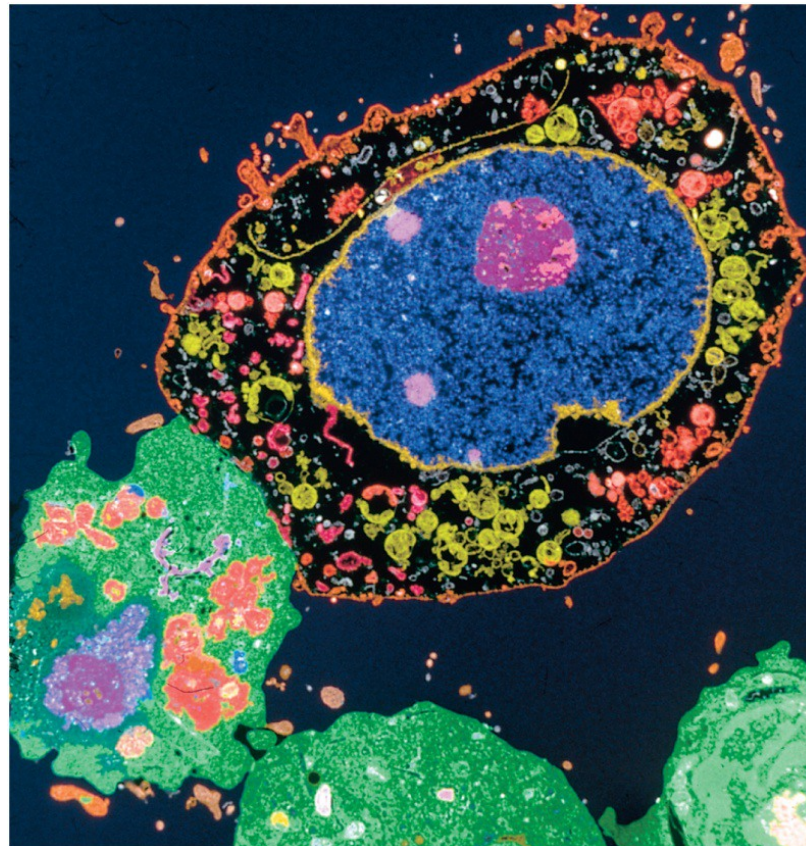


An Introduction to the Lymphatic System and Immune System





What is the lymphatic system?

Lymphatic system functions as a drainage system

Lymphatic system picks up fluid not reabsorbed across the capillary beds and returns this fluid back into the systemic circuit

The lymph passes through lymph nodes (filters to remove cellular debris and pathogens) before returning lymph to the systemic circuit

“Resting” T and B cells in the lymph nodes are able to recognize and initiate an immune response.

What is the relationship between the lymphatic system and the immune system?

SYSTEMIC CIRCULATION

PULMONARY CIRCULATION

LYMPHATIC DUCTS (thoracic duct, right lymphatic duct) empty lymph into the junction of jugular and subclavian veins of the cardiovascular system.

Subclavian vein

LYMPHATIC VESSELS

pass lymph to lymphatic ducts.

VALVE ensures one-way flow of lymph.

EFFERENT LYMPHATIC VESSELS carry lymph from lymph nodes.

LYMPH NODES filter lymph and remove foreign substances through filtering, phagocytosis, and immune reactions.

AFFERENT LYMPHATIC VESSELS carry lymph from lymphatic capillaries to lymph nodes.

LYMPHATIC CAPILLARIES absorb interstitial fluid and pass lymph to afferent lymphatic vessels

Lymph node

Lymphatic capillaries

Pulmonary blood capillaries

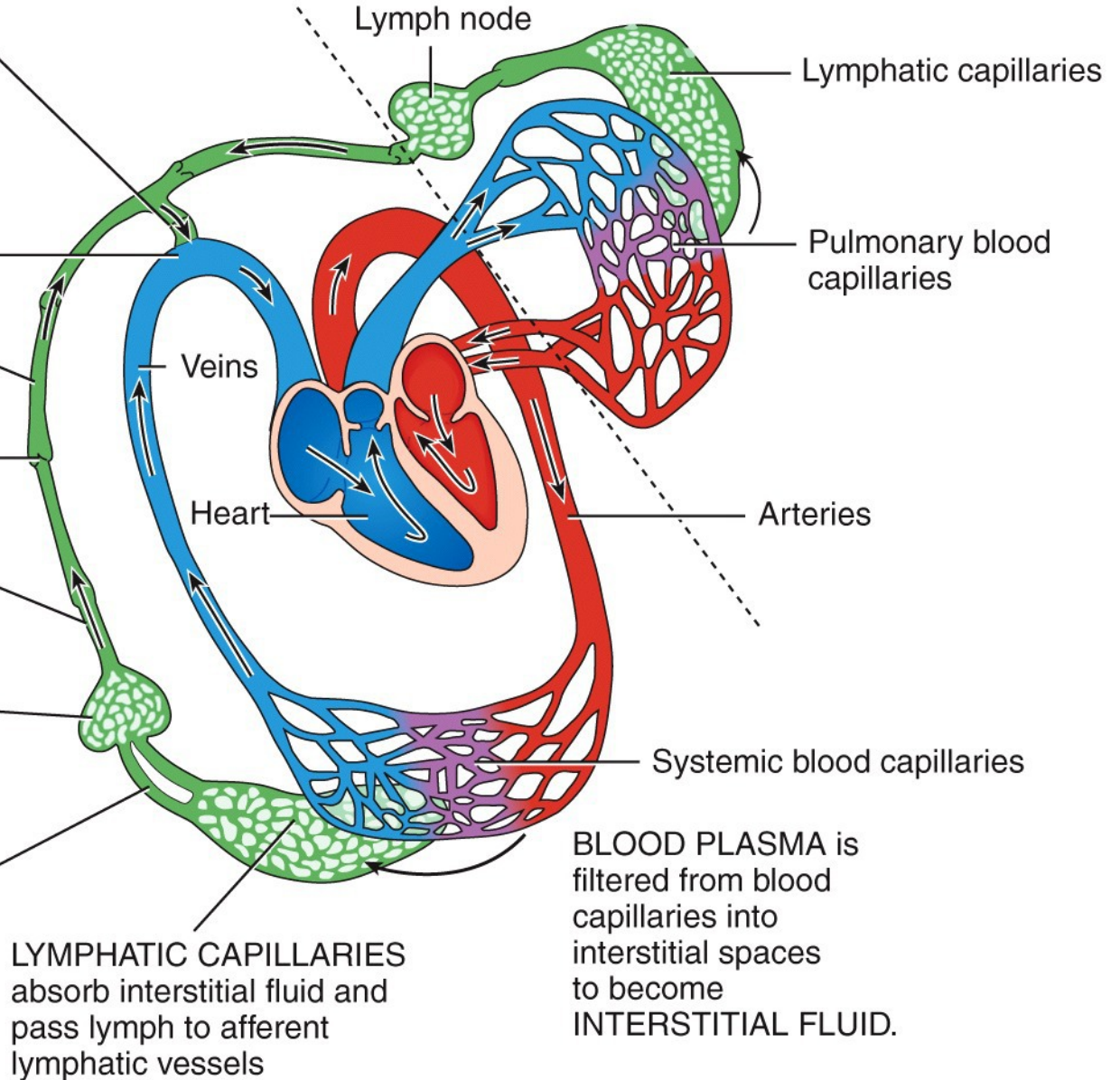
Veins

Heart

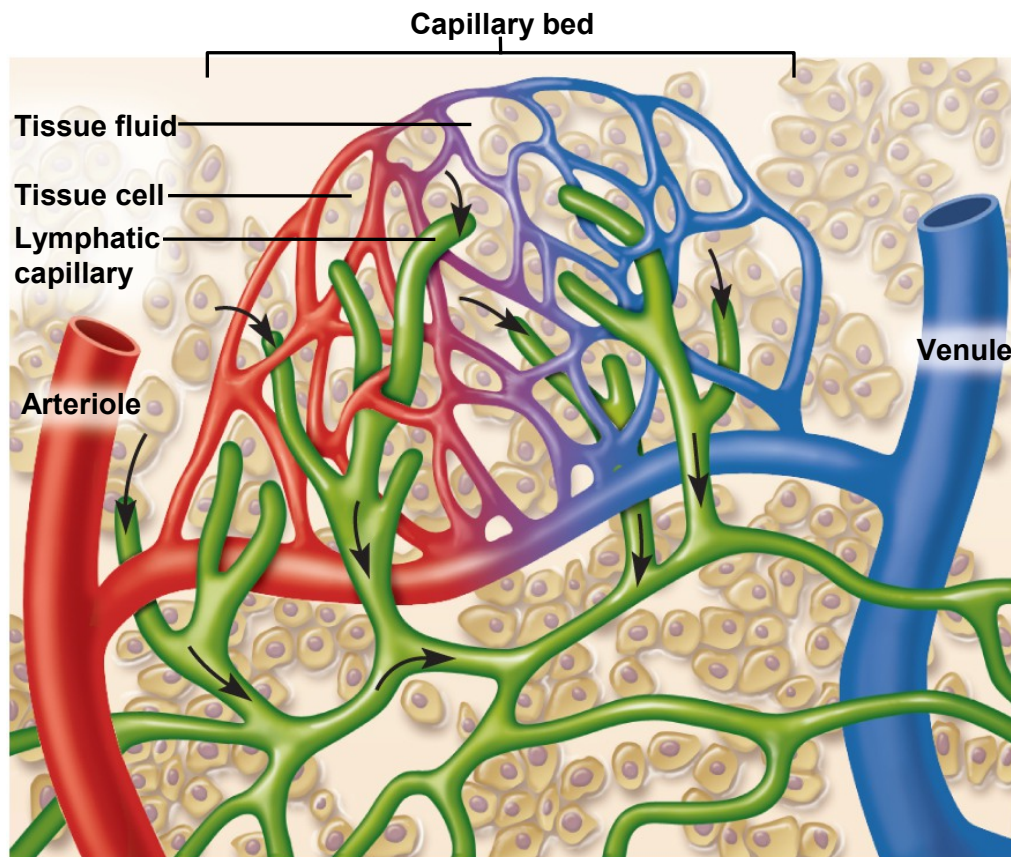
Arteries

Systemic blood capillaries

BLOOD PLASMA is filtered from blood capillaries into interstitial spaces to become **INTERSTITIAL FLUID**.



Structure of a Capillary Bed with Lymphatic Capillaries and Their Afferent Vessels



How much fluid is not recovered at the end of the capillary bed? (15%)



What is the relationship between the lymphatic system and the immune system?

Lymph nodes play a key role in protecting our body from pathogens // lymph nodes are resting sites for immune cells (T cells, B cells, macrophage)

Pathogens are ingested throughout our body by different types of **antigen presenting cells** and transported in the lymph fluid to the lymph nodes

As lymph is moved through a lymph node – the fluid is inspected for signs of APC with pathogens

Inside the lymph nodes, **antigen presenting cells** will display a pathogen's antigen to T and B cells to initiate an immune response

APC are required to activate helper T cells, cytotoxic T cells, and B cells // B cells = humoral immunity and T cells = cellular immunity

What is the immune system?



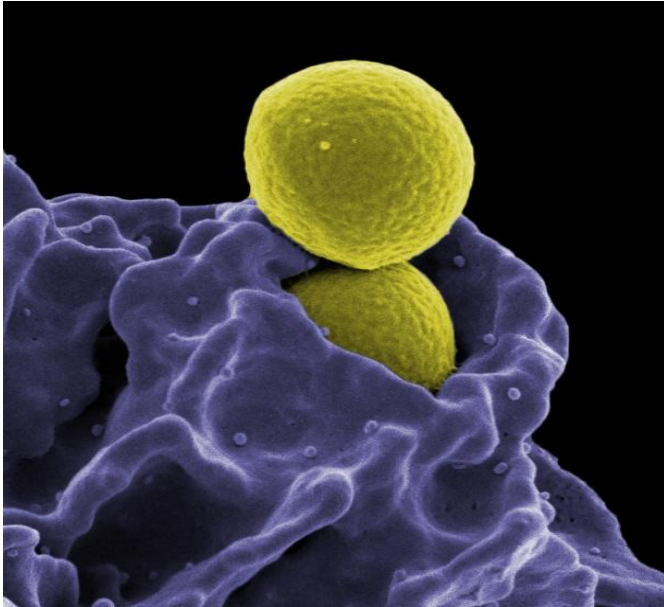
The immune system is not an “organ system”.

The immune system is a collection of cells without adhesion molecules.

The immune system's cells are “nomadic”, free to move between the blood, interstitial spaces, and follow connective tissue into the organs of the body.

The immune system's cells seek to identify and destroy pathogens.

Pathogens cause diseases in a healthy person.



MERSA being engulf by WBC

We have ten bacteria (prokaryotic cell structure) for each human cell (eukaryotic cell structure).

Therefore, 90% of the cells that make-up the human body are foreign prokaryotic cells

Prokaryotic cells are very small (one micrometer) vs eukaryotic cells (10 micrometer)

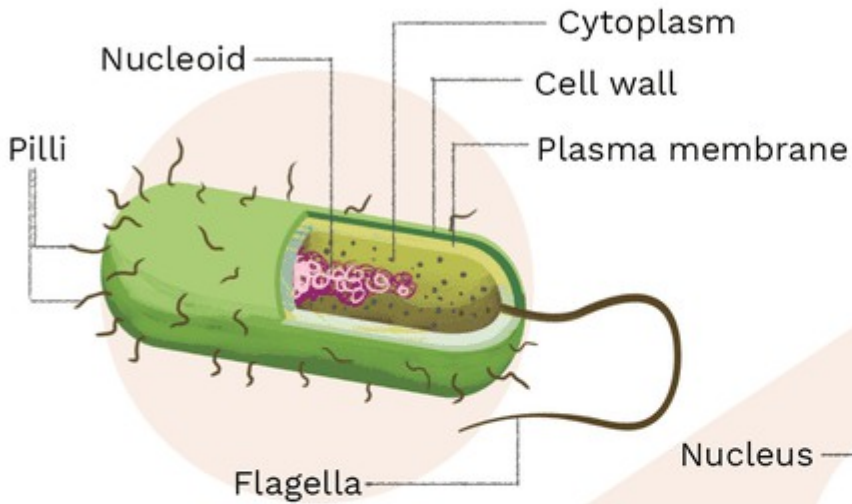
All these prokaryotic cells together weigh less than 2-lbs. It's like an extra average size human organ!

Some of these bacteria are beneficial // e.g. some bacteria form an invisible “shield” over our skin and mucous membranes to protect us!

Other bacteria are pathogens and able to cause diseases – these must be eliminated

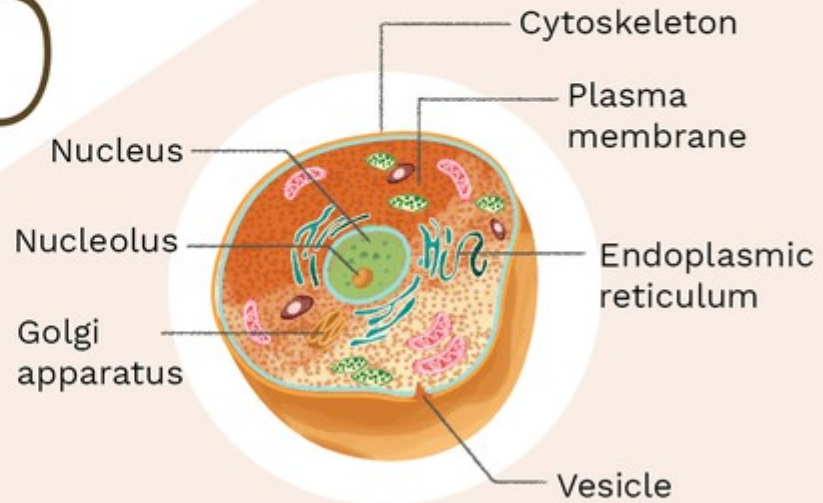
How do we defend ourselves against these threats?

PROKARYOTIC CELL



Ave size 1 micrometer

Ave size 15 micrometer



EUKARYOTIC CELL

ThoughtCo.

- Prokaryotic cell has single circular chromosome
- Eukaryotic cell has many lineal chromosome (humans 46).

The Immune System Has Three Separate Lines of Defenses



1) Physical barriers (innate immunity)

2) Non specific resistance (i.e. innate immunity) = Anti microbial proteins // Phagocytes // Surveillance cells (i.e. NK cells) // Complement // Inflammation (a multi-step process)

3) Acquired Immunity also call Adaptive Immunity (not innate)

- > population of WBC that wander and inhabit all of our organs

- > defend the body from agents of disease (pathogens)

- > especially concentrated in the **lymphatic system**

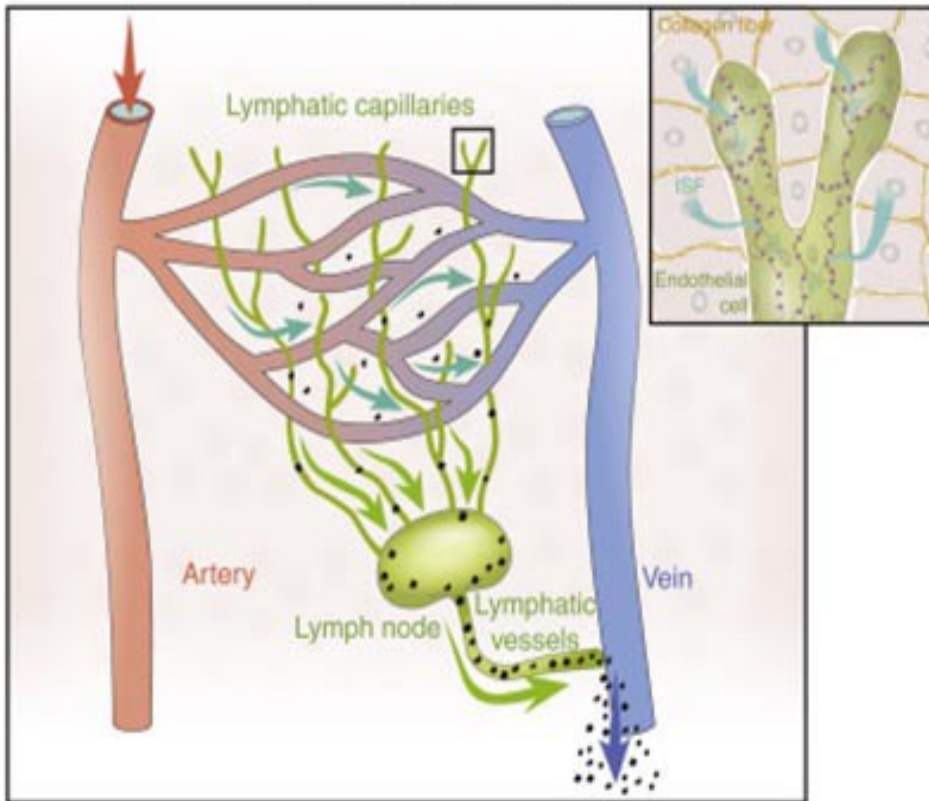
- > these cells must be born, educated, and deployed

- >for every pathogen's antigen (there are billions), adaptive immunity produces two immune cell lines (T-cells and B-cells) with matching “receptor” for the pathogen's antigen(s) // Why?

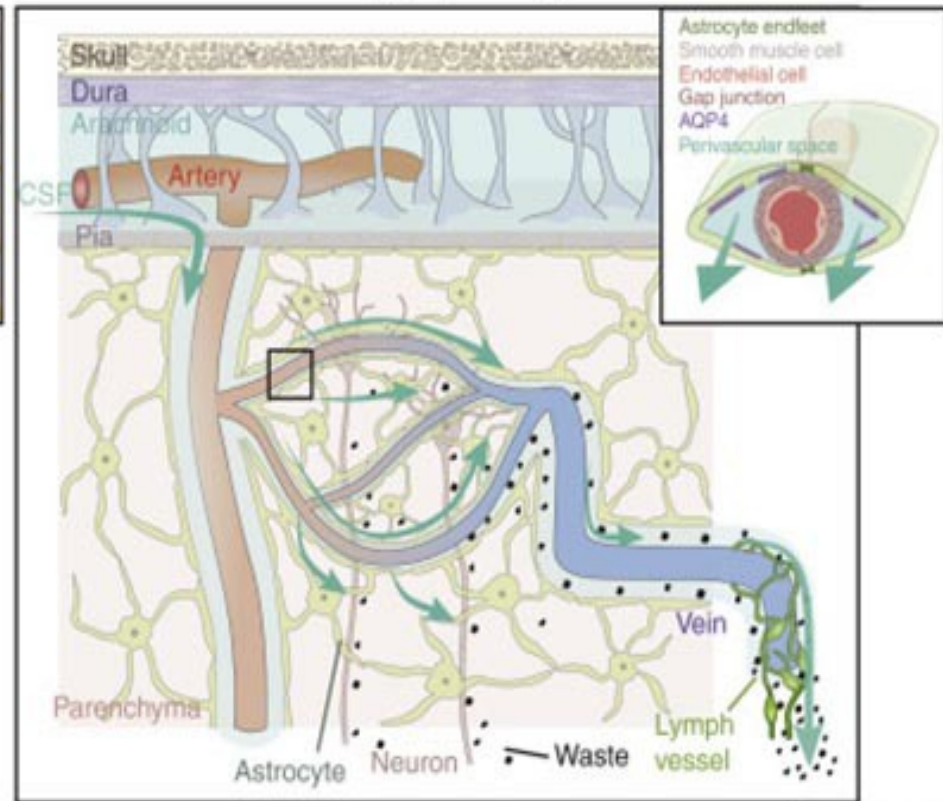
- >after deployed, these cells are able to recognize / react (attack) / remember > key

- > features of immune system = specificity and memory

Peripheral lymphatic system



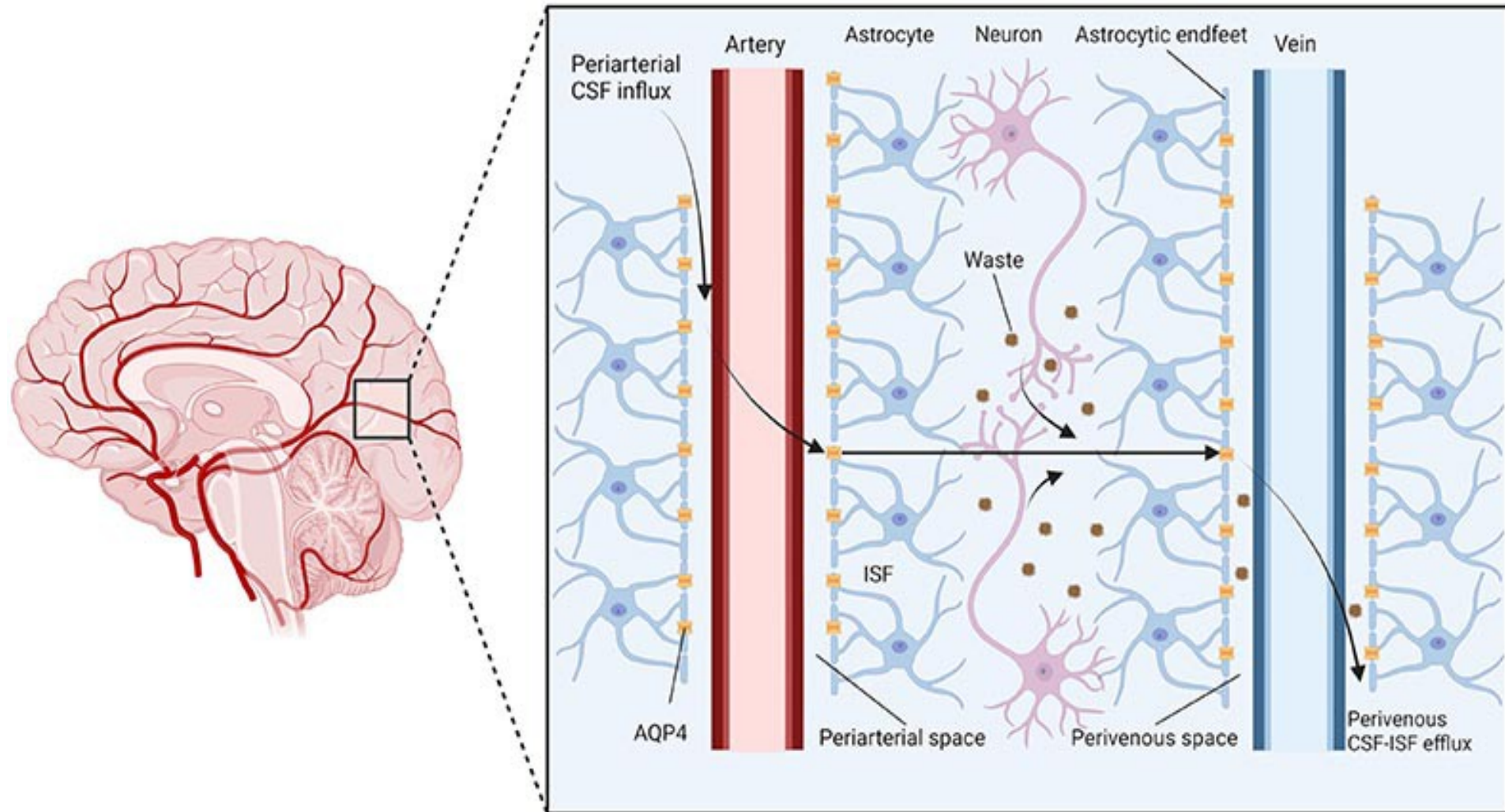
Brain glymphatic system

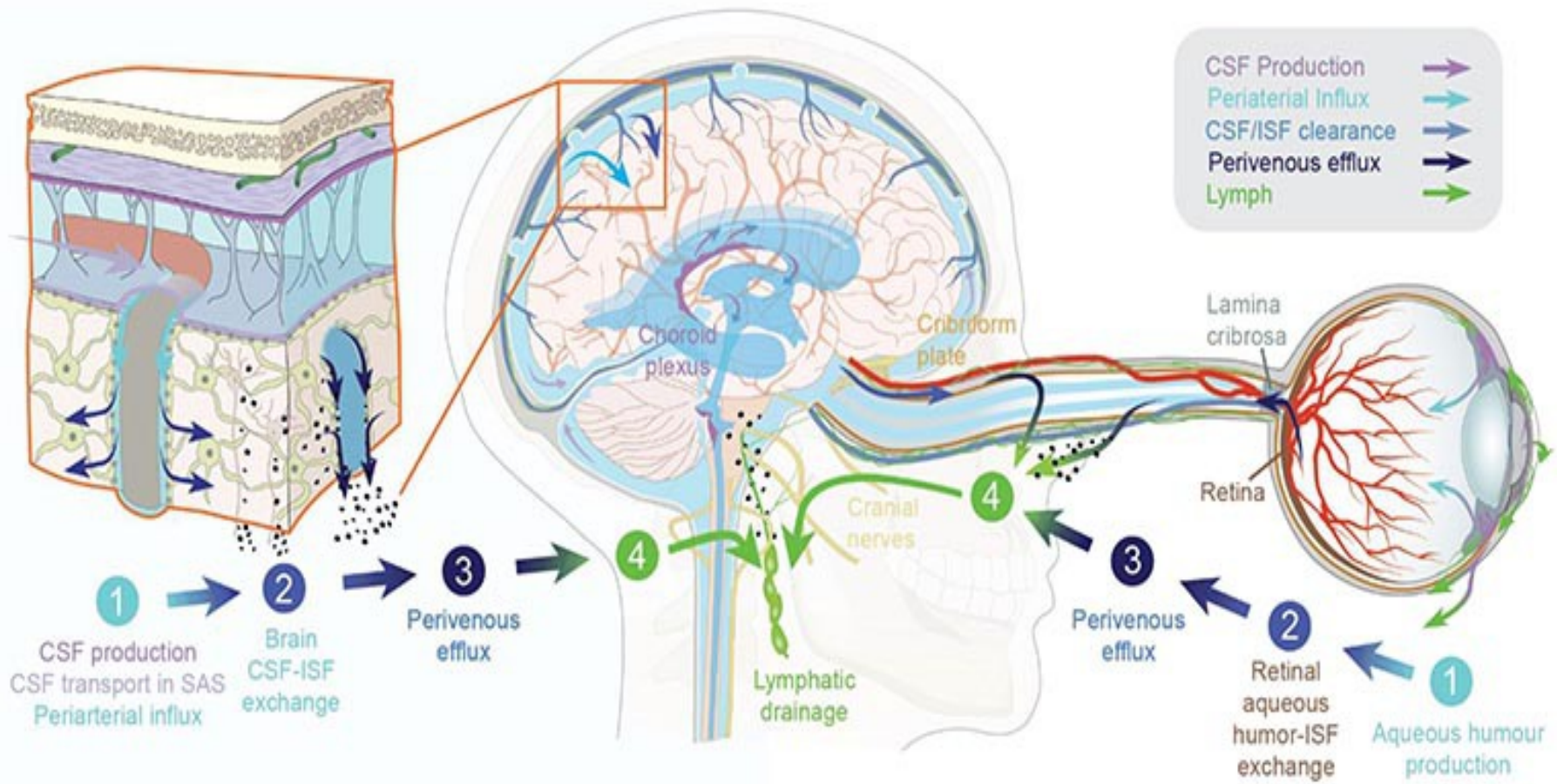


The Glymphatic System in the CNS



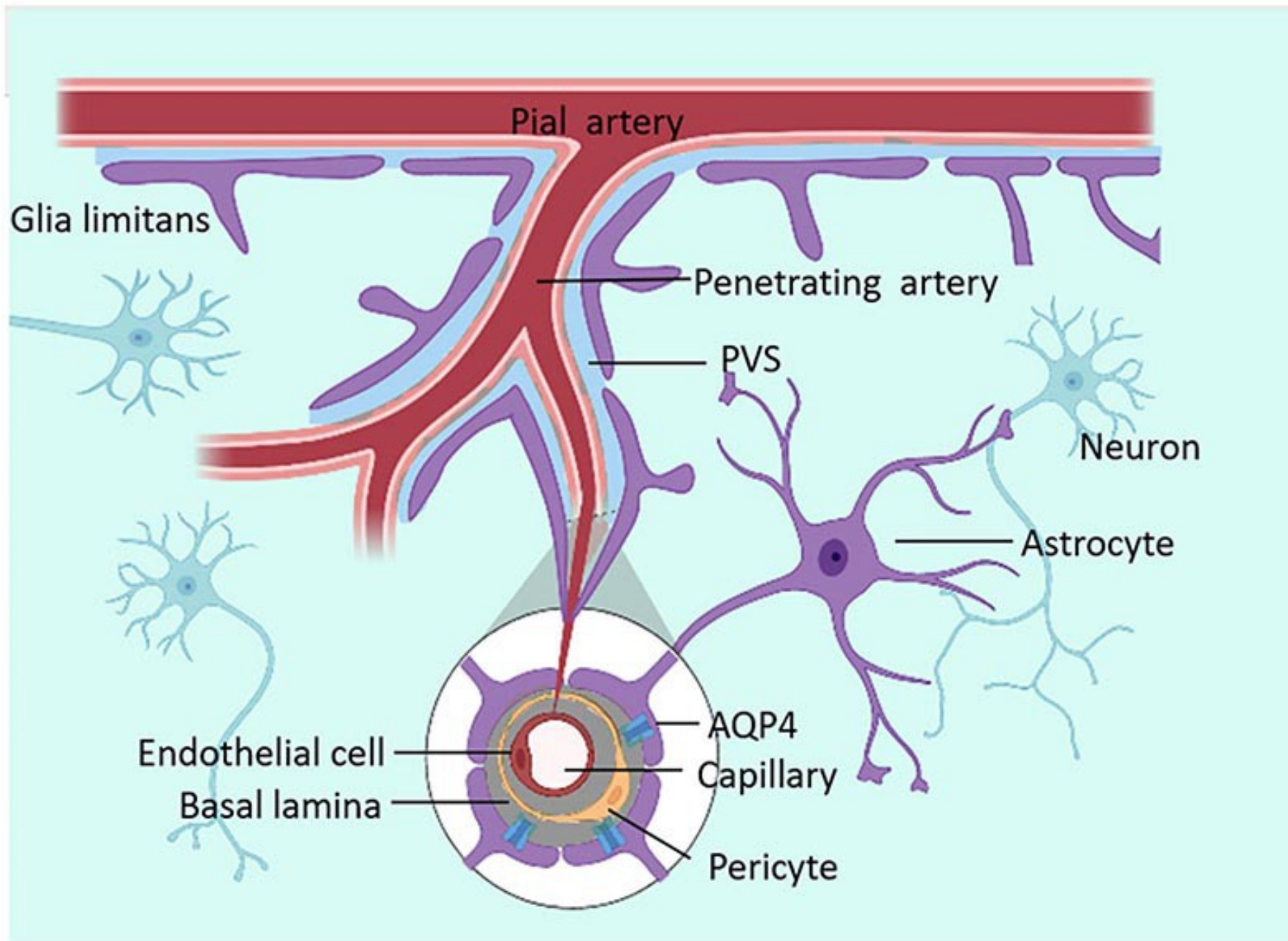
Glymphatic system





Glymphatic system

Ocular Glymphatic system



Pial artery

Glia limitans

Penetrating artery

PVS

Neuron

Astrocyte

Endothelial cell

Basal lamina

AQP4

Capillary

Pericyte