Leaving Cert Biology- Week 9

Topic: The Blood and Immune System

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Leaving Cert
Biology
Grinds

Week 9:
The Blood and Immune System

Sound & Visual Check

“I am now talking….”

“If you **cannot** hear me or see my screen please say “Cannot hear/see you” on the chat.

“If some of you can’t hear me, please restart your computer and join the class again.”

Leaving Cert
Biology
Grinds

Week 9:
The Blood and Immune System

Lesson Overview:

By the end of this lesson, you should:

- **Understand the composition of blood and how this relates to its function.**
- **Understand what is a pathogen and how our body reacts to them.**
- **Know the different blood groups and why they are important.**
- **Know the difference between the general and the specific defence systems.**
- **Have an in-depth understanding of the role of the B cells and the T cells.**

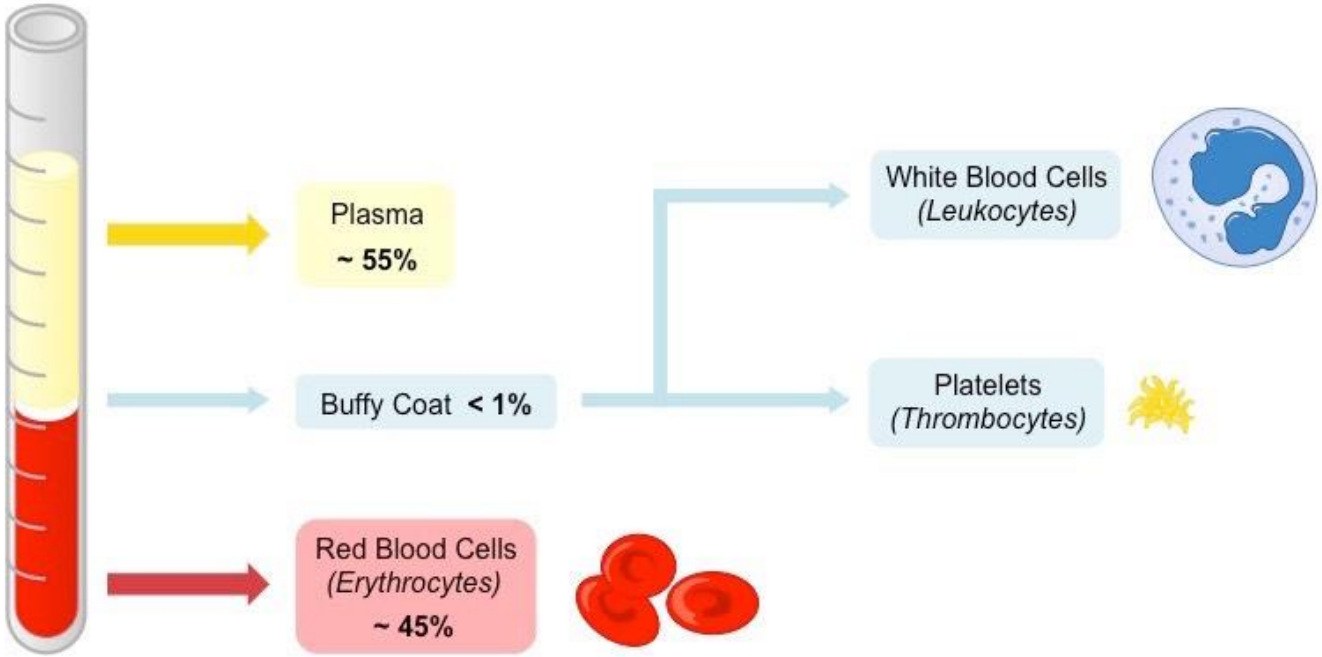
Composition of Blood

What's in blood?

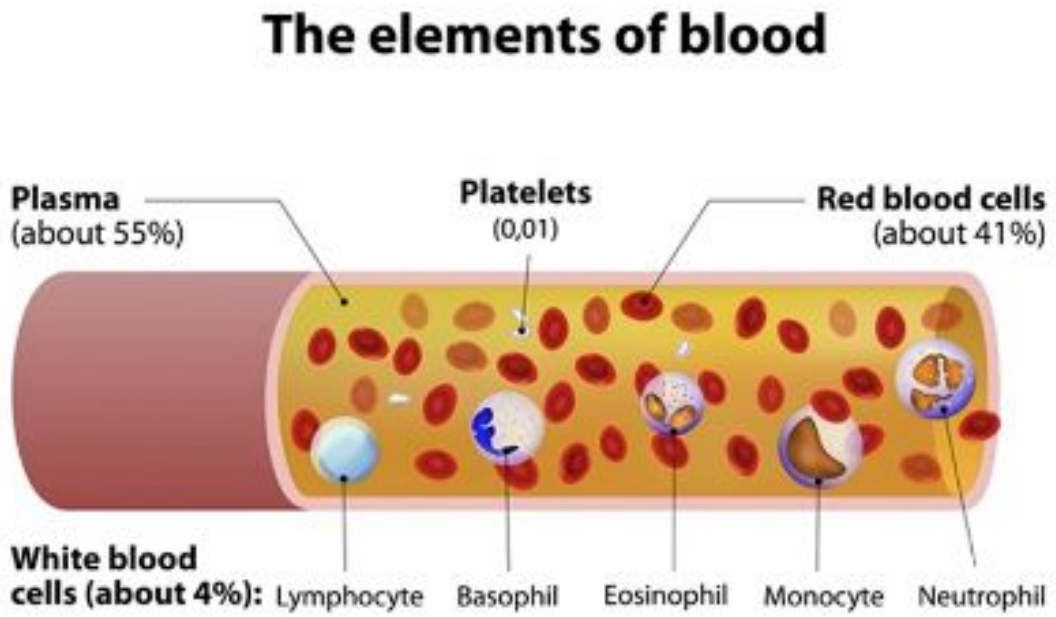
Plasma 55% □ liquid component

Red blood cells 45% □ oxygen carrying components

White blood cells and Platelets <1% □ immune system component



Plasma



Plasma: *liquid* part of blood, contains *90% water, 7% plasma protein, 3% dissolved materials.*

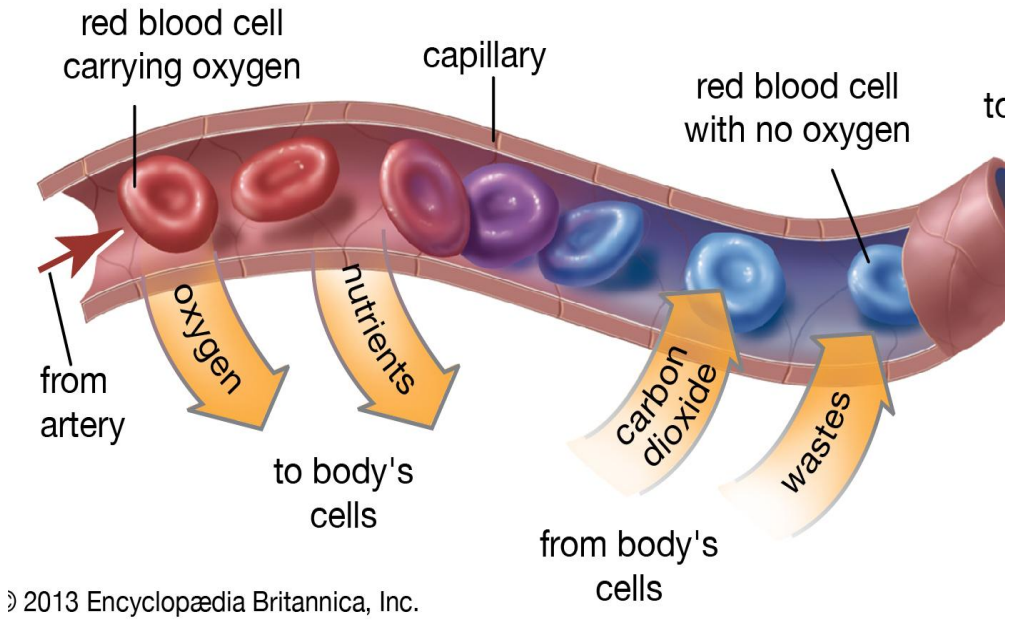
Plasma proteins? *Antibodies* (immune system) and *clotting proteins.*

Function of Plasma:

- *Transport* important materials around the body, e.g., glucose, amino acids, vitamins, hormones as well as waste products such as urea, salts and CO2.
- Plasma is important in transporting *heat* (conduction of heat).
- *Clotting proteins* in plasma are important to stop *bleeding*.

Serum: plasma – clotting proteins

Red Blood Cells (Erythrocytes)



Where are Red Blood Cells made?

- bone marrow of long bones

Structure:

Biconcave shape increase surface area

No mitochondria, no nucleus.

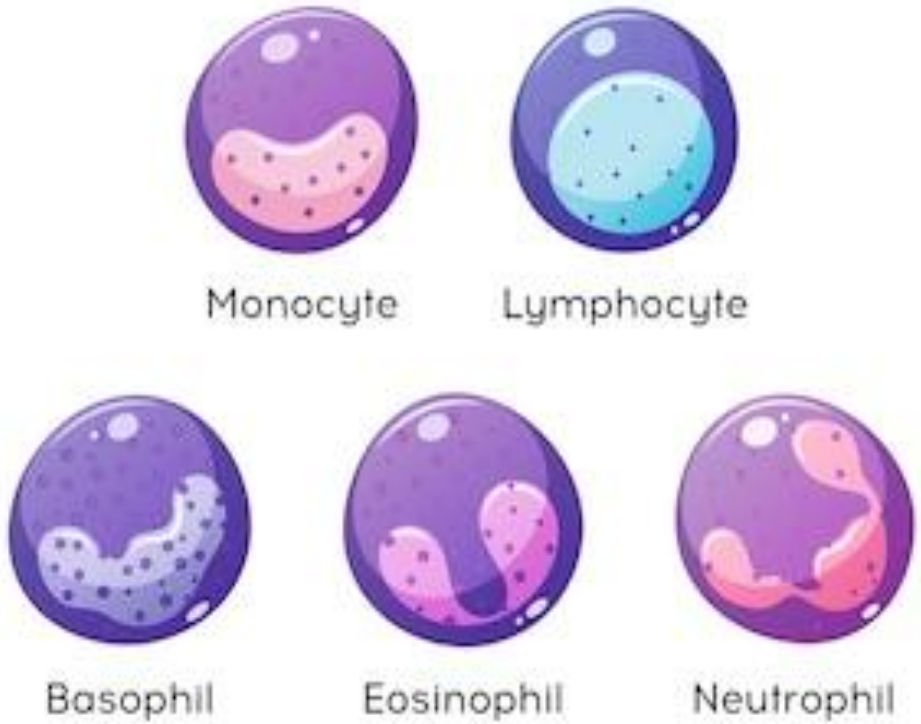
Contain the protein haemoglobin contains heme group which houses iron.

Function:

Carry oxygen and or carbon dioxide in the haemoglobin

Iron in the blood

White Blood Cells



Structure:

Do not have a colour and are much *larger* than RBCs.

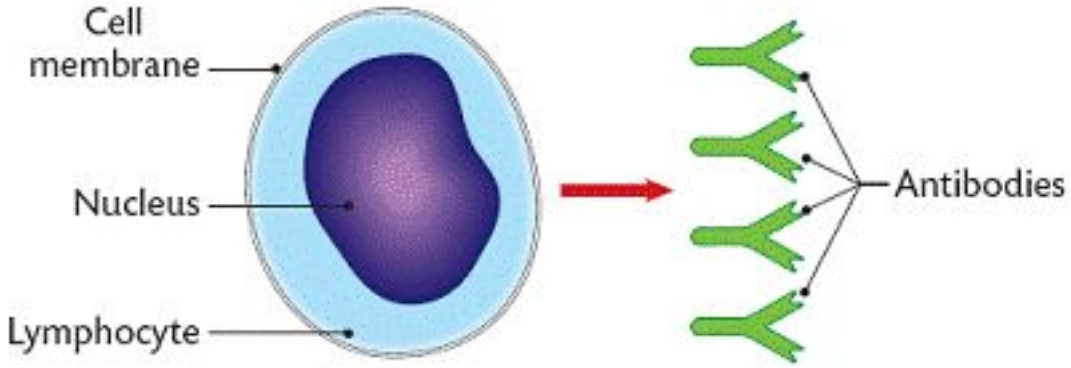
WBCs *do have* both *mitochondria* and a *nucleus*.

They can reproduce, we have less of them at any one time.

Function:

- Defend the body against infection by engulfing (swallowing) pathogens (bugs) and then producing antibodies.
- There are many different types of WBCs lymphocytes and monocytes
- WBCs are made in the bone marrow, some mature in the lymph system

WBCs- Lymphocytes



Lymphocytes make up 25% of the WBCs.

They are stored in parts of the lymphatic system waiting for an infection to occur in the body so they can get to work.

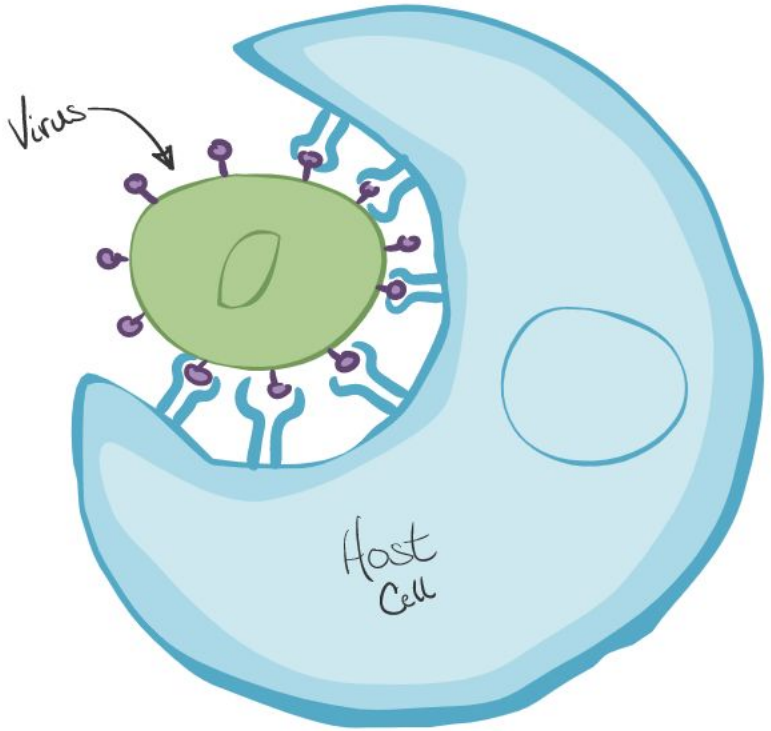
Contain 1 large, rounded nucleus.

Function:

- Make antibodies. Antibodies are proteins that help to destroy any foreign/ invaded cells in the body during infection.

There are B and T lymphocytes.

WBCs- Monocytes



Monocytes make up 5% of the WBCs.

They are the largest type of WBC, and very good at eating pathogens.

Contain 1 large, kidney shaped nucleus.

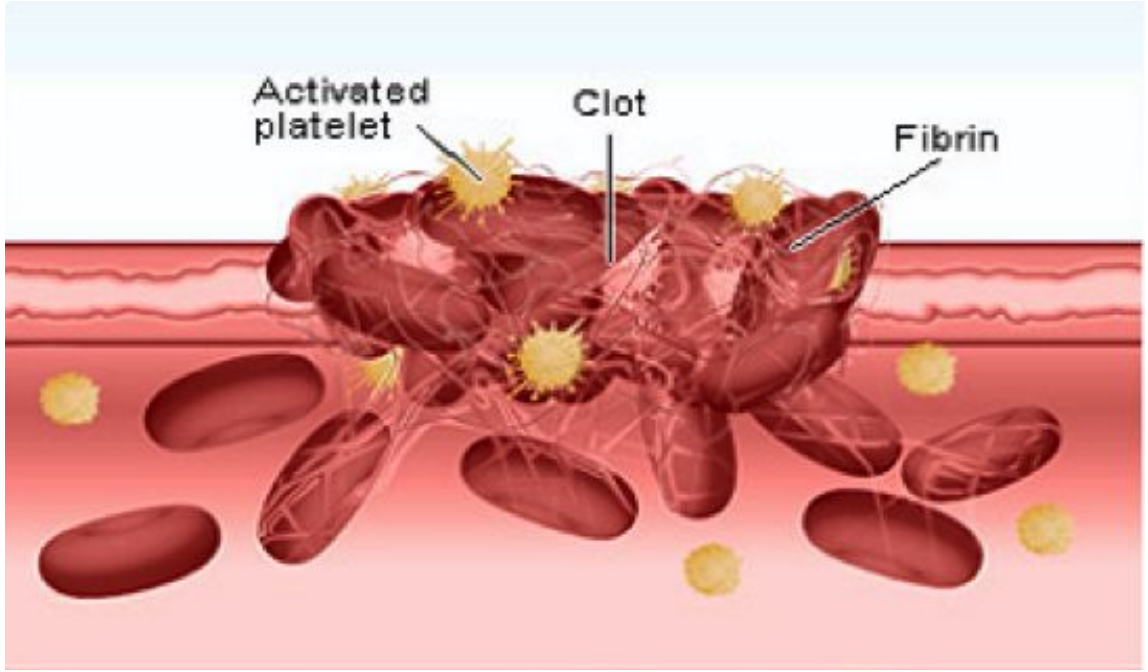
Function:

- Engulf and eat pathogens (bacteria and viruses).
- This process is called phagocytosis.
- Monocytes often called phagocytes or macrophages

Platelets

Platelets: Made in the *bone marrow*, these are small fragments that have split from a large cell found in the bone marrow.

Platelets are **not** cells.



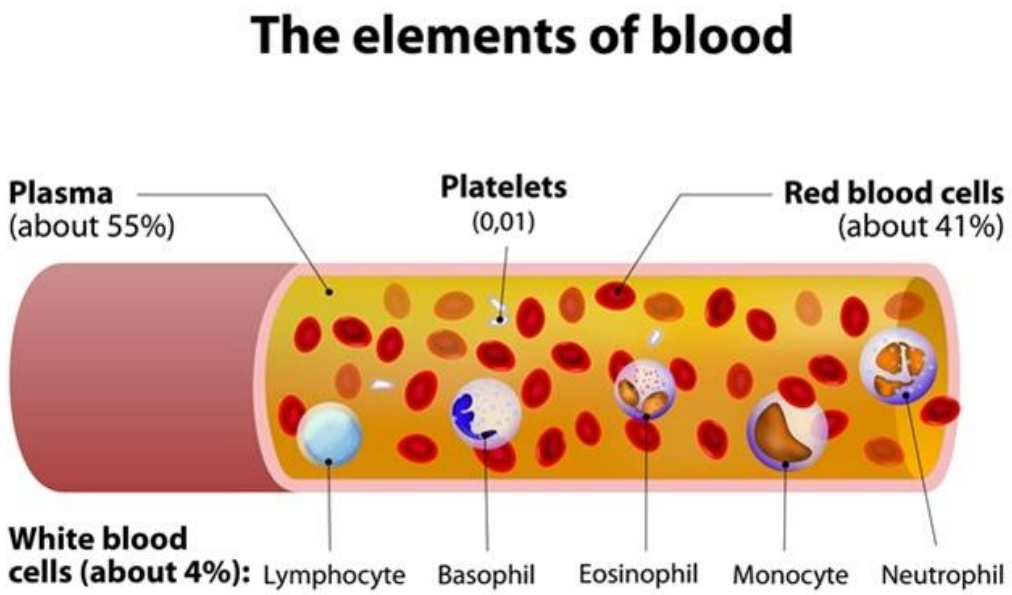
Function:

- Platelets work with the plasma clotting proteins to allow blood to clot stop bleeding.
- Blood clots:
  - Prevent blood loss
  - Prevent entry of pathogens through broke skin/ tissues.

Compare RBCs and WBCs

Red blood cells	White blood cells
Red in colour (when with O2)	Colourless
Made in the bone marrow of long bones	Made in the bone marrow, some mature in lymph sys
Biconcave in shape	No definite shape
No nucleus	Nucleus (different WBC have different shaped nuclei)
No mitochondria	Contain mitochondria
Live up to 4 months	Live for few days
Can’t reproduce	Can reproduce if they need to
Many RBCs in the blood	Less WBCs in the blood

Function of Blood



Transport:

- Food, salts, urea and hormones in *plasma*
- Oxygen and carbon dioxide in *RBCs*
- Heat in *plasma*

Fight Infection:

- Monocytes (WBCs) surround and destroy pathogens by *phagocytosis*.
- Lymphocytes (WBCs) make *antibodies* to fight pathogens.
- Platelets *clot blood* □ prevent further pathogens entering the body.

Blood Groups ABO

- All cells have proteins on their outer surface that make them identifiable.
- Red blood cells have antigens on their cell surface. There are two types found on RBCs A and B.
- People's blood is classified into blood groups depending on whether they have A, B or A and B

Blood Group	Antigen on the Red blood cell
A	A
B	B
AB	A and B
O	No antigens

Blood Groups - Rhesus Factor

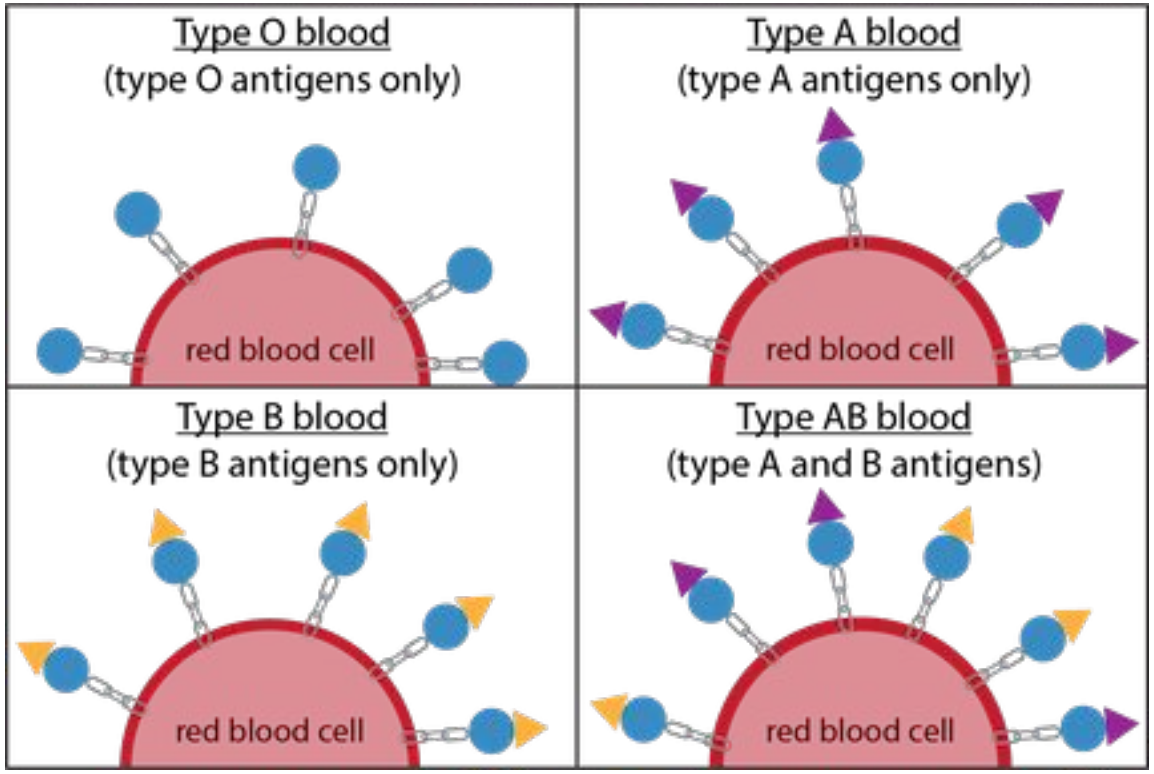
Blood Group	Antigen on the Red blood cell
A-	A antigen, no rhesus factor
AB+	A and B antigens and rhesus factor
O+	No A or B antigen, does have rhesus factor

As well as having A antigens or B antigens or both on the surface of our red blood cells, some people also have another antigen on their red blood cell surfaces Rhesus Factor or antigen D

If someone has Rhesus Factor antigen on their RBC, they are **rhesus positive (+)**

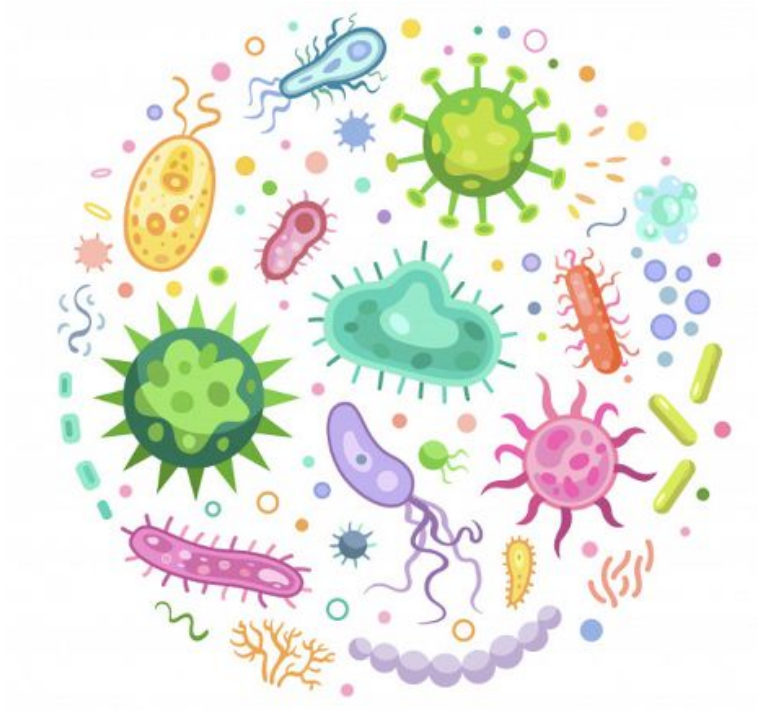
If someone does not have Rhesus Factor antigen on their RBC, they are **rhesus negative (-)**

Why are Blood Groups important?



- It is important to know our blood group if we are ever getting a transfusion.
- If we are O+ and we get a blood transfusion from e.g. A+ our immune cells will not recognise the A antigen on the surface of the red blood cells.
  - Our body will think that these antigens belong to a bug our immune cells will begin to attack the new red blood cells.

Pathogens



Pathogens: a foreign body or cell that causes disease in a host.

Pathogens include bacteria, viruses and fungi.

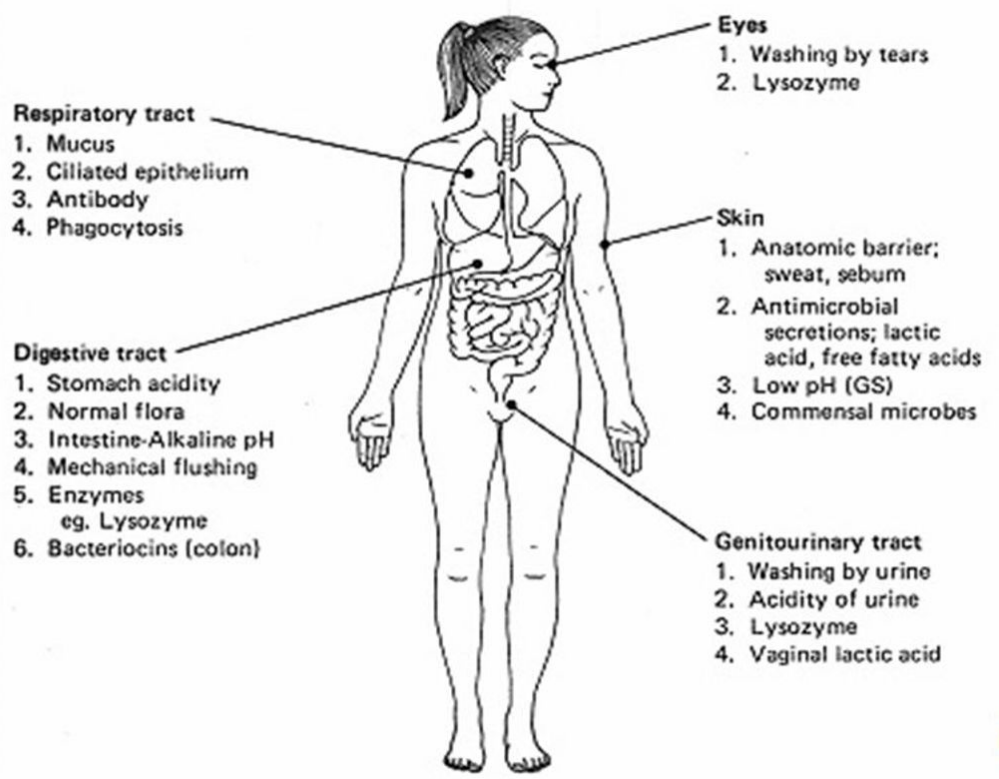
Antigen: Proteins found on the outside of cell membranes of all cells. They are how we recognise cells.

Pathogens also have antigens. Antibodies are made in response to antigens on pathogens.

There are two different defence systems that protect us from pathogens.

1. The General Defence System: acts/ works against any pathogen that enters the body. Helps to trigger the specific defence system.
2. The Specific Defence System: Acts/ works against one specific type of pathogen

General Defence System



1. Preventing entry

The general defence system acts to prevent the pathogens from entering the body by:

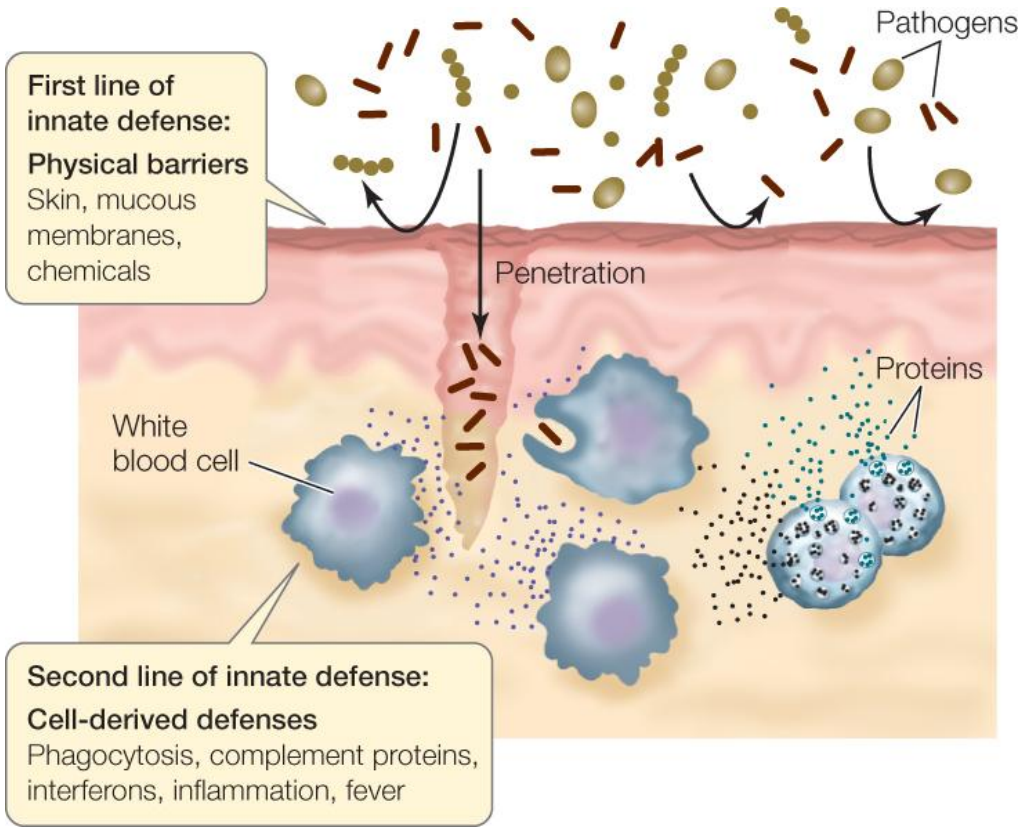
Skin: acts as a barrier to the entry of pathogens

Lysosomes: an enzyme that is found in sweat, tears, saliva and urine. It breaks down the walls of the bacteria death of bacteria

Clotting: at the site of breakage of the skin to prevent further entry of pathogens

Mucous: found in the respiratory system

General Defence System



2. Destroying pathogens at random

The general defence system is non-specific.

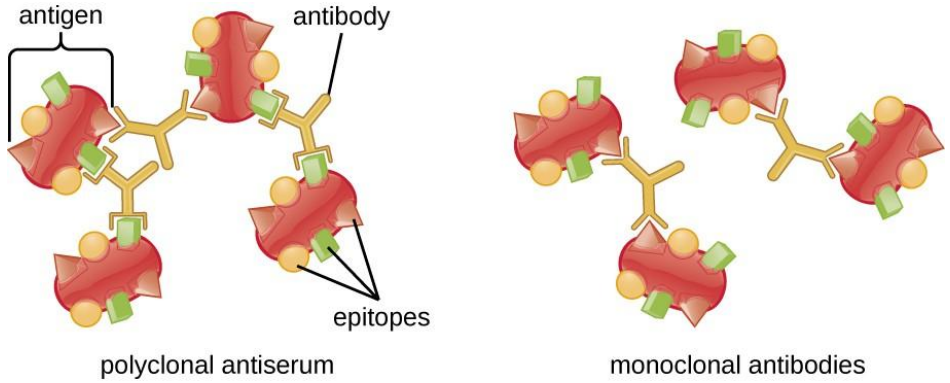
White Blood Cells: surround and destroy any pathogens that enter the body. Monocytes – known also as phagocytes.

Complement: proteins found in the plasma. These small proteins become activated when there is an infection. They work to break down the walls of bacterial cells.

Interferons: another set of proteins. These are produced by most of our cells when they become infected by viruses. Interferons stop the multiplication of viruses.

Inflammation: Caused by infection. Results in heat, redness, and swelling at the site of infection.

Specific Defence System



The specific defence system fights pathogens by producing specific **antibodies** from its **lymphocyte** (WBCs) that attack the **antigens** on a specific pathogen.

Lymphocytes: White blood cells belonging to the specific defence system. 2x types, B-cells and T-cells.

Pathogen Antigens: a foreign substance that stimulates the production of antibodies.

- **Anti**body-**gen**erating molecules
- Found on the surface of viruses and bacteria
- Cancer cells, transplant cells and blood transfusions cells all contain antigen

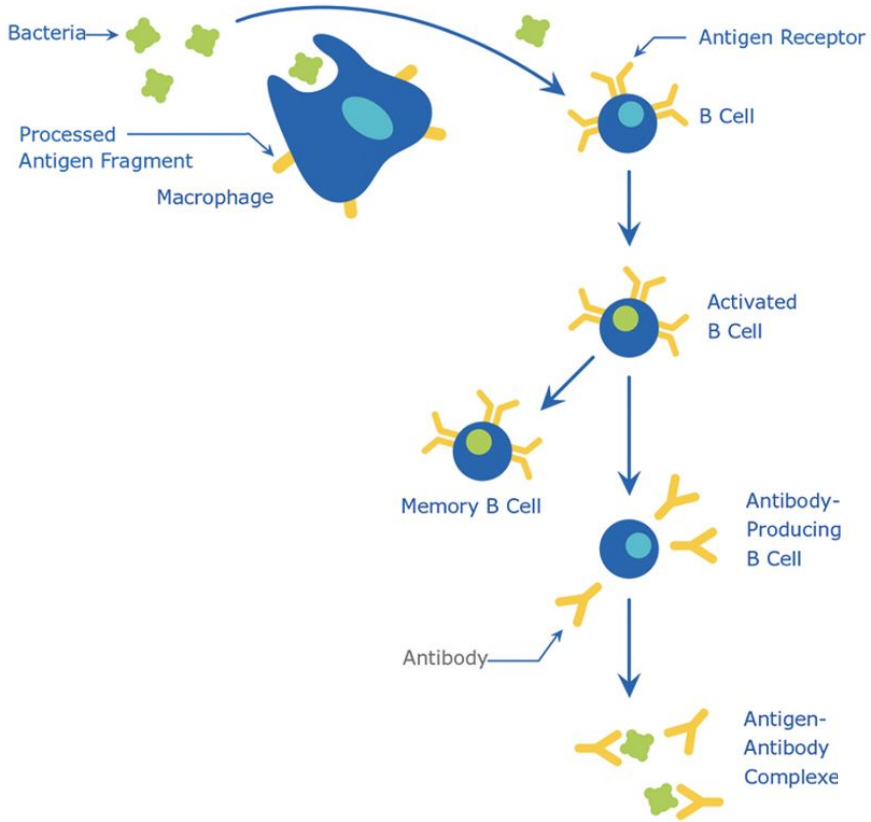
Antibodies: a protein produced by white blood cells in response to an antigen.

- Antibodies are produced by lymphocytes

Antibody Production

Antibody production can take up to 14 days after first infection.

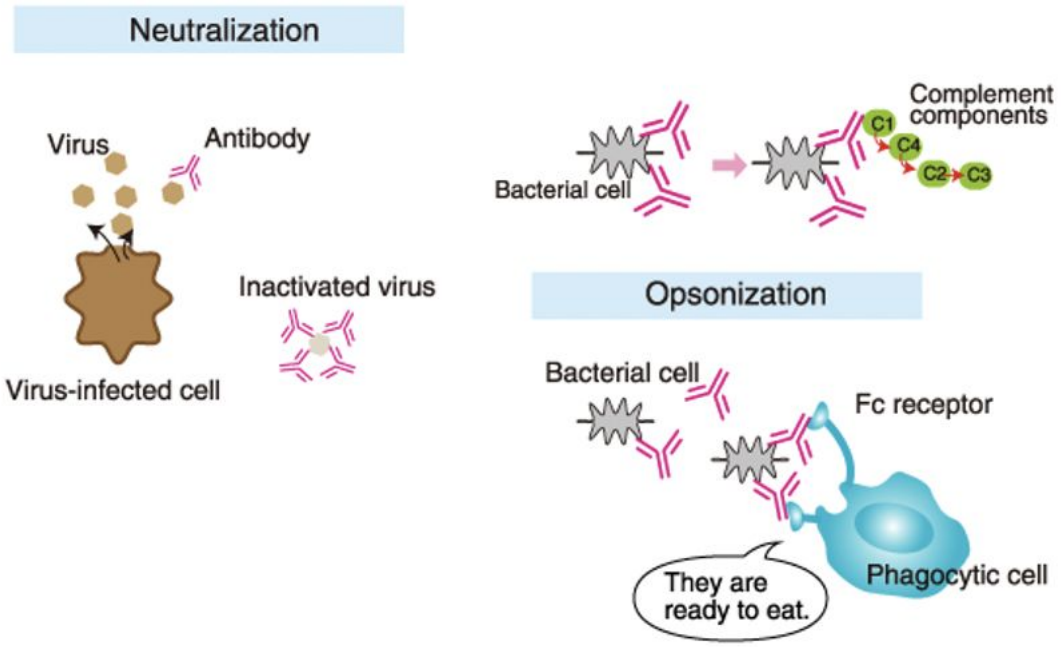
1. Monocytes (WBCs from the general defence system) recognise antigens on the surface of pathogens.
2. Monocytes surround and digest the pathogens.
3. Monocytes can then display the pathogens antigens on their surface.
4. Lymphocytes (WBCs from the specific defence system) recognise the monocytes newly displayed pathogens antigens.
5. The lymphocyte can then make and release specific antibodies that fit into specific antigens.



Antibody function

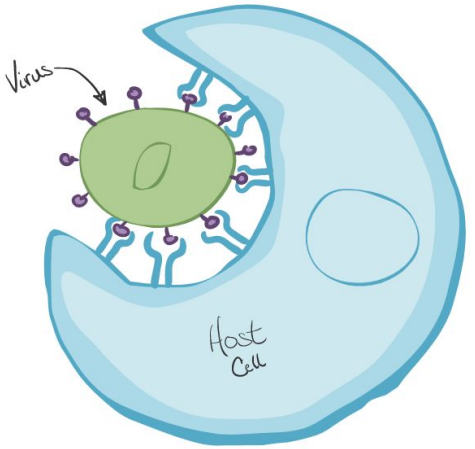
Antibodies work by inactivating the antigens.

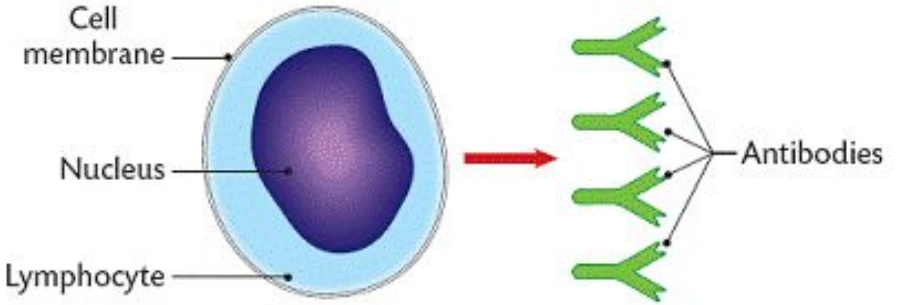
1. Antibodies bind to the antigens on the pathogen and stop them from entering the cell.
2. Antibodies bind to the antigens on the monocytes causing them to clump together. If they're clumped together, they can't function and will be destroyed by nearby phagocytes.
3. Antibodies trigger the complement system complement proteins found in the plasma cause the pathogens to burst



So what kills the pathogen?

1. Monocytes phagocytose the pathogen as part of the *general defence system.*
2. Monocytes that have already digested pathogens display their antigens. Lymphocytes from the *specific defence system* then create antibodies in response to the antigens on the monocytes.
3. Antibodies:
- Clump antigen presenting monocytes together.
- Attach to antigens on the surface of pathogens.
- Trigger the complement system burst pathogen walls





Immunity

Lymphocytes recognise antigens for the second time. If an antigen re enters the body the lymphocyte can start making the antibodies straight away.

Second Exposure to Pathogen: Antibodies are made

- In response to much smaller amounts of the antigen
- Quicker (5 days)
- Much more

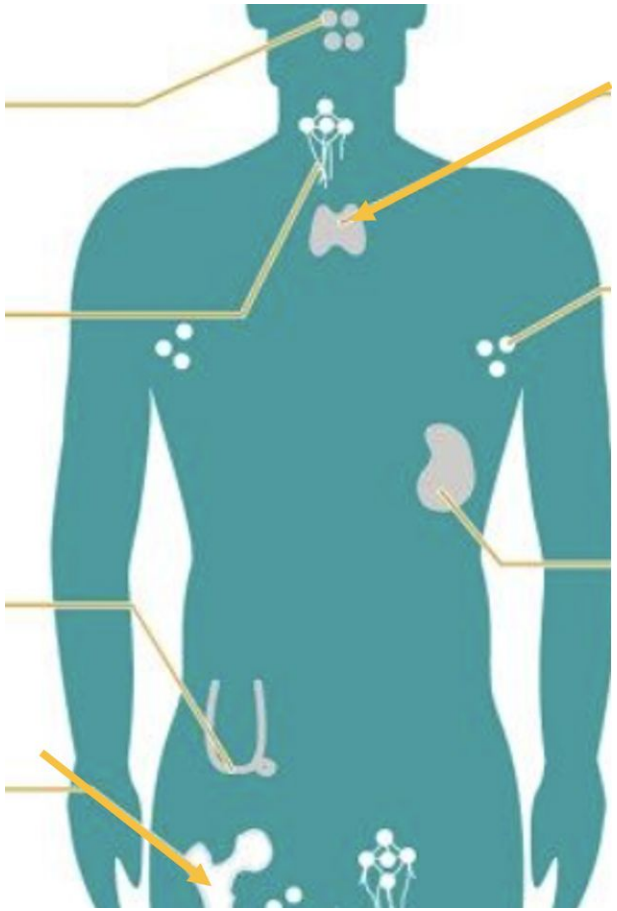
Lymphocytes – B and T cells

White blood cells that belong to *specific defence system*.

All lymphocytes are made in the bone marrow. Different lymphocytes mature in different places.

- **B** Lymphocytes mature in the **B**one marrow.
- **T** Lymphocytes mature in the **T**hyroid gland.

- **B cells:** Responsible for fighting free pathogens that are in the bloodstream/ extracellular space.
- **T cells:** Responsible for fighting/ killing pathogens that already in our cells. Kills infected cells.



B Cells (lymphocytes)

Made in the bone marrow. Mature in the bone marrow.

Once they are mature cells they move to the lymph nodes.

V cells produce antibodies.

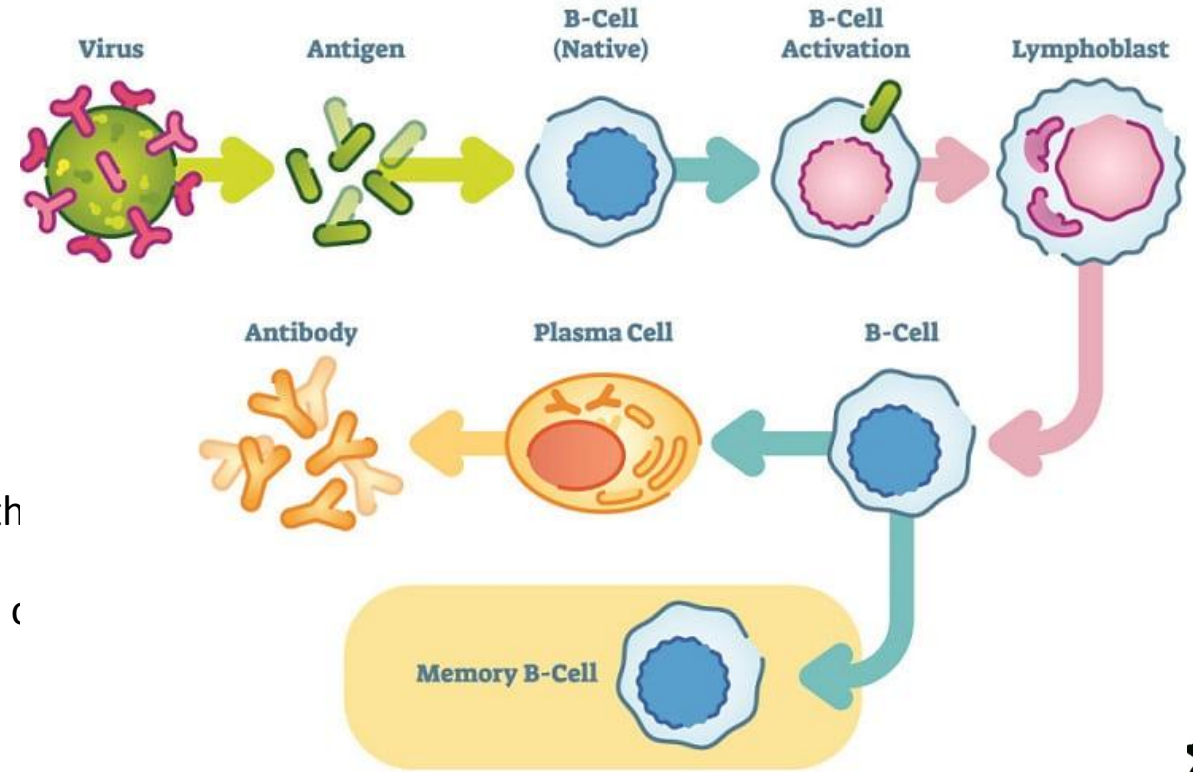
We are born with millions of different B cells.

- Each different B cell produces a different antibody.

Each antibody has the potential to fit an antigen.

If an antigen fits an antibody, that cell will multiply.

- The more of that cell there is the more of the antibodies th will be.
- These cells produce antibodies to kill the pathogen. Some c them stay as memory B cells.



T- Cells (Lymphocytes)

T cells are made in the bone marrow and mature in the thymus gland.

T cells don't produce antibodies. There are 4 types.

Helper T cells: Recognise antigens on monocytes

Go on to stimulate B cells with the right antibodies to multiply

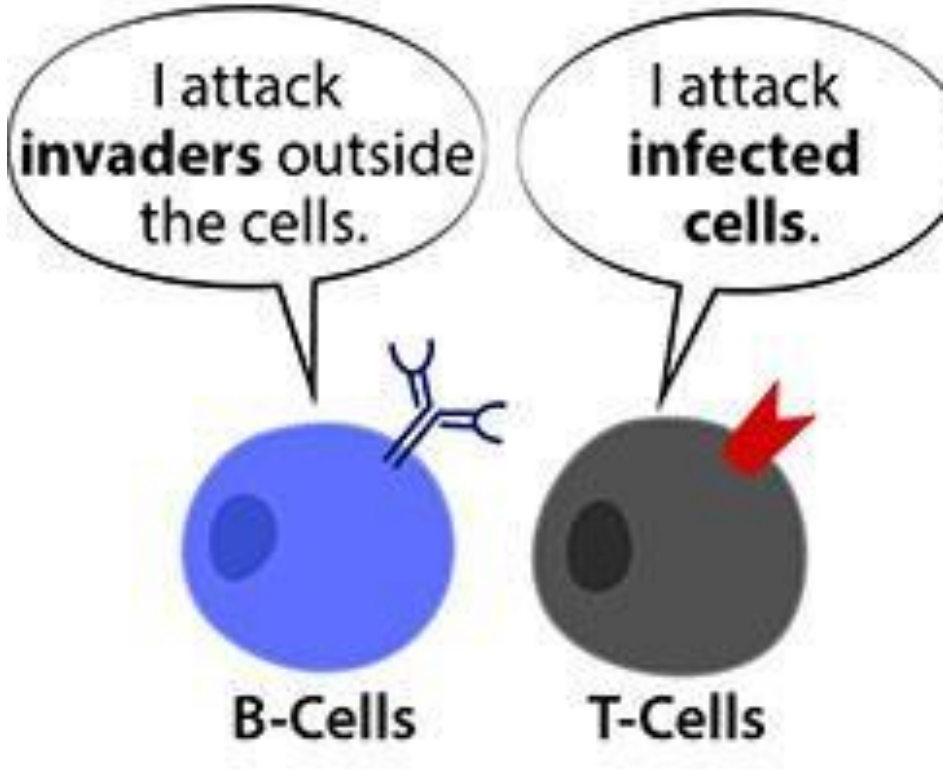
Stimulates the production of killer T cells

Killer T cells: attach and destroy any abnormal cells in our body

Anything with antigens that they don't recognise. Cells infected with viruses and cancer cells too.

Suppressor T cells: Inhibit B and T cells when the infection has been resolved. At the end of the fight!

Memory T cells: Stimulate B and Killer T cells to multiple straight away if the infection enters the body again!



Ordinary Level Questions

6. The diagram shows the label found on blood stored for transfusion in a hospital.

(a) Name the liquid part of blood.

(b) State **one** function of this liquid.

(c) What may be removed from blood to prevent it clotting during storage?

(d) The diagram shows blood group AB. Name **two** other blood groups.

(e) Name the blood cells that transport oxygen in the body.

(f) Name the blood cells that produce antibodies to fight infection.

Ordinary Level Questions

2016

(a) Answer the following in relation to blood.

(i) What is blood plasma?
(ii) Name **two** types of cell found in the blood and give a function for **each**.
(iii) The ABO blood group system has four blood groups. Name any **two** of these groups.
(iv) Blood groups can be positive (+) or negative (−) according to whether the blood contains or does not contain a particular factor. Name this factor.
(v) Suggest a reason why it is important to know a person's blood group.
(vi) What is the function of platelets in the blood?

Ordinary Level Questions

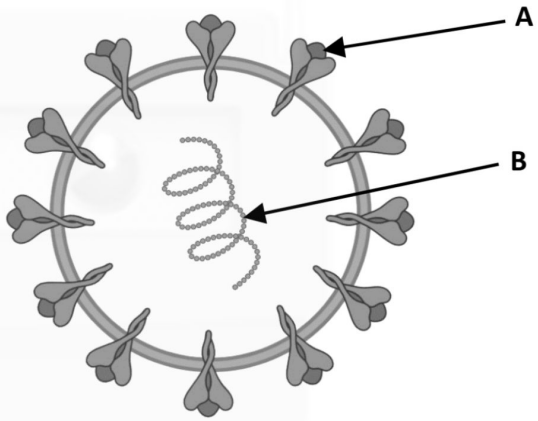
2018

(b) In 1796 an English doctor-scientist called Edward Jenner inserted pus from a cowpox blister into a young boy's arm. Later, he infected the boy with the much more serious disease of smallpox but the boy never developed smallpox. Jenner concluded that infection with cowpox must protect people from smallpox. This discovery led to the modern practice of vaccination (from the Latin 'vacca' for cow). Following worldwide vaccination in the second half of the 20th century, smallpox was declared eradicated in 1980.

(i) Edward Jenner discovered a vaccination against which disease?
(ii) Explain what we now understand about how vaccination works.
(iii) What is meant by the term *immunity*?
(iv) Outline the difference between active immunity and passive immunity.
(v) What is a pathogen?
(vi) Colostrum is the first milk a baby gets from its mother.
How does colostrum help to protect the baby from disease?

Ordinary Level Questions

5. The diagram shows the structure of a virus such as COVID-19.



(a) Why are viruses not considered to be living organisms?

(b) Identify the **two** parts labelled **A** and **B** that are found in all viruses.

A. | B.

(c) Describe **one** way viruses may be spread from person to person.

(d) State **one** way the body can defend itself against viruses.

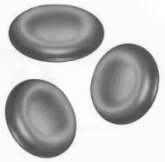
(e) Give **one** way in which viruses are beneficial.

(f) Explain why viruses are described as obligate parasites.

Higher Level Questions

2019

5. Some typical human red blood cells are shown below. They are disc shaped.



(a) What word is used to describe the shape of the two faces of these cells?

(b) Red blood cells are wider than some capillaries.
What feature of red blood cells allows them to pass through the narrow capillaries?

(c) Name the molecule in red blood cells that carries oxygen.

(d) Human red blood cells live for about 120 days.
Give a reason for this, based on the composition of these cells.

(e) Give a location in the body where red blood cells are:

1.	Produced.
2.	Usually broken down.

(f) Red blood cells are transported in the blood plasma.
Name the transport fluid in humans that does not contain red blood cells.

Higher Level Questions

2012

(b) (i) State **two** ways, other than colour, in which red blood cells differ from white blood cells.

(ii) Name a group of white blood cells, other than lymphocytes.

(iii) Lymphocytes may be divided into B cells and T cells. B cells produce antibodies.

1. What is the role of antibodies in the body?
2. Name any **three** types of T cell.
3. State a role of **each** of the T cell types that you named in part 2.

Higher Level Questions

2017

(b) (i) An outbreak of measles occurred in Ireland during the summer of 2016.
Name a group of people who would be most at risk if exposed to such an outbreak.

(ii) What is a vaccine **and** how does it result in immunity?

(iii) List any **three** types of T lymphocyte active in the human immune response.

(iv) Describe the role of **each** of the T cells referred to in part (iii) above.

Summary

Learn your definitions

Understand the shape of different blood cells and how they relate to their function.

Know where the different cells are formed, where they mature and what their function is.

Next Week's Lesson:

Leaving Cert Biology Grinds - Week 10

Topic: The Circulation System

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