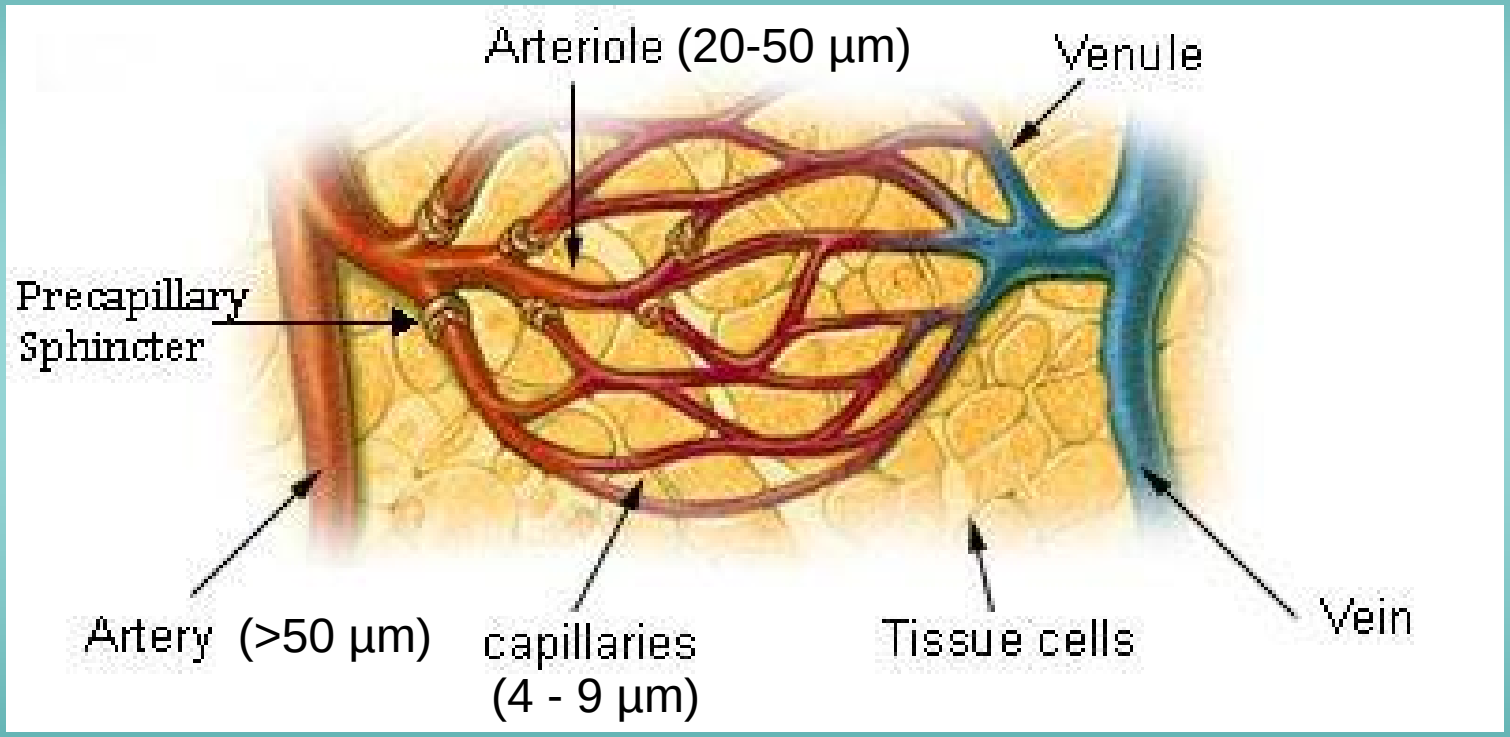
MICROCIRCULATION

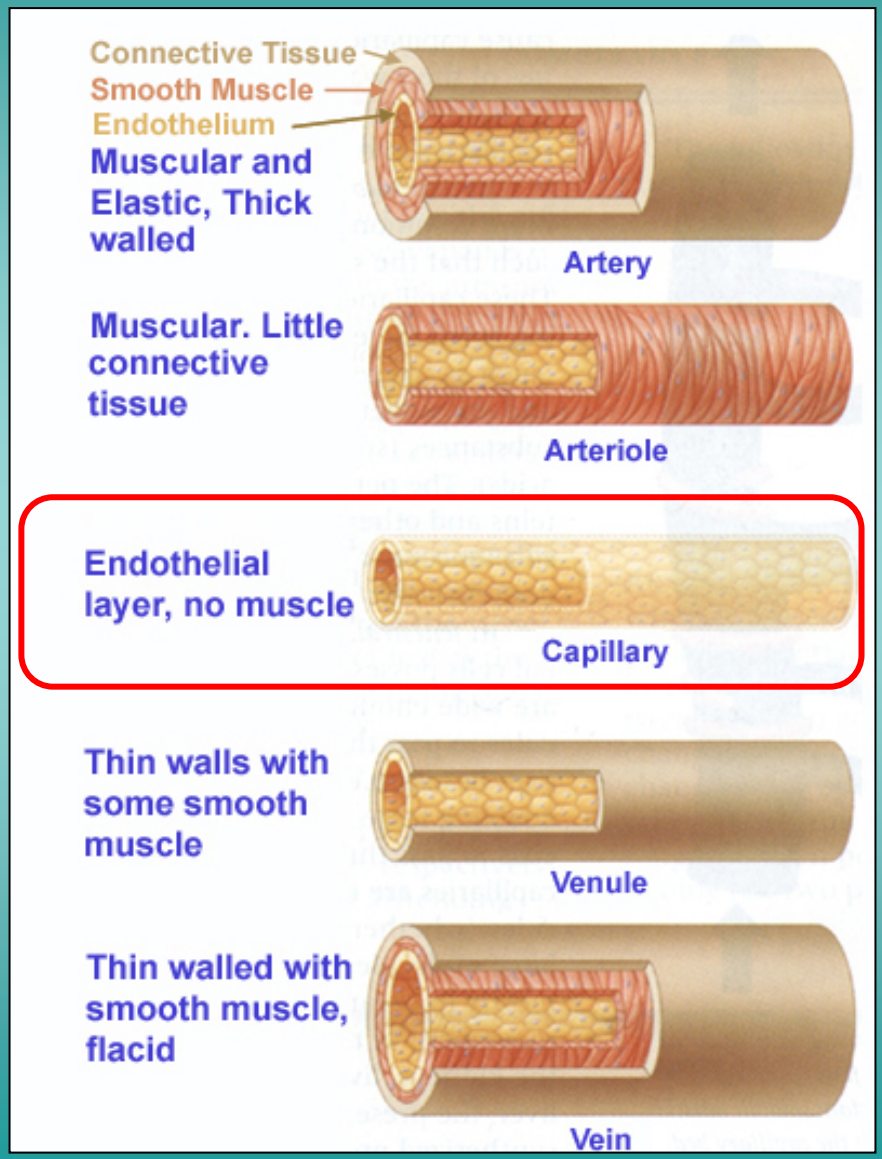
FUNCTIONAL ANATOMY

Microcirculation is circulation of the blood through the smallest vessels of the body – arteriols, capillaries and venules.



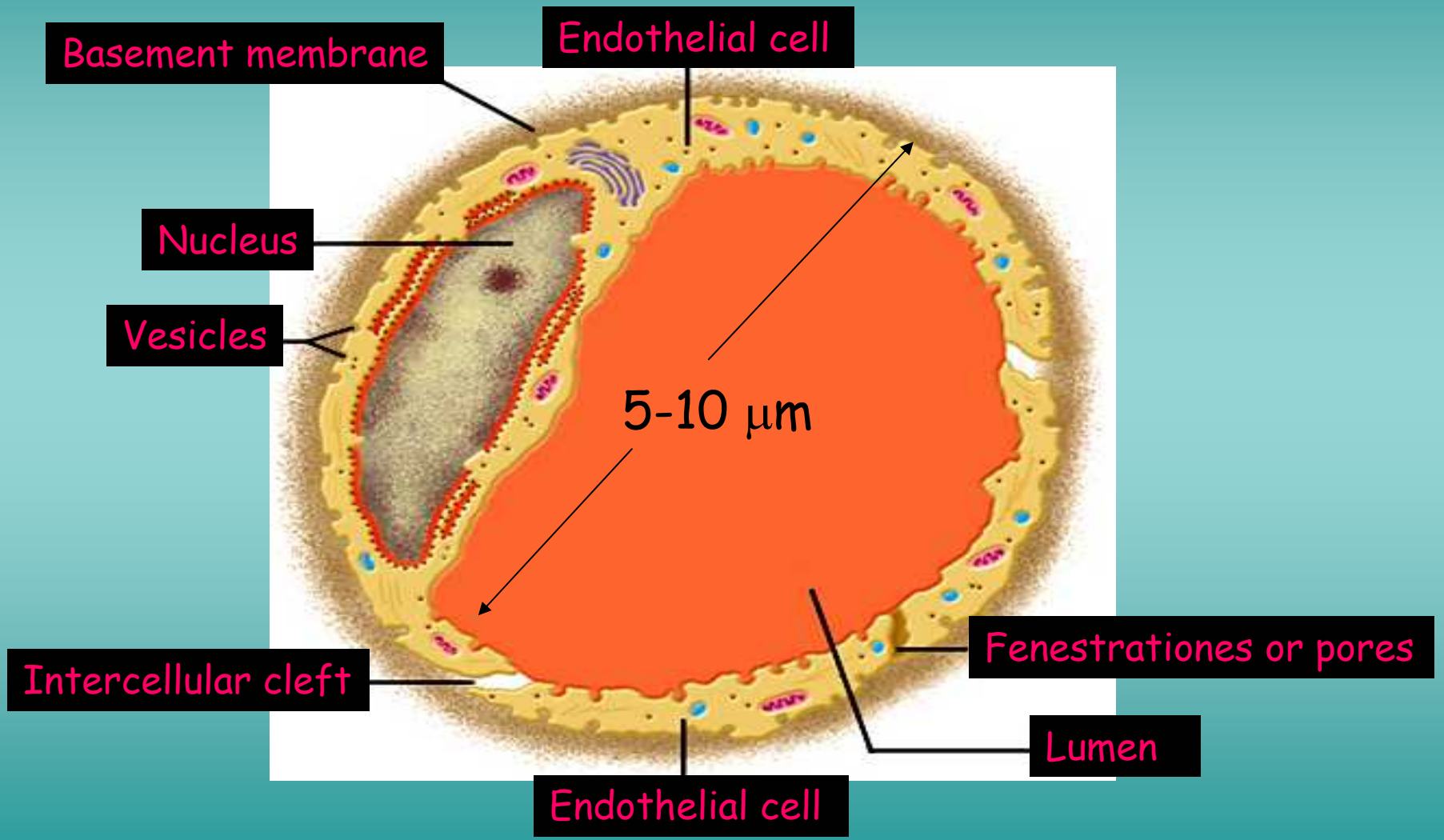
The principal function of the microcirculation is to permit the transfer of substances (water, solutes, gases) between the vascular system and the tissues.

STRUCTURE OF VESSEL WALL

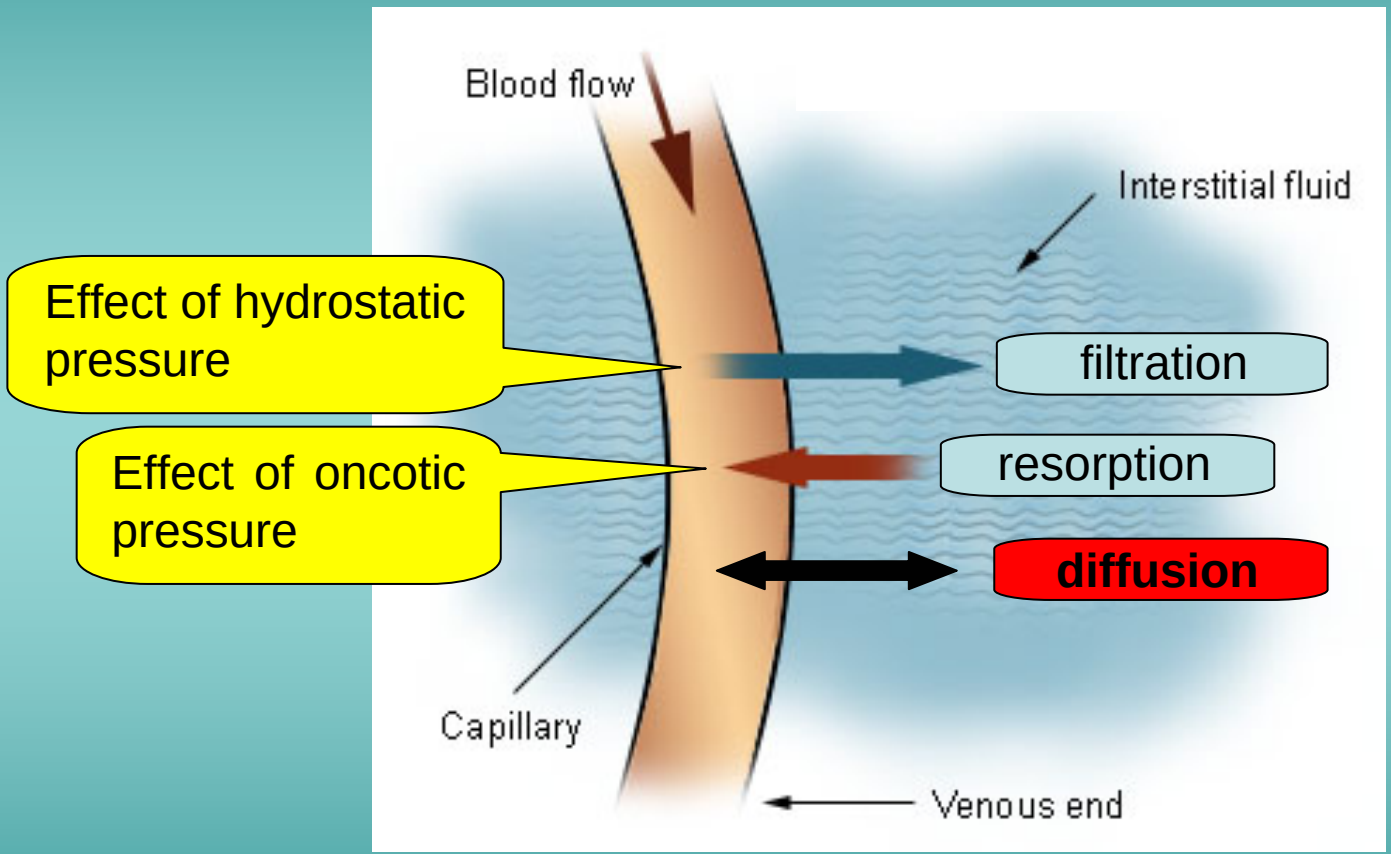


1. The capillary wall is about 1 μm thick.
2. The total area of all the capillary walls in the body exceeds 500 m^2.
3. The rate of blood flow in capillaries is 0.2 - 1 mm/s.
4. Transit time from arterial to venular end of a capillary is 1 - 2 seconds.

ULTRASTRUCTURE OF CAPILLARY

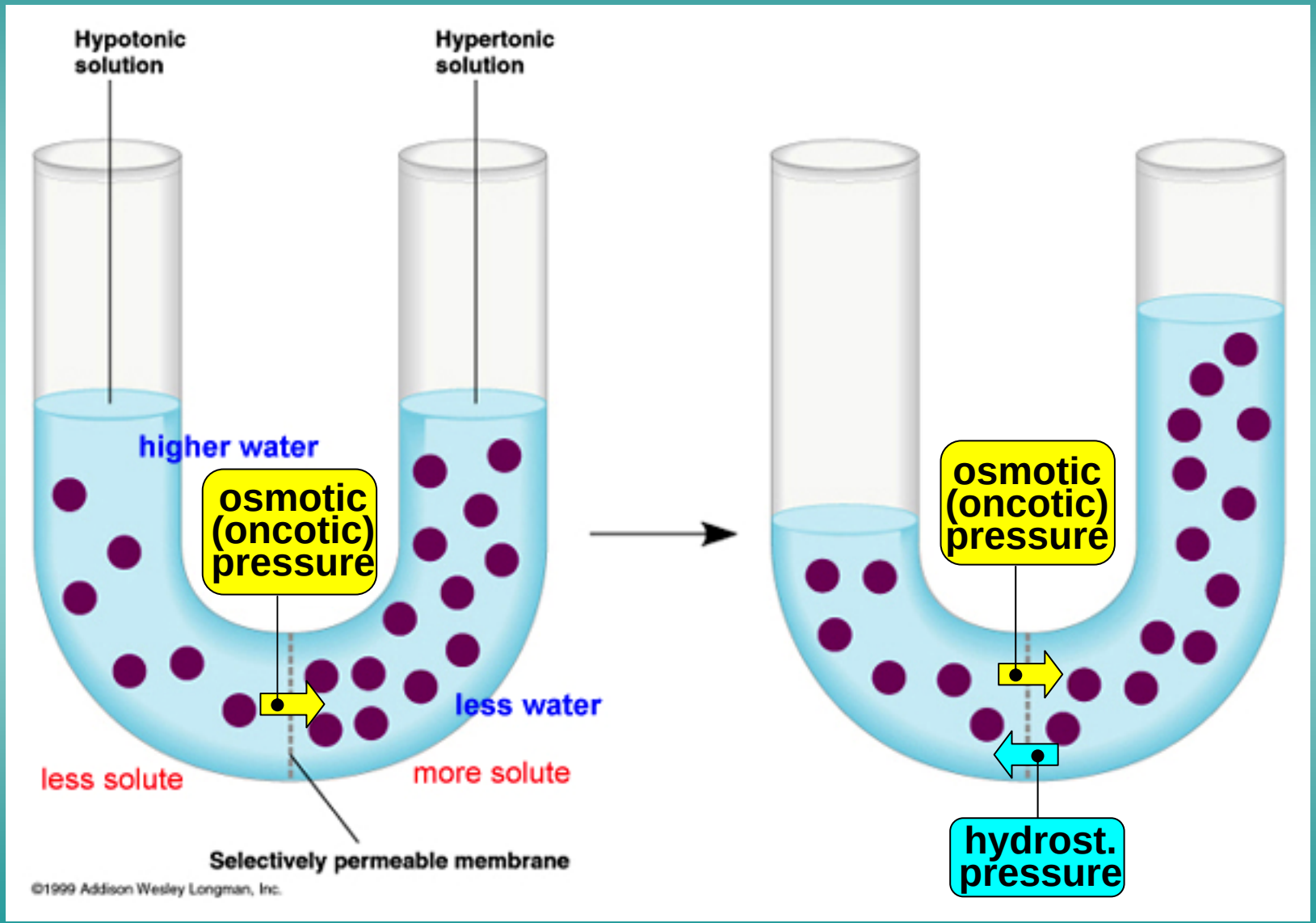


MOVEMENT OF FLUID ACCROSS CAPILLARY WALL

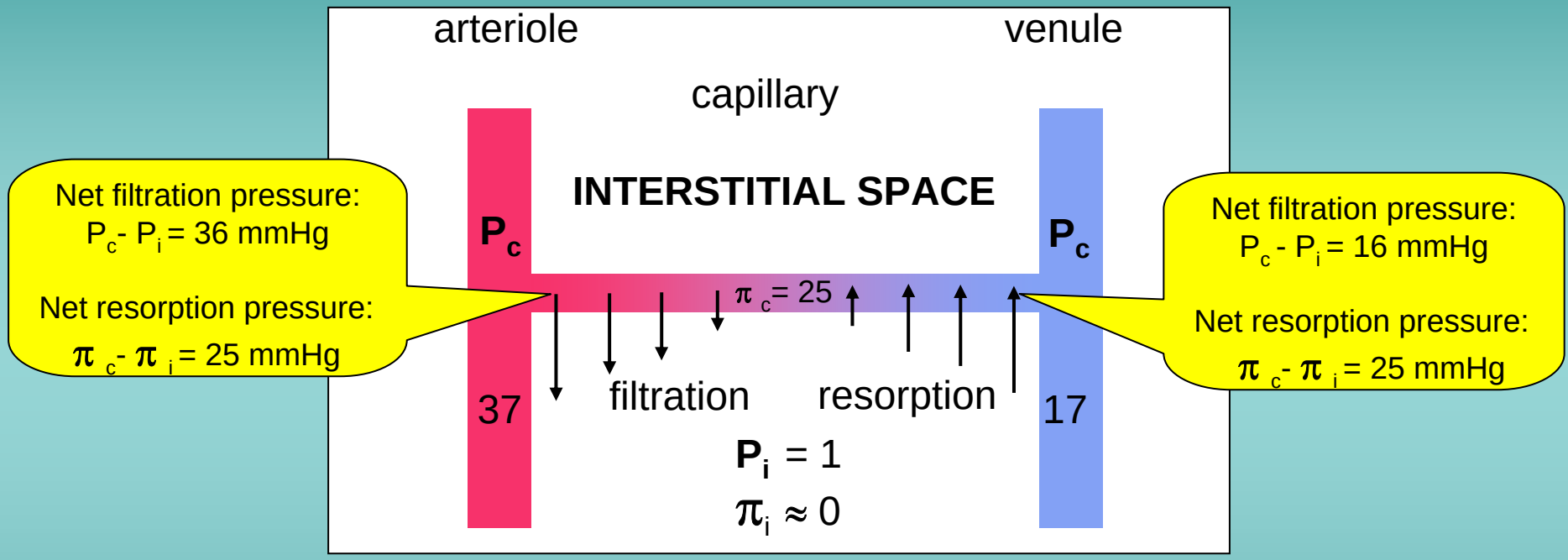


The diffusion, filtration and resorption of water across capillary wall occur through Intercellular clefts, pores and fenestrations.

OSMOTIC PREASURE



PRESSURE GRADIENTS ACROSS THE WALL OF CAPILLARY



CAPILLARY HYDROSTATIC PRESSURE **P_c = 37 - 17 mmHg**

INTERSTITIAL HYDROSTATIC PRESSURE **P_i = 1 mmHg**

CAPILLARY ONCOTIC PRESSURE **π_c = 25 mmHg**

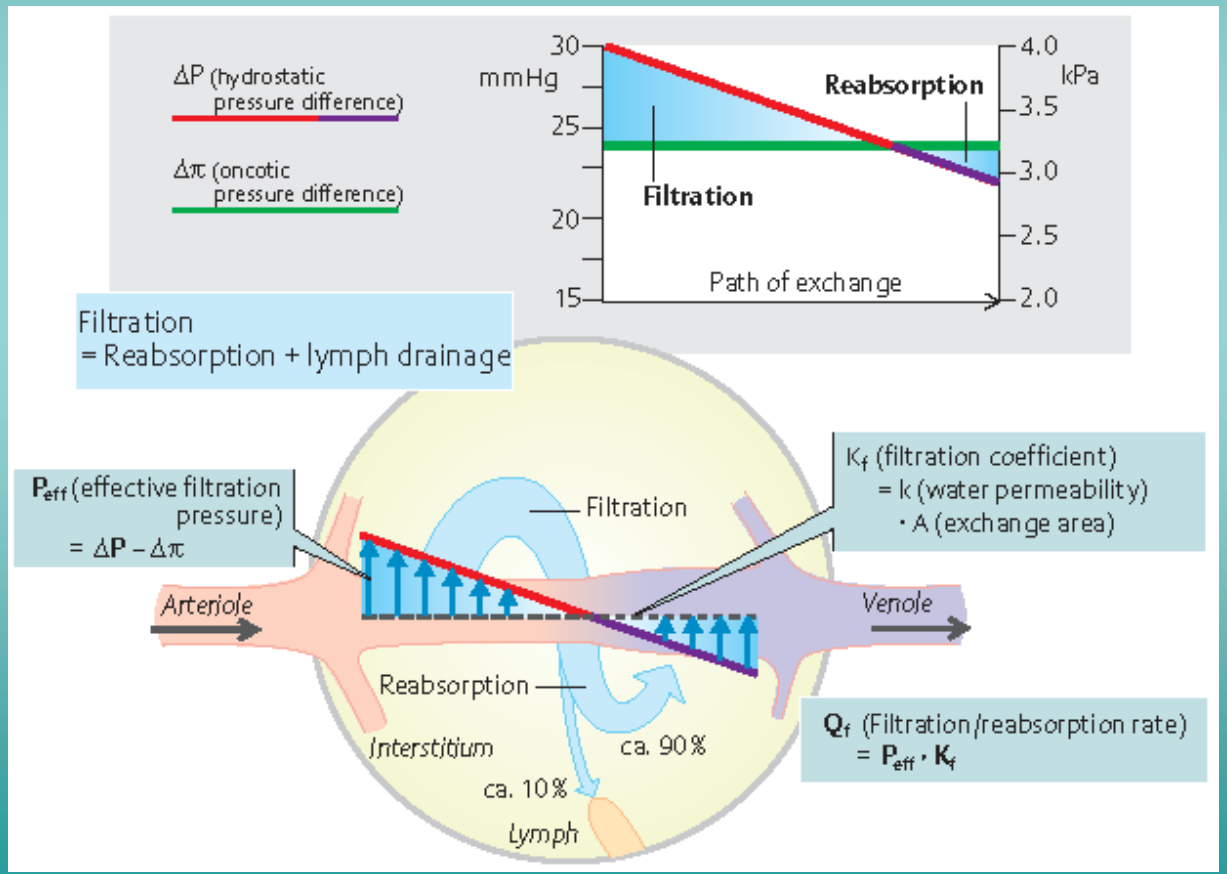
INTERSTITIAL ONCOTIC PRESSURE **$\pi_i \approx$ 0 mmHg**

EXCHANGE OF FLUID VIA CAPILLARIES

Net filtration pressure

Net resorption pressure

$([P_c - P_i] - \sigma\,[\pi_c - \pi_i])$ - **effective filtration pressure**



STARLING'S EQUATION

$$J_v = K_f([P_c - P_i] - \sigma[\pi_c - \pi_i])$$

J_v - NET FLUID MOVEMENT ACROSS CAPILLARY WALL

K_f - Filtration coefficient

P_c - capillary hydrostatic pressure

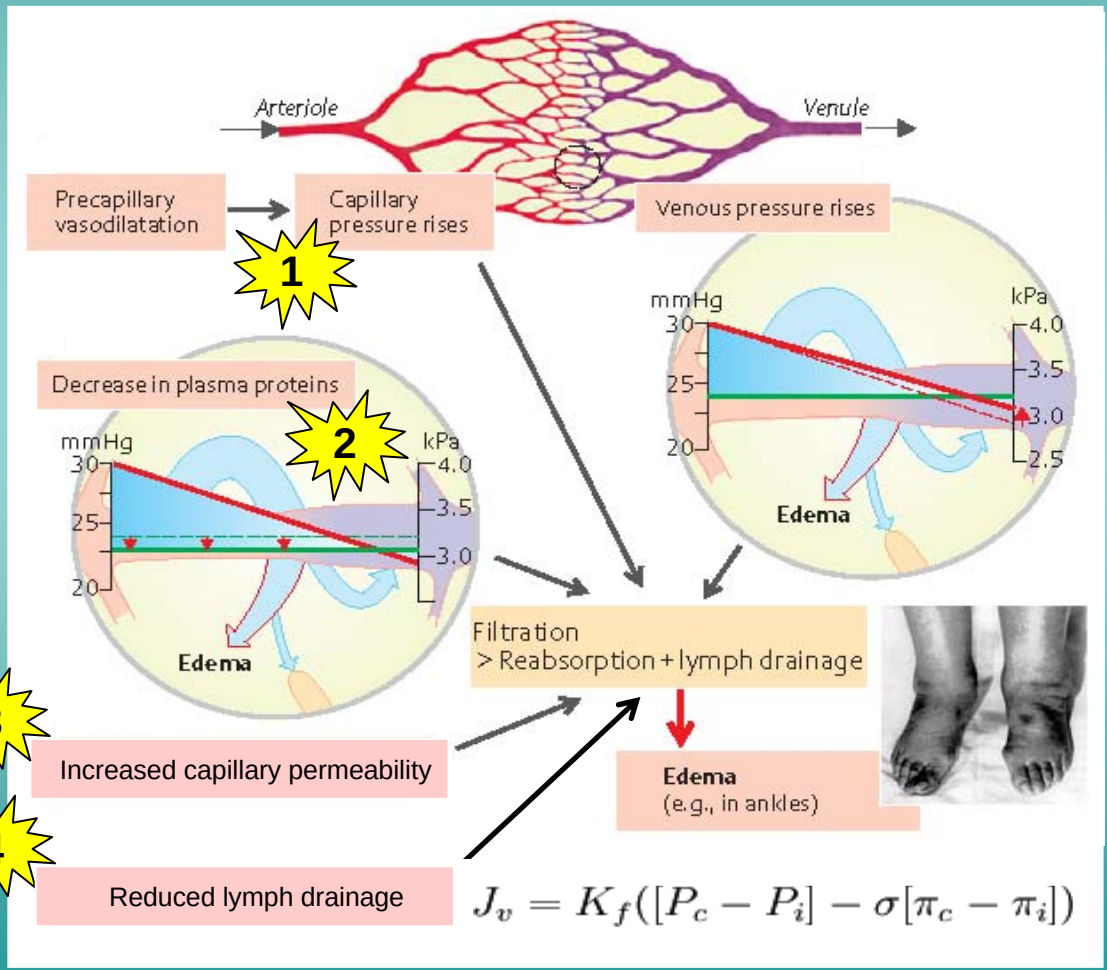
P_i - interstitial hydrostatic pressure

π_z - capillary oncotic pressure

π_i - interstitial oncotic pressure

σ - coefficient permeabilty

CAUSES OF INCREASED INTERSTITIAL FLUID VOLUME (EDEMA)



MOVEMENT OF SOLUTES ACCROSS CAPILLARY WALL

- **DIFFUSION -** if there is, for a certain solute, a concentration difference between the plasma and interstitial space the solute diffuses across the capillary wall. Lipid-soluble molecules (e.g. O_2 ,CO_2) move across the capillary wall directly while lipid insoluble molecules (e.g. ions, urea) move across the capillary wall by Intercellular clefts, pores or fenestrations.

- **SOLVENT DRAG -** The dissolved particles are dragged through the capillary wall along with filtered and reabsorbed water.

!!! TO REMEMBER !!!

Four forces known as Starling forces determine net fluid movement across the capillary membranes.

P_c= Capillary Pressure→ Tends to move fluid out of the capillary.

P_i= Interstitial Fluid Pressure→ Tends to move fluid into the capillary.

π_c = Plasma Colloid Osmotic Pressure→ Tends to cause osmosis of fluid into capillary.

π_i = Interstitial fluid colloid osmotic pressure→ Tends to cause osmosis of fluid out of the capillary

$$\text{Effective filtration pressure} = ((P_c - P_i) - (\pi_c - \pi_i))$$

The diffusion is the key factor in providing exchange of gases, substrates and waste products between the capillaries and the tissue cells.

CAUSES OF EDEMA DEVELOPMENT:

↑ **Capillary Pressure** - P_c (↑hydrostatic pressure, heart failure)

↓ **Plasma Proteins** (nephrotic syndrome)

↑ **Capillary Permeability** - K_f (infections)

↓ **Lymph drainage**- π_i (lymphatic blockage)