Week 29

# A-Level Biology

Homework bundle for this week

本周作业合集

exercises.lol

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A-Level Biology Name: _____ Score: _____

1. A phagocyte engulfs and digests a pathogen in a process called _____.

   _____

2. Memory cells make the secondary immune response faster and stronger than the first.

   ☐ True ☐ False

3. Monoclonal antibodies are:

   ☐ identical antibodies, all made by one type of cell, that bind the same antigen

   ☐ a random mix of antibodies

   ☐ a type of pathogen

   ☐ white blood cells

4. A vaccine gives a person which kind of immunity?

   ☐ active — the body makes its own antibodies and memory cells

   ☐ passive

   ☐ no immunity at all

   ☐ temporary maternal immunity

5. Phagocytes such as macrophages and neutrophils are types of white blood cell.

   ☐ True ☐ False

6. T-helper cells in the immune response:

   ☐ recognise the displayed antigen and switch on other immune cells

   ☐ engulf the pathogen first

   ☐ release ready-made antibodies

   ☐ form the cell wall

7. The variable region of an antibody:

   ☐ is the binding site whose shape fits one specific antigen

   ☐ is the same in every antibody

   ☐ breaks down pathogens with enzymes

   ☐ is made of carbohydrate

8. Passive immunity (ready-made antibodies) acts fast but is short-lived, because no memory cells are made.

   ☐ True ☐ False

9. In phagocytosis, a phagocyte:

   ☐ surrounds the pathogen, takes it in, and digests it with enzymes

   ☐ makes antibodies

   ☐ becomes a memory cell

   ☐ releases ready-made antibodies

10. Select **all** the ways antibodies help destroy pathogens.

    ☐ clump pathogens together (agglutination)

    ☐ mark pathogens for phagocytes

    ☐ block toxins

    ☐ build the cell wall

    *Tick every correct option.*



## 11. Immunity

**Answers · 答案**

A-Level Biology

1. **phagocytosis**

   Phagocytosis is part of the first line of internal defence — fast and non-specific.

2. **True**

   Memory cells left from the first exposure react quickly when the same pathogen returns — the basis of long-term immunity.

3. **identical antibodies, all made by one type of cell, that bind the same antigen**

   Monoclonal = "one clone" — all identical, so they all bind the same target.

4. **active — the body makes its own antibodies and memory cells**

   A vaccine makes the body respond itself, so it builds active, long-lasting immunity.

5. **True**

   Yes — phagocytes are white blood cells; they are the first cells to respond to a pathogen.

6. **recognise the displayed antigen and switch on other immune cells**

   T-helper cells recognise the presented antigen and activate B-lymphocytes and other cells.

7. **is the binding site whose shape fits one specific antigen**

   The two tips of the Y are variable regions — each shaped to bind one specific antigen.

8. **True**

   Passive immunity gives instant antibodies but no memory cells, so it wears off; active immunity is slower but lasts.

9. **surrounds the pathogen, takes it in, and digests it with enzymes**

   A phagocyte engulfs the pathogen into a vesicle and digests it with enzymes.

10. **clump pathogens together (agglutination); mark pathogens for phagocytes; block toxins**

    Antibodies agglutinate pathogens, mark them for phagocytes and neutralise toxins — they do not build cell walls.

A-LEVEL BIOLOGY • EXERCISE SHEET

# 11.1 The immune system

Name: _____ Class: _____ Date: _____ **Total: 12 marks**

**KEY WORDS** immune response 免疫反应 • immune system 免疫系统 • antigen 抗原 • self antigen 自身抗原 • phagocyte 吞噬细胞

## Objective

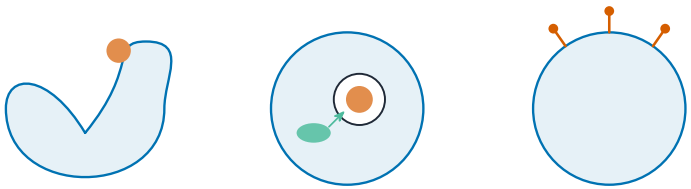
Build the skills to answer exam questions on **the immune system** — **phagocytes** 吞噬细胞, **antigens** 抗原, the **primary immune response** 初次免疫反应, and **memory cells** 记忆细胞.

**You must be able to:**

- describe the mode of action of phagocytes and explain self vs non-self antigens
- describe the primary immune response (macrophages, B- and T-lymphocytes)
- explain the role of memory cells in the secondary response and long-term immunity

## 1 Worked examples

### Phagocytes

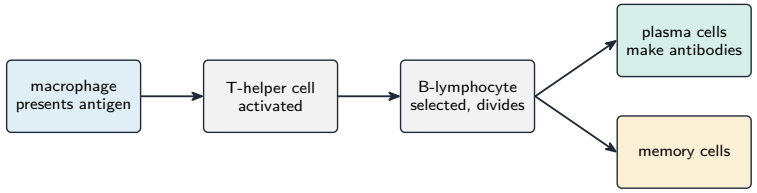



*Phagocytosis: the phagocyte engulfs the pathogen, digests it, then displays its antigen*

A phagocyte (macrophage or neutrophil) destroys a pathogen by **phagocytosis** 吞噬作用: it engulfs the pathogen, digests it with enzymes, then displays its **antigen**. A **self antigen** is the body's own marker (ignored); a **non-self antigen** is foreign (triggers a response).



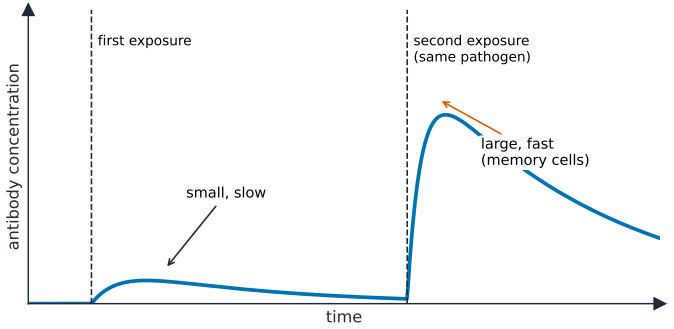
### The primary immune response




*Only the B-lymphocyte matching the antigen is selected and cloned into plasma cells and memory cells*

A macrophage presents the antigen; a matching **T-helper cell** 辅助性 T 细胞 activates the matching **B-lymphocyte**, which divides into **plasma cells** 浆细胞 (make **antibodies** 抗体) and **memory cells**. **T-killer cells** destroy infected body cells.

### Memory cells and the secondary response




*The secondary response is faster and larger because memory cells are ready*

Memory cells stay for years; a second exposure to the **same** pathogen gives a faster, larger secondary response, destroying it before illness.

## 2 Practice

**2.1** State what an antigen is, and the difference between a self and a non-self antigen. [2]

**2.2** Name the cells that (a) make antibodies and (b) remain to give long-term immunity. [2]

## 3 Exam-style questions

**3.1** What does a macrophage do **after** digesting a pathogen? [1]

- **A** makes antibodies
- **B** displays the pathogen's antigen on its surface
- **C** becomes a memory cell
- **D** divides to form plasma cells

**3.2** Why is the secondary immune response faster than the primary response? [1]

- **A** there are more pathogens
- **B** memory cells are already present and respond quickly
- **C** phagocytes work faster the second time
- **D** the antigen has changed shape

**3.3** Describe the sequence of events in the primary immune response, from a macrophage presenting an antigen to the production of antibodies. [4]



**3.4** Explain why a person who has recovered from a disease is often immune to that same disease for many years. [2]

## Solutions

**2.1** an antigen is a molecule (usually a protein) on a cell surface that the immune system recognises; a self antigen is the body's own (ignored), a non-self antigen is foreign and triggers a response.

**2.2** (a) plasma cells; (b) memory cells.

**3.1 B**. A macrophage displays the antigen to alert other immune cells.

**3.2 B**. Memory cells are already present, giving a quicker, larger response.

**3.3** a macrophage engulfs the pathogen and displays its antigen; a T-helper cell with a matching receptor is activated; it activates the matching B-lymphocyte, which divides; into plasma cells that secrete antibodies.

**3.4** memory cells made in the first infection remain in the body; they respond rapidly and strongly if the same pathogen returns, destroying it before illness.



Name:



**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

A-LEVEL BIOLOGY • EXERCISE SHEET

# 11.2 Antibodies and vaccination

Name: _____ Class: _____ Date: _____ **Total: 13 marks**

**KEY WORDS** monoclonal antibodies 单克隆抗体 • vaccine 疫苗 • immunity 免疫 • hybridoma 杂交瘤 • active immunity 主动免疫

## Objective

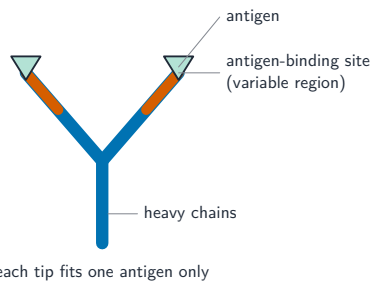
Build the skills to answer exam questions on **antibodies and vaccination** — antibody structure, **monoclonal antibodies** 单克隆抗体, types of **immunity** 免疫, and **vaccination** 疫苗接种.

**You must be able to:**

- relate antibody structure to function and outline the hybridoma method
- distinguish active/passive and natural/artificial immunity
- explain how vaccines and vaccination programmes give long-term immunity

## 1 Worked examples

### Antibody structure and function

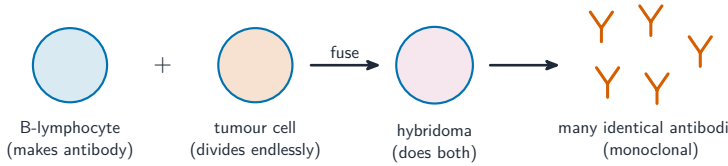



*The two tips are variable regions that bind one specific antigen*

An antibody is a Y-shaped protein; its two **variable regions** 可变区 bind one antigen only. Antibodies clump pathogens together, mark them for phagocytes, and block toxins.



### Monoclonal antibodies




*A hybridoma pours out one identical (monoclonal) antibody*

A **hybridoma** 杂交瘤 = a B-lymphocyte (makes the wanted antibody) fused with a tumour cell (divides endlessly). Uses: **diagnosis** (e.g. pregnancy test) and treatment (carry drugs to target cells).

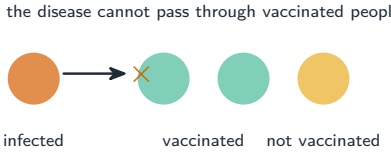
### Types of immunity

| | natural | artificial |
|---|---|---|
| active | after an infection (your body responds) | vaccination (safe dose of antigen) |
| passive | antibodies passed from mother to baby | injection of ready-made antibodies |

**active** = your body makes its own antibodies (slow, long-lasting);
**passive** = ready-made antibodies given (fast, short-lived)

*Active immunity lasts (your body responds); passive is fast but short (ready-made antibodies)*

### Vaccination and herd immunity




*When enough people are vaccinated, the pathogen cannot reach the few who are not*

A **vaccine** contains antigens that trigger a primary response and make memory cells — long-term immunity without illness. If enough people are vaccinated, **herd im-**

**munity** 群体免疫 protects the rest.

## 2 Practice

**2.1** State the part of an antibody that binds the antigen, and explain why it binds only one antigen. [2]

**2.2** State one difference between active and passive immunity. [1]

## 3 Exam-style questions

**3.1** Which is an example of **passive natural** immunity? [1]

- **A** recovering from chickenpox
- **B** being given a vaccine
- **C** antibodies passing from a mother to her baby in breast milk
- **D** being injected with ready-made antibodies

**3.2** Why does passive immunity not last long? [1]

- **A** the antibodies are the wrong shape
- **B** no memory cells are produced
- **C** the antigens are destroyed
- **D** phagocytes remove the antibodies



**3.3** (a) Outline how monoclonal antibodies are produced by the hybridoma method. [3]

(b) State **one** use of monoclonal antibodies in medicine and explain how their specificity is important. [2]

**3.4** Explain how a vaccination programme can protect even people who have not been vaccinated. [3]

## Solutions

**2.1** the variable region / antigen-binding site; its shape is complementary to one antigen only.

**2.2** active immunity is made by your own body and is long-lasting; passive immunity uses ready-made antibodies and is short-lived.

**3.1 C**. Antibodies passing from mother to baby = passive (ready-made) and natural.

**3.2 B**. No memory cells are made, so the immunity is short-lived.

**3.3** (a) an animal is given the antigen so it makes B-lymphocytes producing the wanted antibody; these are fused with tumour cells to form hybridomas; the hybridomas both make the antibody and divide endlessly, giving many identical antibodies.
(b) e.g. diagnosis (pregnancy test) or carrying drugs to cancer cells; the antibody binds only the target molecule/cell, so it is specific and does not affect others.

**3.4** vaccinating enough people means the pathogen cannot pass easily between them; so it cannot reach the unvaccinated people — this is herd immunity.





**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

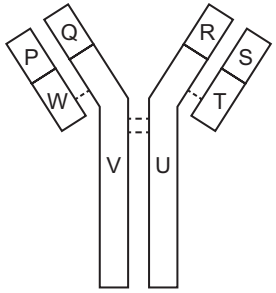
**B** stem cell and T-lymphocyte

**C** tumour cell and B-lymphocyte

**D** tumour cell and T-lymphocyte



**40** The diagram shows an antibody molecule with some parts labelled.




Which row is correct about the parts that form an antigen-binding site and have identical amino acid sequences?

| | form an antigen-binding site | have identical amino acid sequences |
|---|---|---|
| **A** | P and Q | R and S |
| **B** | Q and V | P and S |
| **C** | R and S | U and V |
| **D** | U and V | Q and R |

**39** Four different treatments were tested in a human volunteer during a year. One of these treatments was a vaccine.

The treatments were injected into the volunteer and blood samples were taken after two weeks. The samples were analysed to obtain a cell count for four types of cell.

The results are shown in the table.

Which treatment was the vaccine?

(Assume the volunteer's baseline blood cell count was the same before each treatment.)

| | cell count / cells per $cm^3$ | | | |
|---|---|---|---|---|
| | monocytes | neutrophils | plasma cells | macrophages |
| **A** | 250 | 180 | 450 | 230 |
| **B** | 500 | 190 | 220 | 240 |
| **C** | 260 | 450 | 240 | 250 |
| **D** | 250 | 190 | 230 | 550 |

**40** A bacterial pathogen produces a protein that acts as a toxin. This toxin is harmful to humans.

People can be vaccinated to protect them from the effects of this pathogen.

Which statement describes the sequences of events that occur in a vaccinated person to protect them from the effects of this pathogen?

**A** Memory cells divide by mitosis and then differentiate into macrophages that engulf and digest the toxin.

**B** Memory cells divide by mitosis and then differentiate into plasma cells that produce antibodies to bind to the toxin.

**C** Macrophages divide by mitosis and then differentiate into memory cells that engulf and digest the toxin.

**D** Plasma cells divide by mitosis and then differentiate into memory cells that produce antibodies to bind to the toxin.



**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.





**39** An antiserum to a snake toxin can be obtained by injecting the toxin into a horse. The antiserum is made from blood plasma taken from the horse a few weeks later. The antiserum is injected into a person who has been bitten by the same species of snake.

Which type of immunity occurs as a result of using this antiserum?

**A** artificial active

**B** artificial passive

**C** natural active

**D** natural passive

**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.