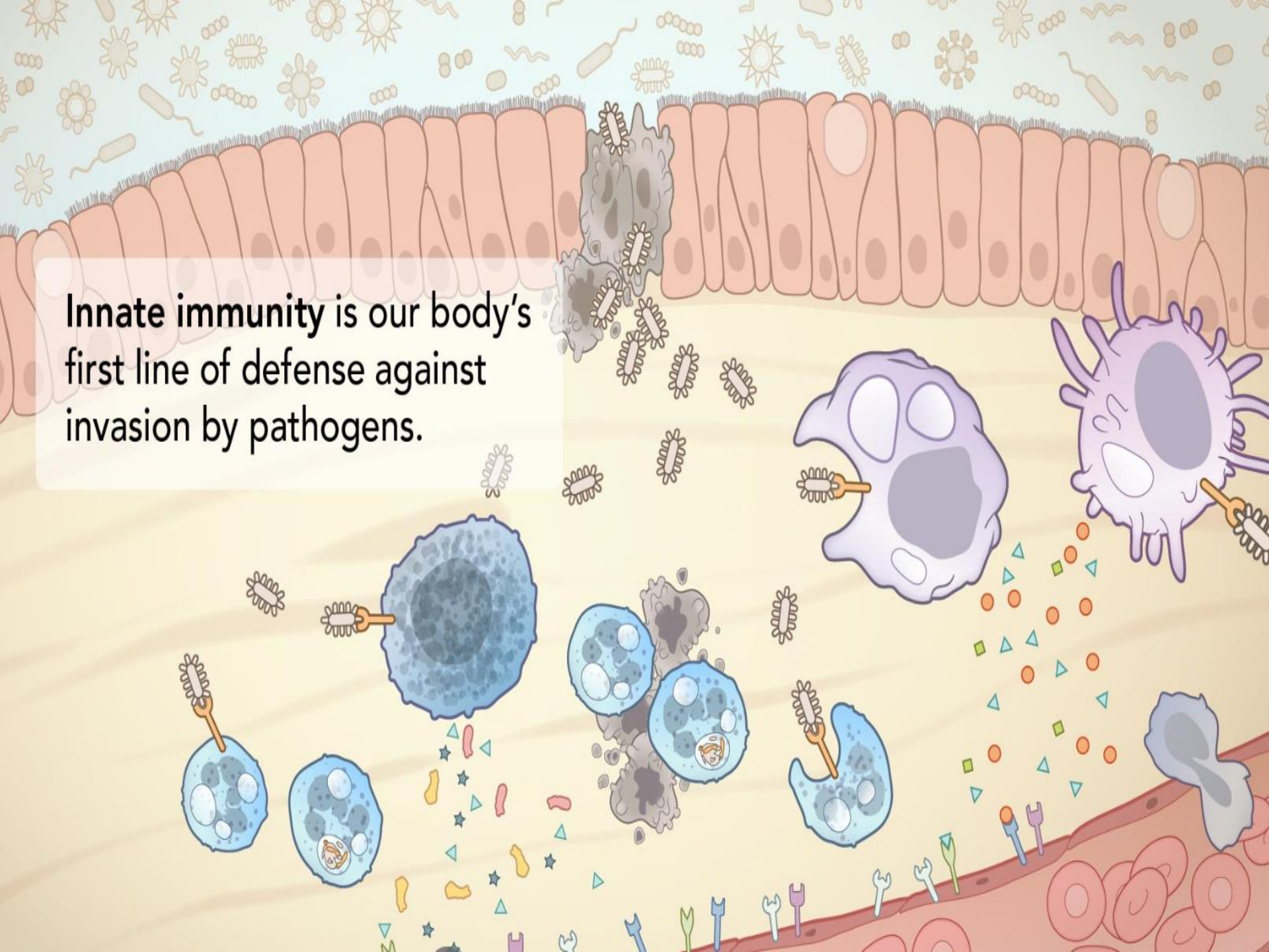
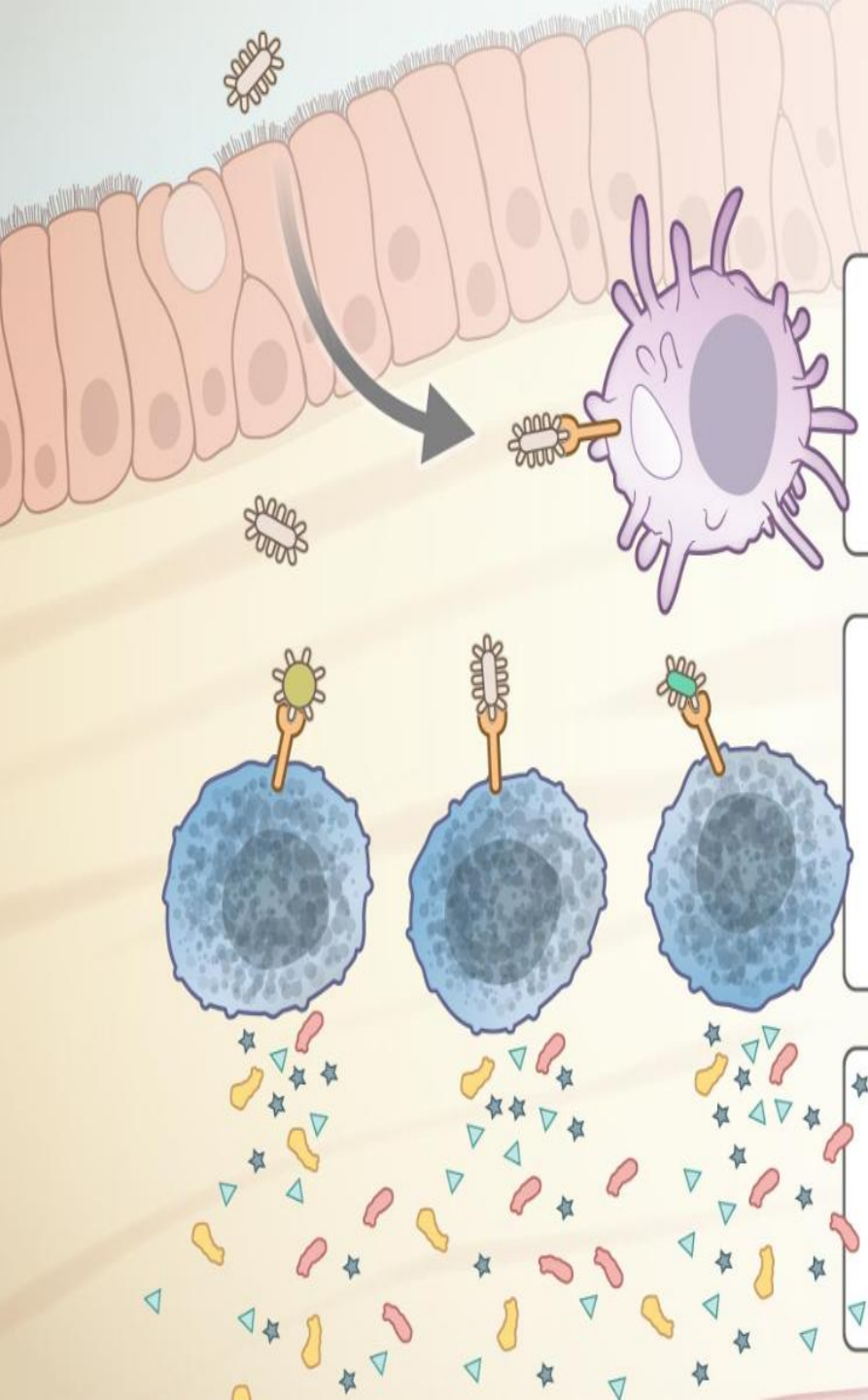
Innate immune system


Innate immunity is our body's first line of defense against invasion by pathogens.



The innate immune system is...

Always ready to react

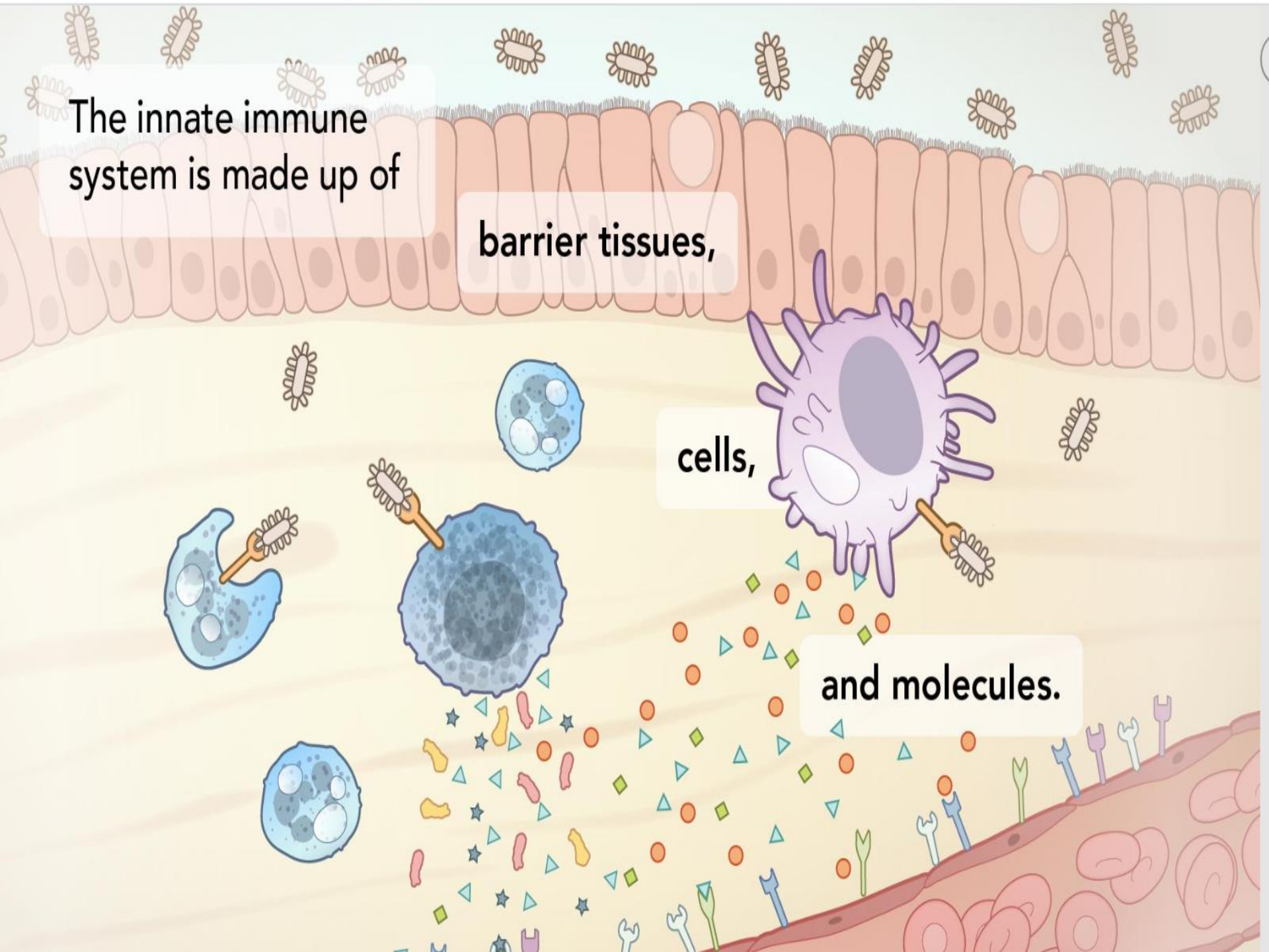
Provides the first response to injury and assault by pathogens.

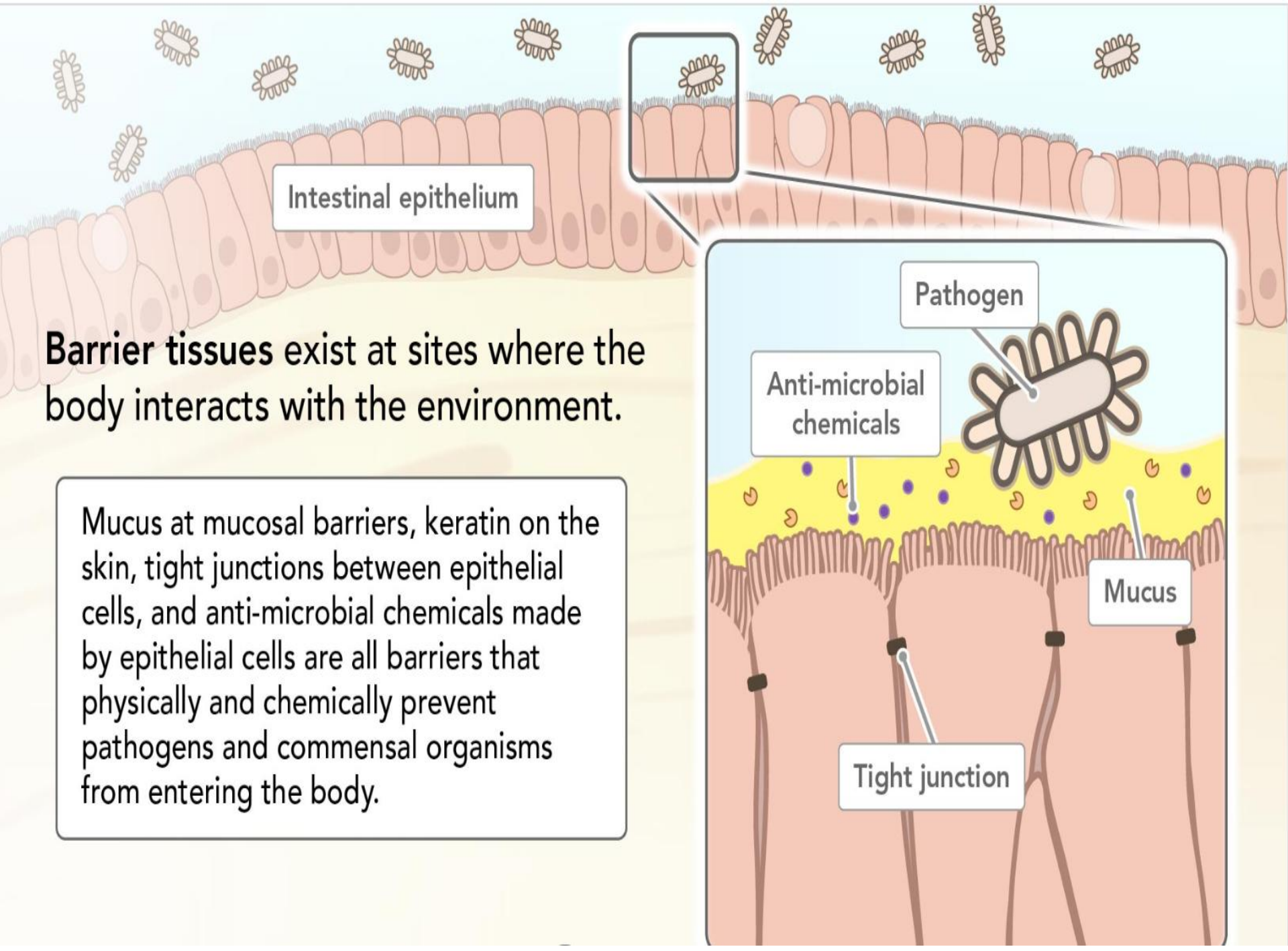
Broadly-specific

Recognizes common patterns associated with many pathogens or types of injury, rather than specific pathogens.

Consistent

Reacts in the same way to repeated exposure to a particular threat.

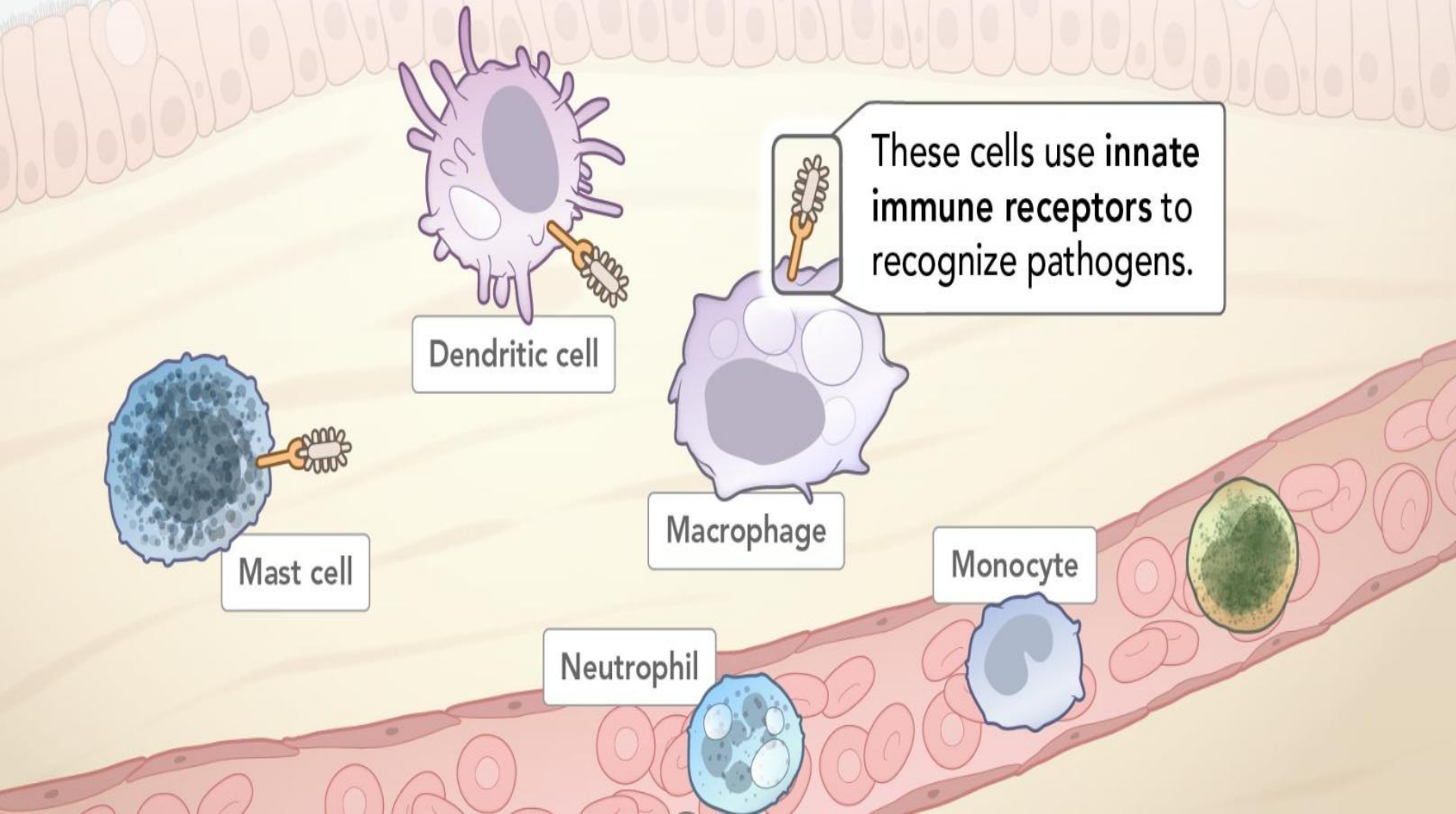

The innate immune system is made up of
barrier tissues,
cells,
and molecules.



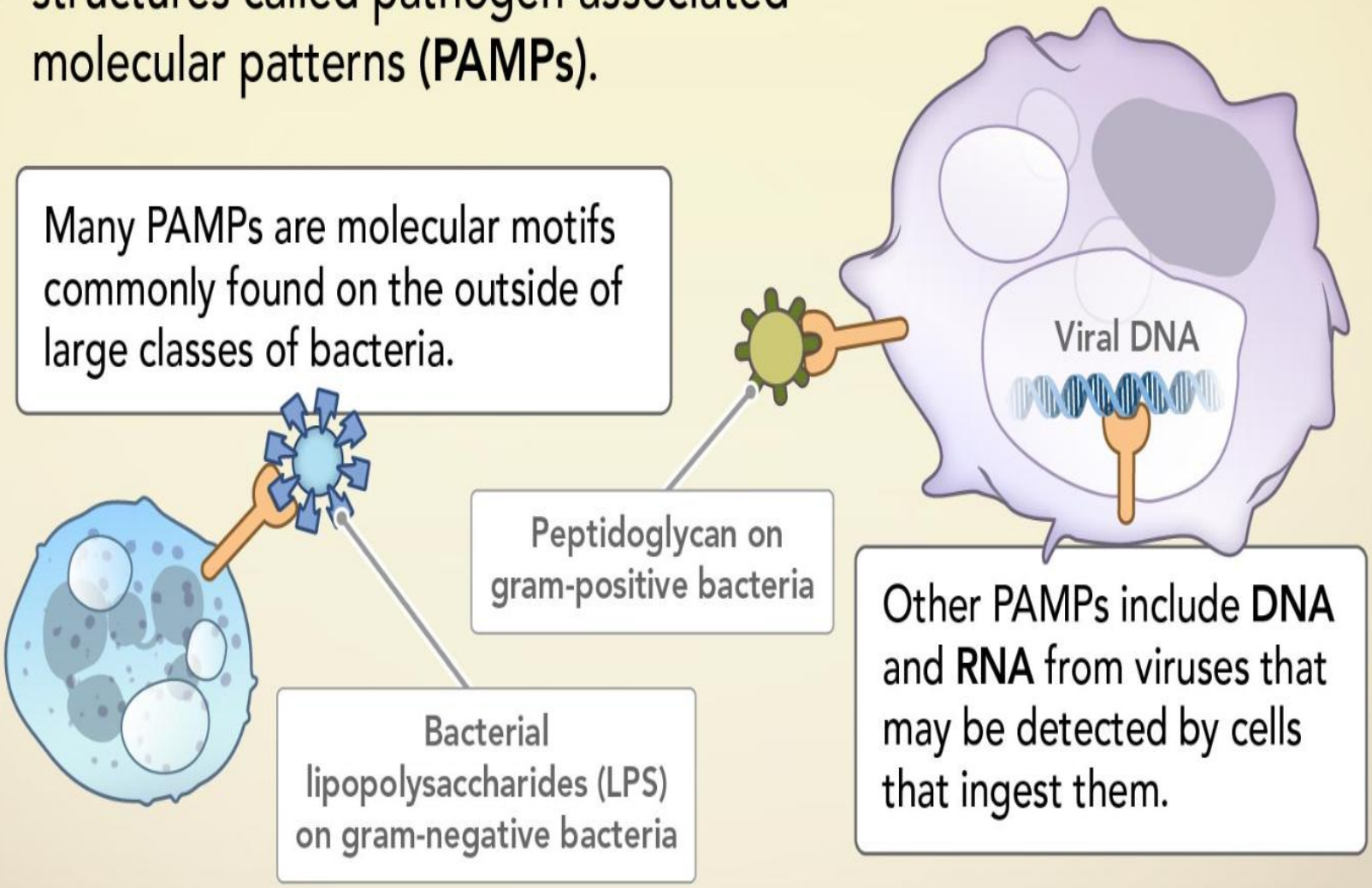
Barrier tissues exist at sites where the body interacts with the environment.

Mucus at mucosal barriers, keratin on the skin, tight junctions between epithelial cells, and anti-microbial chemicals made by epithelial cells are all barriers that physically and chemically prevent pathogens and commensal organisms from entering the body.

Key **cells** in innate immunity include several types of circulating white blood cells (leukocytes) and cells that reside in tissues.

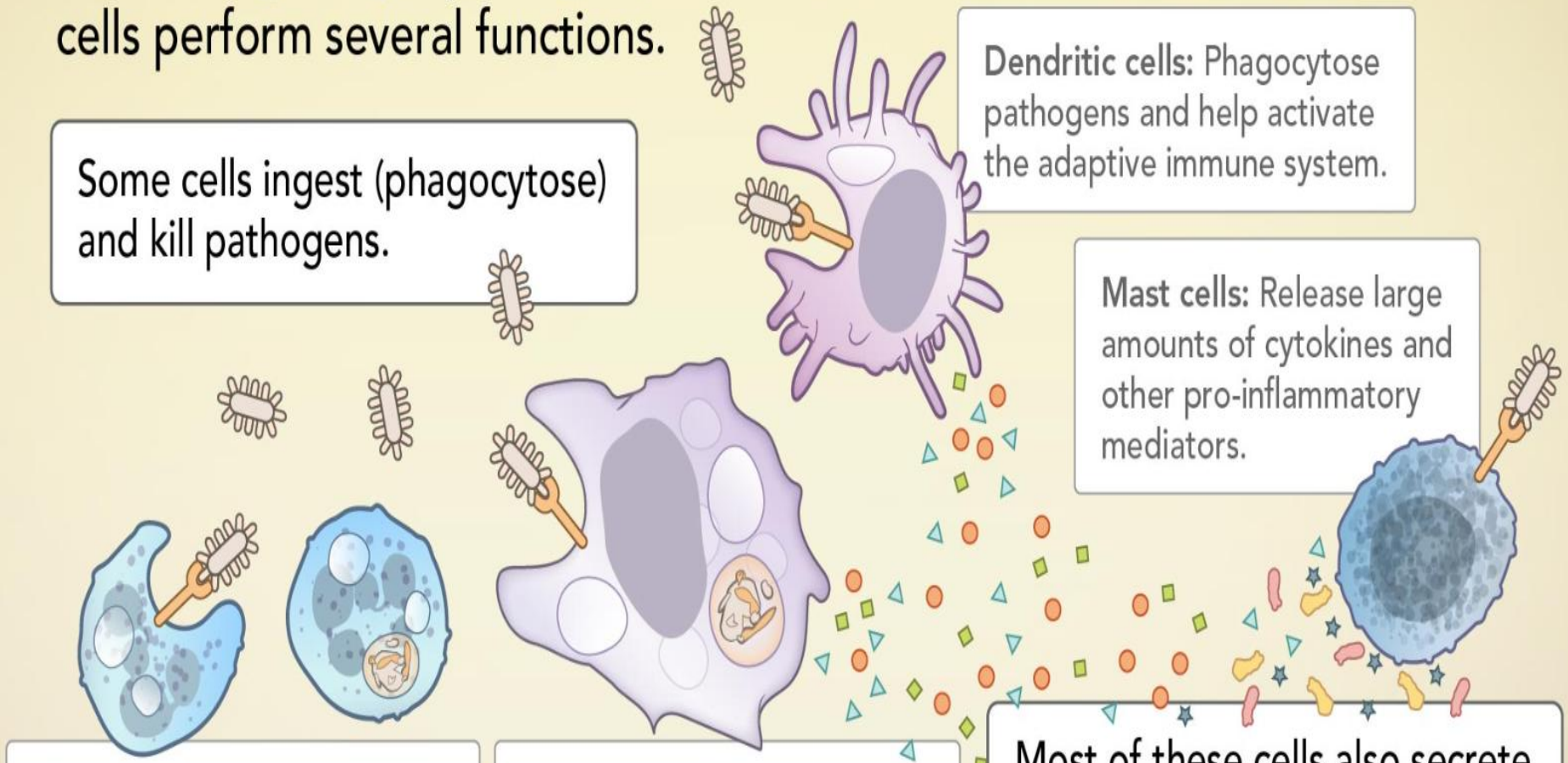


The innate immune receptors on these cells are able to bind to a wide variety of threats by recognizing common structures called pathogen-associated molecular patterns (**PAMPs**).



After recognizing a pathogen, innate immune cells perform several functions.

Some cells ingest (phagocytose) and kill pathogens.



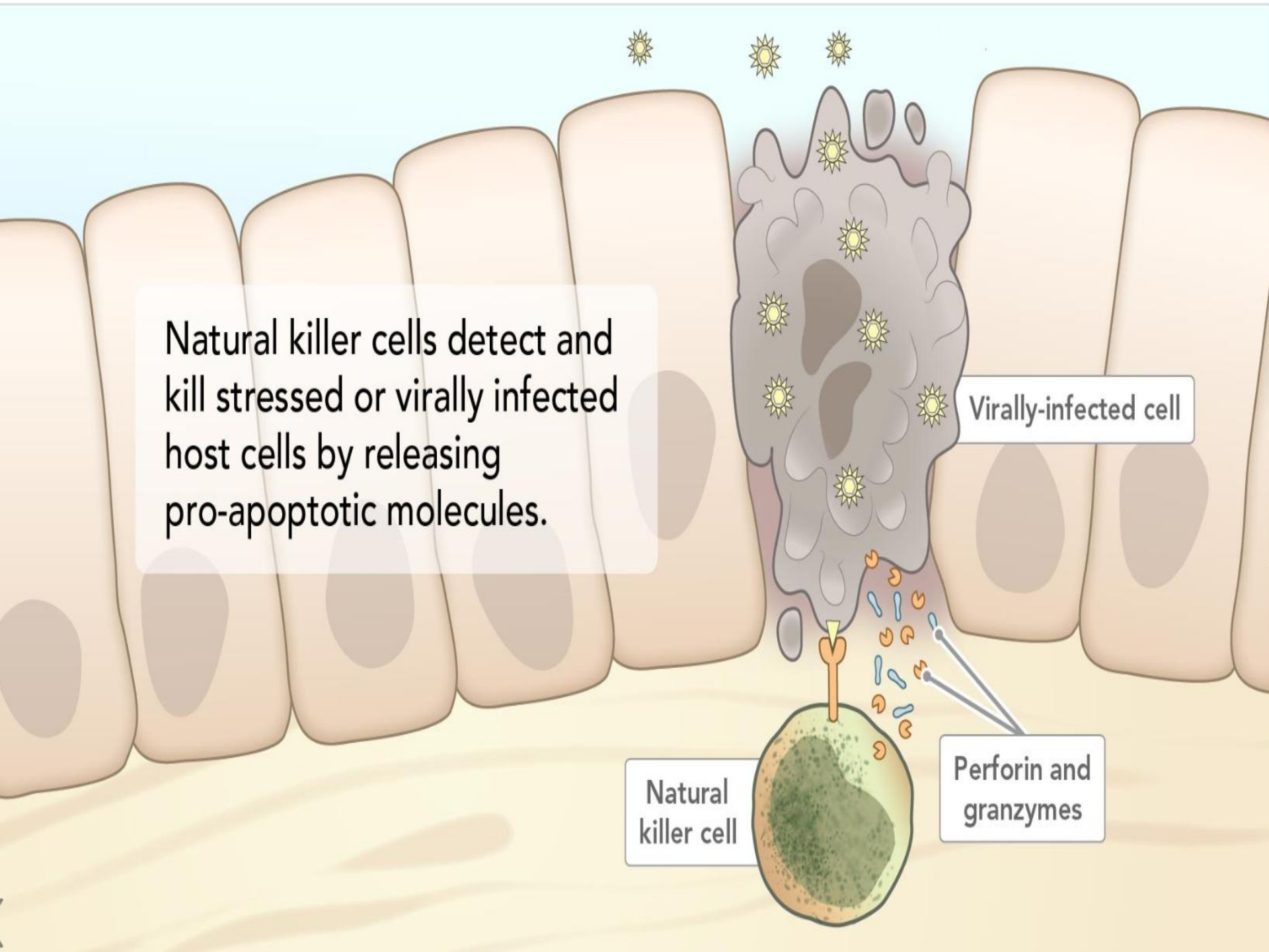
Dendritic cells: Phagocytose pathogens and help activate the adaptive immune system.

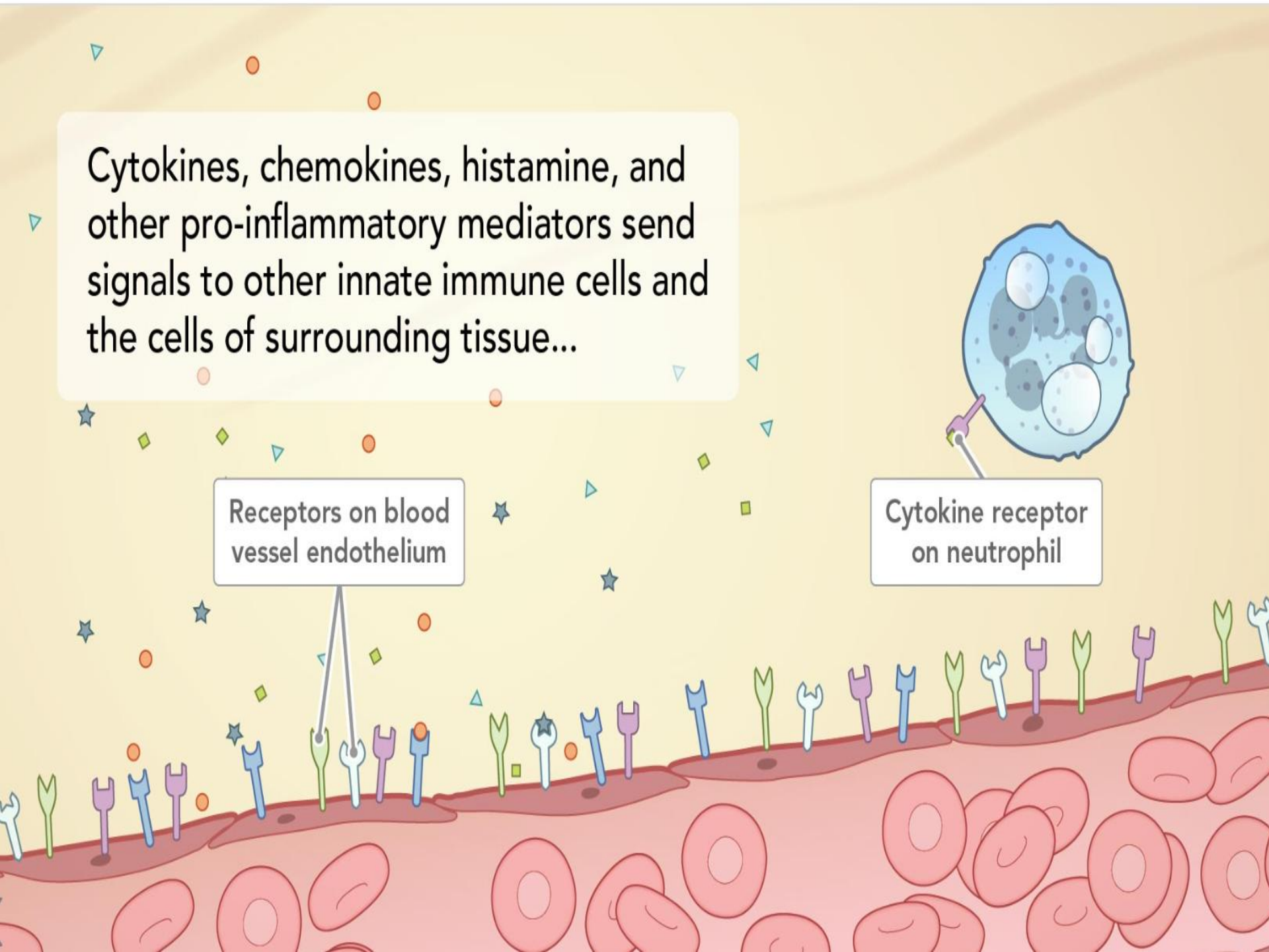
Mast cells: Release large amounts of cytokines and other pro-inflammatory mediators.

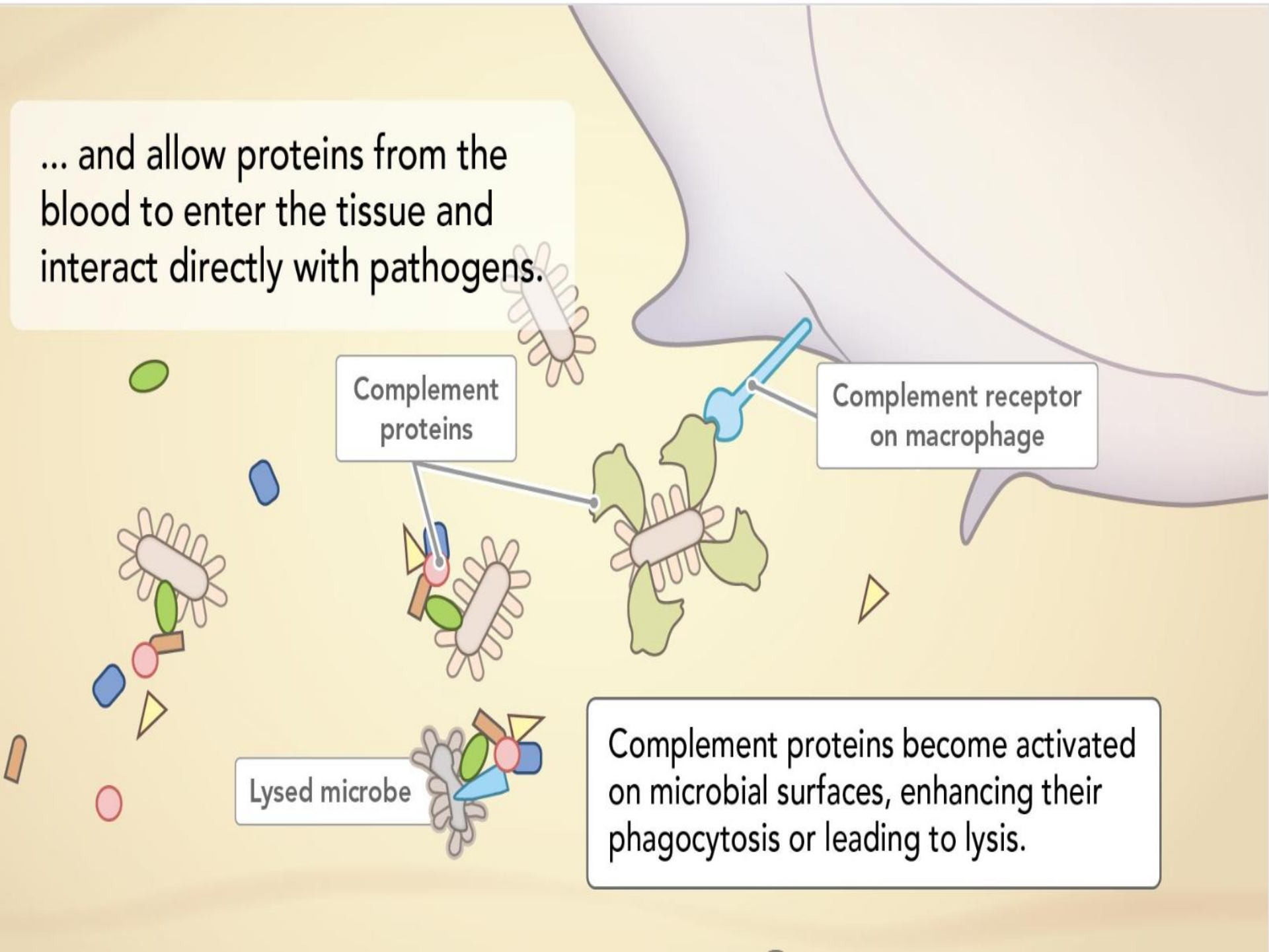
Neutrophils: Migrate from the blood stream to phacocytose and kill pathogens.

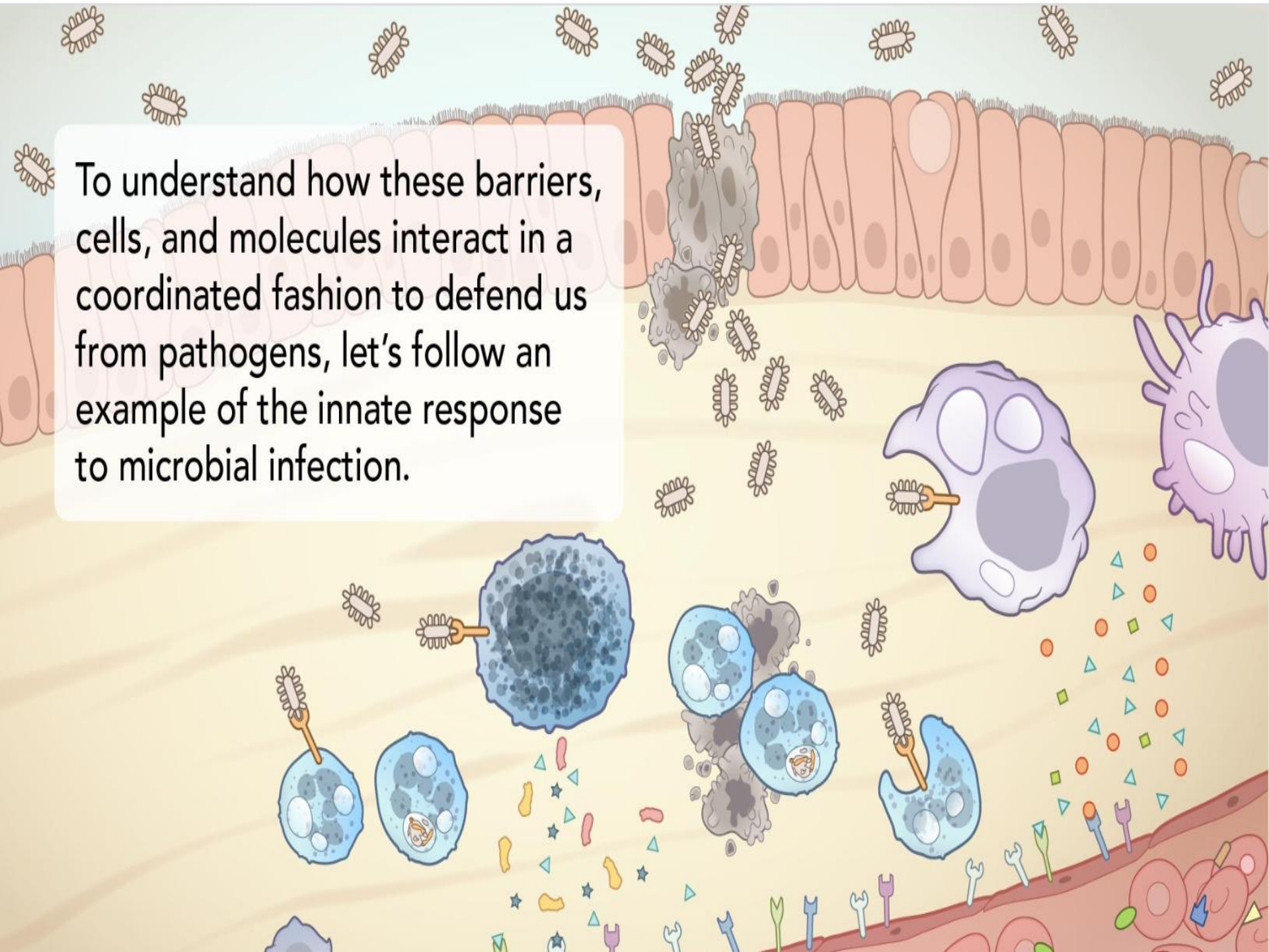
Macrophages: Phagocytose pathogens and dead cells and play a role in tissue repair.

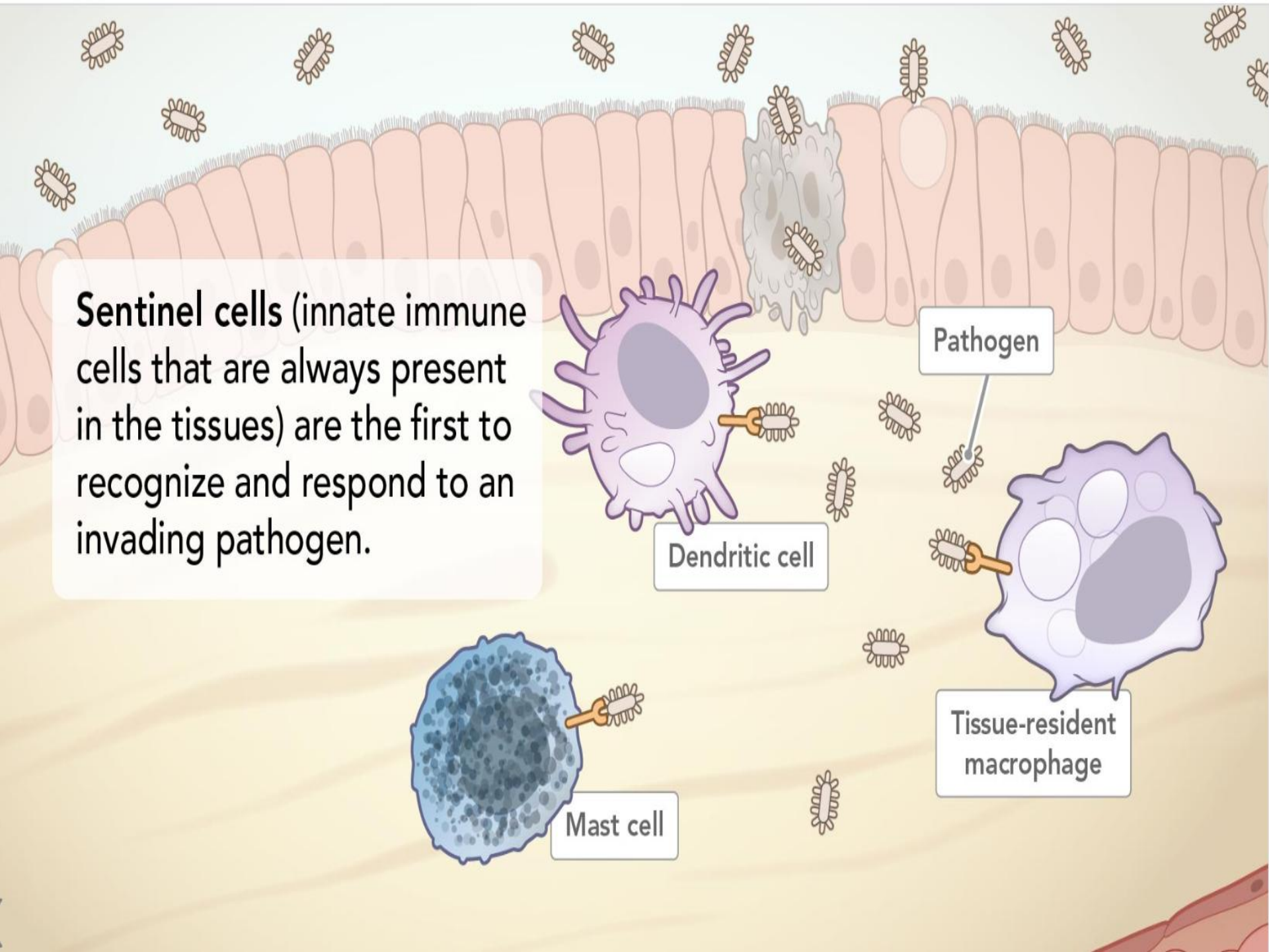
Most of these cells also secrete molecules that act on blood vessels to enhance recruitment of more inflammatory cells and molecules from the blood.

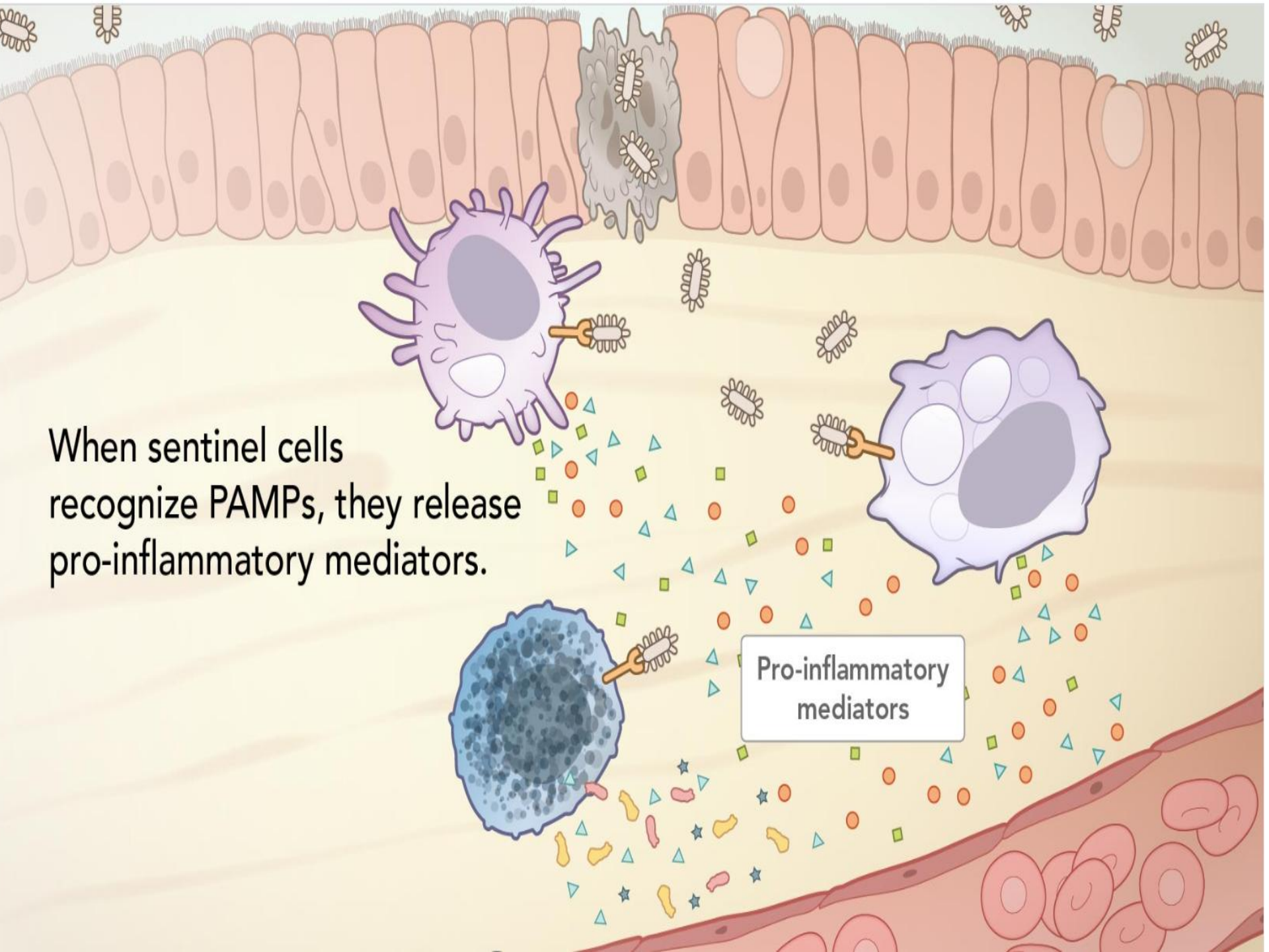

Natural killer cells detect and kill stressed or virally infected host cells by releasing pro-apoptotic molecules.
Virally-infected cell
Natural killer cell
Perforin and granzymes

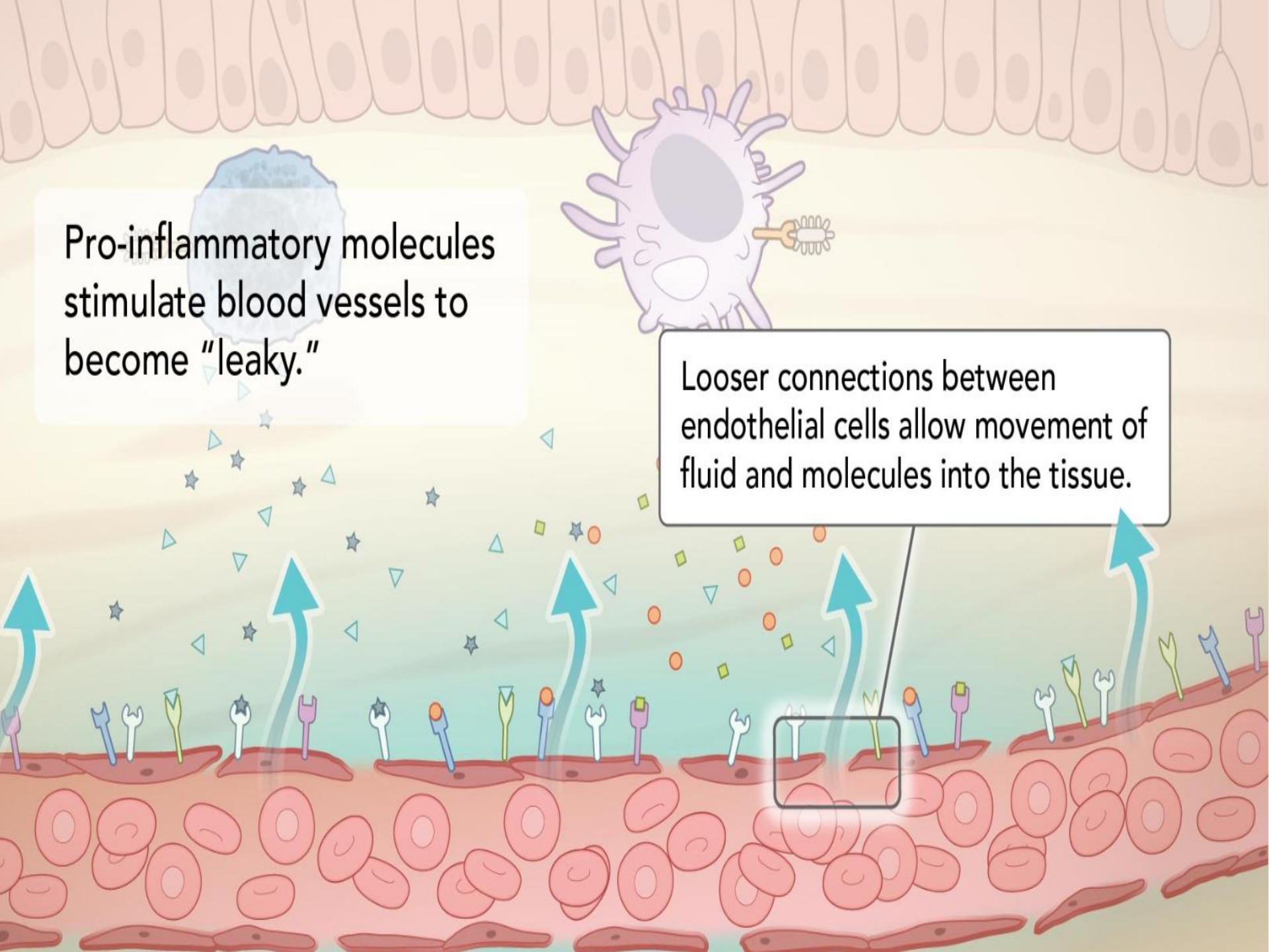

Cytokines, chemokines, histamine, and other pro-inflammatory mediators send signals to other innate immune cells and the cells of surrounding tissue...
Receptors on blood vessel endothelium
Cytokine receptor on neutrophil


... and allow proteins from the blood to enter the tissue and interact directly with pathogens.
Complement proteins
Complement receptor on macrophage
Lysed microbe
Complement proteins become activated on microbial surfaces, enhancing their phagocytosis or leading to lysis.

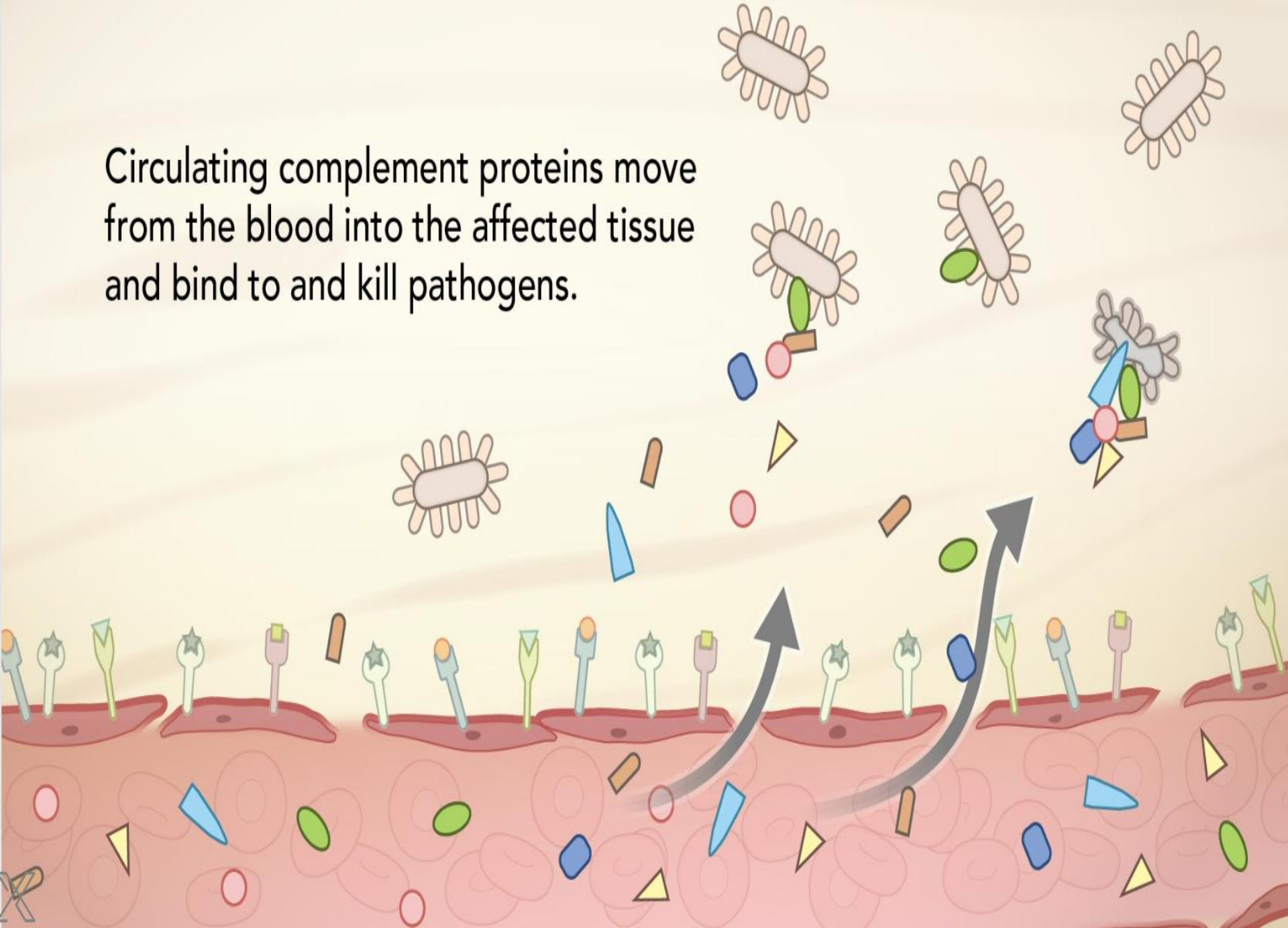

To understand how these barriers, cells, and molecules interact in a coordinated fashion to defend us from pathogens, let's follow an example of the innate response to microbial infection.


Sentinel cells (innate immune cells that are always present in the tissues) are the first to recognize and respond to an invading pathogen.
Pathogen
Dendritic cell
Tissue-resident macrophage
Mast cell

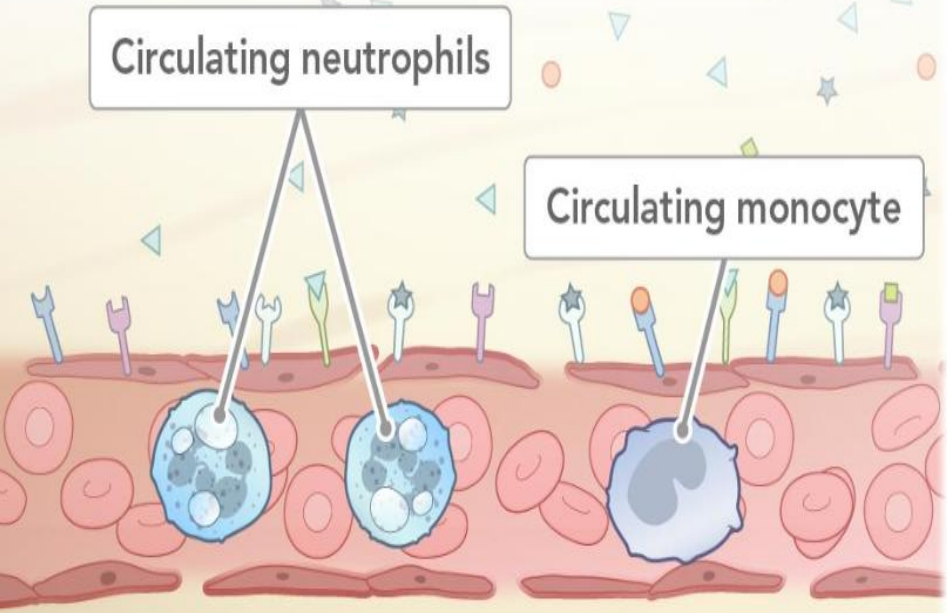

When sentinel cells recognize PAMPs, they release pro-inflammatory mediators.
Pro-inflammatory mediators


Pro-inflammatory molecules stimulate blood vessels to become "leaky."
Looser connections between endothelial cells allow movement of fluid and molecules into the tissue.

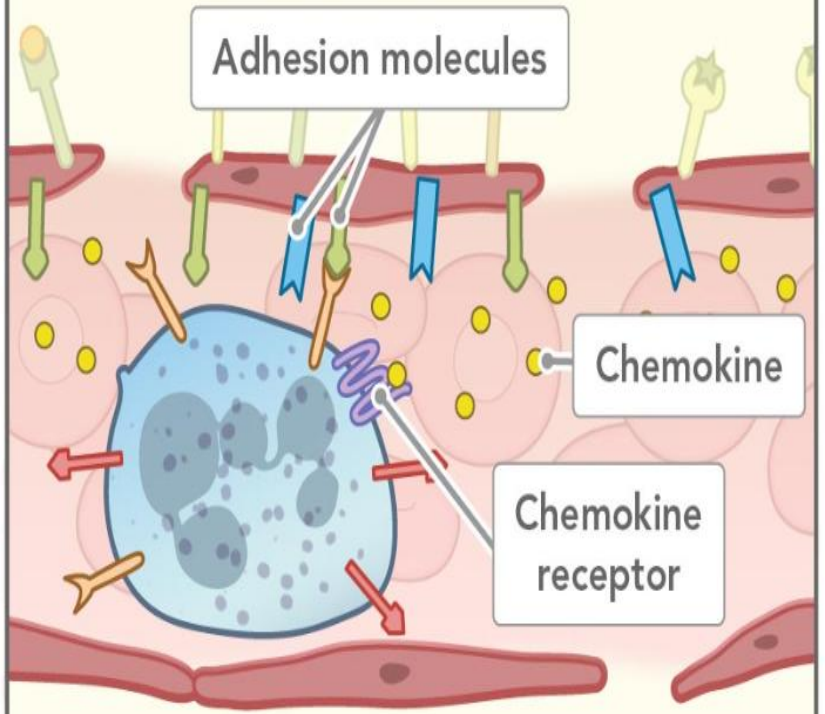
Circulating complement proteins move from the blood into the affected tissue and bind to and kill pathogens.

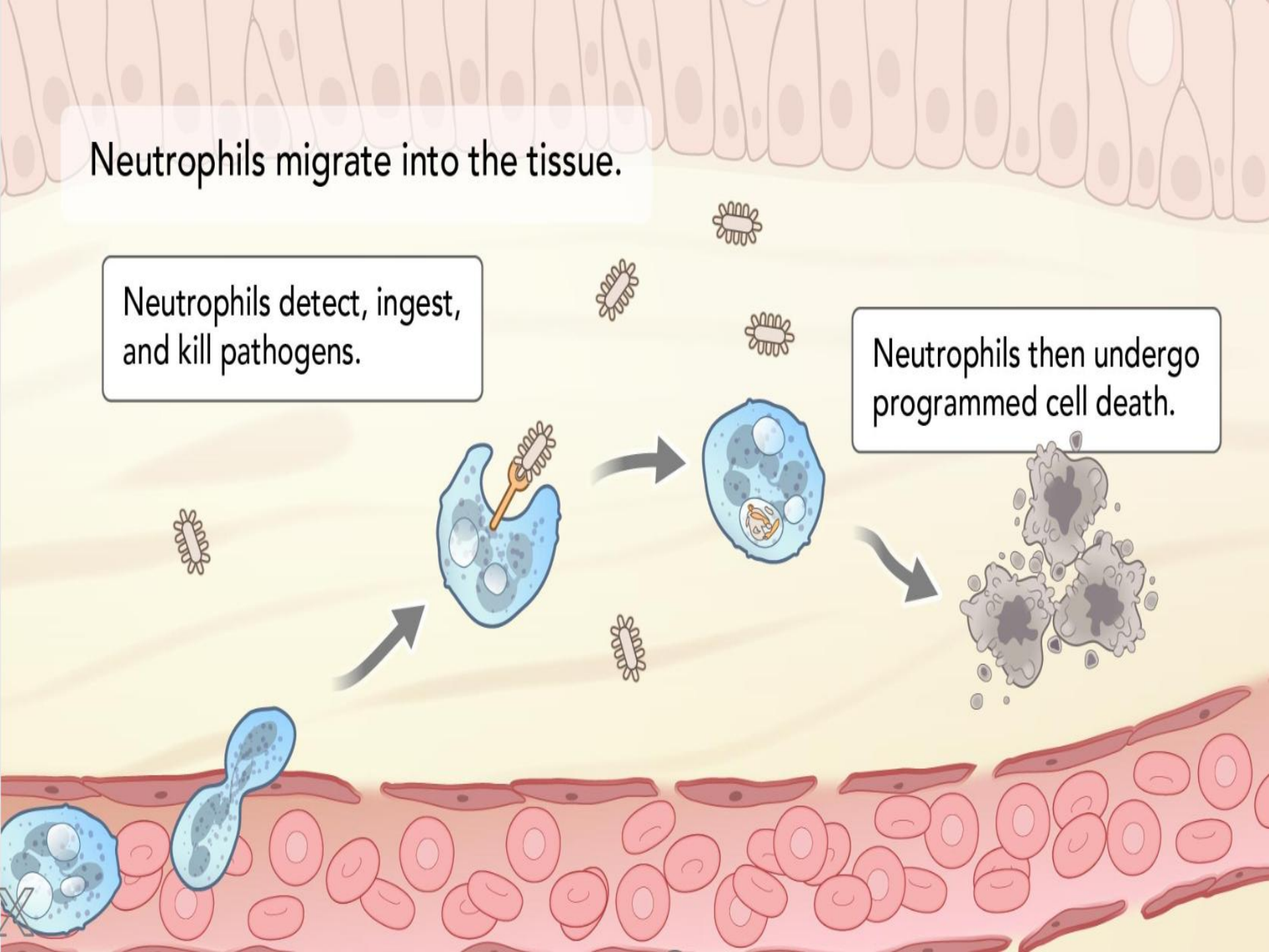


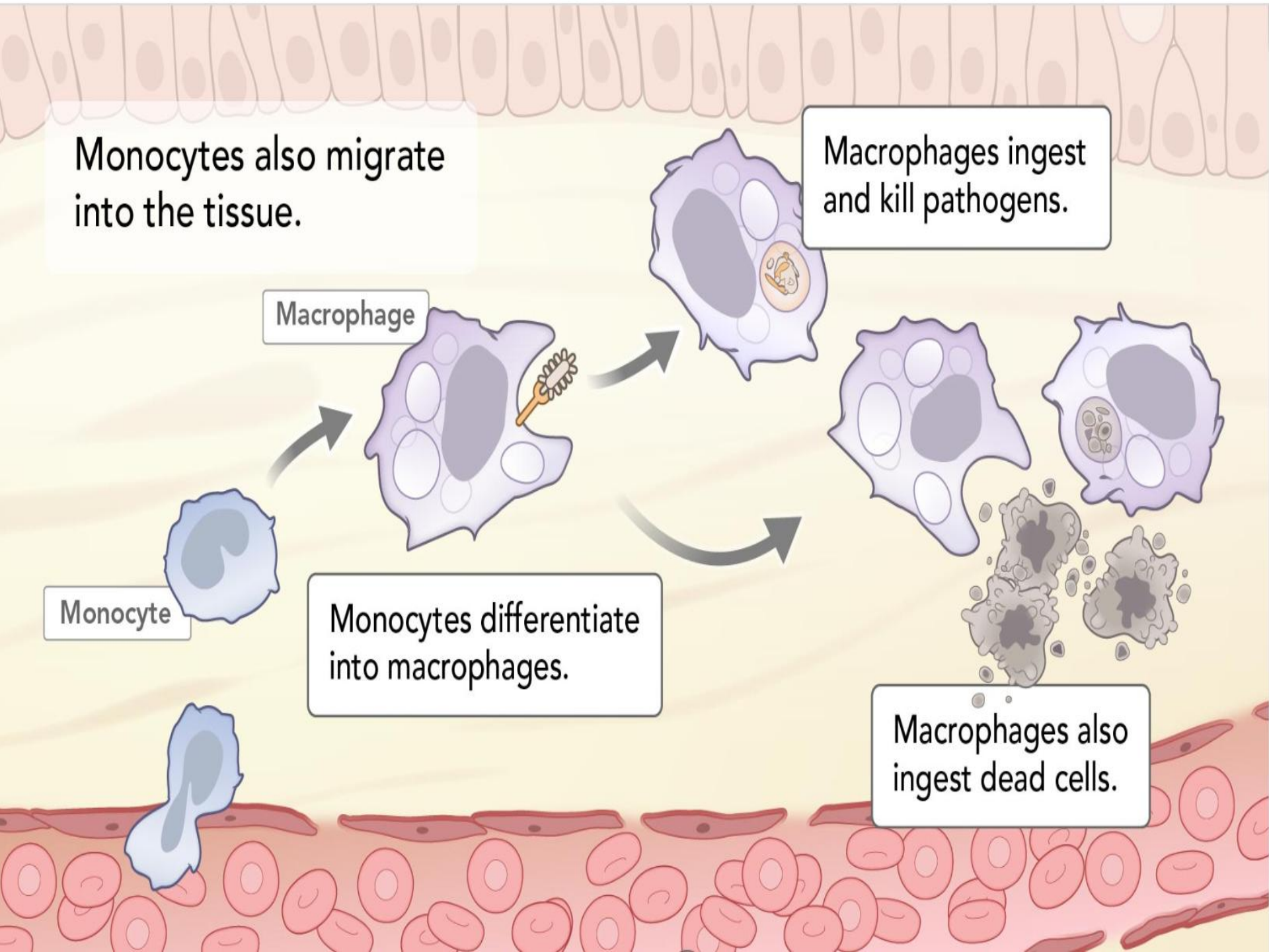
Cytokines also stimulate blood vessels to attract circulating immune cells.

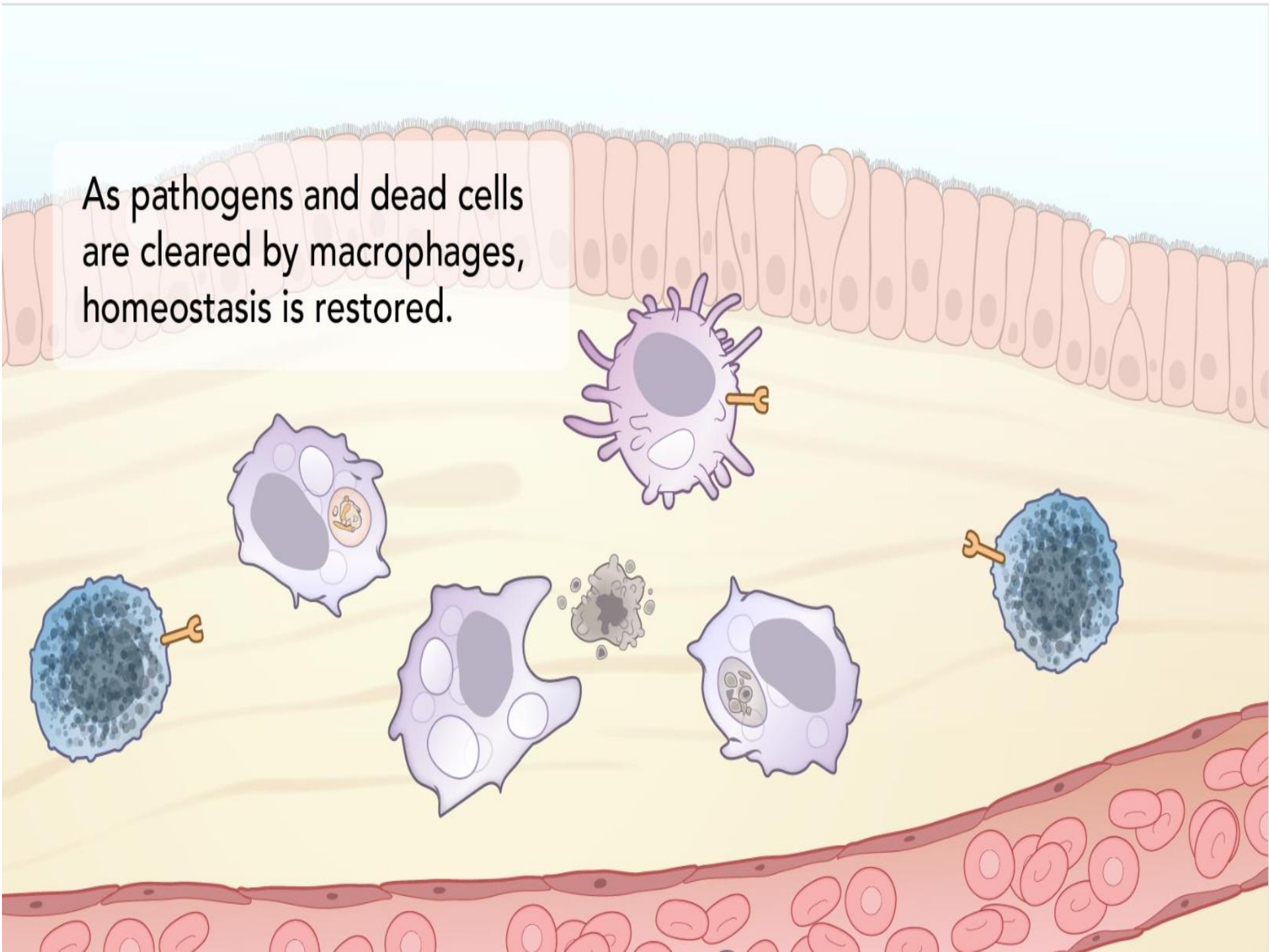


Adhesion molecules and chemokines on the surface of blood vessel endothelial cells allow cells to stick at the infection site.

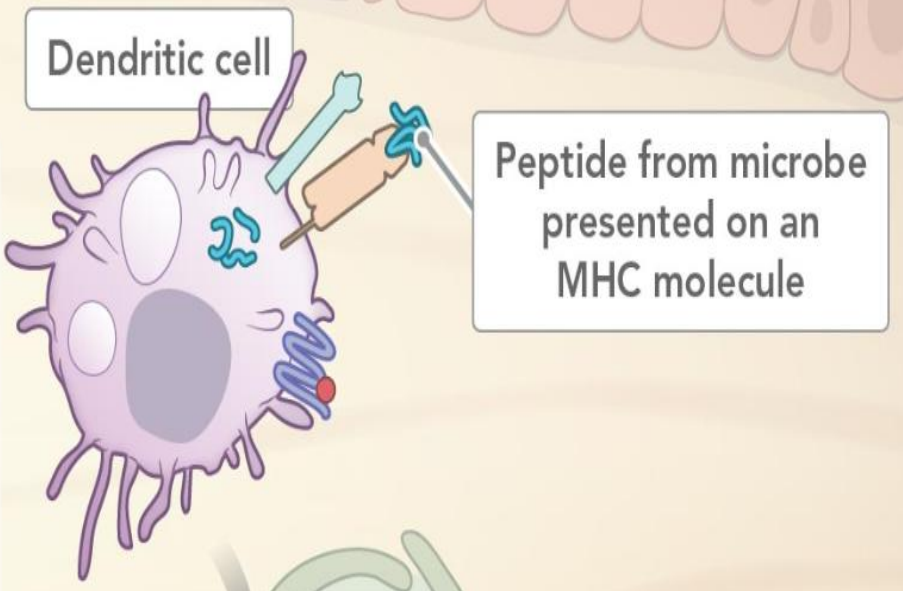



Neutrophils migrate into the tissue.
Neutrophils detect, ingest, and kill pathogens.
Neutrophils then undergo programmed cell death.

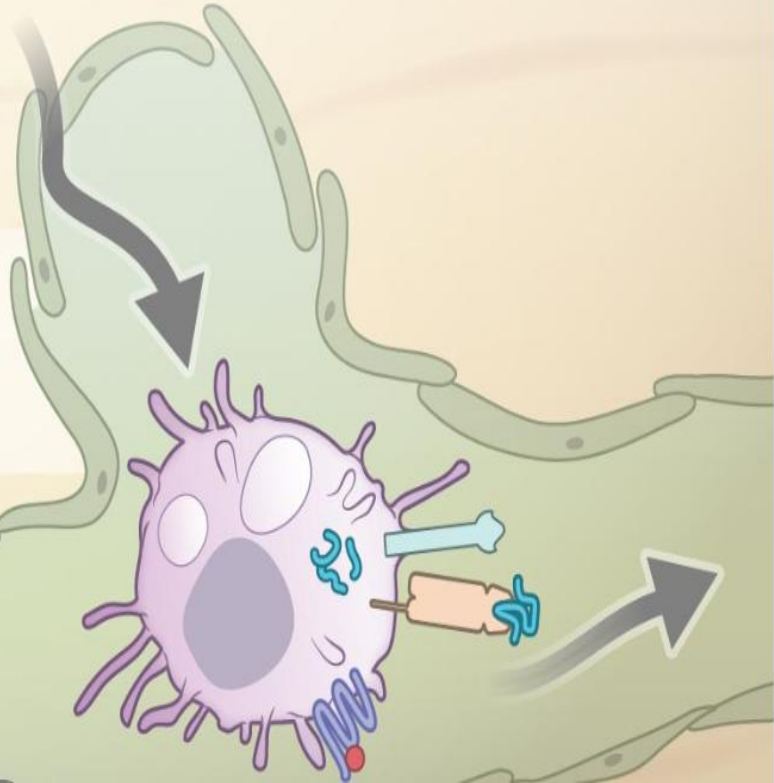

Monocytes also migrate into the tissue.
Macrophage
Macrophages ingest and kill pathogens.
Monocyte
Monocytes differentiate into macrophages.
Macrophages also ingest dead cells.


As pathogens and dead cells are cleared by macrophages, homeostasis is restored.

Additionally, dendritic cells ingest proteins made by pathogens at the site of infection and process them into peptides that are displayed on the dendritic cell surface.



These dendritic cells enter lymphatic vessels that drain into...



...lymph nodes, where they can stimulate T cells of the adaptive immune system.