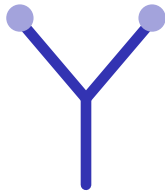


Immunity

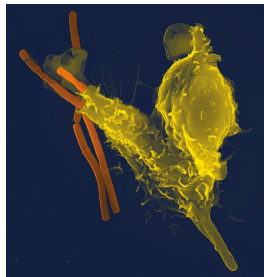
A-Level Biology ■ Topic 11

A-Level Biology



What we will cover

- 1 Phagocytosis
- 2 The primary response
- 3 Memory & immunity
- 4 Antibodies
- 5 Monoclonal antibodies
- 6 Vaccination



a phagocyte engulfing bacteria

1

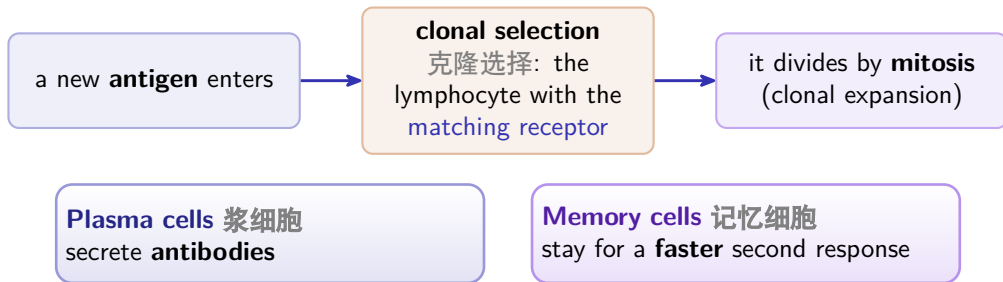
Defences

Phagocytosis

- a **phagocyte** 吞噬细胞 recognises a pathogen and engulfs it in a vesicle
- the vesicle fuses with a **lysosome** 溶酶体 and the pathogen is digested
- antigens are displayed on the surface

Displaying the antigen links innate defence to the specific response.

The primary immune response



The first response is **slow**: days to reach its peak.

Memory and long-term immunity

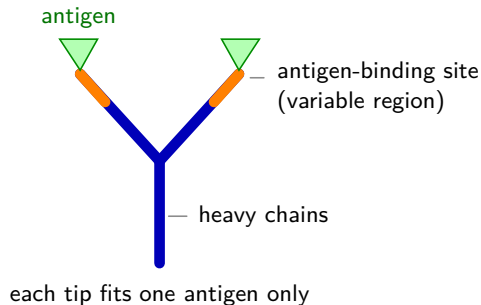
On re-exposure, memory cells divide at once: a faster, larger **secondary response** 二次应答. That is why vaccination works – it creates memory without the disease.

Active immunity makes your own memory cells (infection or vaccine). Passive immunity is borrowed antibodies – immediate, not lasting.

2

Antibodies

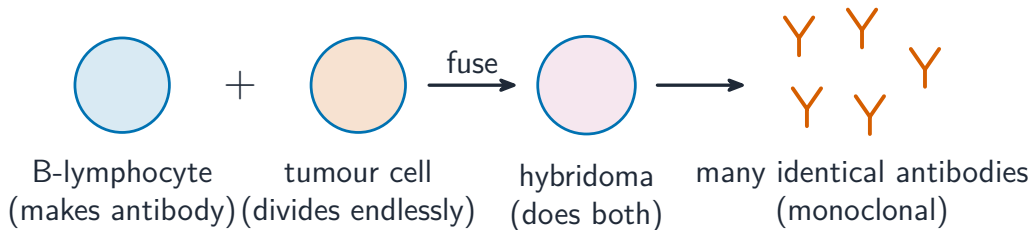
Antibodies



An **antibody** 抗体 is a Y-shaped protein; its two tips (the **variable region** 可变区) bind one antigen only. They clump pathogens, mark them for phagocytes, and block toxins.

Monoclonal antibodies

A **monoclonal antibody** 单克隆抗体 is one identical antibody, made by the **hybridoma** 杂交瘤 method (a B-lymphocyte fused with a tumour cell). Used in **diagnosis** 诊断 (pregnancy tests) and treatment (drug targeting).



3

Immunity and vaccination

Types of immunity

- **active** 主动免疫 – your body makes its own antibodies (slow, **lasting**)
- **passive** 被动免疫 – ready-made antibodies (fast, **short**)

Each can be **natural** 天然 or **artificial** 人工.

	natural	artificial
passive active	after an infection (your body responds)	vaccination (safe dose of antigen)
	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)

Vaccination and herd immunity

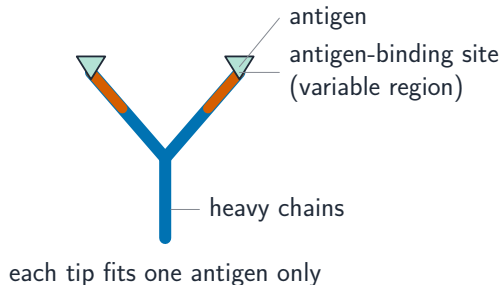
the disease cannot pass through vaccinated people



A **vaccine** 疫苗 gives antigens that trigger memory cells – immunity **without** illness.

If enough people are vaccinated, the pathogen cannot spread – **herd immunity** 群体免疫 protects even the unvaccinated.

The Y-shaped antibody and its variable regions



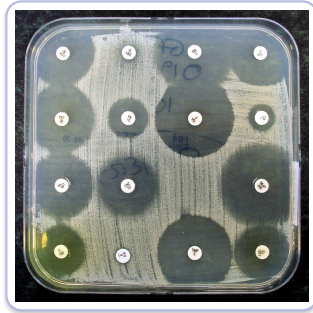
An antibody is Y-shaped; the two tips are the variable regions that bind one specific antigen

What an antibody actually does

the shape	Y-shaped, with two antigen-binding sites 抗原结合位点 whose shape is complementary to one antigen
neutralising	sticks to antigens, blocking the pathogen from binding to a host cell
agglutination	clumps pathogens together, so they are easier to engulf and cannot spread
opsonisation	marks pathogens so phagocytes recognise and engulf them
and toxins	antibodies bind bacterial toxins, rendering them harmless
natural immunity 天然免疫 and artificial immunity 人工免疫	acquired by infection or by vaccine; active means your own cells made the antibodies, passive means they were given to you

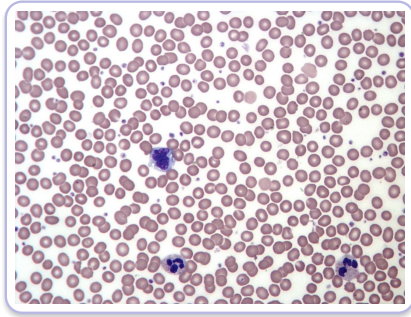
Breast milk is **natural passive**; a vaccine is **artificial active**; an antivenom is **artificial passive**.
Both axes are asked together.

Antigens: self and non-self



Clear zones on a culture plate: the immune system recognises non-self antigens and attacks foreign cells

Phagocytes – the first defence



A blood smear: the large stained cells are white blood cells, scattered among the many red cells

The cells of the immune response

neutrophils 中性粒细胞	the commonest phagocyte – a lobed nucleus, short-lived, first to arrive
macrophages 巨噬细胞	larger and longer-lived; they also present antigen to lymphocytes
B-lymphocytes B 淋巴细胞	divide into plasma cells, which secrete antibodies
T-helper cells 辅助性 T 细胞	recognise presented antigen and activate B cells and other T cells
T-killer cells	destroy the body's own infected cells
memory cells	remain after the infection, giving the fast, large secondary response

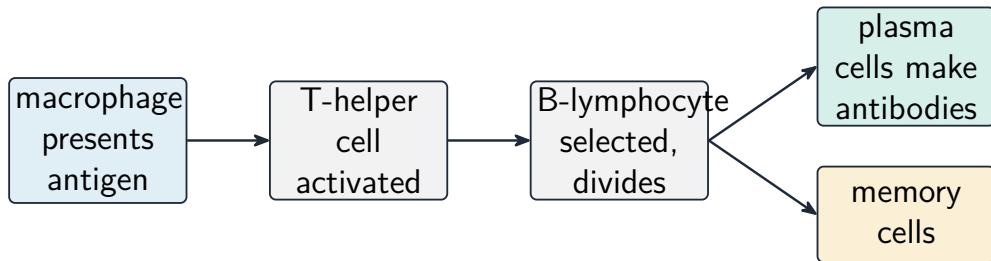
Phagocytosis is non-specific and immediate; the lymphocyte response is specific and slow the first time. The vaccine's whole purpose is to make the *second* response the first one you need.

The four kinds of immunity

natural active 自然主动免疫	you meet the pathogen, your own lymphocytes respond and leave memory cells
artificial active 人工主动免疫	a vaccine does the same without the disease
natural passive 自然被动免疫	antibodies received across the placenta or in breast milk
artificial passive 人工被动免疫	antibodies injected – an antivenom, or an antitoxin
active lasts	because memory cells remain
passive is immediate and brief	the antibodies were not made by you, so nothing remembers them

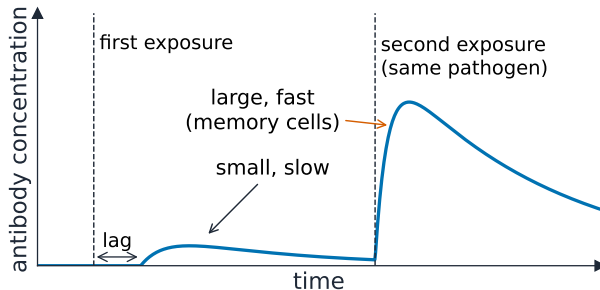
Two axes: **natural or artificial** is how you got it, **active or passive** is whether *your* cells made the antibodies. The exam asks for both words.

Clonal selection: plasma cells and memory cells



Only the B-lymphocyte whose shape matches the antigen is selected and cloned – into antibody-making plasma cells and long-lived memory cells

Memory cells and long-term immunity



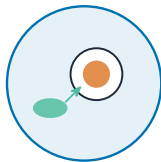
secondary response: faster and larger (memory cells)

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

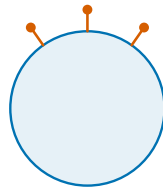
Phagocytosis, step by step



1. engulfs the
pathogen



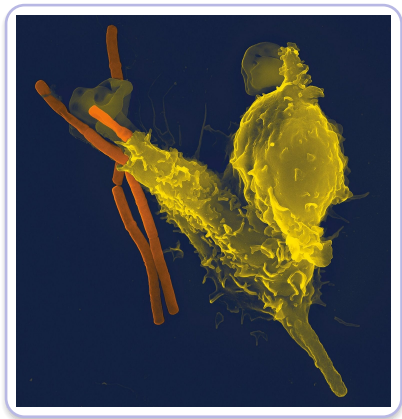
2. digests it
with enzymes



3. displays the
antigen

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

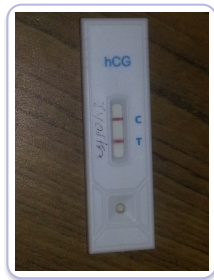
A phagocyte caught in the act



A false-coloured electron micrograph of the real thing: a **neutrophil** 中性粒细胞 (yellow), one kind of phagocyte, stretching finger-like projections out to grab rod-shaped bacteria (orange).

It engulfs the pathogen, digests it inside a vesicle with enzymes, then **displays the antigen** on its own surface – which is what alerts the lymphocytes.

A monoclonal antibody at work: the pregnancy test



A pregnancy test is monoclonal antibodies at work. The antibodies are fixed at the T line and grab only one molecule – the pregnancy hormone hCG. The T line turns red only if hCG is in the urine; the C line always appears, to show the test ran properly

Antibodies fixed at the **T line** bind only hCG, the pregnancy hormone: T turns red only if hCG is in the urine. The **C line** always appears, to show the test ran.

Exam tips

- Distinguish **phagocytes** (engulf, non-specific) from lymphocytes: B cells → antibodies (humoral), T cells (helper/killer, cell-mediated).
- Label an **antibody** (variable region, antigen-binding site) and explain agglutination and neutralisation.
- Compare the **primary and secondary response** on a graph – memory cells make the secondary faster and larger.
- Distinguish **active vs passive** and **natural vs artificial** immunity with an example of each; explain vaccination and herd immunity.

4

Recap

Worked example – primary vs secondary response

Explain why the second exposure to a pathogen produces a much faster, larger antibody response.

- **Primary:** few B cells carry the right receptor, so clonal expansion takes days.
- They differentiate into **plasma cells** (antibody) and **memory cells**.
- **Secondary:** many memory cells are already circulating, specific to that antigen.
- They become plasma cells at once ⇒ **faster, higher, longer** – often no symptoms.

Memory cells are the whole point of vaccination. The lag in the primary response is **clonal expansion** – finding and multiplying the right B cell.

Topic 11 – key takeaways

1

Phagocytosis

engulf, digest, display the antigen

2

Response

select & clone B-cells; plasma & memory cells

3

Memory

secondary response is faster & larger

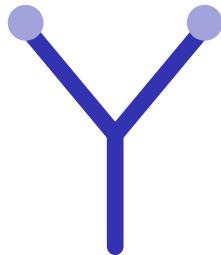
4

Vaccination

builds memory; herd immunity protects all

Check yourself

- 1 What does a phagocyte display after digesting a pathogen?
- 2 Which cells give long-term immunity?
- 3 Which part of an antibody binds the antigen?
- 4 What protects the unvaccinated when most are immune?



Answers 1. the pathogen's antigen 2. memory cells 3. the variable region 4. herd immunity