Lymphatic System

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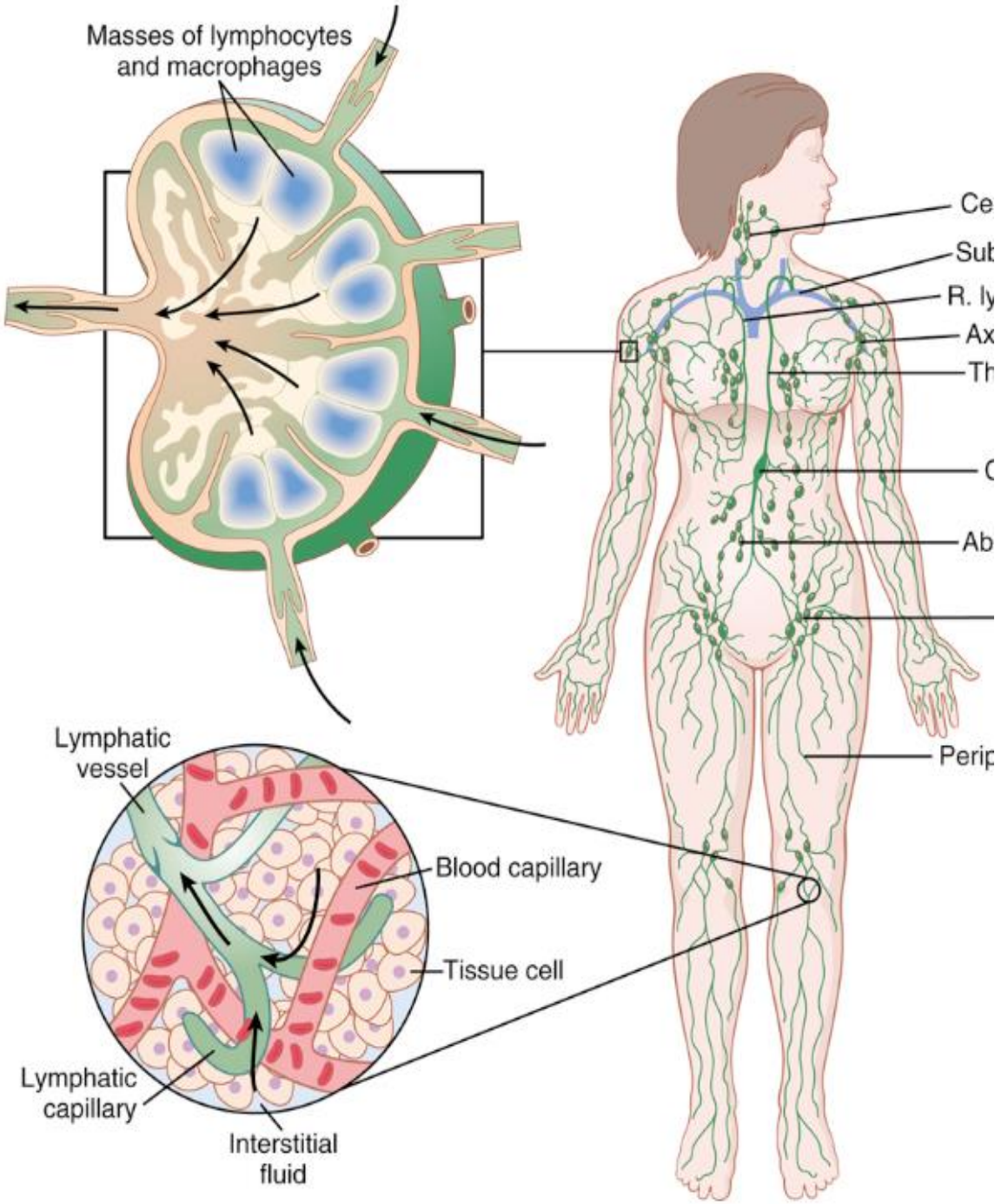
Doctor's notes are in this color.



Hematology Body Fluids

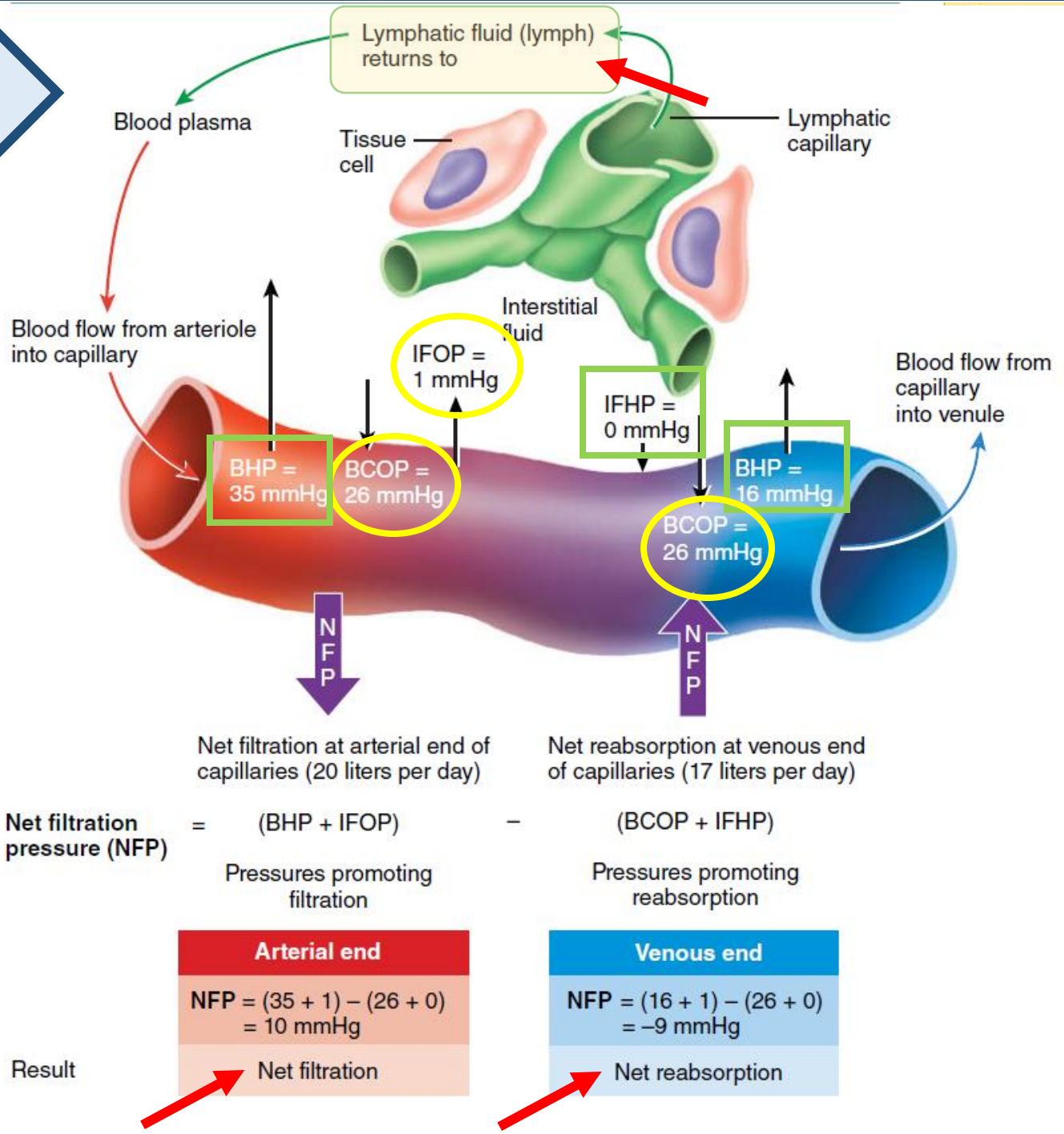
Key:

BHP = Blood hydrostatic pressure
IFHP = Interstitial fluid hydrostatic pressure
BCOP = Blood colloid osmotic pressure
IFOP = Interstitial fluid osmotic pressure
NFP = Net filtration pressure

Blood hydrostatic pressure pushes fluid out of capillaries (filtration)

Blood colloid osmotic pressure pulls fluid into capillaries (reabsorption)

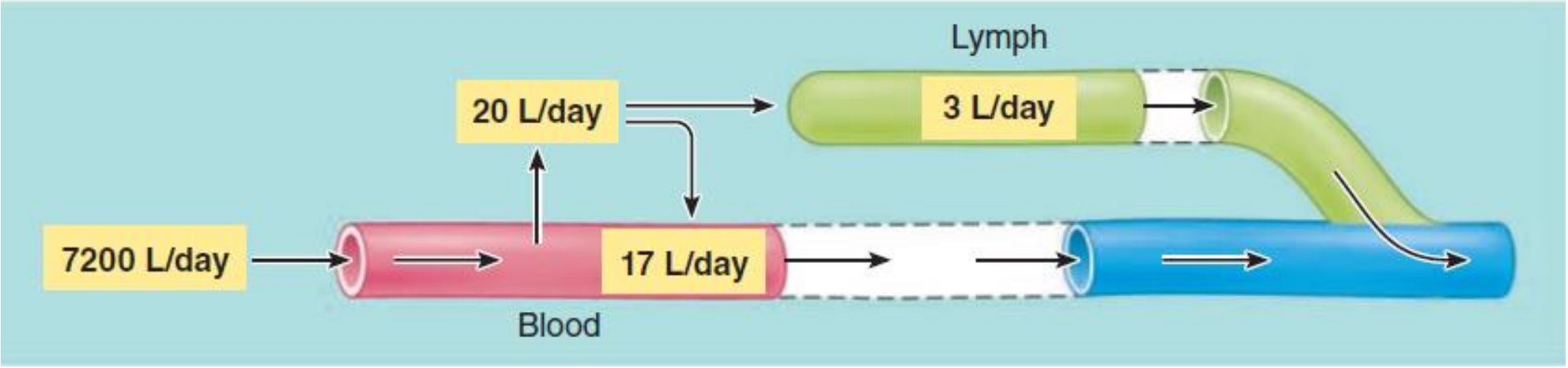
**The processes of filtration, reabsorption, diffusion, and osmosis allow continual exchange of water and solutes among body fluid compartments . Yet the volume of fluid in each compartment remains remarkably stable.



Hematology Lymph

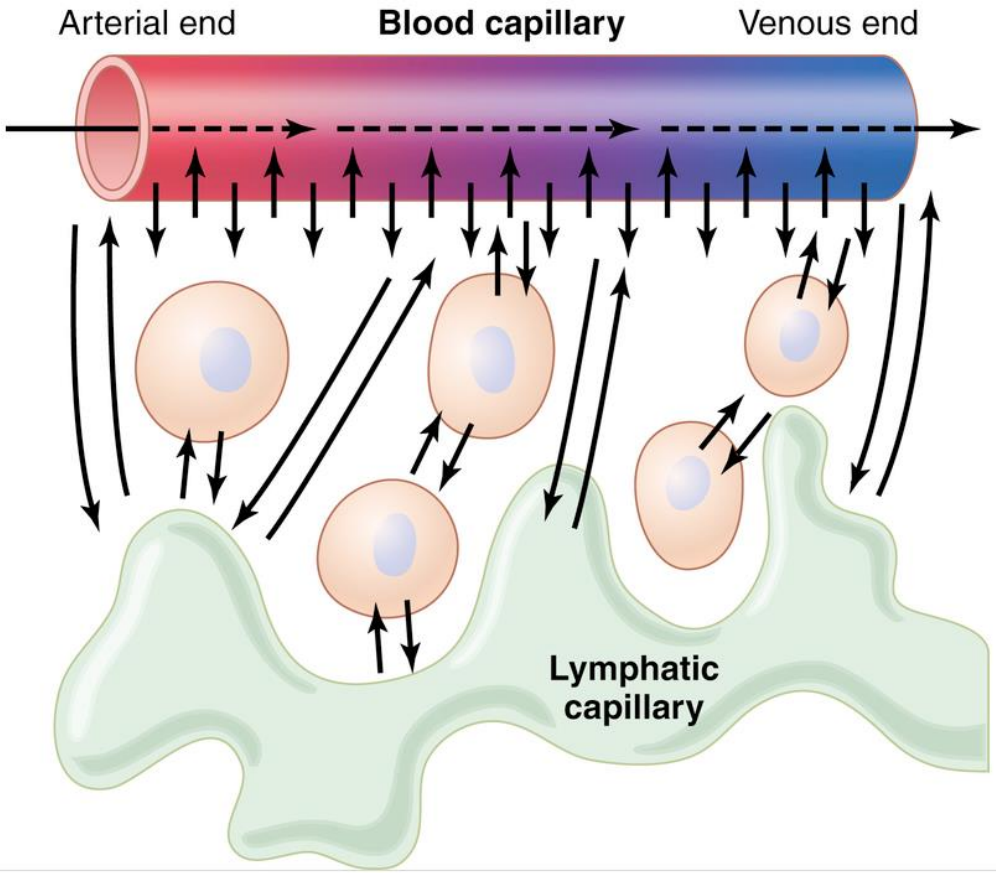
- Even under normal circumstances, slightly more fluid is filtered out of the capillaries into the interstitial fluid than is reabsorbed from the interstitial fluid back into the plasma.
- On average, about one tenth of the fluid instead enters the lymphatic capillaries and returns to the blood through the lymphatic system rather than through the venous capillaries. The total quantity of all this lymph is normally only 2 to 3 L/day.

** 3 liters per day, compared with 7200 liters per day through the circulatory system.



Lymph Composition

- Lymph is derived from interstitial fluid that flows into the lymphatics. Therefore, lymph as it first enters the terminal lymphatics has almost the same composition as the interstitial fluid.

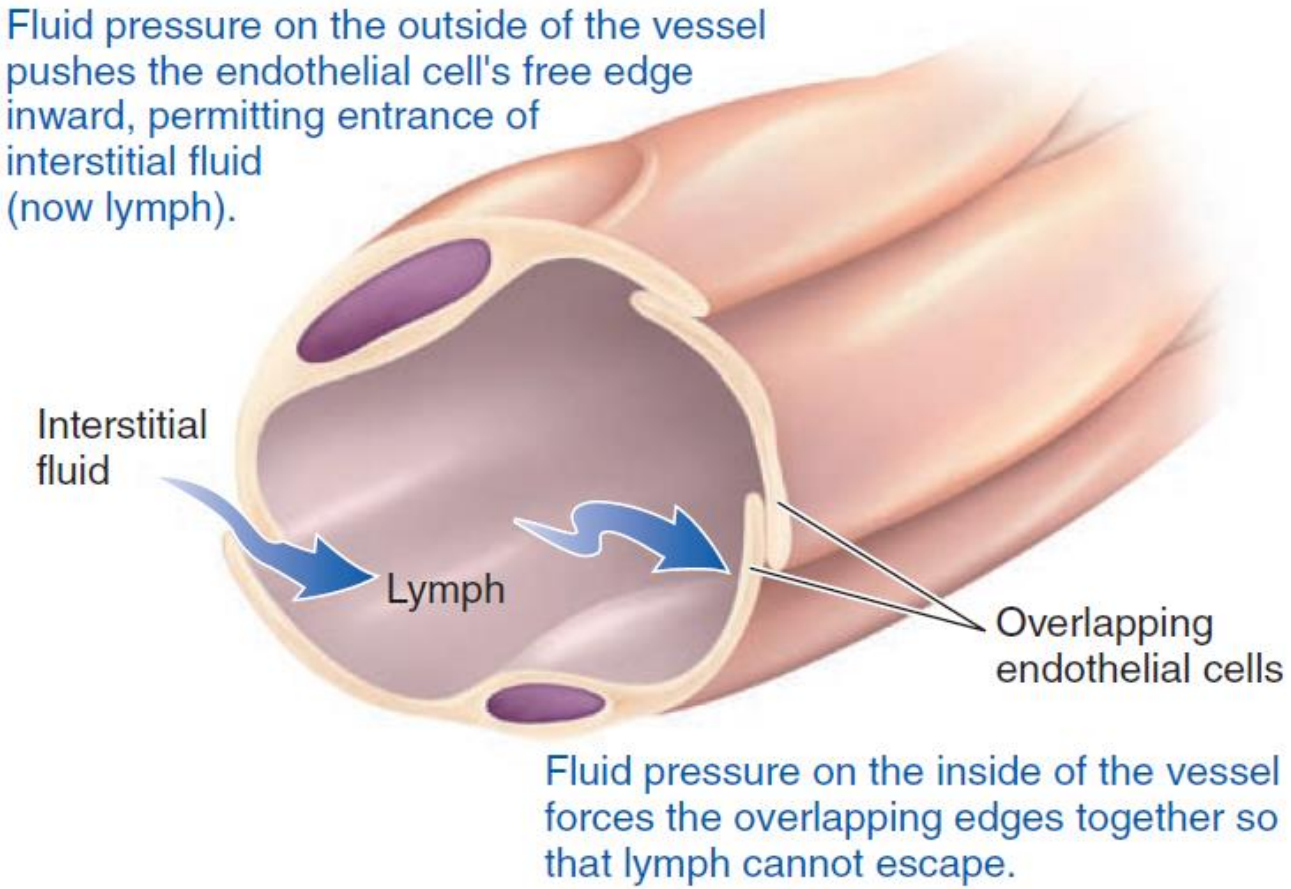


** Diffusion Through the Capillary Membrane Is the Most Important Means of Transferring Substances Between Plasma and Interstitial Fluid

as the blood flows along the lumen of the capillary, tremendous numbers of water molecules and dissolved particles diffuse back and forth through the capillary wall, providing continual mixing between the interstitial fluid and plasma. Electrolytes, nutrients, and waste products of metabolism all diffuse easily through the capillary membrane. The proteins are the only dissolved constituents in the plasma and interstitial fluids that do not readily pass through the capillary membrane.

Lymph Circulation

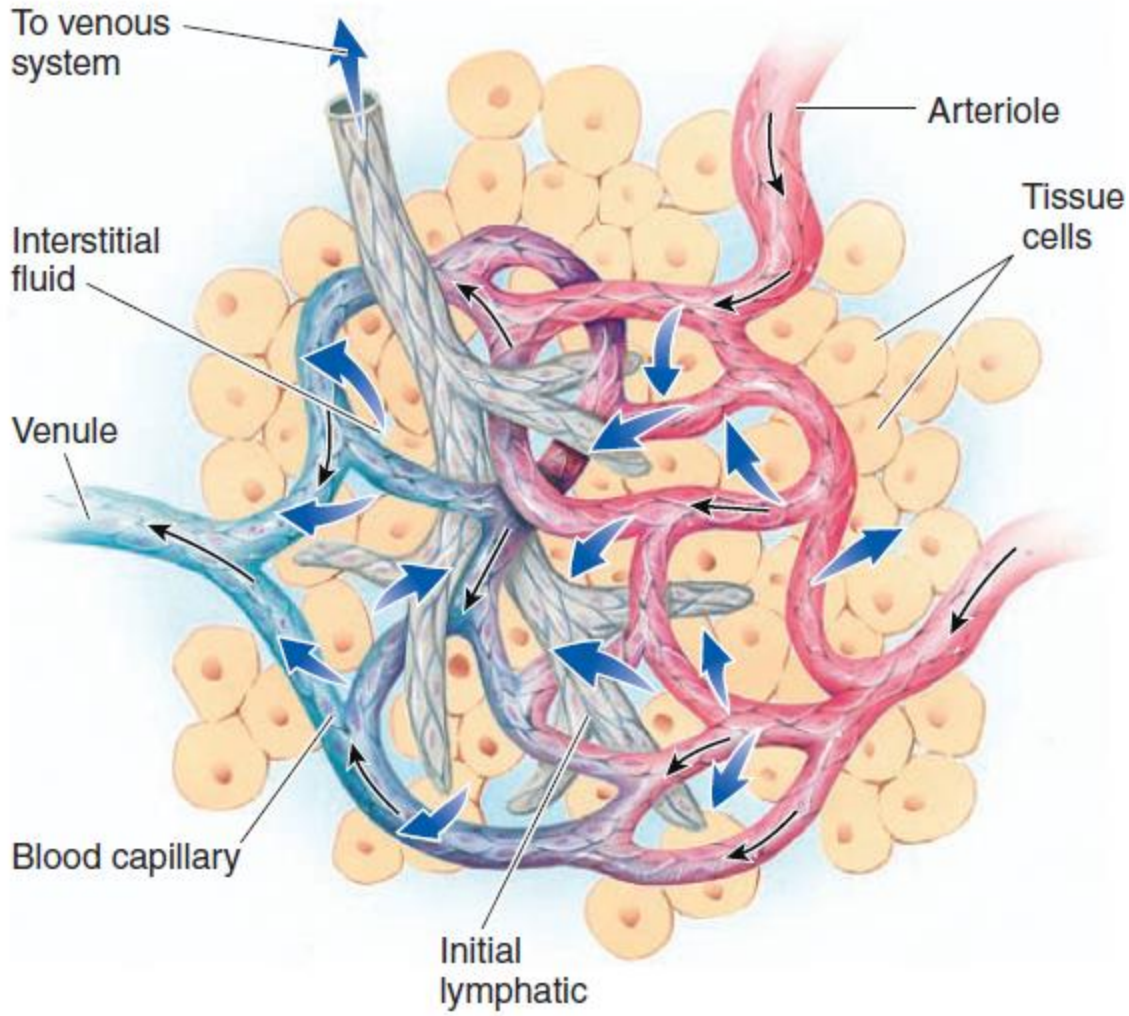
These lymphatic valve-like openings are larger than the pores in blood capillaries. Consequently,
large particles in the interstitial fluid, such as escaped plasma proteins and bacteria, can gain access to initial lymphatics
but are excluded from blood capillaries.



Lymph Circulation

lymph is directed from the tissues toward the venous system by two mechanisms:

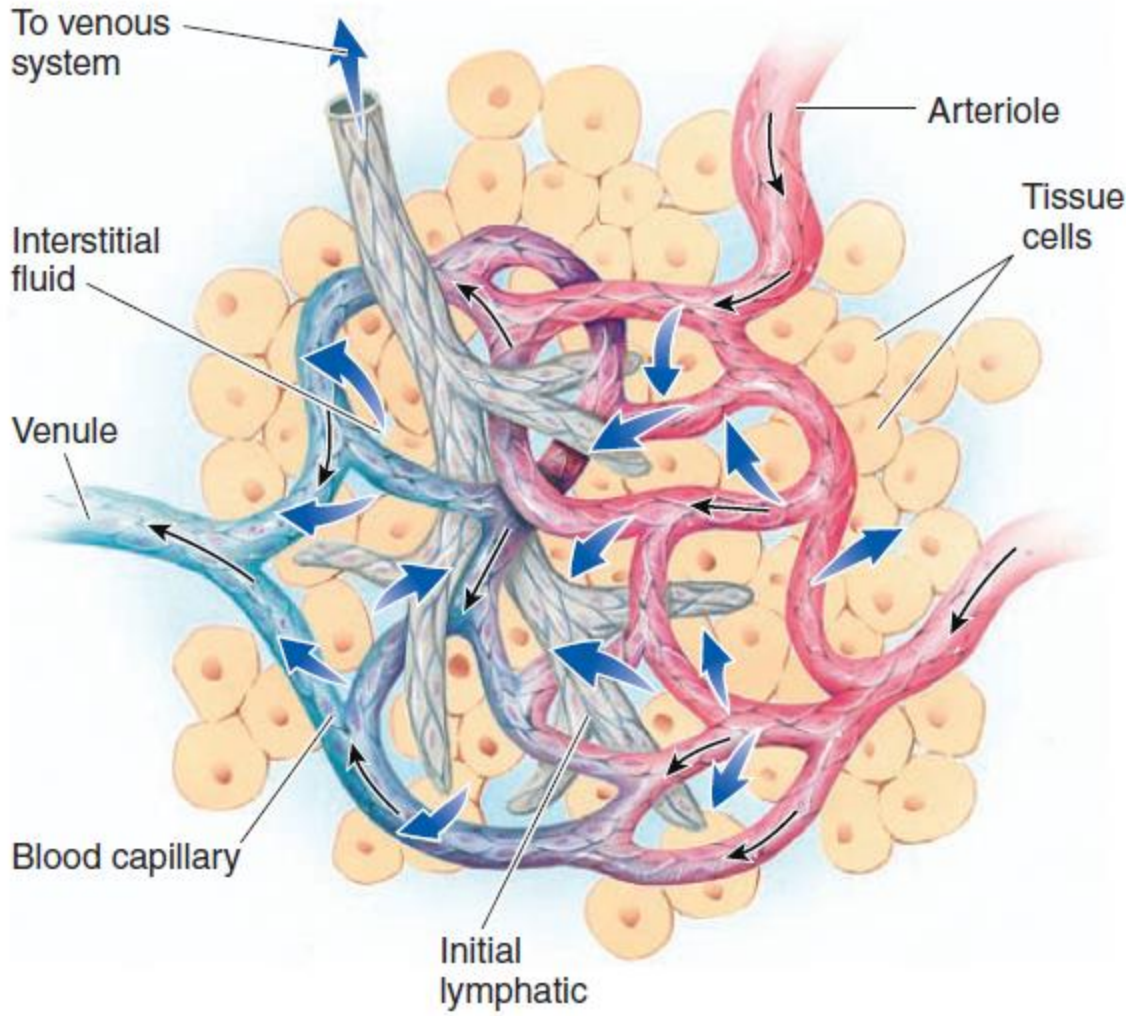
1. lymph vessels beyond the initial lymphatics are surrounded by smooth muscle, which contracts rhythmically as a result of myogenic activity.



Lymph Circulation

lymph is directed from the tissues toward the venous system by two mechanisms:

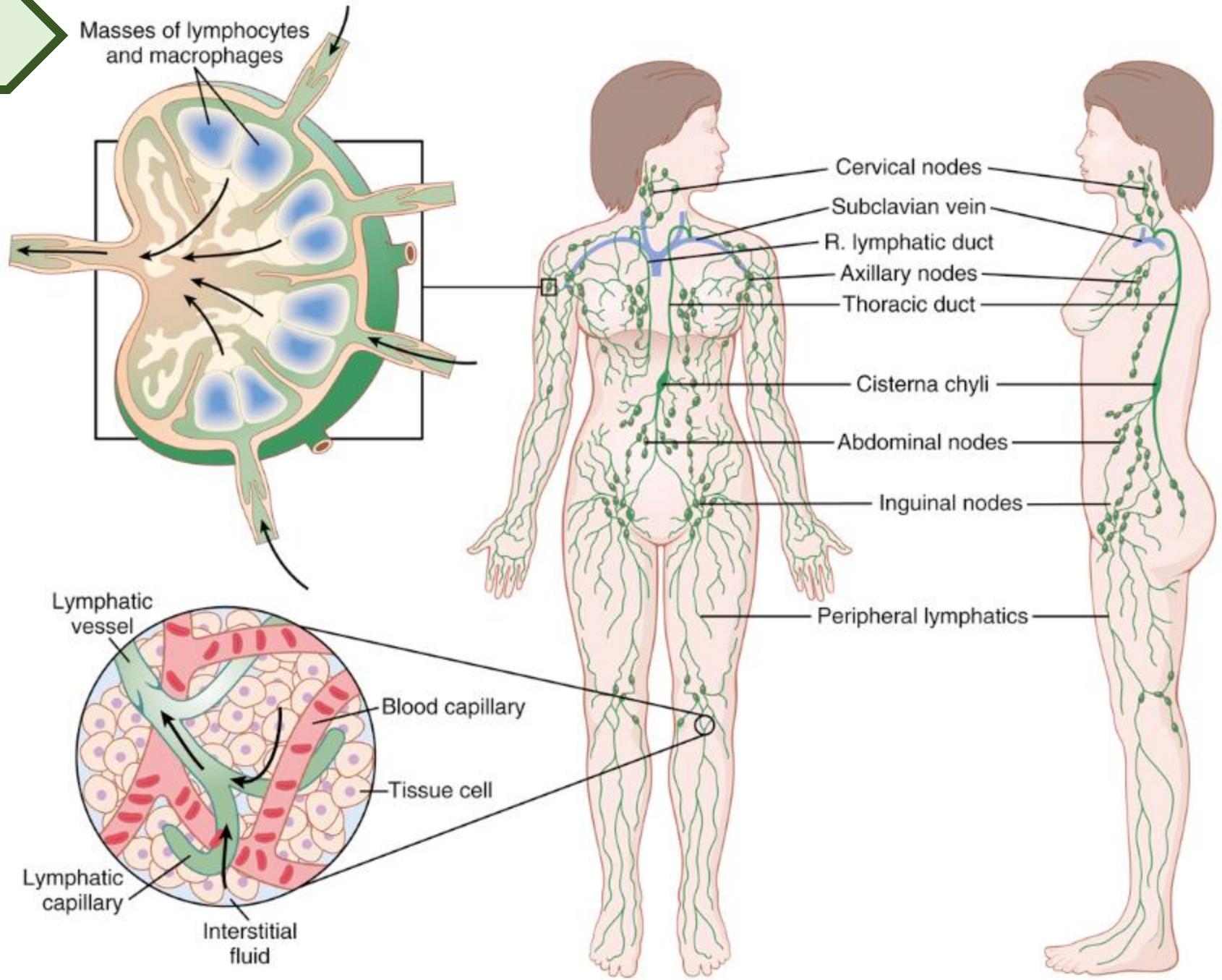
2. Contraction of skeletal muscles squeezes the lymph out of the vessels.



Lymph Circulation

- Almost all tissues of the body have special lymph channels that drain excess fluid directly from the interstitial spaces

**The exceptions include the epidermis, central nervous system, endomysium of muscles, and bones.



Lymph Circulation

- lower part of the body → empty into the thoracic duct → empties into the blood venous system.
- Left side of the head, left arm, and parts of the chest region → thoracic duct before it empties into the veins.
- Right side of the neck and head, right arm, and parts of the right thorax enters the right lymph duct.

Lymph Function

- Return of excess filtered fluid.
- Defense against disease.
- Transport of absorbed fat.
- Return of filtered protein.

**Lymph formed in the liver has a protein concentration as high as 6 g/dl, and lymph formed in the intestines has a protein concentration as high as 3 to 4 g/dl. Because about two thirds of all lymph normally is derived from the liver and intestines, the thoracic duct lymph, which is a common mixture of lymph from all areas of the body, usually has a protein concentration of 3 to 5 g/dl.

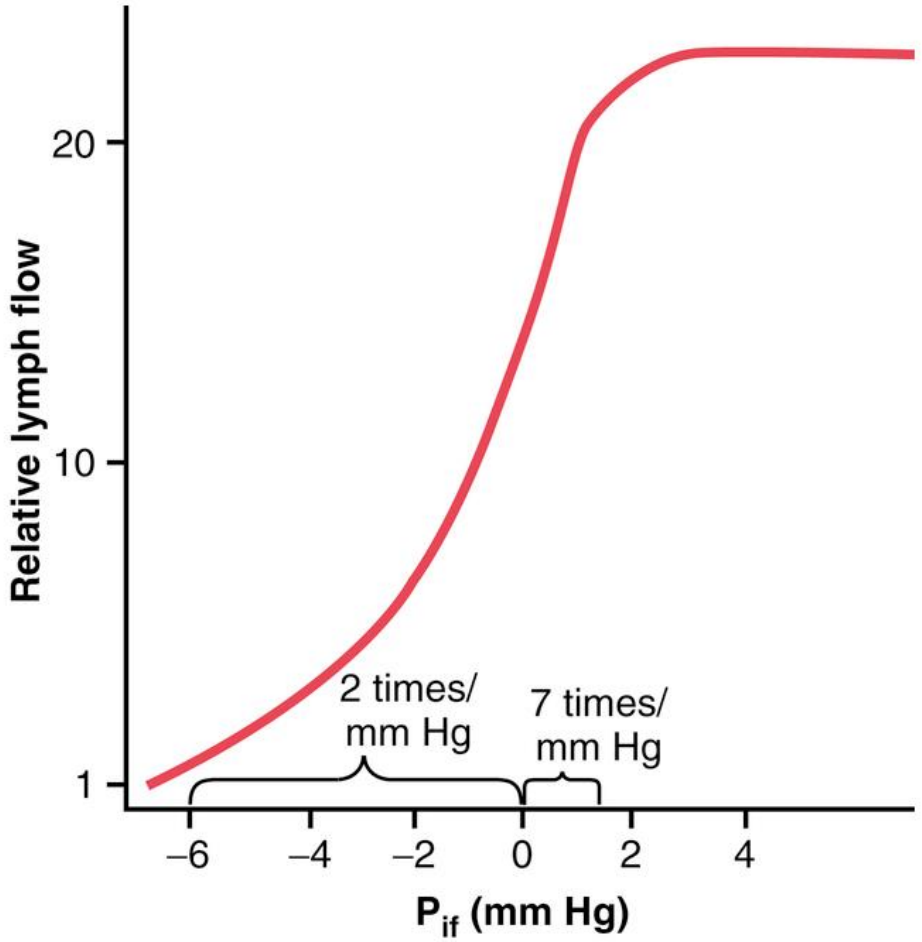
** The lymphatic system is also one of the major routes for absorption of nutrients from the gastrointestinal tract, especially for absorption of virtually all fats in food.

** Finally, even large particles, such as bacteria, can push their way between the endothelial cells of the lymphatic capillaries and in this way enter the lymph. As the lymph passes through the lymph nodes, these particles are almost entirely removed and destroyed.

Relationship between interstitial fluid pressure and lymph flow

All these factors favor net fluid movement into the interstitium, thus increasing interstitial fluid volume, interstitial fluid pressure, and lymph flow all at the same time

- Elevated capillary hydrostatic pressure
- Decreased plasma colloid osmotic pressure
- Increased interstitial fluid colloid osmotic pressure
- Increased permeability of the capillaries



- ** The interstitial fluid hydrostatic pressure, which tends to force fluid inward through the capillary membrane when is positive but outward when is negative
- ne might formulate a general rule that the normal interstitial fluid pressure is usually several millimeters of mercury negative with respect to the pressure that surrounds each tissue.

when the **interstitial fluid hydrostatic pressure becomes 1 or 2 mm Hg greater than atmospheric pressure (>0 mm Hg), **lymph flow fails** to rise any further at still higher pressures. This results from the fact that the increasing tissue pressure not only increases entry of fluid into the lymphatic capillaries, but also **compresses the outside surfaces of the larger lymphatics**, thus **impeding lymph flow**.

Two primary factors that determine lymph flow are:

(1) the interstitial fluid pressure.

(2) the activity of the lymphatic pump.

There are two general causes of extracellular edema:

(1) abnormal leakage of fluid from the plasma to the interstitial spaces across the capillaries; and

(2) failure of the lymphatics to return fluid from the interstitium back into the blood, often called **lymphedema**

Lymph lymphedema

Blockage of lymph return due to:

A. Cancer

B. Infections (e.g., filarial nematodes)

C. Surgery

D. Congenital absence or abnormality of lymphatic vessels

When lymphatic function is greatly impaired as a result of blockage or loss of the lymph vessels, edema can become especially severe because plasma proteins that leak into the interstitium cannot be removed in any other way. The rise in protein concentration raises the colloid osmotic pressure of interstitial fluid, which draws even more fluid out of the capillaries.