surface area : volume idea.

New ideas

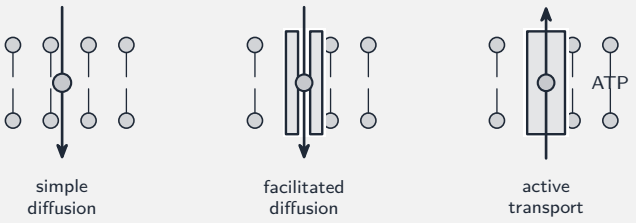
Read these first, then do the Practice.

1 Passive transport (no energy)

- **simple diffusion** 简单扩散—small or non-polar molecules (like **oxygen** 氧气) pass straight through the bilayer, **down** the **concentration gradient** 浓度梯度.
- **facilitated diffusion** 易化扩散—**ions** 离子 and large polar molecules (like **glucose** 葡萄糖) cross through channel or carrier proteins, still down the gradient.
- **osmosis** 渗透—water moves across a partially permeable membrane from higher to lower **water potential** 水势.

2 Active transport (uses ATP)

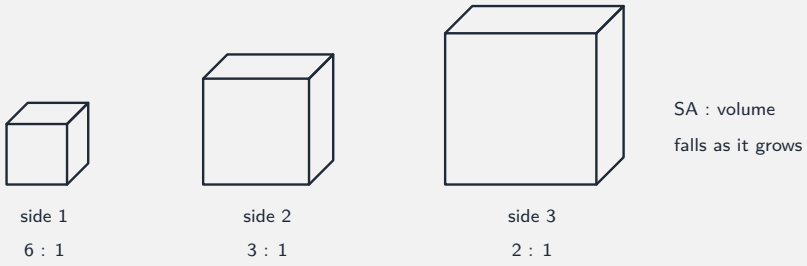
Active transport 主动运输 moves a substance **against** its concentration gradient (low → high). It needs a carrier protein **and** energy from **ATP**.



Larger amounts move in bulk by **endocytosis** 胞吞 (folding material in) and **exocytosis** 胞吐 (releasing material out), both using ATP.

3 Surface area to volume ratio

A cell exchanges substances across its surface. As it grows, **volume** 体积 grows faster than **surface area** 表面积, so the surface area : volume ratio gets **smaller**.



This is why small or thin, flat cells exchange materials fast, while large cells cannot rely on diffusion alone.

4 Cells in solutions

- a plant cell in pure water becomes **turgid** 膨胀 (the wall stops it bursting); in a strong solution it loses water and undergoes **plasmolysis** 质壁分离.
- an animal cell has no wall: in pure water it may **burst**; in a strong solution it **shrinks**.

Watch out: passive transport (diffusion, facilitated diffusion, osmosis) goes *down* the gradient with *no* energy; active transport goes *against* the gradient and needs ATP and a carrier protein. As a cell grows, its surface-area-to-volume ratio *falls*.

Practice

Try these in order.

4.1 Name the process that moves a substance **against** its concentration gradient. [1]

4.2 State one difference between simple diffusion and facilitated diffusion. [1]

4.3 Active transport and facilitated diffusion both use proteins. State one way they differ. [1]

4.4 A cube-shaped cell of side 2 has a surface area : volume ratio of 3 : 1. Explain what

happens to this ratio as the cell grows larger. [2]

4.5 Explain why a small cell can exchange substances faster than a large cell. [2]

4.6 An animal cell and a plant cell are both placed in pure water. Describe what happens to each. [2]

4.7 Challenge. Cells lining the gut are covered in tiny folds called microvilli. Explain how this helps absorption, using the idea of surface area. [2]

16 A sample of healthy plant cells taken from the same tissue is placed in a beaker containing distilled water.

The cells change in size.

What would explain this change in size?

A Water will leave the cells by active transport.

B Water will enter the cells by osmosis.

C Solutes will enter the cells by active transport.

D Solutes will leave the cells by osmosis.

17 When red blood cells are put into distilled water they burst (haemolysis).

Which statements explain this haemolysis?

1 The water potential of the surrounding liquid is lower than the water potential of the contents of the red blood cell.

2 The cell surface membranes of red blood cells are **not** supported by cell walls.

3 More water moves into the red blood cells by osmosis than leaves the cells.

4 Water enters the red blood cells by osmosis but does **not** leave the cells.

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

5 Chromosomes and mitosis – 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)		
chromosomes	染色体			
genes	基因			
DNA	脱氧核糖核酸			
chromosome	染色体			
histones	组蛋白			
nucleus	细胞核			
replication	复制			
sister chromatids	姐妹染色单体			
centromere	着丝粒			
telomeres	端粒			
cell cycle	细胞周期			
interphase	间期			
mitosis	有丝分裂			
cytokinesis	胞质分裂			
stem cell	干细胞			

English	中文	Write it 3 times (English)
differentiate	分化	

Recall

At IGCSE you learned that **chromosomes** 染色体 in the nucleus carry the **genes** 基因, and that cells divide to make new cells.

- **DNA** 脱氧核糖核酸 is the molecule that stores the genetic information.
- A cell copies its DNA before it divides.

Nothing here is harder than IGCSE —it just adds the right words and a clearer picture.

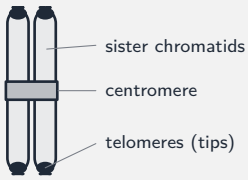
New ideas

Read these first, then do the Practice.

1 The structure of a chromosome

A **chromosome** 染色体 is one long molecule of DNA wound tightly around proteins called **histones** 组蛋白. Winding it up lets a huge length fit inside the **nucleus** 细胞核.

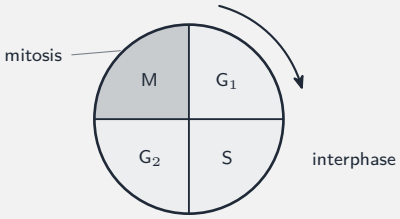
Before a cell divides, its DNA is copied (**replication** 复制). Each chromosome is then two identical copies —the **sister chromatids** 姐妹染色单体—joined at the **centromere** 着丝粒. The tips are capped by **telomeres** 端粒.



2 The cell cycle

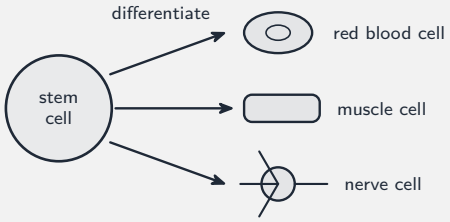
The **cell cycle** 细胞周期 is the full life of a cell from one division to the next:

1. **interphase** 间期—the longest part: the cell grows, then copies its DNA (replication), then grows again.
2. **mitosis** 有丝分裂—the nucleus divides into two identical nuclei.
3. **cytokinesis** 胞质分裂—the rest of the cell splits into two.



3 Telomeres and stem cells

- **telomeres** carry no genes. A little is lost at each division, so the telomeres shorten **instead of** important genes.
- a **stem cell** 干细胞 is an unspecialised cell that keeps dividing and can **differentiate** 分化 (change) into many specialised cell types.



Watch out: after replication a chromosome is *two* sister chromatids joined at the centromere —but it is still *one* chromosome until anaphase separates them. Telomeres are sacrificed at each division so the gene-carrying DNA is not lost.

Practice

Try these in order.

5.1 A chromosome is DNA wound around proteins. Name those proteins. [1]

5.2 After replication a chromosome has two identical parts. Name (a) these parts, (b) the point where they are joined. [2]

5.3 Put the cell cycle in order: mitosis, cytokinesis, interphase. [1]

5.4 In which stage of the cell cycle is the DNA copied? [1]

5.5 Telomeres carry no genes. Explain why this is useful when DNA is copied. [2]

5.6 What is a stem cell? [2]

5.7 Challenge. Most body cells can divide only a limited number of times before they stop. Suggest how the shortening of telomeres could explain this limit. [2]

20 Telomeres become shorter during each cell cycle of a specialised cell.

In which phase of the cell cycle do telomeres shorten?

A cytokinesis

B G_1

C S

D G_2

21 What are roles of adult stem cells in humans?

1 repair other cells by mitosis

2 divide to replace cells in tissues

3 differentiate into a new organism

A 1 and 3 **B** 1 only **C** 2 and 3 **D** 2 only

22 Which statements are correct for the mitotic cell cycle?

1 DNA is replicated semi-conservatively during mitosis.

2 DNA is never changed from one generation of cells to the next generation.

3 The daughter cells at the end of a mitotic cell division have the potential to produce the same enzymes as the parent cell.

4 The same quantity of DNA is distributed to the nuclei of two new cells at the end of a mitotic cell division.

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

5 Chromosomes and mitosis – 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)		
sister chromatids	姐妹染色单体			
centromere	着丝粒			
mitosis	有丝分裂			
genetically identical	基因相同			
daughter cells	子细胞			
multicellular	多细胞			
asexual reproduction	无性生殖			
prophase	前期			
nuclear envelope	核膜			
spindle	纺锤体			
metaphase	中期			
equator	赤道			
anaphase	后期			
poles	两极			
telophase	末期			

English	中文	Write it 3 times (English)		
cytokinesis	胞质分裂			
tumour	肿瘤			

Recall

From Part 1 you know a chromosome becomes two **sister chromatids** 姐妹染色单体 joined at the **centromere** 着丝粒 after copying. Here we watch how they are shared out in **mitosis** 有丝分裂.

- Mitosis makes two new cells that are **genetically identical** 基因相同 to the parent.
- At IGCSE you saw cells dividing in a root tip.

New ideas

Read these first, then do the Practice.

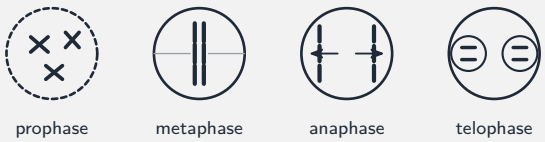
1 Why mitosis matters

Mitosis 有丝分裂 makes two **daughter cells** 子细胞 with exactly the same genes as the parent. It is used for:

- **growth** of a **multicellular** 多细胞 organism (more cells).
- **repair** and **replacement** of damaged cells.
- **asexual reproduction** 无性生殖 (one parent, identical offspring).

2 The four stages of mitosis

Stage	What happens
prophase 前期	chromosomes coil up and become visible; the **nuclear envelope** 核膜 breaks down; a **spindle** 纺锤体 forms
metaphase 中期	chromosomes line up along the middle (the **equator** 赤道)
anaphase 后期	the centromeres split; sister chromatids are pulled to opposite **poles** 两极
telophase 末期	a nuclear envelope forms around each set, making two nuclei

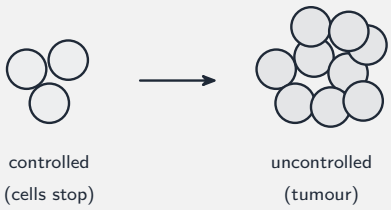


A simple way to remember the order: **P**rophase, **M**etaphase, **A**naphase, **T**elophase ("PMAT").

3 Cytokinesis and uncontrolled division

After telophase, **cytokinesis** 胞质分裂 splits the rest of the cell into two identical daughter cells.

The cell cycle is normally tightly controlled. If control is lost, a cell may divide again and again to form a lump of cells —a **tumour** 肿瘤.



Watch out: mitosis makes two *genetically identical* daughter cells; the stage order is PMAT (prophase → metaphase → anaphase → telophase). A tumour forms when the *control* of the cell cycle is lost —not from normal mitosis.

Practice

Try these in order.

5.1 State two uses of mitosis in the body. [2]

5.2 The two daughter cells made by mitosis are described as *genetically identical*. What does this mean? [1]

5.3 Name the stage of mitosis in which: (a) chromosomes line up at the equator, (b) sister chromatids are pulled to opposite poles. [2]

5.4 During prophase, two things happen to prepare for division. State them. [2]

5.5 What is the name of the process that splits the rest of the cell after mitosis? [1]

5.6 Explain how a tumour forms. [2]

5.7 Challenge. Mitosis normally makes genetically identical cells, yet a tumour keeps growing. Explain why a tumour still uses mitosis but is harmful. [2]

19 A human muscle cell contains 46 chromosomes.

How many centromeres will be present in a cell during the stages of the mitotic cell cycle?

	early prophase	metaphase	anaphase
A	46	46	92
B	46	92	92
C	46	46	46
D	92	46	46

22 Which events listed are part of mitosis?

1 interphase

2 prophase

3 cytokinesis

A 1, 2 and 3 **B** 1 and 2 only **C** 1 only **D** 2 only

6 Nucleic acids – 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)		
DNA	脱氧核糖核酸			
Nucleic acids	核酸			
nucleotides	核苷酸			
phosphate	磷酸			
sugar	糖			
base	碱基			
purines	嘌呤			
pyrimidines	嘧啶			
double helix	双螺旋			
deoxyribose	脱氧核糖			
complementary base pairing	碱基互补配对			
hydrogen bonds	氢键			
antiparallel	反平行			
Replication	复制			
semi-conservative	半保留			

English	中文	Write it 3 times (English)		
DNA polymerase	聚合酶			

Recall

At IGCSE you met **DNA** 脱氧核糖核酸 as the molecule in the nucleus that carries the genetic information. Now we look at what it is made of and how it is copied.

- DNA is a very long molecule built from small repeating units.
- It can be **copied** exactly, which is how cells pass on their information.

Nothing here is harder than IGCSE —it just adds detail and the right words.

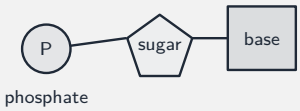
New ideas

Read these first, then do the Practice.

1 Nucleotides

Nucleic acids 核酸 (DNA and RNA) are polymers of **nucleotides** 核苷酸. Each nucleotide has three parts:

- a **phosphate** 磷酸 group,
- a 5-carbon **sugar** 糖,
- a nitrogen-containing **base** 碱基.



There are five bases in two groups: **purines** 嘌呤 (a double ring —adenine, guanine) and **pyrimidines** 嘧啶 (a single ring —cytosine, thymine, uracil).

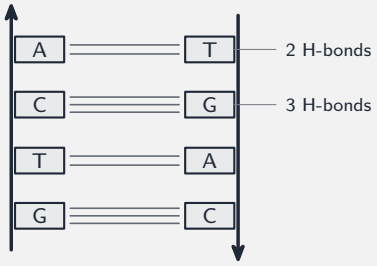
2 The DNA double helix

A DNA molecule is two strands twisted into a **double helix** 双螺旋. Each strand has a backbone of alternating sugar (**deoxyribose** 脱氧核糖) and phosphate.

The two strands are held together by **complementary base pairing** 碱基互补配对:

- A pairs with T (two **hydrogen bonds** 氢键).
- C pairs with G (three hydrogen bonds).

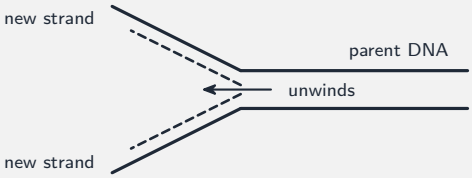
The strands run in opposite directions —they are **antiparallel** 反平行.



3 DNA replication

Replication 复制 (copying) is **semi-conservative** 半保留: each new molecule keeps **one old strand and one new strand**.

1. the helix unwinds and the hydrogen bonds break, so the strands separate.
2. each old strand is a template; free nucleotides pair with the exposed bases.
3. the enzyme **DNA polymerase** 聚合酶 joins the new nucleotides into a strand.



Watch out: A pairs with T (two hydrogen bonds), C pairs with G (three). The strands are *antiparallel*. Replication is *semi-conservative* —each new molecule keeps *one* old strand and one new strand.

Practice

Try these in order.

6.1 Name the three parts of a nucleotide. [3]

6.2 In DNA, which base pairs with (a) adenine, (b) cytosine? [2]

6.3 A C–G base pair is held by three hydrogen bonds; an A–T pair by two. Which pair is harder to separate? [1]

6.4 What is meant by saying the two DNA strands are *antiparallel*? [1]

6.5 Explain why DNA replication is described as *semi-conservative*. [2]

6.6 Name the enzyme that joins new nucleotides together during replication. [1]

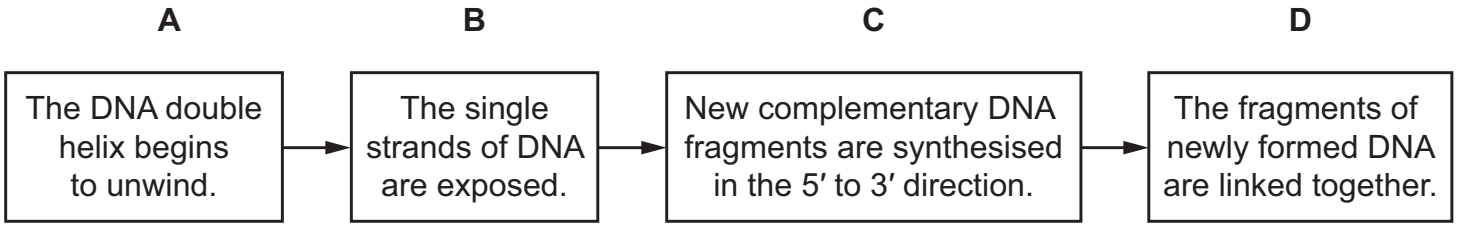
6.7 Challenge. One strand of DNA reads A–T–G–C–C. Write the base sequence of the complementary strand. [2]

24 Which row describes the role of the enzymes DNA polymerase and DNA ligase?

	DNA polymerase	DNA ligase
A	adds nucleotides in a 5′ to 3′ direction	joins sections of DNA together on the lagging strand
B	adds nucleotides in a 3′ to 5′ direction	joins sections of DNA together on the leading strand
C	adds nucleotides in a 3′ to 5′ direction	joins sections of DNA together on the lagging strand
D	adds nucleotides in a 5′ to 3′ direction	joins sections of DNA together on the leading strand

24 The flow diagram shows some of the stages in the replication of a lagging strand of DNA.

Which stage of DNA replication uses the enzyme DNA ligase?



25 Which statements about complementary base pairing are correct?

1 It occurs during translation.

2 Purines and pyrimidines are the same size.

3 The base pairs are of equal length.

4 Uracil forms three hydrogen bonds with adenine.

A 1 and 2 **B** 1 and 3 **C** 2 and 3 **D** 3 and 4

6 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)		
DNA	脱氧核糖核酸			
gene	基因			
protein	蛋白质			
RNA	核糖核酸			
ribose	核糖			
uracil	尿嘧啶			
Messenger RNA (mRNA)	信使			
triplets	三联体			
amino acid	氨基酸			
transcription	转录			
RNA polymerase	聚合酶			
template strand	模板链			
translation	翻译			
codons	密码子			
transfer RNA (tRNA)	转运			

English	中文	Write it 3 times (English)		
anticodon	反密码子			
ribosome	核糖体			
peptide bonds	肽键			
mutation	突变			
substitution	替换			
deletion	缺失			
insertion	插入			
frameshift	移码			

Recall

From Part 1 you know **DNA** 脱氧核糖核酸 is a double helix of paired bases. Here we see how a **gene** 基因 is used to build a **protein** 蛋白质.

- A gene is a length of DNA that codes for one polypeptide.
- The information is carried out of the nucleus by **RNA** 核糖核酸.

New ideas

Read these first, then do the Practice.

■ 1 RNA and the genetic code

RNA is also made of nucleotides, but it is a **single strand**, its sugar is **ribose** 核糖, and it uses **uracil** 尿嘧啶 in place of thymine. **Messenger RNA (mRNA)** 信使 RNA carries a copy of a gene out of the nucleus.

The code is read in **triplets** 三联体—groups of three bases. Each triplet codes for one **amino acid** 氨基酸 (or a start/stop signal). There are 64 triplets but only 20 common amino acids, so most amino acids have more than one triplet.

■ 2 Transcription (in the nucleus)

Copying a gene into mRNA is **transcription** 转录:

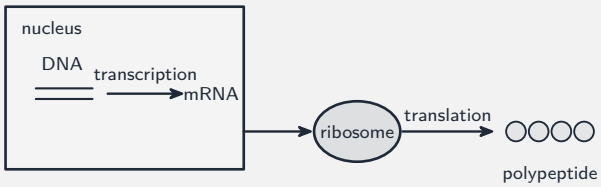
- the enzyme **RNA polymerase** 聚合酶 joins RNA nucleotides that pair with the **template strand** 模板链 (uracil pairs with adenine).

- the finished mRNA leaves the nucleus.

3 Translation (at the ribosome)

Building the polypeptide from the mRNA is **translation** 翻译:

- the mRNA is read in **codons** 密码子 (each codon is one triplet).
- **transfer RNA (tRNA)** 转运 RNA brings amino acids; each tRNA has an **anticodon** 反密码子 that pairs with a codon.
- the **ribosome** 核糖体 joins the amino acids with **peptide bonds** 肽键.



4 Gene mutations

A **mutation** 突变 is a change in the base sequence of DNA. Three types:

- **substitution** 替换—one base is swapped; changes at most one amino acid.
- **deletion** 缺失—a base is removed.
- **insertion** 插入—a base is added.

A deletion or insertion shifts how every later triplet is read (a **frameshift** 移码), so it usually changes many amino acids.

Watch out: transcription (DNA → mRNA) happens in the *nucleus*; translation (mRNA → protein) at the *ribosome*. In RNA, uracil replaces thymine, so A pairs with U. A frameshift (deletion/insertion) changes *many* amino acids; a substitution at most one.

Practice

Try these in order.

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

6.2 A triplet (codon) is how many bases? [1]

6.3 Name the process that: (a) copies a gene into mRNA, (b) builds a polypeptide at the ribosome. [2]

6.4 What does a tRNA molecule bring to the ribosome, and what part of it pairs with a codon? [2]

6.5 A substitution changes only one amino acid, but a deletion can change many. Explain why. [2]

6.6 Define a gene mutation. [1]

6.7 Challenge. A DNA template strand reads T–A–C. Write the mRNA codon transcribed from it. [2]

26 How is a primary transcript modified to form mRNA?

A It becomes longer as exons are joined together.

B It becomes shorter as exons are removed.

C It becomes longer as introns are joined together.

D It becomes shorter as introns are removed.

26 Which statement is correct for protein synthesis?

A During translation, the strand of DNA used is the template strand.

B mRNA is formed when introns are removed from the primary transcript.

C The DNA primary transcript is modified by removing exons.

D tRNA has codons which attach to anticodons on the mRNA.

25 When a gene mutation occurs, which of the following may be altered, resulting in the production of a non-functional protein?

1 amino acid sequence

2 DNA nucleotide sequence

3 mRNA nucleotide sequence

A 1, 2 and 3 **B** 1 and 2 only **C** 2 and 3 only **D** 2 only

7 Transport in plants – 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)		
osmosis	渗透			
tissues	组织			
xylem	木质部			
mineral ions	矿物离子			
phloem	韧皮部			
vessel	导管			
lignin	木质素			
sieve tube	筛管			
sieve plates	筛板			
companion cell	伴胞			
root hair cell	根毛细胞			
apoplast pathway	质外体途径			
cell walls	细胞壁			
symplast pathway	共质体途径			
cytoplasm	细胞质			

English	中文	Write it 3 times (English)		
endodermis	内皮层			
Casparian strip	凯氏带			

Recall

At IGCSE you learned that plants take up water through their roots and that leaves lose water. Now we look at the two transport tissues and how water reaches them.

- Plants have tubes that carry water and food, a bit like our blood vessels.
- Water enters the root by **osmosis** 渗透 (from the Cell membranes sheet).

Nothing here is harder than IGCSE —it just adds the right words.

New ideas

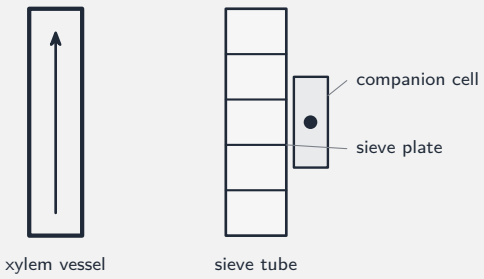
Read these first, then do the Practice.

1 The two transport tissues

Plants move substances through two **tissues** 组织:

- **xylem** 木质部 carries **water** and dissolved **mineral ions** 矿物离子 **up** from the roots.
- **phloem** 韧皮部 carries dissolved food (mainly sugars) to wherever it is needed.

Tissue	Structure	Suits its job because···
xylem **vessel** 导管	dead, empty cells joined end to end; walls strengthened with **lignin** 木质素	a hollow open pipe lets water flow fast; lignin gives support
phloem **sieve tube** 筛管	living cells with **sieve plates** 筛板; a **companion cell** 伴胞 alongside	the companion cell does the living work and loads sugars



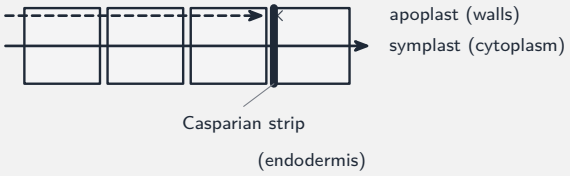
2 Water from soil to xylem

Water enters a **root hair cell** 根毛细胞 by osmosis, then crosses the root by two pathways:

- the **apoplast pathway** 质外体途径—through the **cell walls** 细胞壁 and spaces, **not** through the cytoplasm (fast).

- the **symplast pathway** 共质体途径—through the **cytoplasm** 细胞质, from cell to cell.

At the **endodermis** 内皮层 a waterproof band, the **Casparian strip** 凯氏带, blocks the apoplast. This forces water through the cell membrane, so the plant can control what enters the xylem.



Watch out: xylem is made of *dead*, hollow, lignified tubes carrying water *up*; phloem is *living* sieve tubes carrying sugars. The Casparian strip forces water through a cell membrane, so the plant controls what enters the xylem.

Practice

Try these in order.

7.1 State what each tissue carries: (a) xylem, (b) phloem. [2]

7.2 Xylem vessels are made of dead, empty cells with no end walls. Explain how this suits their job. [2]

7.3 What substance strengthens and waterproofs the walls of xylem vessels? [1]

7.4 Name the two pathways by which water crosses the root to the xylem. [2]

7.5 The Casparian strip blocks the apoplast pathway at the endodermis. Explain why

this is useful to the plant. [2]

7.6 What is the role of the companion cell next to a sieve tube? [1]

7.7 Challenge. Xylem vessels are dead and hollow, but phloem sieve tubes are living. Explain why each suits its transport job. [2]

27 Which features of xylem vessels help to reduce the resistance to water flow?

1 Lignin forms an incomplete secondary wall.

2 There are **no** cross walls between the vessel elements.

3 The xylem vessels form narrow tubes.

A 1, 2 and 3 **B** 1 and 2 only **C** 2 only **D** 3 only

27 Which feature of xylem vessel elements allows them to have reduced resistance to water movement?

A Lignin forms an incomplete secondary wall.

B New vessels transport extra water as a plant grows.

C There are no cross walls between vessel elements.

D Vessel elements join to form narrow tubes.

7 Transport in plants – 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)		
xylem	木质部			
phloem	韧皮部			
Transpiration	蒸腾作用			
evaporates	蒸发			
diffuses	扩散			
stomata	气孔			
hydrogen bonds	氢键			
cohesion	内聚力			
tension	张力			
xerophyte	旱生植物			
adapted	适应			
cuticle	角质层			
Translocation	运输			
sucrose	蔗糖			
source	源			

English	中文	Write it 3 times (English)		
sink	库			
active transport	主动运输			
water potential	水势			
pressure	压力			
mass flow	集流			

Recall

From Part 1 you know **xylem** 木质部 carries water up and **phloem** 韧皮部 carries food. Here we see what pulls the water up and how the food is moved.

- Leaves lose water vapour —you saw this at IGCSE.
- Water molecules stick together, which turns out to be very important.

New ideas

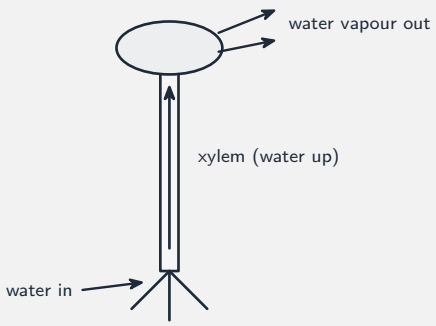
Read these first, then do the Practice.

1 Transpiration

Transpiration 蒸腾作用 is the loss of water vapour from a plant. Water **evaporates** 蒸发 from wet cell surfaces inside the leaf, then **diffuses** 扩散 out through the **stomata** 气孔.

This loss at the top pulls a continuous column of water **up** the xylem:

- water molecules attract each other by **hydrogen bonds** 氢键, so they stick together —this is **cohesion** 内聚力.
- the whole column is pulled up under **tension** 张力 (the cohesion–tension idea).



■ 2 Xerophytes

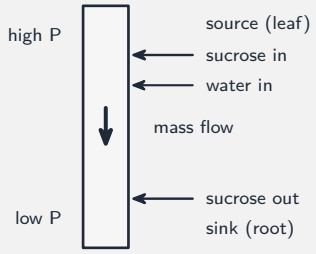
A **xerophyte** 旱生植物 is a plant **adapted** 适应 to dry places. Its leaves cut water loss with a thick waxy **cuticle** 角质层, **stomata** sunk in pits, hairs that trap moist air, and leaves that can roll up.

■ 3 Translocation (moving sugars)

Translocation 运输 carries sugars (**sucrose** 蔗糖) in the phloem from a **source** 源 to a **sink** 库:

- a **source** is where sugar is made or released (e.g. a leaf).
- a **sink** is where it is used or stored (e.g. a growing root).

Companion cells load sucrose into the sieve tube by **active transport** 主动运输. This lowers the **water potential** 水势, so water enters and raises the **pressure** 压力. Sap then flows from high pressure (source) to low pressure (sink) —this is **mass flow** 集流.



Watch out: transpiration *pulls* water up the xylem by cohesion–tension (no energy used). Translocation in the phloem *actively* loads sugars and moves them source → sink by mass flow (this *does* use energy).

Practice

Try these in order.

7.1 Define transpiration. [1]

7.2 Describe how water vapour leaves a leaf, using the words *evaporate*, *stomata* and *diffuse*. [2]

7.3 Water molecules stick together as they move up the xylem. (a) Name this sticking

together. (b) Name the force that holds the molecules together. [2]

7.4 State two ways a xerophyte leaf reduces water loss. [2]

7.5 In translocation, explain the difference between a *source* and a *sink*. [2]

7.6 Loading sucrose into a sieve tube causes water to enter it. Explain why. [2]

7.7 Challenge. Water rises to the top of a tall tree with no pump. Explain how transpiration and cohesion make this possible. [2]

28 What causes water to move from the root hair cells to the endodermis?

A diffusion through cell walls and osmosis down a water potential gradient in the cytoplasm

B diffusion through the symplast and osmosis and root pressure through the apoplast

C osmosis from cell vacuole to cell vacuole and active transport into the endodermis

D osmosis through the intercellular spaces and diffusion in cell walls and cytoplasm

28 Which statement describes movement through a plant in the apoplast pathway?

A Water moves through the cell walls.

B Water moves through the cytoplasm.

C Water moves through the plasmodesmata.

D Water moves through the vacuoles.

29 What is the correct name for the attraction due to the hydrogen bonding between water molecules during mass flow in plants?

A transpiration

B cohesion

C tension

D adhesion

8 Transport in mammals – 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)		
heart	心脏			
blood	血液			
blood vessels	血管			
double circulation	双循环			
pulmonary circulation	肺循环			
systemic circulation	体循环			
artery	动脉			
elastic	弹性			
lumen	管腔			
capillary	毛细血管			
exchange	交换			
vein	静脉			
valves	瓣膜			
plasma	血浆			
tissue fluid	组织液			

Recall

At IGCSE you learned that the **heart** 心脏 pumps **blood** 血液 around the body through **blood vessels** 血管. Now we look more carefully at the vessels and the two loops.

- Blood carries oxygen, food and waste around the body.
- The heart is a pump —in fact, two pumps side by side.

Nothing here is harder than IGCSE —it just adds detail and the right words.

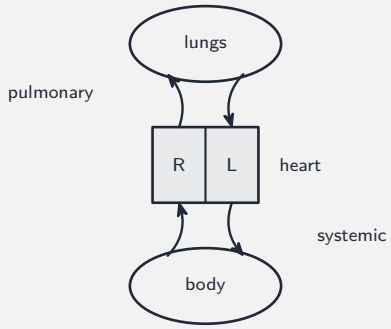
New ideas

Read these first, then do the Practice.

1 Double circulation

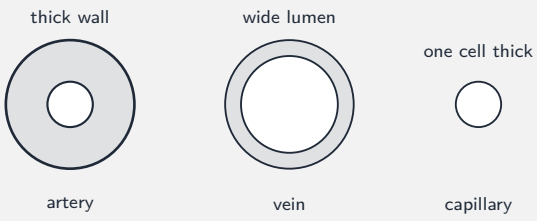
Mammals have a **double circulation** 双循环: the blood passes through the heart **twice** for each trip round the body. It is also **closed** (the blood stays inside vessels). There are two loops:

- the **pulmonary circulation** 肺循环—heart → lungs → heart.
- the **systemic circulation** 体循环—heart → body → heart.



2 The three vessels

Vessel	Structure	Function
artery 动脉	thick wall of muscle and **elastic** 弹性 fibres; narrow **lumen** 管腔	carries blood at high pressure **away** from the heart
capillary 毛细血管	wall just **one cell** thick	short distance for **exchange** 交换 of substances
vein 静脉	thin wall; wide lumen; has **valves** 瓣膜	returns blood at low pressure to the heart; valves stop backflow



3 Tissue fluid

At the start of a capillary, high blood pressure pushes liquid (but not cells or large proteins) out of the **plasma** 血浆 and through the capillary wall. This liquid around

the cells is **tissue fluid** 组织液. It supplies the cells with oxygen and glucose. Most of it returns to the capillary at the far end, where the pressure is lower.

Watch out: arteries carry blood *away* from the heart at high pressure (thick elastic walls); veins *return* it at low pressure (valves stop backflow); capillaries are one cell thick for fast exchange. "Artery" does not mean "oxygenated".

Practice

Try these in order.

8.1 What is meant by a *double* circulation? [1]

8.2 Name the loop that carries blood (a) to the lungs, (b) to the rest of the body. [2]

8.3 Explain why an artery has a thick, elastic wall. [2]

8.4 A capillary wall is only one cell thick. Explain how this suits its function. [2]

8.5 What is the job of the valves in a vein? [1]

8.6 What is tissue fluid, and how is it formed? [2]

8.7 Challenge. The pulmonary artery carries *deoxygenated* blood, yet it is still called an artery. Explain why, using the definition of an artery. [2]

30 Which statement correctly compares blood plasma and tissue fluid in a healthy person?

A Blood plasma contains more protein than tissue fluid.

B Both blood plasma and tissue fluid contain red blood cells.

C Tissue fluid contains white blood cells whereas blood plasma does **not** contain lymphocytes.

D Tissue fluid is formed from blood plasma and is **not** returned to blood plasma.

33 How many times must a carbon dioxide molecule pass through a cell surface membrane to travel from the tissue fluid into the blood plasma?

(Assume there are no pores between the cells the carbon dioxide molecule must pass through.)

A 1 **B** 2 **C** 3 **D** 4

32 Which blood vessel carries blood with the lowest pressure?

A aorta

B pulmonary artery

C pulmonary vein

D vena cava

8 Transport in mammals – 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)		
oxygen	氧气			
haemoglobin	血红蛋白			
atria	心房			
ventricles	心室			
sinoatrial node	窦房结			
pacemaker	起搏点			
atrioventricular node	房室结			
Purkyne tissue	浦肯野组织			
oxygen dissociation curve	氧解离曲线			
saturation	饱和度			
partial pressure	分压			
carbon dioxide	二氧化碳			
Bohr shift	波尔位移			

Recall

From Part 1 you know the heart is a double pump. Here we look inside it, and at how the blood carries **oxygen** 氧气.

- The heart has four chambers (you met them at IGCSE).
- Oxygen is carried by **haemoglobin** 血红蛋白 in the red blood cells.

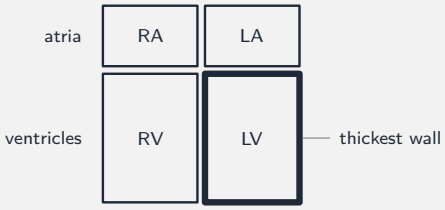
New ideas

Read these first, then do the Practice.

1 The four chambers

The two upper chambers are the **atria** 心房 (thin walls —they only push blood to the chambers below). The two lower chambers are the **ventricles** 心室 (thick muscular walls —they pump blood out).

The **left ventricle** wall is the thickest, because it pumps blood all the way round the **body**, while the right side only pumps to the nearby **lungs**.



2 Controlling the heartbeat

The heart sets its own rhythm:

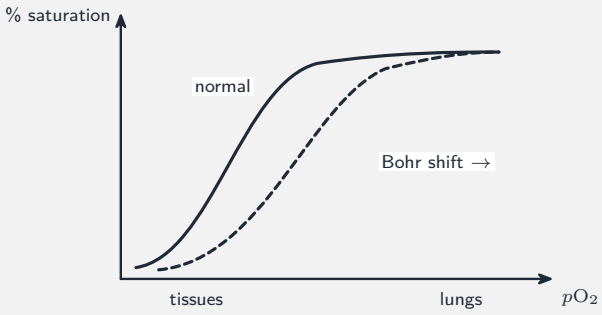
- the **sinoatrial node** 窦房结 (SAN) is the **pacemaker** 起搏点; it starts each beat and makes the atria contract.
- the **atrioventricular node** 房室结 (AVN) passes the signal on, after a short delay so the atria empty first.
- the **Purkyne tissue** 浦肯野组织 carries the signal down the ventricle walls so they contract from the bottom up.

3 Carrying oxygen

Haemoglobin 血红蛋白 in the red blood cells carries oxygen. The **oxygen dissociation curve** 氧解离曲线 (an S-shape) plots **saturation** 饱和度 (how full of oxygen) against the **partial pressure** 分压 of oxygen:

- where oxygen is **high** (lungs), haemoglobin loads up and becomes almost full.
- where oxygen is **low** (active tissues), haemoglobin unloads its oxygen.

When tissues are active they release **carbon dioxide** 二氧化碳, which makes haemoglobin give up oxygen more easily —the curve shifts right. This is the **Bohr shift** 波尔位移.



Watch out: the *left* ventricle wall is thickest because it pumps to the whole body. The SAN is the pacemaker; the AVN delay lets the atria empty first. On the dissociation curve, high oxygen (lungs) → haemoglobin loads; low oxygen (active tissues) → it unloads.

Practice

Try these in order.

8.1 Name (a) the two upper chambers, (b) the two lower chambers of the heart. [2]

8.2 Explain why the left ventricle wall is thicker than the right. [2]

8.3 Which part of the heart acts as the pacemaker? [1]

8.4 The atrioventricular node delays the signal for a moment. Explain why this delay is useful. [2]

8.5 Using the oxygen dissociation curve, describe what haemoglobin does where the

partial pressure of oxygen is (a) high, (b) low. [2]

8.6 What is the Bohr shift? [1]

8.7 Challenge. During exercise, muscles release more carbon dioxide. Using the Bohr shift, explain how this helps the muscles get more oxygen. [2]

32 Red blood cells may contain a molecule known as 2,3-bisphosphoglycerate (2,3-BPG).

When 2,3-BPG binds to haemoglobin, a higher partial pressure of oxygen is needed to bring about 50% saturation of haemoglobin with oxygen.

Which statements about the effect of 2,3-BPG are correct?

1 2,3-BPG in red blood cells causes the oxygen dissociation curve to shift to the right.

2 The binding of 2,3-BPG to haemoglobin reduces the Bohr effect.

3 The binding of 2,3-BPG to haemoglobin lowers the affinity of the haemoglobin for oxygen.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

33 Which statement correctly describes the Bohr shift?

A the decrease in affinity of haemoglobin for oxygen that occurs when pH is lowered

B the increase in affinity of haemoglobin for oxygen that occurs when oxygen concentration rises

C the increase in affinity of haemoglobin for oxygen that occurs when pH is at an optimum

D the release of oxygen from oxyhaemoglobin in the absence of carbonic acid

33 A person has a small hole in the septum between the ventricles. This is called a ventricular septal defect (VSD). The person has no other heart defects.

What is the direction of the net flow of blood during ventricular systole in the heart of this person?

A left ventricle to left atrium

B right ventricle to right atrium

C left ventricle to right ventricle

D right ventricle to left ventricle

34 Which row correctly describes the features for two of the heart chambers?

	left atrium	left ventricle
A	large force of contraction to allow blood to travel a long distance	large force of contraction to allow blood to travel a long distance
B	small force of contraction as blood only needs to travel a short distance	large force of contraction to allow blood to travel a long distance
C	small force of contraction as blood only needs to travel a short distance	small force of contraction as blood only needs to travel a short distance
D	large force of contraction to allow blood to travel a long distance	small force of contraction as blood only needs to travel a short distance

9 Gas exchange – 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)		
oxygen	氧气			
carbon dioxide	二氧化碳			
lungs	肺			
trachea	气管			
bronchi	支气管			
bronchioles	细支气管			
alveoli	肺泡			
cartilage	软骨			
ciliated epithelium	纤毛上皮			
cilia	纤毛			
mucus	黏液			
goblet cells	杯状细胞			
microbes	微生物			
smooth muscle	平滑肌			

Recall

At IGCSE you learned that we breathe in **oxygen** 氧气 and breathe out **carbon dioxide** 二氧化碳, and that this swap happens in the **lungs** 肺. Now we follow the air in and look at the airway walls.

- Air travels down a set of branching tubes to tiny air sacs.
- The airways have special tissues that keep the lungs clean and open.

Nothing here is harder than IGCSE —it just adds the right words.

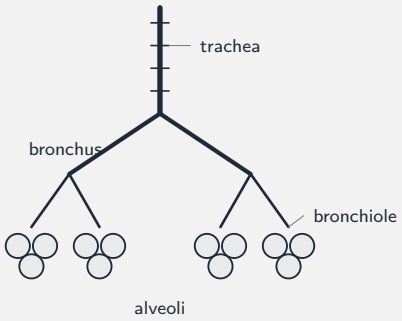
New ideas

Read these first, then do the Practice.

1 The path of the air

Air follows this path into the lungs:

- down the **trachea** 气管 (windpipe),
- into two **bronchi** 支气管 (one to each lung),
- into many smaller **bronchioles** 细支气管,
- into tiny air sacs, the **alveoli** 肺泡.

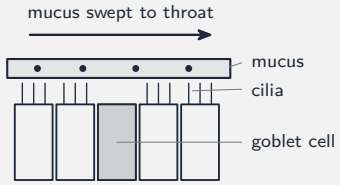


2 Tissues of the airways

Tissue	Function
cartilage 软骨	C-shaped rings that hold the airway **open** so it cannot collapse
ciliated epithelium 纤毛上皮	tiny hairs (**cilia** 纤毛) beat to sweep **mucus** 黏液 up to the throat
goblet cells 杯状细胞	make the mucus, which traps dust and **microbes** 微生物
smooth muscle 平滑肌	contracts to make the airway narrower

3 Keeping the lungs clean

The mucus traps dust and microbes you breathe in. The cilia then sweep the dirty mucus up to the throat, where it is swallowed —so the lungs stay clean and healthy.



Watch out: the air path is trachea → bronchi → bronchioles → alveoli. Cartilage holds the airways *open*; goblet cells make the mucus that traps dirt; cilia sweep it up. If the cilia are damaged, mucus builds up.

Practice

Try these in order.

9.1 Put these in the order air passes through them: bronchioles, trachea, alveoli, bronchi. [1]

9.2 What is the job of the cartilage rings in the trachea and bronchi? [1]

9.3 Explain how the goblet cells and cilia work together to keep the lungs clean. [2]

9.4 Name the tiny air sacs where gas exchange happens. [1]

9.5 What does the smooth muscle in the airway walls do when it contracts? [1]

9.6 Suggest why a smoker, whose cilia are damaged, often has a cough. [2]

9.7 Challenge. Explain why breathing in dirty air is more harmful to a smoker (whose cilia are damaged) than to a non-smoker. [2]

9 Gas exchange – 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)		
alveoli	肺泡			
diffusion	扩散			
capillaries	毛细血管			
surface area	表面积			
concentration gradients	浓度梯度			
oxygen	氧气			
carbon dioxide	二氧化碳			

Recall

From Part 1 you know air reaches the **alveoli** 肺泡 deep in the lungs. Here we see how the gases actually cross into the blood.

- Gases move by **diffusion** 扩散 (from the Cell membranes sheet) —high to low concentration.
- Each alveolus is wrapped in tiny blood **capillaries** 毛细血管.

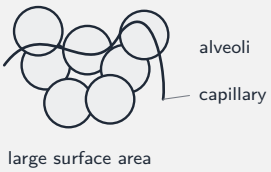
New ideas

Read these first, then do the Practice.

■ 1 A good exchange surface

The alveoli are excellent for swapping gases because they have:

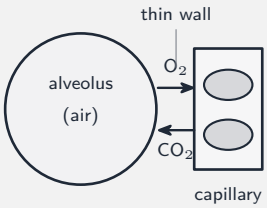
- a very large total **surface area** 表面积 (millions of tiny sacs),
- very **thin** walls —the alveolus wall and the capillary wall are each only **one cell thick**,
- a rich blood supply,
- a **moist** lining, so gases dissolve before crossing.



■ 2 Diffusion of the gases

Gases diffuse down their **concentration gradients** 浓度梯度:

- **oxygen** 氧气 is high in the alveolar air and low in the blood, so it diffuses **into** the blood.
- **carbon dioxide** 二氧化碳 is high in the blood and low in the air, so it diffuses **out** to be breathed out.



■ 3 Keeping it fast

Breathing keeps fresh air in the alveoli, and the flowing blood keeps carrying the gases away. Both keep the concentration gradients **steep**, so gas exchange stays fast.

Watch out: gases cross the alveolus by *diffusion* down a concentration gradient. The alveoli are efficient because of a *large* surface area, *thin* (one-cell) walls, a rich blood supply and a moist lining —and breathing plus blood flow keep the gradient steep.

Practice

Try these in order.

9.1 State two features of the alveoli that make them good for gas exchange. [2]

9.2 In which direction does (a) oxygen, (b) carbon dioxide diffuse at the alveolus? [2]

9.3 The alveolus wall and capillary wall are each one cell thick. Explain why this helps gas exchange. [2]

9.4 By what process do the gases cross the alveolus wall? [1]

9.5 Explain how breathing and the flow of blood keep the concentration gradients steep. [2]

9.6 Suggest why having millions of tiny alveoli is better than one large air sac. [2]

9.7 Challenge. In the disease emphysema, the walls between alveoli break down, merging them into fewer, larger sacs. Explain why this makes gas exchange less efficient. [2]

35 Which tissues would be seen in a photomicrograph of the wall of the trachea?

	elastic fibres	smooth muscle
A	✗	✓
B	✓	✗
C	✓	✓
D	✗	✗

key

✓ = present

✗ = **not** present

35 What helps to maintain a concentration gradient between blood and the air in the alveolus?

A the flow of blood through the lungs

B the presence of haemoglobin in blood cells

C the single-celled alveolar walls

D the squamous epithelium of capillaries

10 Infectious disease – 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)		
microbes	微生物			
infectious	传染性			
pathogen	病原体			
infectious disease	传染病			
transmitted	传播			
cholera	霍乱			
bacterium	细菌			
faeces	粪便			
malaria	疟疾			
protoctist	原生生物			
mosquito	蚊子			
vector	媒介			
tuberculosis	结核病			
droplets	飞沫			
virus	病毒			

English	中文	Write it 3 times (English)
vaccine	疫苗	

Recall

At IGCSE you learned that some diseases are caused by **microbes** 微生物 and can spread from person to person. Now we name the pathogens and how they spread.

- A disease that spreads is called **infectious** 传染性.
- Different diseases spread in different ways —knowing how helps us stop them.

Nothing here is harder than IGCSE —it just organises the facts.

New ideas

Read these first, then do the Practice.

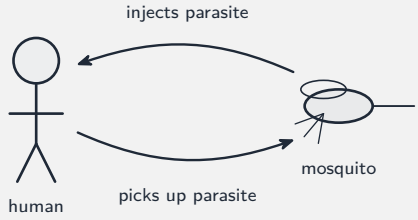
1 Pathogens and four diseases

A **pathogen** 病原体 is an organism that lives in or on a host and causes harm. An **infectious disease** 传染病 can be **transmitted** 传播 (passed) from one person to another.

Disease	Pathogen	How it spreads
cholera 霍乱	a **bacterium** 细菌	water or food with **faeces** 粪便 in it
malaria 疟疾	a **protoctist** 原生生物	bite of an infected **mosquito** 蚊子 (a **vector** 媒介)
tuberculosis 结核病	a bacterium	airborne **droplets** 飞沫 from coughs
HIV/AIDS	a **virus** 病毒	unprotected sex, infected blood, mother to baby

2 The mosquito vector

Malaria needs a **vector** 媒介—a carrier that passes the pathogen on. A mosquito bites an infected person and picks up the parasite, then injects it into the next person it bites. This is why malaria control targets the **mosquito**.



3 Controlling the diseases

Control has **biological**, **social** and **economic** sides:

- **cholera** —clean water and proper sewage; good hygiene.

- **malaria** —sleep under nets; remove still water where mosquitoes breed; insecticides.
- **TB** —find and treat patients; the BCG **vaccine** 疫苗; reduce overcrowding.
- **HIV** —use condoms and clean needles; test donated blood; educate people.

Watch out: learn the pathogen *type* for each disease —cholera and TB are bacteria, malaria is a protoctist, HIV is a virus. A *vector* (like the mosquito) *carries* the pathogen but is not itself the pathogen.

Practice

Try these in order.

10.1 What is a pathogen? [1]

10.2 Name the type of pathogen that causes (a) malaria, (b) HIV/AIDS, (c) cholera. [3]

10.3 How is tuberculosis spread from person to person? [1]

10.4 Explain what is meant by a *vector*, using the mosquito as an example. [2]

10.5 Cholera spreads through contaminated water. State one way to control it. [1]

10.6 Suggest why removing still water helps to control malaria. [2]

10.7 Challenge. Cholera and tuberculosis are both caused by bacteria, yet they spread in different ways. State how each spreads, and explain why their control methods differ.[2]

5 Which statement about viruses is correct?

A They are cells with a capsid made of phospholipids.

B They are cells with a capsid made of protein.

C They are particles with a capsid made of phospholipids.

D They are particles with a capsid made of protein.

36 Which row correctly identifies the pathogens causing malaria and TB?

	malaria	TB
A	protoctist	virus
B	protoctist	bacterium
C	prokaryote	bacterium
D	prokaryote	virus

37 What could be used to help prevent an outbreak of cholera in a town?

A treatment of sewage waste

B spraying still water with insecticides to kill mosquito larvae

C increased use of antiviral medicine

D preventing the reuse of hypodermic needles

10 Infectious disease – 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)		
bacteria	细菌			
antibiotics	抗生素			
antibiotic	抗生素			
penicillin	青霉素			
cell walls	细胞壁			
viruses	病毒			
mutation	突变			
resistant	耐药			
natural selection	自然选择			

Recall

From Part 1 you know **bacteria** 细菌 cause diseases like cholera and TB. Here we look at the drugs that fight bacteria —and why they are losing their power.

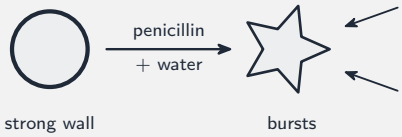
- You met **antibiotics** 抗生素 at IGCSE as medicines that treat bacterial infections.
- They do **not** work against viruses —this part explains why.

New ideas

Read these first, then do the Practice.

1 How antibiotics work

An **antibiotic** 抗生素 is a drug that kills bacteria or stops them growing. For example, **penicillin** 青霉素 stops bacteria from building their **cell walls** 细胞壁. As the bacterium grows, its weak wall cannot hold it, so the cell takes in water and **bursts**.



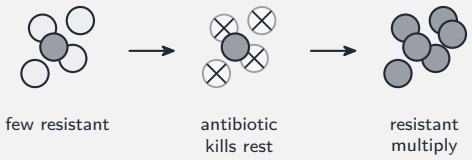
2 Why not viruses?

Antibiotics do **not** work against **viruses** 病毒. A virus has no cell wall and no chemical reactions of its own —it just uses the host cell's machinery. So there is **no antibiotic target** in a virus. (This is why antibiotics do not treat a cold.)

3 Antibiotic resistance

Sometimes a **mutation** 突变 makes a bacterium **resistant** 耐药—the antibiotic no longer kills it. Resistance spreads by **natural selection** 自然选择:

- when the antibiotic is used, the non-resistant bacteria die, but the resistant ones survive.
- the survivors multiply, so over time more and more bacteria are resistant.



To slow resistance: only use antibiotics when needed, always **finish the full course**, and reduce their heavy use in farming.

Watch out: antibiotics kill *bacteria* (e.g. by stopping cell-wall building) but do *nothing* to viruses (no cell wall, no reactions of their own to target). Resistance spreads by *natural selection*.

Practice

Try these in order.

10.1 What is an antibiotic? [1]

10.2 Explain how penicillin causes a growing bacterium to burst. [2]

10.3 Give one reason why antibiotics do not work against viruses. [1]

10.4 A few bacteria in a population are resistant to an antibiotic. Explain how, over time, most of the population can become resistant. [3]

10.5 State two things people can do to slow down antibiotic resistance. [2]

10.6 Challenge. Stopping a course of antibiotics early can make resistance worse. Explain why, using natural selection. [2]

38 How does penicillin affect bacteria?

A It inhibits DNA replication by binding to nucleotides.

B It inhibits translation by preventing tRNA binding to ribosomes.

C It is a competitive inhibitor of an enzyme in cell wall synthesis.

D It is a competitive inhibitor of an enzyme in protein synthesis.

37 Scientists investigated the sensitivity and resistance of a bacterium called *Clostridium difficile* to four antibiotics. Colonies of bacteria were grown on agar plates for 24 hours, after which a different antibiotic was added to each plate. The number of bacterial colonies that died, stopped growing and continued growing were then counted. A bacterial colony is a group of bacterial cells that have multiplied from one bacterium.

Which antibiotic would be the best to treat a person infected with *Clostridium difficile*?

	antibiotic	number of colonies that died	number of colonies that stopped growing	number of colonies that continued growing
A	ampicillin	2	5	13
B	clindamycin	4	8	6
C	metronidazole	13	6	1
D	cefoxitin	9	5	4

11 Immunity – 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)		
white blood cells	白细胞			
antibodies	抗体			
immune system	免疫系统			
pathogens	病原体			
phagocytes	吞噬细胞			
phagocytosis	吞噬作用			
enzymes	酶			
antigen	抗原			
self antigens	自身抗原			
non-self antigens	非自身抗原			
antibody	抗体			
plasma cells	浆细胞			
antigen-binding sites	抗原结合位点			

Recall

At IGCSE you learned that **white blood cells** 白细胞 defend the body against germs. Now we look at how they do it.

- Some white cells eat germs; others make **antibodies** 抗体.
- The body can tell its own cells apart from invaders.

Nothing here is harder than IGCSE —it just adds the right words.

New ideas

Read these first, then do the Practice.

1 Phagocytes

The **immune system** 免疫系统 is the set of cells that defend the body against **pathogens** 病原体. The first to act are **phagocytes** 吞噬细胞 (a type of white blood cell).

A phagocyte destroys a pathogen by **phagocytosis** 吞噬作用:

1. it **engulfs** the pathogen (surrounds and takes it inside a vesicle).
2. it **digests** the pathogen with **enzymes** 酶.
3. it then **displays** the pathogen's antigen on its surface, to alert other cells.

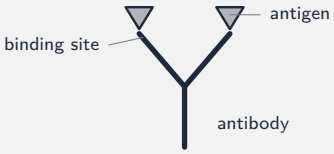
2 Antigens: self and non-self

An **antigen** 抗原 is a molecule (usually a protein) on a cell surface that the immune system can recognise:

- **self antigens** 自身抗原 are the body's own markers —the immune system ignores them.
- **non-self antigens** 非自身抗原 are foreign (e.g. on a pathogen) —they trigger a response.

3 Antibodies

An **antibody** 抗体 is a **Y-shaped** protein made by **plasma cells** 浆细胞. The two tips of the Y are **antigen-binding sites** 抗原结合位点. Each tip has a special shape that fits **one antigen only**, like a lock and key.



Antibodies stick to antigens, clump pathogens together, and mark them so phagocytes find them.

Watch out: an *antigen* is the marker on a cell surface; an *antibody* is the Y-shaped protein that binds it. Each antibody's binding site fits *one* antigen only (a complementary shape). Self antigens are ignored; non-self ones trigger a response.

Practice

Try these in order.

11.1 Name the process by which a phagocyte engulfs and digests a pathogen. [1]

11.2 Put these phagocytosis steps in order: digest, display antigen, engulf. [1]

11.3 What is an antigen? [1]

11.4 Explain the difference between a *self* and a *non-self* antigen. [2]

11.5 Describe the shape of an antibody and name the part that binds the antigen. [2]

11.6 Each antibody binds only one type of antigen. Explain why. [1]

11.7 Challenge. A transplanted organ can be ”rejected” by the patient's immune system. Suggest why, using the idea of self and non-self antigens. [2]

40 What describes a non-specific immune response?

A activation of killer T-lymphocytes by infected cells

B cloning of B-lymphocytes to form plasma cells

C ingestion of a bacterial cell by a neutrophil

D recognition of antigens on the cell surface of macrophages

39 Which molecule could be a self antigen?

A a viral capsid protein

B a phospholipid in a viral envelope

C a toxin released by a pathogen

D a glycoprotein on the surface of a macrophage

11 Immunity – 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)		
antibodies	抗体			
antigen	抗原			
vaccine	疫苗			
memory cells	记忆细胞			
primary response	初次免疫反应			
secondary response	二次免疫反应			
long-term immunity	长期免疫			
active immunity	主动免疫			
passive immunity	被动免疫			
herd immunity	群体免疫			

Recall

From Part 1 you know **antibodies** 抗体 are made against a pathogen's **antigen** 抗原. Here we see how the body *remembers* a pathogen, and how a **vaccine** 疫苗 uses that memory.

- The first time you meet a germ you may get ill; the second time you often do not.
- That is because of special **memory cells** 记忆细胞.

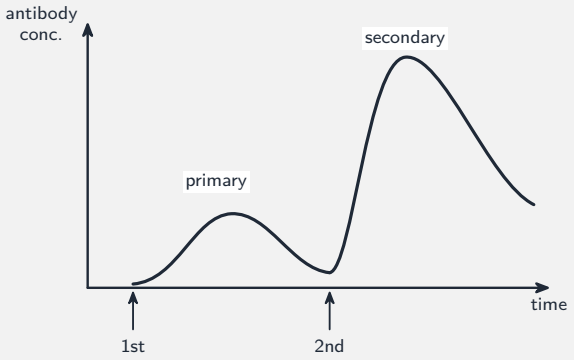
New ideas

Read these first, then do the Practice.

1 Memory cells and the secondary response

The first time a pathogen enters, the body makes a slow **primary response** 初次免疫反应. It also makes long-lived **memory cells** 记忆细胞.

If the **same** pathogen enters again, the memory cells start a **secondary response** 二次免疫反应 that is **faster and larger**, so the pathogen is destroyed before it makes you ill. This is **long-term immunity** 长期免疫.



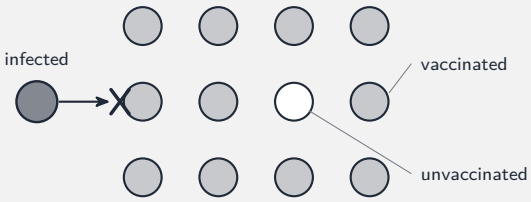
2 Active and passive immunity

- **active immunity** 主动免疫—your own body meets an antigen and makes its own antibodies and memory cells. Slow to start but **long-lasting**.
- **passive immunity** 被动免疫—ready-made antibodies are given from outside (e.g. mother to baby). Works **at once** but does **not** last (no memory cells).

3 Vaccination and herd immunity

A **vaccine** 疫苗 contains antigens —often a dead or weakened pathogen. It triggers a primary response and makes memory cells, so you gain immunity **without** becoming ill.

If enough people are vaccinated, the pathogen cannot pass easily from person to person. This protects even the unvaccinated —an effect called **herd immunity** 群体免疫.



Watch out: the secondary response is *faster* and *larger* (thanks to memory cells). Active immunity (your own antibodies) *lasts*; passive immunity (ready-made antibodies, e.g. from breast milk) is *instant* but does *not* last —there are no memory

cells.

Practice

Try these in order.

11.1 Which cells allow the body to respond faster the second time it meets a pathogen? [1]

11.2 State two ways the secondary response differs from the primary response. [2]

11.3 Explain the difference between active and passive immunity. [2]

11.4 What does a vaccine contain, and what does it make the body produce? [2]

11.5 Explain how vaccinating most of a population protects the few who are not vaccinated. [2]

11.6 A baby gets antibodies in its mother's milk. Is this active or passive immunity?

Explain. [2]

11.7 Challenge. A vaccine gives long-lasting immunity without making you ill. Explain how it achieves both. [2]

39 The hybridoma method is used for the production of monoclonal antibodies.

Which two types of cell are used in this method?

A stem cell and B-lymphocyte

B stem cell and T-lymphocyte

C tumour cell and B-lymphocyte

D tumour cell and T-lymphocyte

38 A vaccine is used to create artificial active immunity. After a person has been given a vaccine, it takes a period of time before they develop long-term immunity to the disease.

Which statement about this period of time explains the delay in developing long-term immunity?

A **No** memory cells have been produced from B-lymphocytes.

B **No** plasma cells have been produced from B-lymphocytes.

C The primary immune response has **not** produced enough antibodies.

D The secondary immune response has **not** produced enough antibodies.

40 Which statement describes the feature of monoclonal antibodies that allows them to accurately treat a specific disease?

A They bind to human hormones to produce a colour change.

B A fluorescent dye can be attached to them.

C They have active sites that are complementary to antigens.

D They can carry toxic chemicals.