Learning Intention: -To understand how the body distinguishes between self and non-self molecules
- To learn about the types of pathogens our body fights.

Success Criteria:

- I can explain how the body distinguish between self and non-self
- I can state and differentiate the different types of pathogens.

Study design dot point

- ~~initiation of an immune response, including antigen presentation~~, the distinction between self-antigens and non-self antigens, cellular and non-cellular pathogens, and allergens

Warm up

In one minute name as many diseases and organisms that cause those diseases.

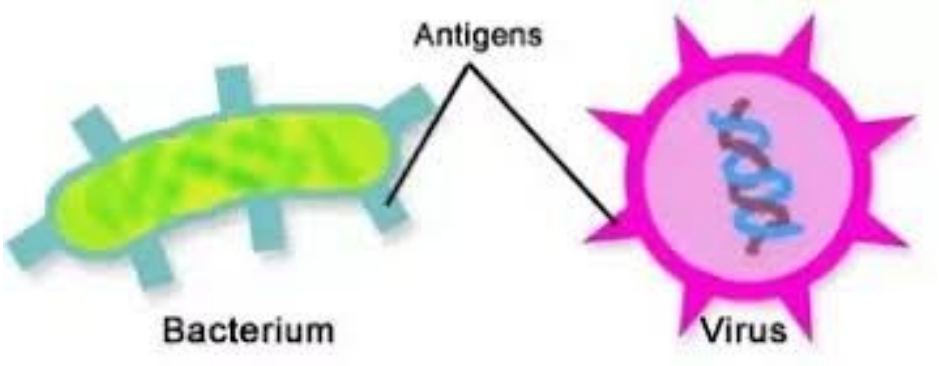
Antigens

Antigens are like labels signalling to the body's immune system to respond is various ways: *Eliminate me!***Antigen** is any molecule that may trigger an immune response.

What are antigens made from?

Most antigens are protein-based and can be composed of one or more polypeptide chains. However, antigens can also be composed of carbohydrates, lipids and even nucleic acids. For example, the complex carbohydrates of the human ABO blood group are antigens

Antigens do not need to be attached to a pathogen or cell, but they can simply be free-floating molecules. Example; pollen, whole bacteria or segment of it, chemicals in snake venom, drugs, dust, proteins in good.

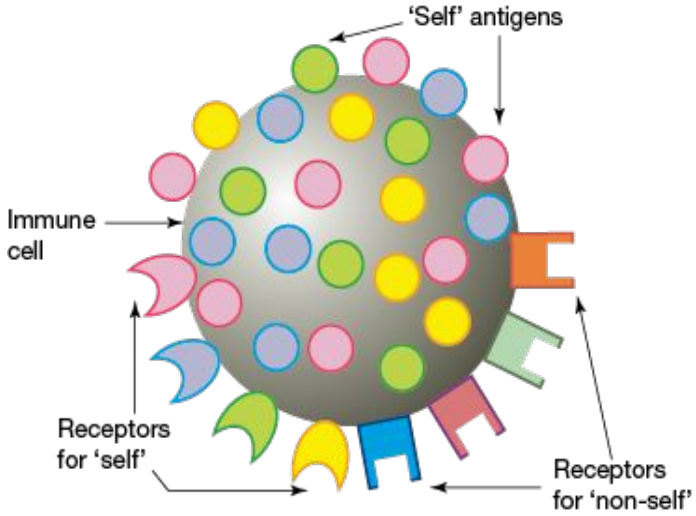


Self and non-self

Defence against infection depends on the ability of the body's immune system to:

1. **identify cells or molecules that are foreign or 'non-self' and react to and eliminate them.** Bacteria, bacterial toxins, viruses, and even one's own altered body cells, such as cancer cells.

2. **recognise the body's own cells and the compounds they produce as 'self' and not react against them.** If process 2 fails and the immune system attacks the body's own cells, the damage produces a so-called autoimmune disease.

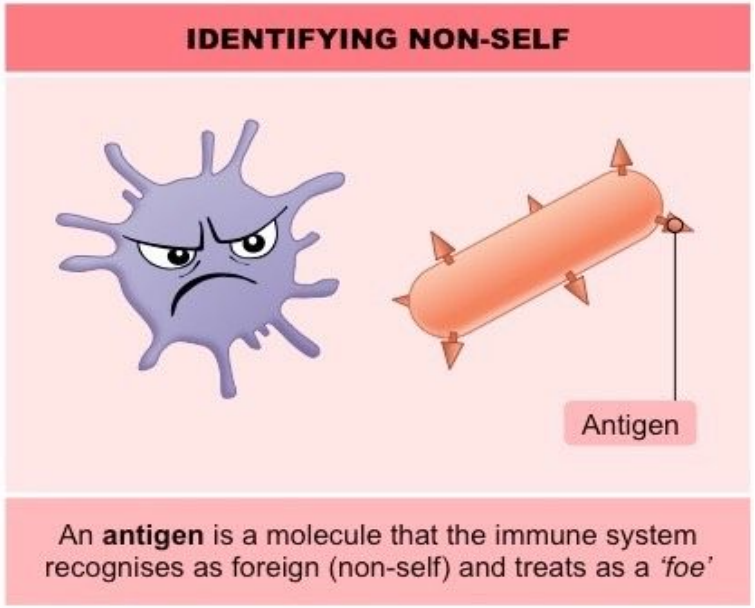


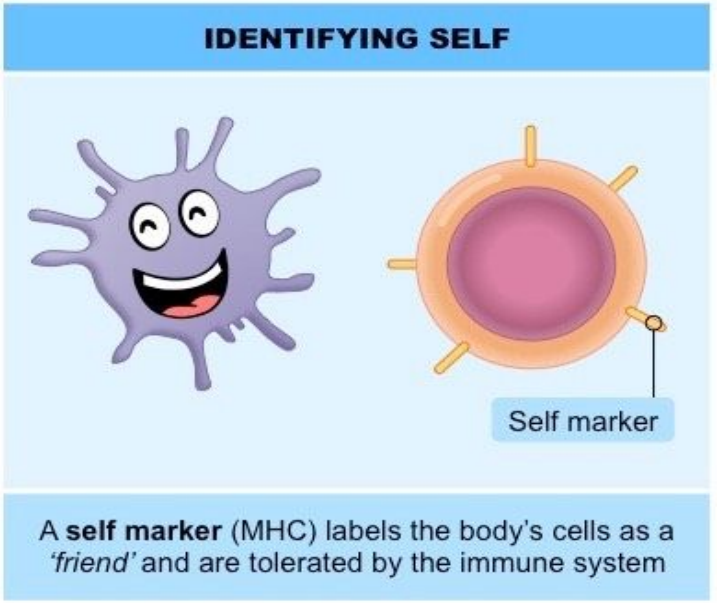
Self antigens- Major histocompatibility complex (MHC) proteins.

Self-antigens, located on the surface of cells, mark the cells of an organism as ‘self’ so that the immune system doesn’t attack them.

In humans, the most important self-antigens take the form of **major histocompatibility complex (MHC) proteins.**

MHC are sometimes also called **Human Leukocyte antigens (HLA)**





Major histocompatibility complex:

MHC proteins: A group of proteins present on the surface of all self-cells that enables the immune system to distinguish it from non-self material. Also known
as self-antigens.
MHC's can be divided into two different classes:
(a) **MHC I proteins** are expressed on all nucleated cells in the body. Therefore, virtually all cells in the human body except for those without a nucleus (e.g. red blood cells) express MHC I proteins.

(b) **MHC II proteins** are found on specialised cells of the immune system.

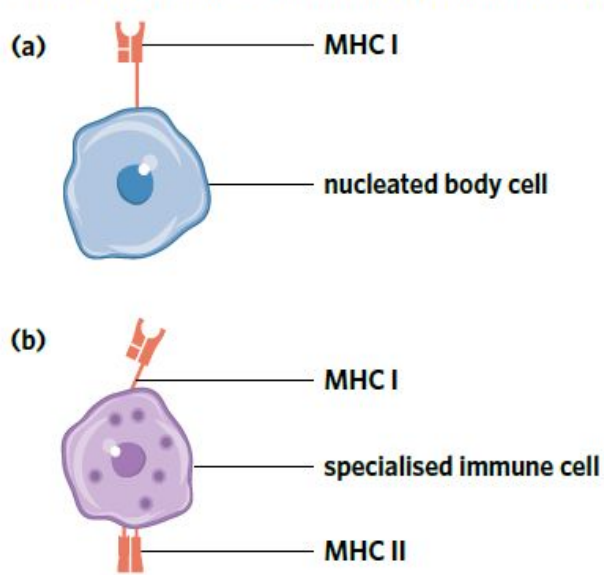


Figure 1 **(a)** A regular nucleated body cell with only MHC I proteins and **(b)** a specialised immune cell with both MHC I and MHC II proteins

Non-self antigens

Non-self antigens are antigens that the immune system reads as ‘foreign’. Due to this, the immune system is activated and it attempts to eliminate the antigen.
For example, if a pathogen such as a bacterium enters the body, the immune system will recognise specific bacterial proteins present on its surface as foreign and launch an attack in response. In this case, the bacterial proteins are serving as antigens.

Immune response in Organ transplant:
The MHC proteins found on our cells differ between individuals. For example, in an organ transplant, the MHC I proteins expressed on the donor organ will be different to the MHC I proteins of the organ receiver, which can stimulate the receiver’s immune system to recognise the transplanted organ as non-self and launch an attack. Therefore, organ transplant recipients must routinely take immunosuppressant's in order to prevent the immune system from attacking the donated organ.

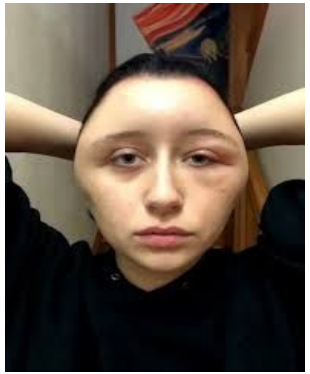
Note: Not all antigens (including not all non-self antigens) elicit an immune response, and antigens that do elicit an immune response are called **immunogens.**

Malfunctioning of immune system

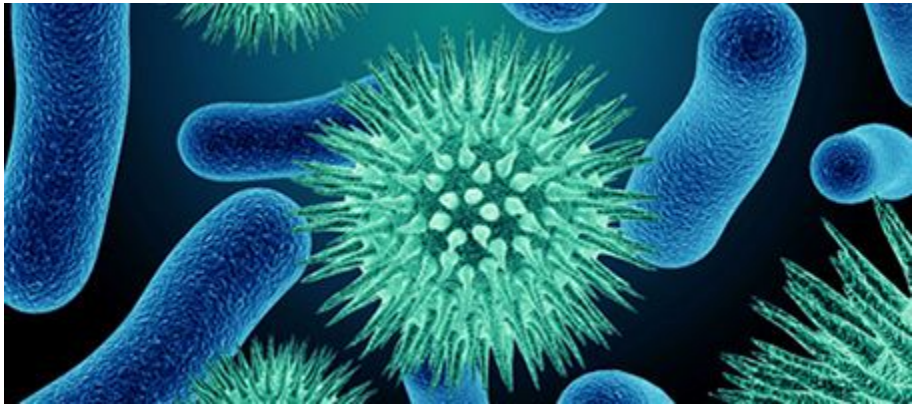
Autoimmune disease: When an error in the immune system results in the recognition of self-antigens as non-self, the immune system starts attacking self-cells and is known as an autoimmune disease. Examples include rheumatoid arthritis and lupus.

Allergy: Allergens are antigens that the immune system recognises as non-self and initiates a strong immune response towards. Allergens aren't pathogenic. The immune response they generate is called an allergic reaction. Common types of allergens include pollen, dust, and peanuts.

Depending on the particular individual and antigen, the hypersensitivity reaction can range from mild to being a life-threatening reaction known as **anaphylaxis.**



Microbes & pathogens



We are constantly exposed to microbes (micro organism, fungi, bacteria, protista), most are harmless but some can cause infection or disease.
Harmful microbes are called **pathogenic** microbes.

Pathogen is an agent that causes diseases.
The immune system protects our body by scanning for and destroying pathogens. The immune system uses antigens to recognise if a cell or molecule is self or non-self. If it is identified as non-self, an immune response is initiated.

Pathogens

There are many different types of pathogens that can infect organisms and make them sick, including bacteria, fungi, worms, protozoa, viruses, and prions.

To cause a disease, the pathogen must first:

- gain entry to the body and reach target site(s) in the body
- overcome the defence mechanisms of the body
- become established at one or more sites
- multiply rapidly, causing harm to the host and producing the symptoms of the disease.

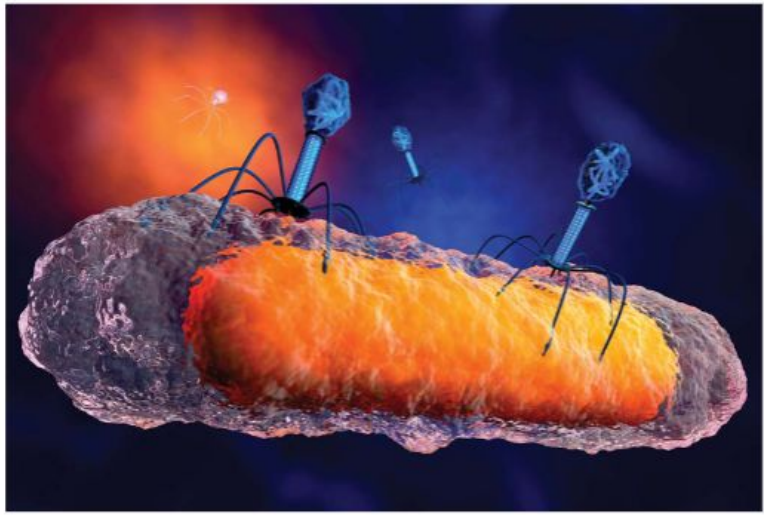
Pathogens affect the normal functioning of our cells, and cause disease by:

- producing toxins which cause the lysis of cells,
- inhibiting protein or nucleic acid synthesis,
- affecting cellular respiration, preventing cells from producing energy

Types of Pathogens: Cellular and non-cellular

Pathogens can be categorised as:
Cellular pathogens- have a cellular structure and are living organisms.

Non-cellular pathogens- do not have a cellular structure and are non-living.



Bacteriophage- a virus (non-cellular pathogen) that infects bacteria (cellular pathogen)

Pathogen	Description	Examples
Cellular pathogens		
Bacteria	Unicellular prokaryotes that can infect almost any part of the body. Bacteria can cause disease through the production of toxins and enzymes which either affect the functioning of cells or cause their death.	• *Neisseria meningitidis* causing meningitis • *Clostridium tetani* causing tetanus
Fungi	Eukaryotic organisms that include yeasts and moulds and contain long, branching filaments called **hyphae**.	• Thrush • *Trichophyton* spp. causing athlete's foot (Tinea pedis) • Ringworm (Tinea)
Worms	Multicellular invertebrate parasites whose development include egg, larval, and adult stages. Can vary in length, with the longest worms being over 55 m in length.	• **Parasite** (e.g. tapeworm) infection leading to malnutrition • Roundworm (Ascaris)
Protozoa	Single-celled eukaryotes that can be free-living or parasitic. Protozoa have many different mechanisms of action – for example, some can inhibit nucleic acid synthesis, protein synthesis, and various stages of cellular respiration.	• *Plasmodium* causing malaria

Non-cellular pathogens		
Viruses	An infectious agent composed of genetic material (DNA or RNA) inside a protein coat (capsid). In some instances the protein coat is surrounded by a lipid envelope. Viruses are not able to independently reproduce, instead they insert their genetic material into a host's cell and use the cell to replicate. Viruses can cause disease through the lysis of cells during viral replication, the formation of cancer by affecting gene expression, and the over-stimulation of the immune system leading to organ damage.	• Rhinovirus causing the common cold • Influenza causing the flu • Ebola virus causing ebola • SARS-CoV-2 causing COVID-19
Prions	Abnormally folded proteins that have the ability to induce normal proteins nearby to become misfolded. They only occur in mammals and affect only the brain and other neural structures. They are currently the only known infectious agents that don't contain nucleic acids.	• Creutzfeldt-Jakob disease • Bovine spongiform encephalopathy (also known as mad cow disease)

Worked example

Q. In the future, scientists aim to grow full-size kidneys for transplantation use in patients with kidney disease using the patient's own skin cells. This would overcome the problem of rejection of the transplanted kidney by the immune system. Which of the following is responsible for causing organ rejection?

A. pathogens from the donor's kidney

B. the MHC proteins on the donor's kidney

C. the MHC proteins on the receiver's kidney

D. self-antigens from the receiver's body not recognising the donor kidney cells

Summary

Antigens:

- have a unique molecular structure
- are composed of one or more polypeptide chains but can also be composed of nucleic acids, carbohydrates or lipids
- can identify cells as self or non-self
  - can be found on the surface of the plasma membrane of cells or circulating freely in body fluids (e.g. bacterial toxins).

Antigens that elicit an immune response are called immunogens. Antigens that elicit an allergic response insusceptible individuals are called allergens. Self-antigens do not normally elicit an immune response. This is known as self-tolerance. Under normal conditions, any foreign molecule is recognised by the immune system as a non-self antigen.

Pathogens are sources of non-self antigens and agents that cause disease.Cellular pathogens include bacteria, fungi, oomycetes, protozoans and some worms and arthropods. Non-cellular pathogens include viruses, viroids and prions.

Reflection

Edrolo Ch 7 A Q 1-4, 12-15, 18-20