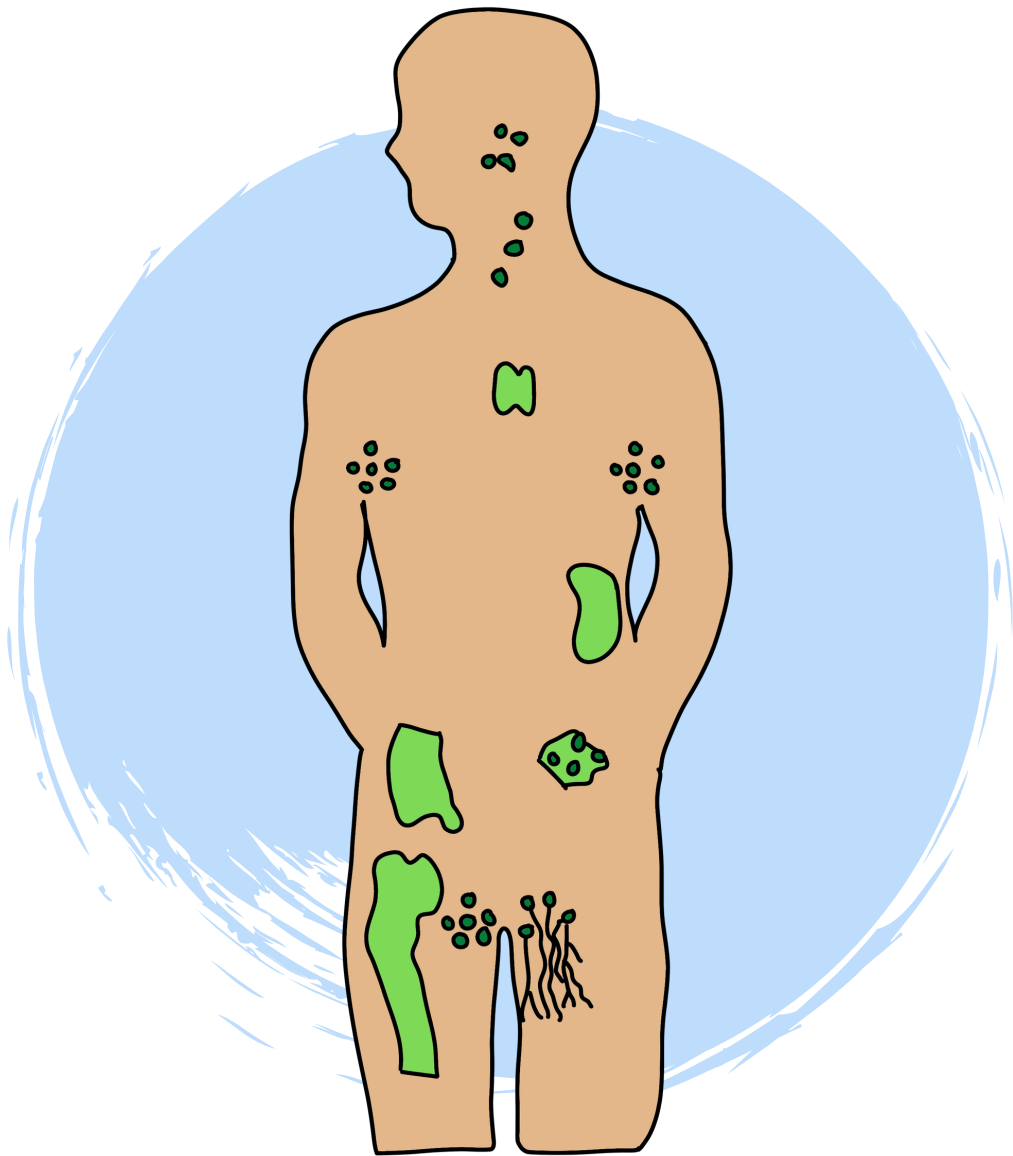


the three lines of defense: immunity

step by step

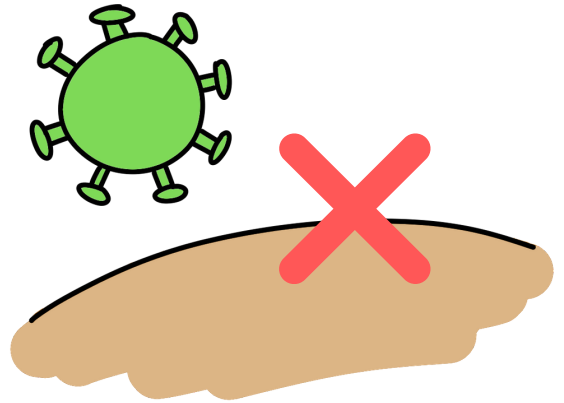


dealing with pathogens

A pathogen is any outside body (virus, bacteria, microorganism, etc.) that can cause disease. In innate immunity, the body reacts in defense towards the pathogen. Our body has three lines of defense against pathogens.

1 *surface barriers*

Skin is a barrier between the outside and insides of your body. Besides from keeping all organs, bones, and muscles in place, skin helps protect the amount of contact that internal mechanisms would have with external pathogens.



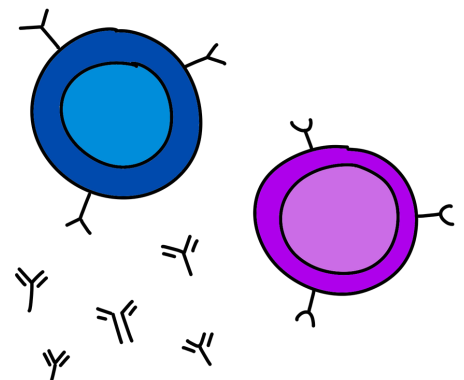
2 *innate immune system*

If the pathogen bypasses the surface barrier, then the innate immune system goes into defense. With the pathogen now inside the body, the body reacts with non-specific responses. They are done as a general measure to being infiltrated. This system responds to infections the same way every time.



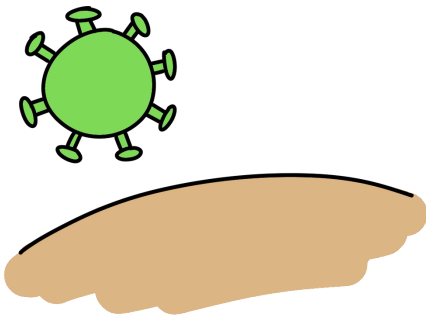
3 *adaptive immune system*

If an unspecialized solution does not take care of the pathogen, a specialized response may be needed by the adaptive immune system. This system can differentiate and target a response specific to a pathogen, and responds fast, in order to prevent symptoms from further developing or worsening.



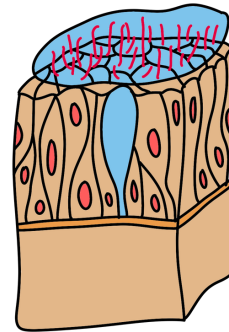
surface barrier

The surface barrier is the first line of defense. It is a preventative solution towards infection. There are four different barriers and measures your body utilizes in order to block pathogens.



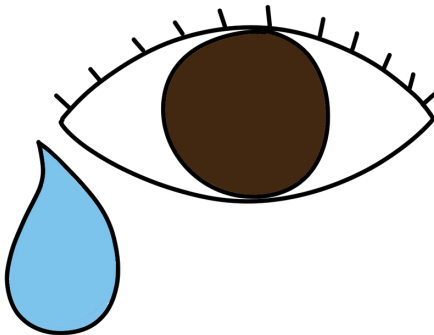
skin

If bacteria are unable to penetrate the skin, there is no possibility for infection. Skin as a barrier is efficient and allows the body to not be sensitive to every surface or pathogen.



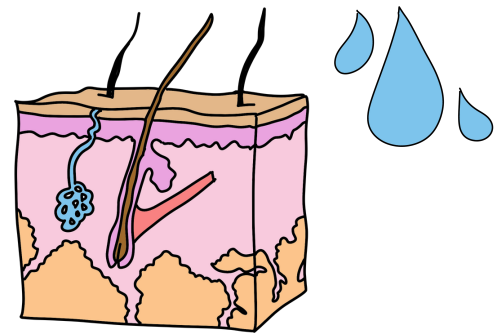
mucous membrane

A mucous membrane allows for the secretion of a mucous, which can trap pathogens and particles, to prevent it from spreading and causing further possible damage.



chemical secretions

Pathogens can enter the body through ducts with mucous, such as eyes, mouth, throat, etc. By secreting chemicals with antimicrobial proteins, infection can be inhibited.

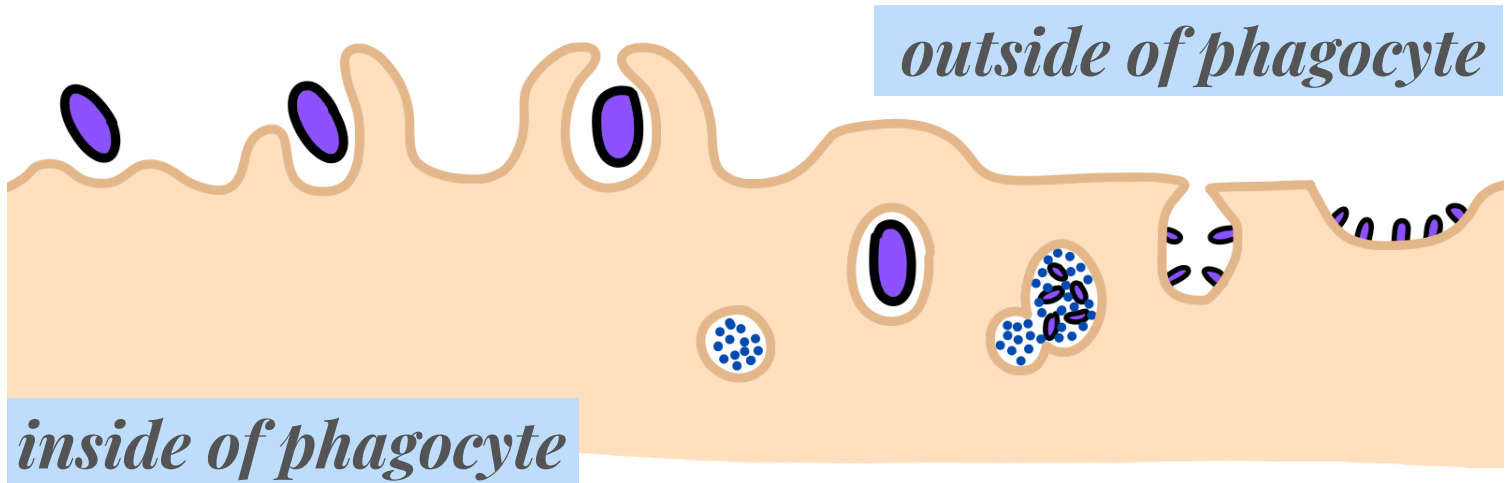


ph & sweat

The skin releases sweat, which helps keep the optimum pH levels for skin to defend from pathogens. The pH levels of skin, around 3-5, is able to kill most microbes through the sweat's pH.

innate immunity

If pathogens penetrate past the surface barrier, they are now inside the body. Innate immunity, second line of defense, will take place through a general approach, using phagocytosis to ingest the cell. The body can also react in additional ways.



Phagocytosis - a process in which pathogens are ingested by a cell to digest and dispose the cell, and to use fragments of pathogens at the end to stimulate the third line of defense (if needed).

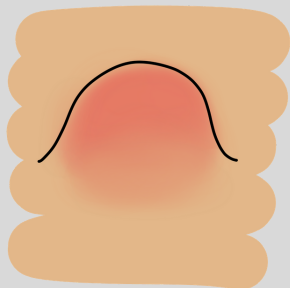
From left to right of the scene:

1. Pathogen approaches phagocyte, in which pseudopodia (cell extensions, flaps) surround the pathogen.
2. Pseudopodia engulfs the pathogen and creates a vesicle
3. Vesicle fuses with a lysosome, in which the pathogen gets digested
4. Fragments will be presented on the surface of phagocyte to stimulate the last line of defense

additional reactions:

Inflammation

If tissue is damaged, increased valve dilation and increased permeability is opened to enhance clotting elements to heal area.



Fever

If severe damage is done, the body will target a widespread-response by increasing body temperature to denature pathogen growth.

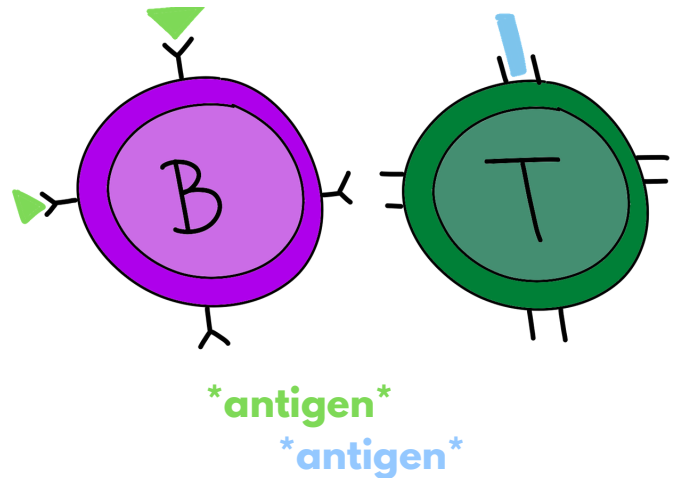


adaptive immunity

If a specialized reaction is needed to take down a pathogen, adaptive immunity, the third line of defense, comes to play. It will react accordingly to the pathogen, responding to specific microbes on the foreign pathogen's membrane (antigens).

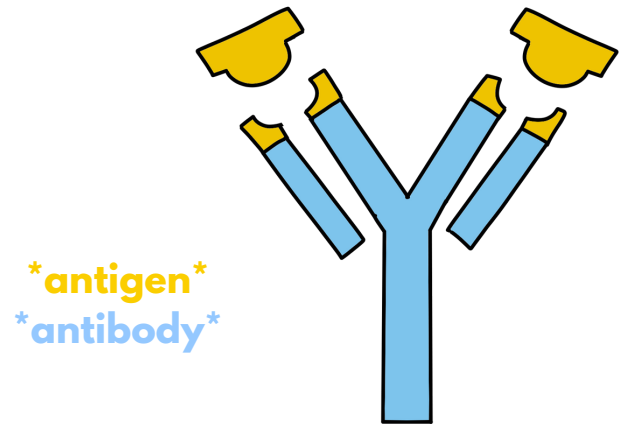
b cell & t cell activation

Any time antigens are recognized, both B and T cells will activate. Antigens are molecules from foreign cells that helps the body see which cell is friend or pathogen. When these foreign antigens bond to the surface of B and T cells, it allows them to start multiplying so that plasma cells, Memory B cells, and cytokines can be made.



antibodies

Antibodies, made by plasma cells, aid in destroying pathogens. It does so by making soluble antigens soluble, clustering cell-bound antigens together, masking dangerous parts of pathogens, triggering the release of histamine, all which mark the pathogen down for attack and prep it for phagocytosis. Complement proteins make a hole in the membrane, which causes lysis, and for the pathogen to break apart and die.



memory cells

If the body were to encounter the same pathogen again, memory cells will prevent a delay in antibody production. With memory cells, it will cause a more vigorous and faster production of antibodies, allowing the body to outnumber the rate of pathogens reproduction to cause disease symptoms. No disease can occur, and therefore immunity from that specific pathogen is now achieved.

