Human defence systems

4.3.1.6 · Biology · revision notes

How your body stops pathogens getting in (the non-specific defences of the skin, nose, trachea and bronchi, and stomach) and how white blood cells destroy pathogens that do get in. A favourite for 'describe' and 'explain' questions, often in unfamiliar contexts such as smoking.

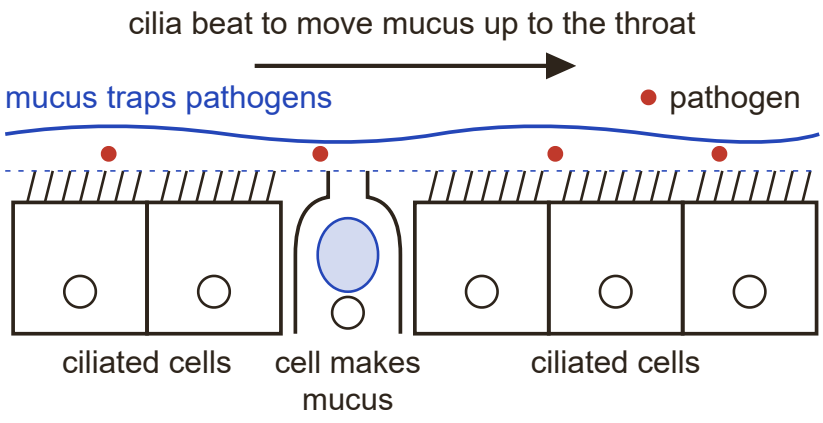
Key facts

- Skin: physical barrier + antimicrobial secretions; scabs seal cuts
- Trachea and bronchi: mucus traps pathogens; cilia move the mucus to the throat
- White blood cells: phagocytosis, antibodies, antitoxins
- Antigen = molecule (e.g. a protein) on the surface of a pathogen
- Antitoxin: neutralises a toxin made by bacteria
- Nose: hairs and mucus trap particles
- Stomach: hydrochloric acid kills pathogens
- Phagocytosis = engulfing and digesting a pathogen
- Antibody: binds to a specific antigen on a pathogen

Notes

Non-specific defences: keeping pathogens out

- **Skin**: a physical barrier that pathogens cannot get through while it is unbroken. It also produces antimicrobial secretions that kill pathogens. If the skin is cut, the blood clots and a scab seals the wound.
- **Nose**: hairs and sticky mucus trap particles, which may contain pathogens, from the air you breathe in.
- **Trachea and bronchi**: cells lining them make **mucus**, which traps pathogens. Other cells have **cilia** (tiny hairs) that beat to move the mucus up to the throat, where it is swallowed.

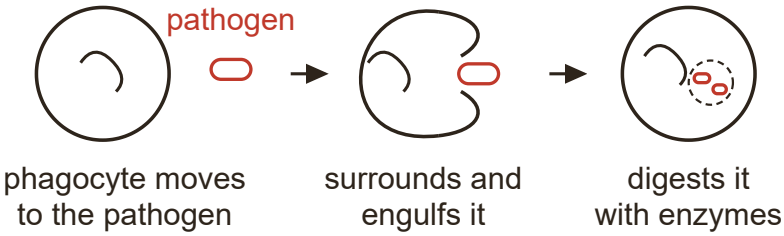


Mucus traps pathogens; cilia sweep it up to the throat.

- **Stomach**: produces **hydrochloric acid**, which kills pathogens in food, drink and swallowed mucus.
- These defences are **non-specific**: they work against all pathogens.

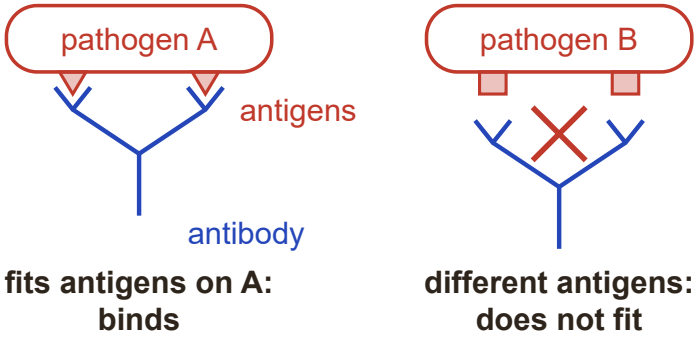
The immune system: white blood cells

- If a pathogen gets into the body, the **immune system** tries to destroy it. White blood cells do this in three ways.
- **Phagocytosis**: white blood cells called phagocytes engulf (surround) pathogens and digest them.



Phagocytosis: engulf, then digest.

- **Antibody production**: white blood cells called lymphocytes make **antibodies**. Antibodies bind to **antigens** (molecules such as proteins) on the surface of a pathogen. This helps to destroy the pathogens, e.g. by sticking them together so phagocytes can engulf them.
- Antibodies are **specific**: each one fits the antigen of only one type of pathogen, so a different antibody is needed for each pathogen.



Antibodies are specific: the shape must fit the antigen.

- **Antitoxin production**: white blood cells make **antitoxins**, which bind to the toxins made by bacteria and neutralise them.

Why you can still get ill

- The first time a pathogen gets in, it takes time for white blood cells to make the right antibodies.
- Meanwhile the pathogen reproduces, so you may feel ill before it is destroyed.

How to answer each type of question

Describe how a part of the body stops pathogens

2 marks | Grade 4

1. Name what does the job (mucus, cilia, acid, skin).
2. Say what it does to the pathogens (traps, moves away, kills, keeps out).

Example. Describe how the trachea and bronchi protect the body against pathogens.

Model answer. Mucus traps pathogens (1). Cilia beat to move the mucus up to the throat, where it is swallowed (1).

Describe how white blood cells defend the body

3 marks | Grade 5

1. Give three separate ways: phagocytosis, antibodies, antitoxins.
2. Add what each one does, not just its name.

Example. Describe **three** ways that white blood cells help to defend the body against pathogens.

Model answer. They engulf and digest pathogens (phagocytosis) (1). They produce antibodies, which bind to antigens on the pathogens (1). They produce antitoxins, which neutralise the toxins made by bacteria (1).

Explain the effect of damage to a defence

3 marks | Grade 7

1. Work out which defence is affected and what it normally does.
2. Say what happens when it stops working.
3. Finish with the result: pathogens are more likely to infect the body.

Example. Chemicals in cigarette smoke stop cilia from beating.
Explain why smokers are more likely to get chest infections.

Model answer. The cilia cannot move the mucus, with its trapped pathogens, up and out of the airways (1). So mucus and pathogens build up in the trachea, bronchi and lungs (1). So the pathogens are more likely to infect the cells of the airways and lungs (1).

Explain why antibodies are specific

2 marks | Grade 7

1. Say that each antibody binds only to one antigen.
2. Say that different pathogens have different antigens.

Example. A child recovers from chickenpox, which is caused by a virus.
Explain why the antibodies the child made against chickenpox do not protect the child against measles.

Model answer. Antibodies are specific: each antibody binds only to one antigen (1). The measles virus has different antigens from the chickenpox virus, so the chickenpox antibodies cannot bind to it (1).

Don't lose marks

- Mixing up antigen, antibody and antibiotic. Antigen = on the pathogen; antibody = made by white blood cells; antibiotic = a medicine that kills bacteria.
- Saying white blood cells 'eat' pathogens without saying that they engulf and digest them.
- Saying cilia trap pathogens. Mucus traps them; cilia move the mucus.
- Saying antibodies neutralise toxins. Antitoxins do that; antibodies bind to antigens on pathogens.
- Saying stomach acid digests pathogens. It kills them.

More tips

Memory tricks

- From outside in: skin, nose, trachea and bronchi, stomach = barrier, trap, sweep, acid.
- Three jobs of white blood cells: eat them (phagocytosis), tag them (antibodies), neutralise their poisons (antitoxins).
- Antibody vs antitoxin: an antibody targets the pathogen itself; an antitoxin targets the toxin.
- Lock and key: an antibody fits one antigen, like a key fits one lock.

Exam technique

- Use the key words: barrier, mucus, cilia, hydrochloric acid, engulf, digest, antibodies, antigens, antitoxins.
- For 'describe three ways white blood cells defend', give three different ways, each with what it does.
- In unfamiliar contexts, work out which defence is affected and follow the consequences one step at a time.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3 — **Name the body's non-specific defences**
The skin, the nose, the trachea and bronchi, and the stomach.

Grade 4 — **Describe how each defence stops pathogens**
Skin is a barrier; mucus traps pathogens; cilia move the mucus away; stomach acid kills pathogens.

Grade 4

Name three ways white blood cells defend

Phagocytosis, producing antibodies and producing antitoxins.

Grade 5

Describe phagocytosis

A white blood cell engulfs a pathogen and digests it.

Grade 5

Explain how antibodies and antitoxins work

Antibodies bind to specific antigens on pathogens; antitoxins bind to the toxins made by bacteria and neutralise them.

Grade 7

Explain why antibodies are specific

Each antibody fits only one antigen, so it binds to only one type of pathogen.

Grade 7

Explain effects of damage to a defence

E.g. smoke stops cilia beating, so mucus and pathogens build up in the airways and infections are more likely.

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