Lines of Defence

Lines of defence help you defend yourself against infectious diseases by setting up natural barriers.

First

Second

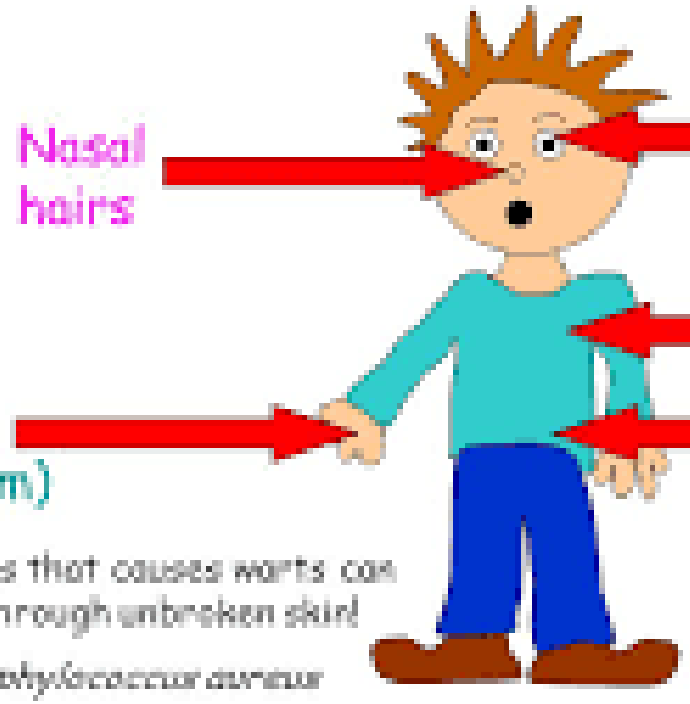
Non-specific (fight the same way for all infections)

Third → Specific (fights differently for different types)

First line of defence

- Physical barriers
- Chemical barriers

What is the body's first line of defence?



Nasal hairs

Tears, saliva (lysozymes and salt)

Lungs (cilia & mucus)

Skin (sebum)

Stomach - HCl

The virus that causes warts can pass through unbroken skin!

Staphylococcus aureus

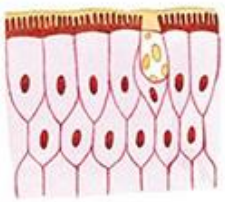
The skin harbours a 'flora' of bacteria – most pathogenic bacteria cannot survive there

Blood clotting

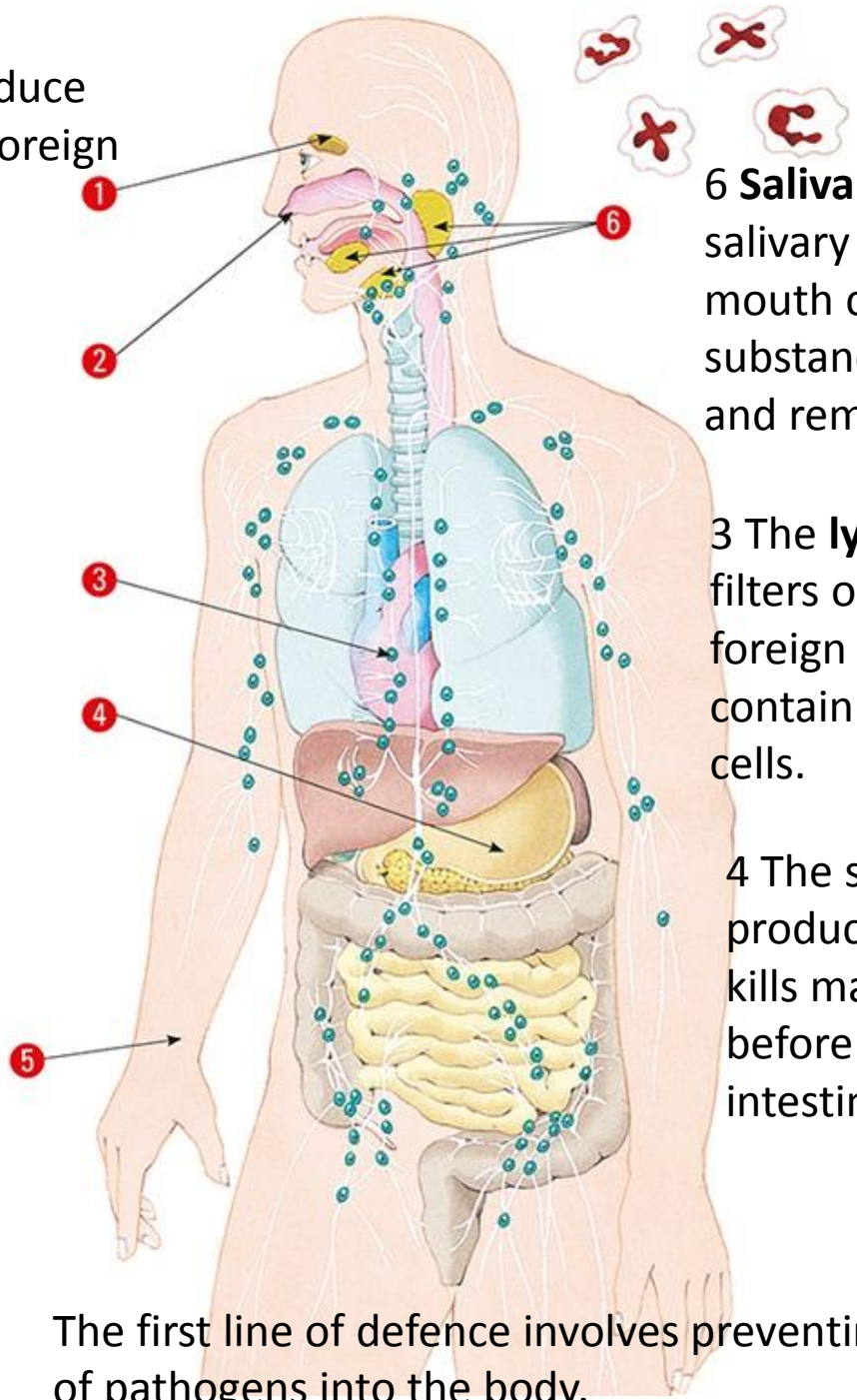
Helps to seal wounds rapidly until more permanent repair by mitosis

Lachrymal glands near the eye produce tears to wash away dust, dirt, and foreign particles.

The **linings** of the body openings, like the nose and throat, produce a sticky mucus to help trap foreign particles.



The **skin** is a surface barrier to most diseases.



6 **Saliva** produced by the salivary glands in the mouth contains substances to help resist and remove microbes.

3 The **lymph nodes** are filters or traps for foreign particles and contain white blood cells.

4 The stomach produces an **acid** that kills many microbes before they reach the intestines.

The first line of defence involves preventing the entry of pathogens into the body.

Physical barriers

Barrier	How it helps
Skin	dry and slightly acidic → prevents the growth of many bacteria and fungi
Coughing	get the mucus out of the lungs
Sneezing	
Cilia	beat and sweep the mucus out of the body
Nasal hairs	Traps dust and microbes

Chemical barriers

- body fluids such as
  - Saliva
  - Tears
  - stomach acid
  - Mucus in the nose (microbes become trapped)
  - acidic vaginal mucus

The **second line of defence** is in your **blood**

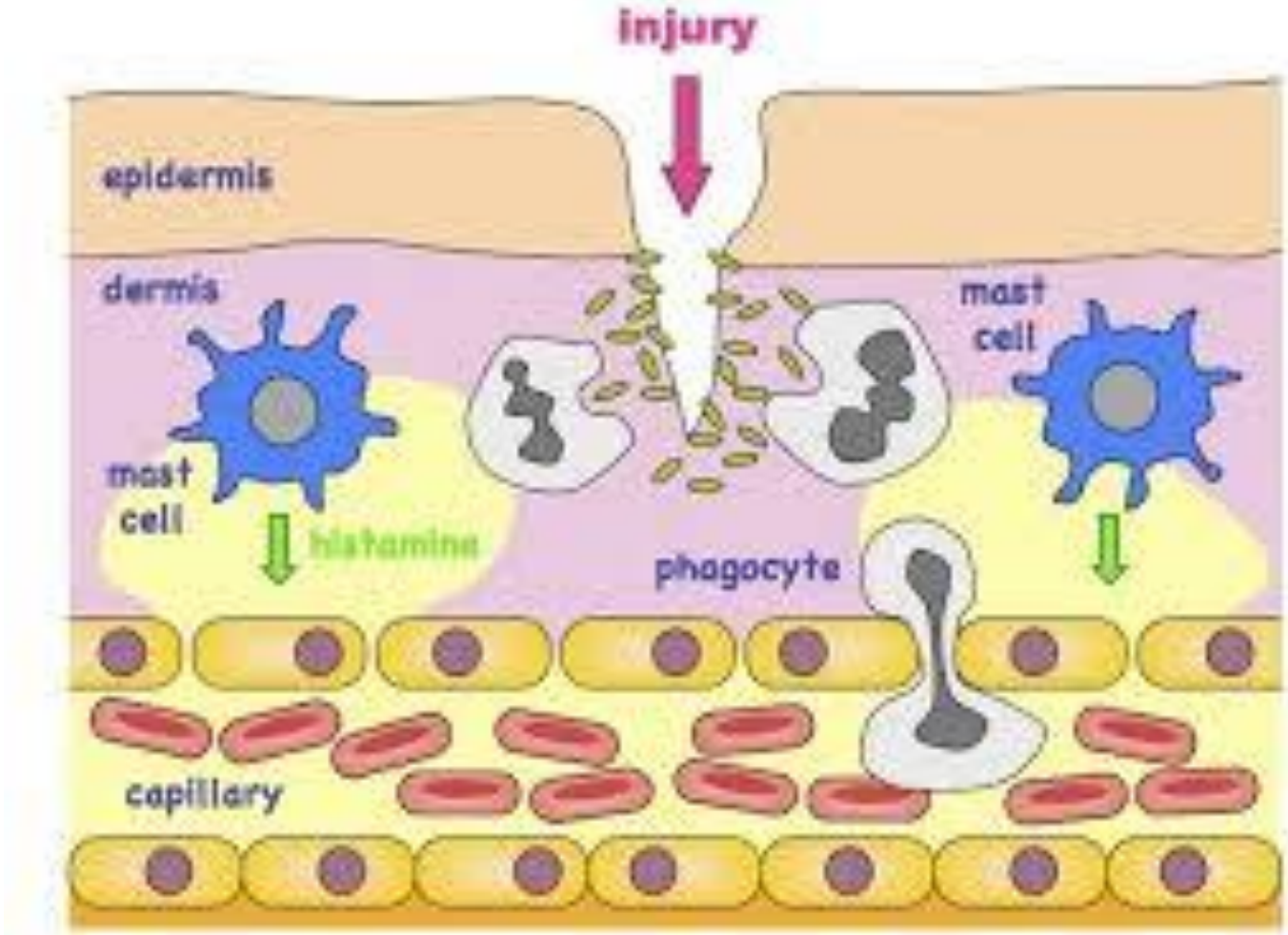
- **Inflammation**: The affected area becomes red, warm and swollen

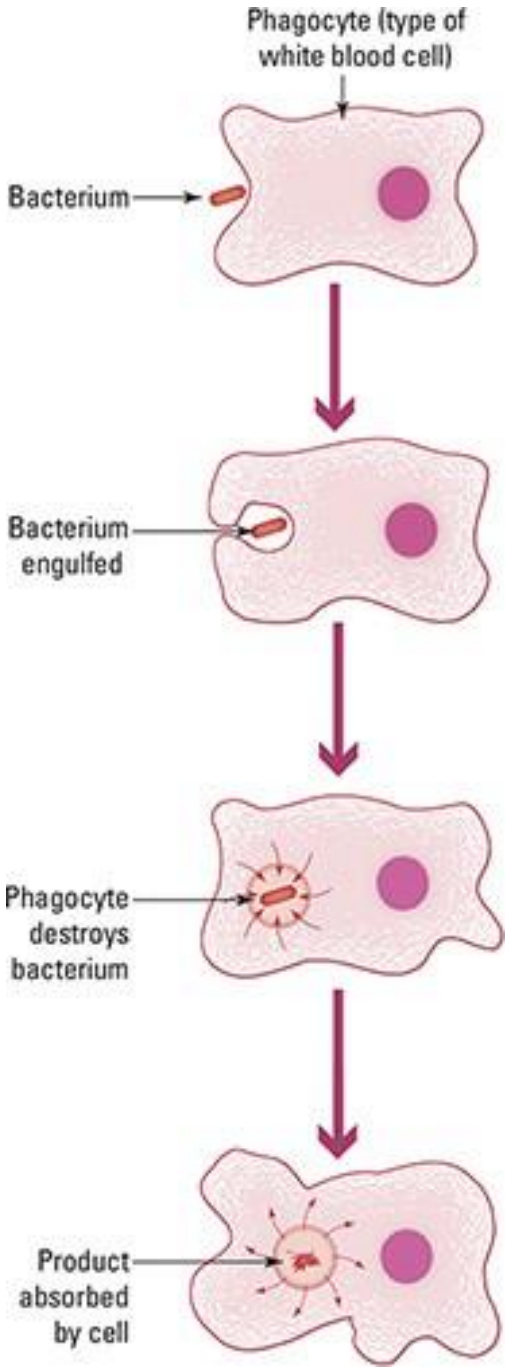
➢ Blood flows to the affected area is increased

➢ White blood cells (**leucocytes**) travel in the blood to the site of infection, engulf and destroy pathogens

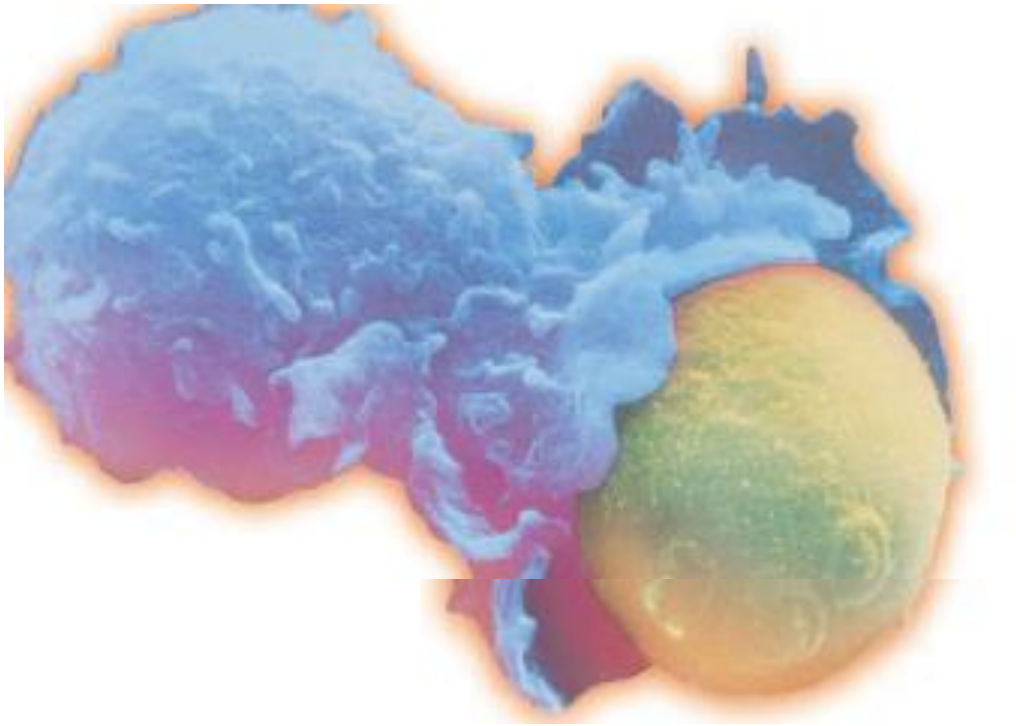
➢ Dead micro-organisms and dead white cells are left behind and form the discharge called **pus**

- **Fever** can help your body fight an infection


injury
epidermis
dermis
mast cell
mast cell
histamine
phagocyte
capillary



Phagocytosis



The body at war.
This white blood cell is engulfing a yeast cell.

Investigation 2.1 (page 52)

Keeping germs at bay

AIM To determine if hand washing and antibacterial sprays are effective in removing bacteria from commonly used surfaces.

You will need:
5 plates of nutrient agar
overhead projector pen
sticky tape
soap
ethanol
3 types of antibacterial soaps or antibacterial sprays
sterile cotton buds
incubator

Use the pen to draw a line down the middle of each plate of nutrient agar (on the outside of the part of the dish that contains the agar).

Gently press your fingers over one half of the agar (you should not leave a mark on the agar).

Wash your hands with the soap. Gently press your fingers over the other half of the plate.

Seal the plate with sticky tape and label it with the pen.

Repeat the above procedure with any available antibacterial soaps. You will need to use a different student's hands.

Swipe a cotton bud over your desk, and then gently rub it over the surface of one half of an agar plate.

Spray your desk with ethanol and dry it with a paper towel. Swipe a clean cotton bud over the desk and rub it on the other half of the plate.

Repeat the above steps using any of the antiseptic sprays available (you will need to use a different surface than your desk).

Incubate the plates upside down at 30°C for 48 hours.

Do not open the plates to look at them, look through the plastic.

Discussion

1. Explain why it is dangerous to open the plates after incubation.

2. After incubation you may be able to see colonies of bacteria or fungi on the agar. Each colony grew from one bacteria or fungus. Copy and complete the table below.

Substance used for cleaning	Number of colonies on half where hands/surface had been cleaned (*)	Number of colonies on half where hands/surface had not been cleaned (*)

* If there are too many colonies to count, estimate what percentage of that half of the plate is covered with colonies.

3 Which cleaning substance was most effective at killing bacteria? Justify your answer.

4 Why were all the plates divided into two halves and the cleaning products used only for one half of each plate?

5 When biologists do experiments involving agar plates they usually include one plate of agar that is kept sealed and untouched. This plate is incubated with the others.

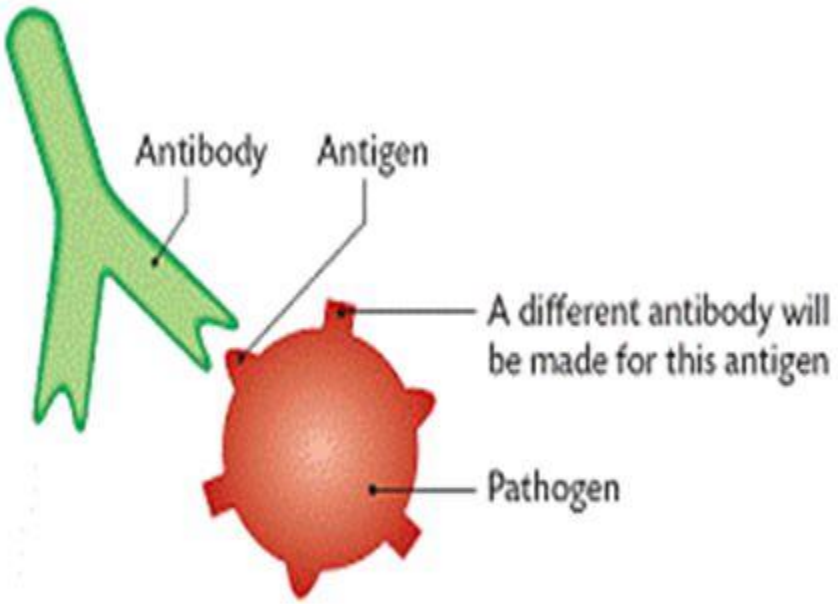
Why is this plate used?

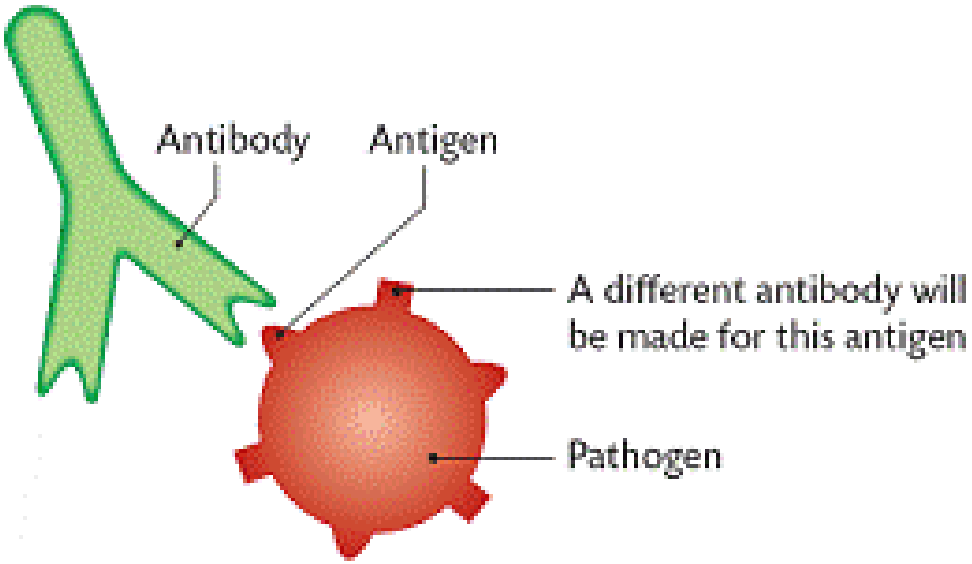
If colonies of microbes were found on this plate after incubation, what would this indicate?

6 How does your school dispose of the agar plates safely?

Antibody

- Is a protein produced by white blood cells (called lymphcytes) in response to an antigen



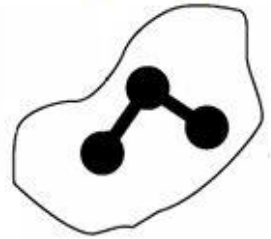

Antibody
Antigen
A different antibody will be made for this antigen
Pathogen

Antigen
It is any foreign particle that stimulates an immune response

Lymphocyte
A special type of white blood cell that is involved in an immune response.

White blood cells
- fight disease

Phagocytes



Lymphocytes

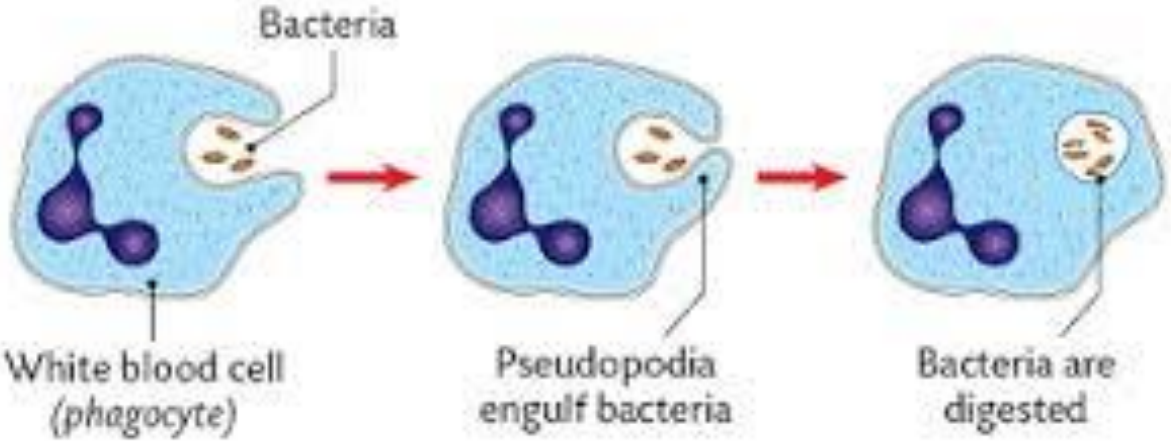
T cells

Recognise antigens, stimulate B cells

B cells → Memory B cells

Make antibodies

'remember' antigens (immunity)


Bacteria
White blood cell
(phagocyte)
Pseudopodia
engulf bacteria
Bacteria are
digested

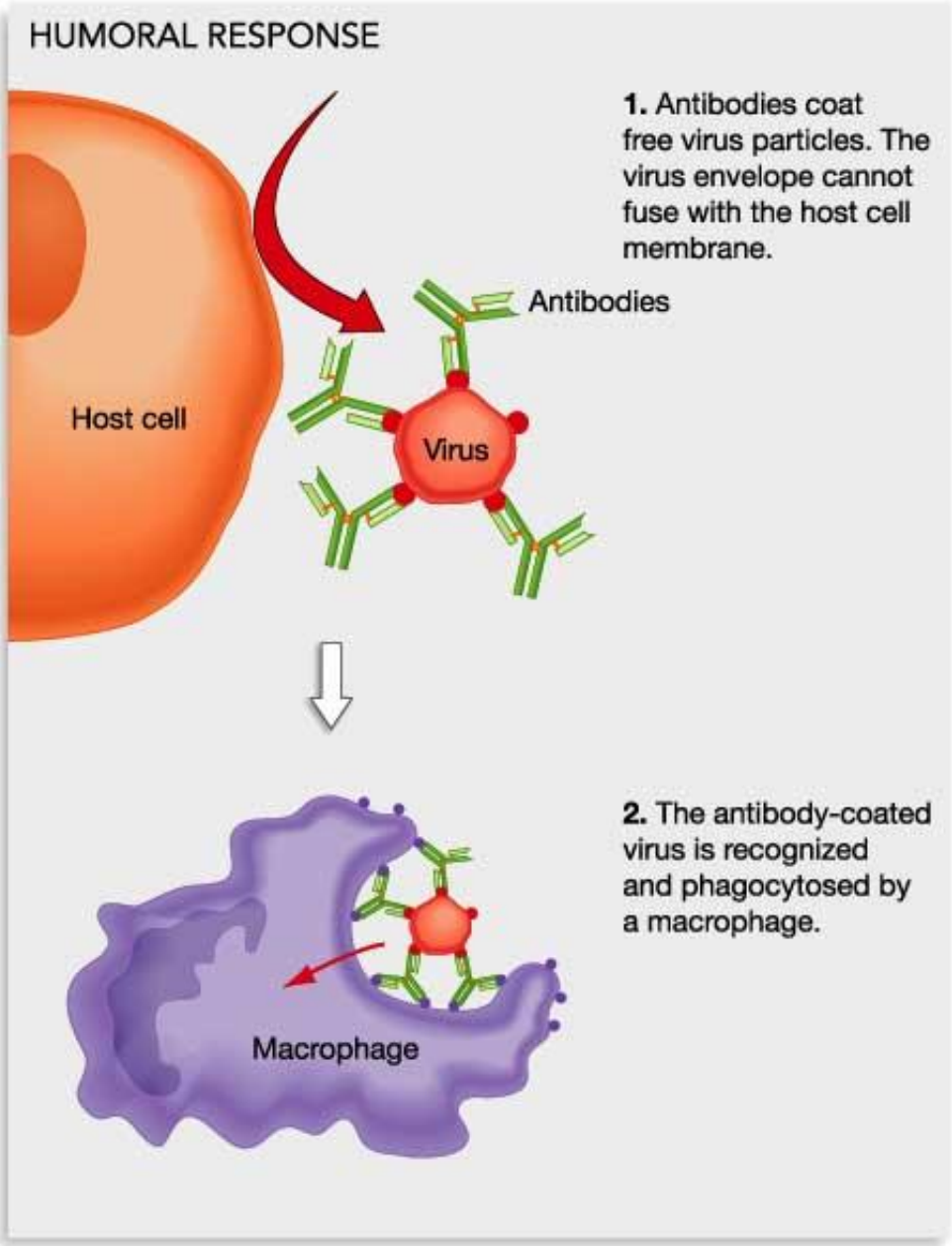
The third line of defence

When invaded by a pathogen your body responds by making **antibodies**.

These antibodies are produced in a process called **acquired immunity**.

The antibodies float around in the blood and attach to a specific part of the pathogen, which is called an **antigen**.

The antibody disables the pathogen, which is then easily consumed by white blood cells, thus destroying the threat.


HUMORAL RESPONSE
1. Antibodies coat free virus particles. The virus envelope cannot fuse with the host cell membrane.
Antibodies
Host cell
Virus
2. The antibody-coated virus is recognized and phagocytosed by a macrophage.
Macrophage

Antibodies are specific to certain diseases

A particular antibody will act against the antigens on only one type of pathogen.

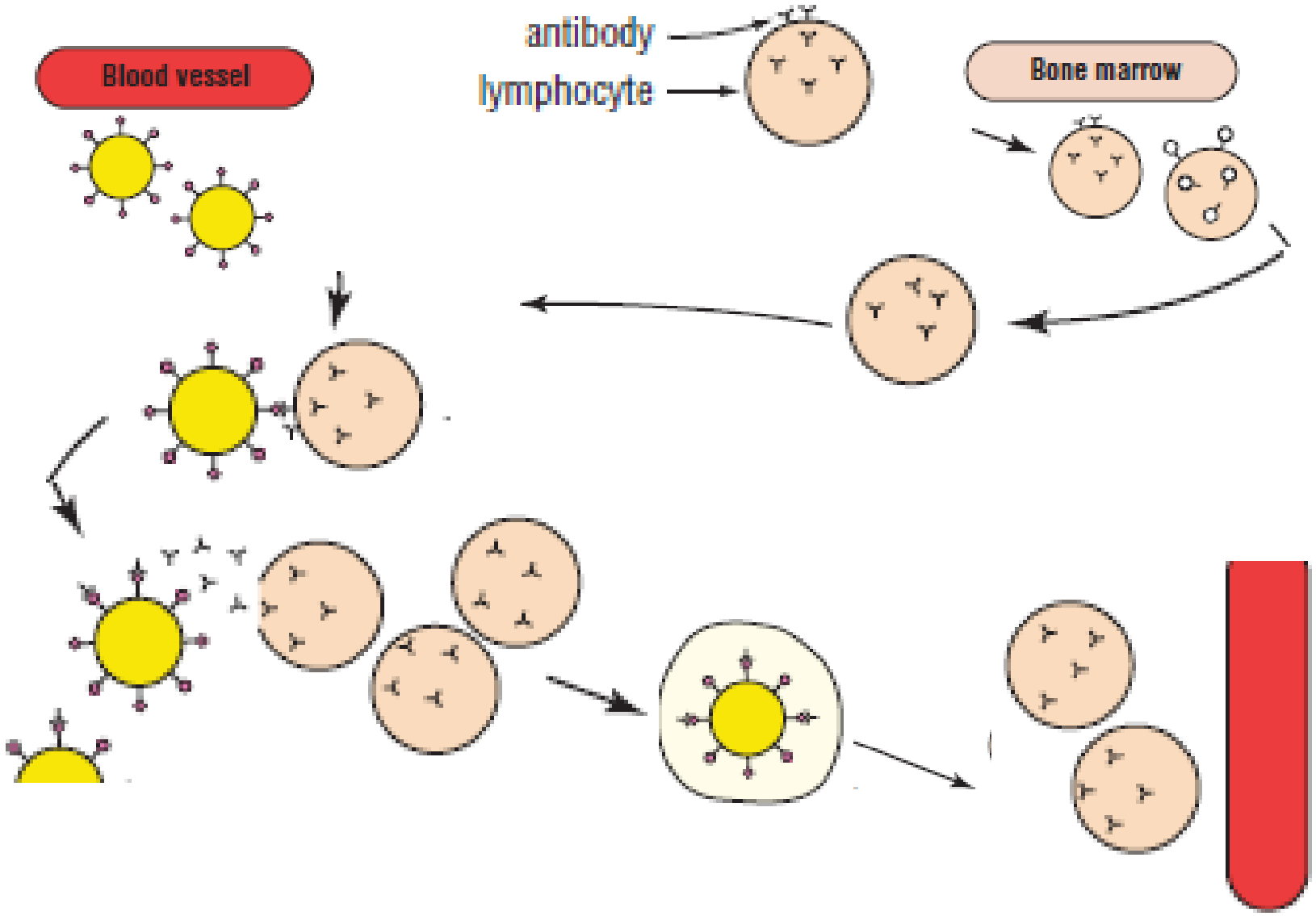
The body will be **immune** to that particular pathogen as long as the antibodies are present.

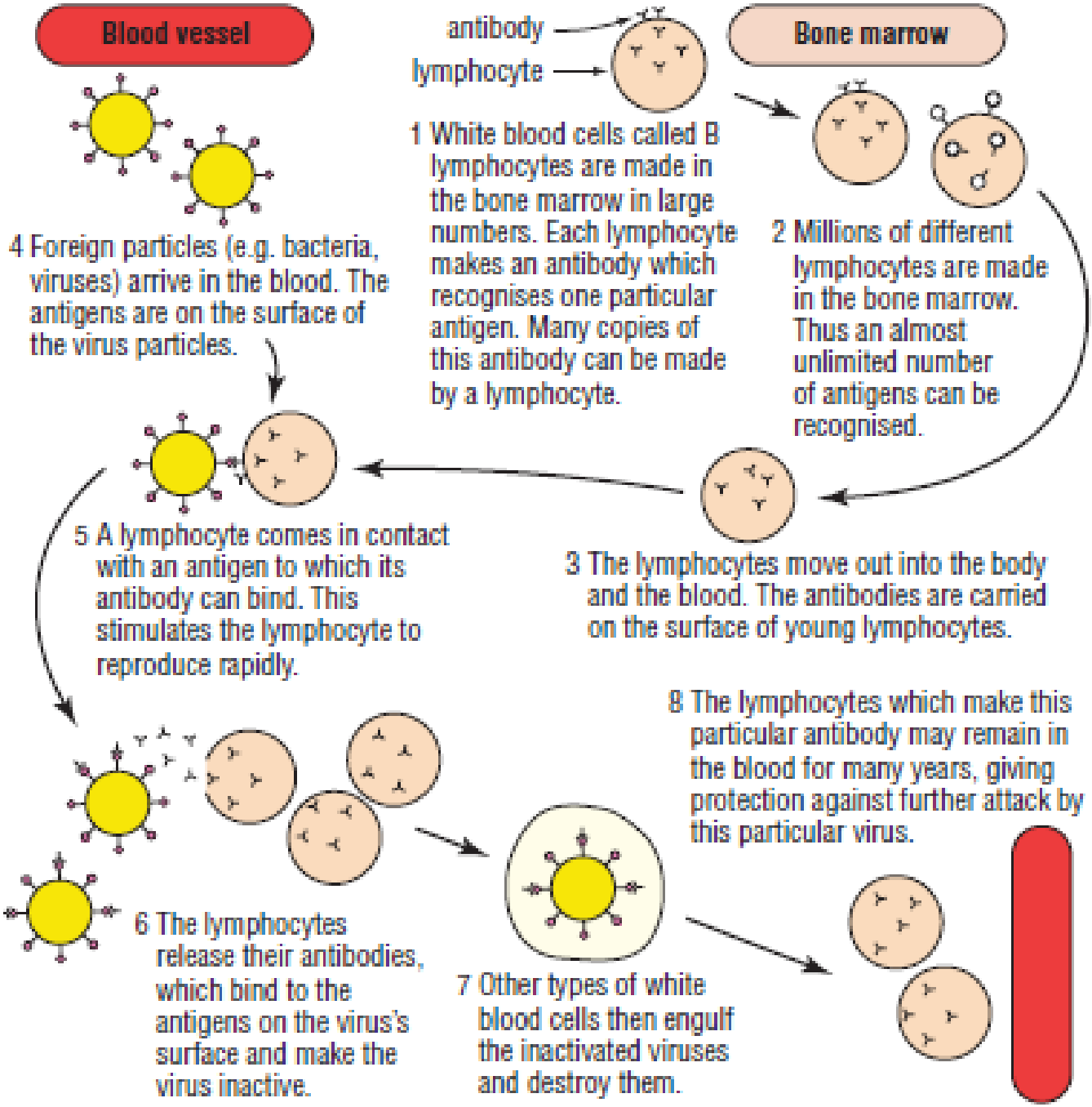
For example, if you had measles in the past then you may still be carrying antibodies for measles.

These antibodies can protect you from measles in the future.

Unfortunately they cannot protect you from chickenpox or any other disease.

The process of acquired immunity

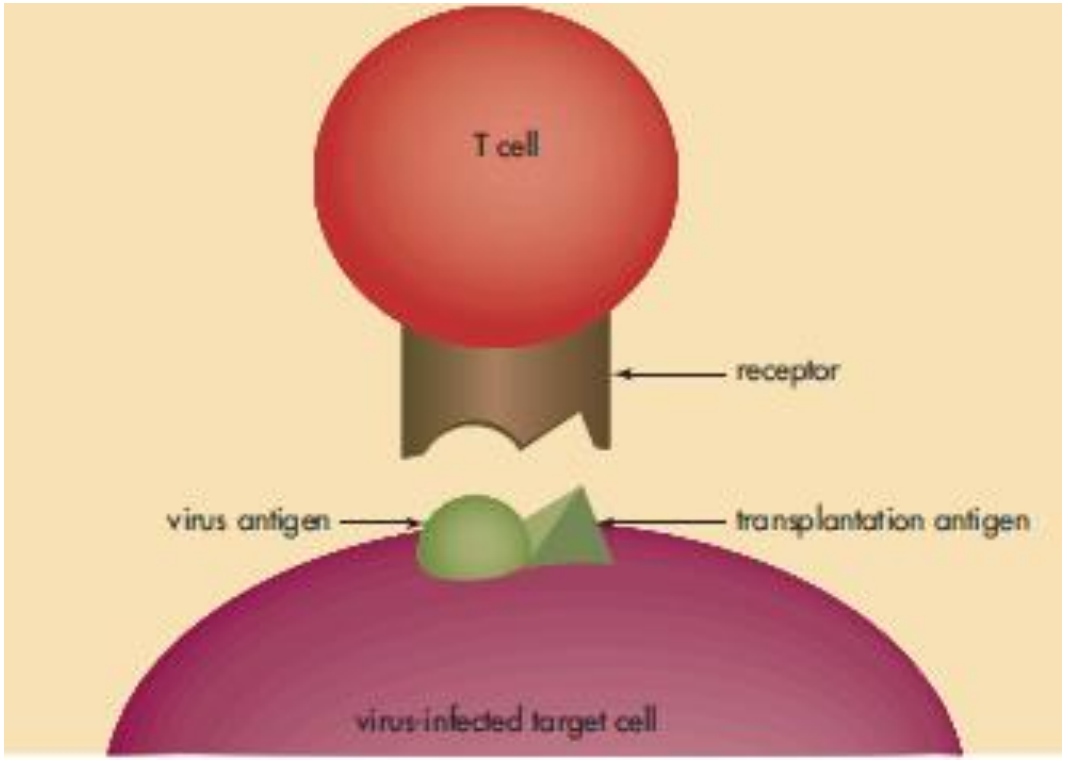



Blood vessel
antibody
lymphocyte
Bone marrow
1 White blood cells called B lymphocytes are made in the bone marrow in large numbers. Each lymphocyte makes an antibody which recognises one particular antigen. Many copies of this antibody can be made by a lymphocyte.
2 Millions of different lymphocytes are made in the bone marrow. Thus an almost unlimited number of antigens can be recognised.
3 The lymphocytes move out into the body and the blood. The antibodies are carried on the surface of young lymphocytes.
4 Foreign particles (e.g. bacteria, viruses) arrive in the blood. The antigens are on the surface of the virus particles.
5 A lymphocyte comes in contact with an antigen to which its antibody can bind. This stimulates the lymphocyte to reproduce rapidly.
6 The lymphocytes release their antibodies, which bind to the antigens on the virus's surface and make the virus inactive.
7 Other types of white blood cells then engulf the inactivated viruses and destroy them.
8 The lymphocytes which make this particular antibody may remain in the blood for many years, giving protection against further attack by this particular virus.

A killer T lymphocyte (T cell) must identify both the virus antigen and the cells of the organism it is trying to protect.

It does this through making a matched fit at the place where the antigen is attached to the host.

The host organism's transplantation antigen acts as the identifier.



Why don’t you catch the same infectious disease twice?

an antigen enters the body

↓

certain types of antibodies are produced

↓

some memory B and T cells are produced

↓

a number of these cells remain in the bloodstream for many years

↓

If the person is exposed to the same antigen at a later stage

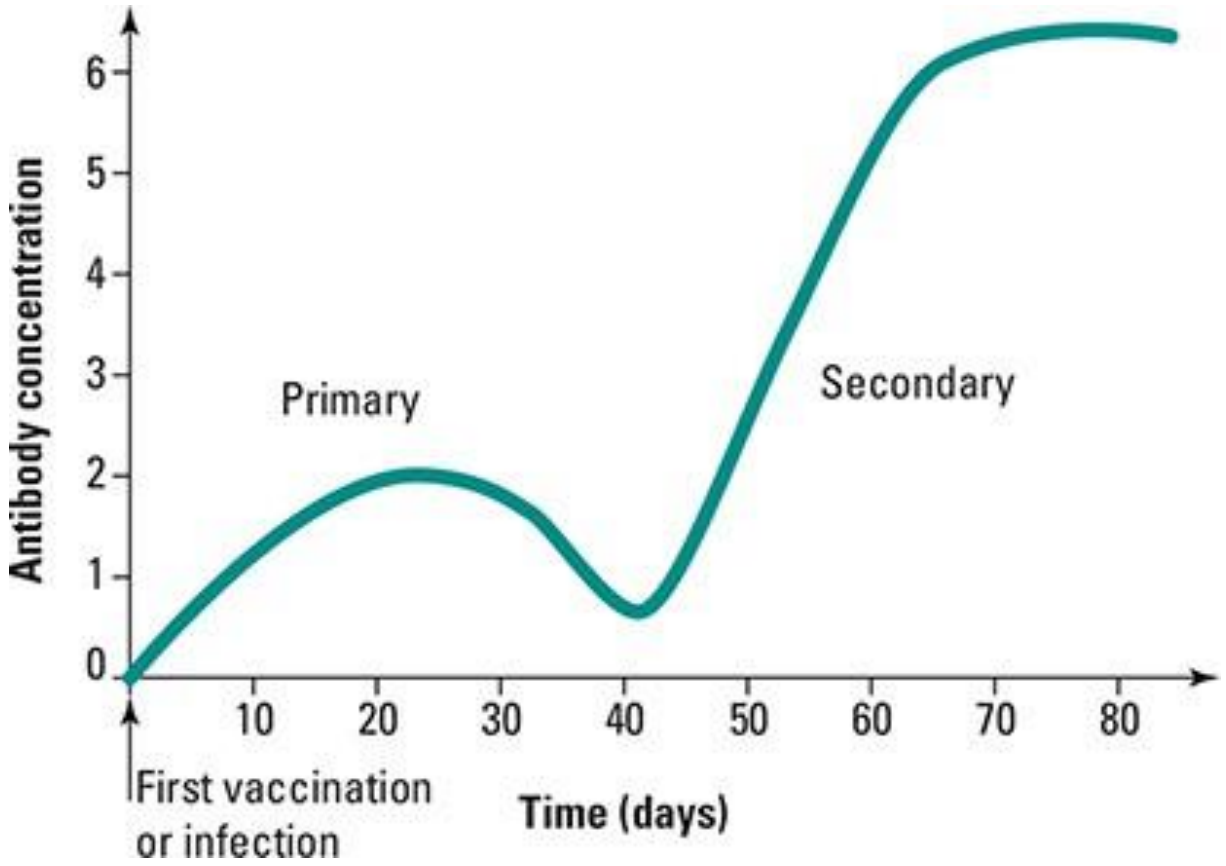
↓

the memory B and T cells will recognise it

↓

the correct type of antibodies will be produced at peak level within 2–7 days.

On the second exposure to an antigen, the immune system is able to start producing antibodies more rapidly and in greater amounts (even before symptoms develop).



Immune Response

The immune system protects the body from harmful substances by responding to antigens.