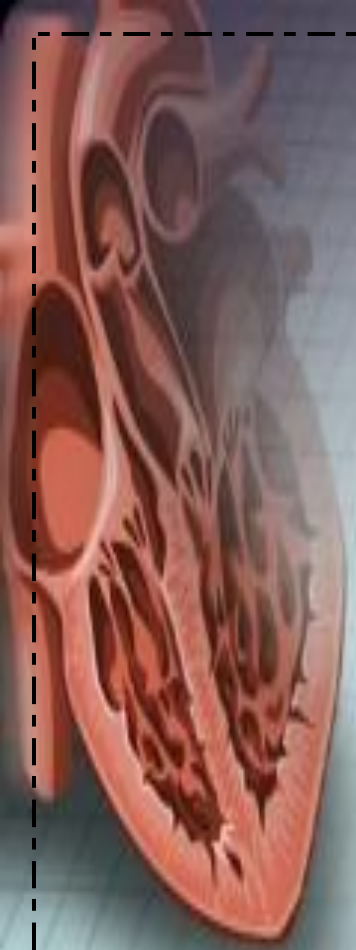

Cardiovascular Block

Physiology Team 430

15th Lecture

Capillary circulation

This Lecture is Done By :

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Functions of the circulation :

To serve the needs of the tissues :

1- Transport nutrients & remove waste products.

2- Transport hormones, enzymes, body heat, electrolytes ---etc.

3-Maintain normal homeostasis for optimal survival & function of cells.

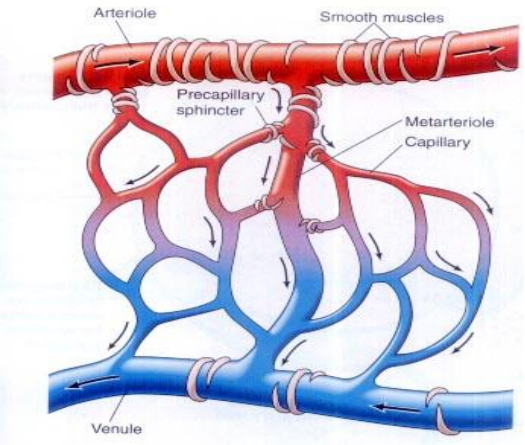
We can divide the circulation to Functional Parts :

1- Arteries: (aorta – large Arteries – medium Arteries)

Have strong muscular walls. Transport blood rapidly under high pressure to the tissues.

2- Arterioles:

Have strong muscular walls they can close the arteriole completely or dilate it, this action is provided by pre-capillary sphincters (circular smooth muscles)



Pre-capillary sphincters control blood flow to the capillaries.

Dilation ➔ ⇧ blood flow

Constriction ➔ ⇩ blood flow to capillaries and so to tissues.

- **If arterioles or capillaries are dilated ➔ ↓ resistance ➔ ↓ BP**
- **During resting if the sphincters open all capillaries ➔ shock (excess loss of blood pressure) occur.**
- **If we restrict the Arterioles ➔ stop blood flow to the capillaries ➔ blood remain behind the Arterioles ➔ ↑ blood volume ➔ ↑ BP**

So, the Arterioles control total peripheral resistance and because that:

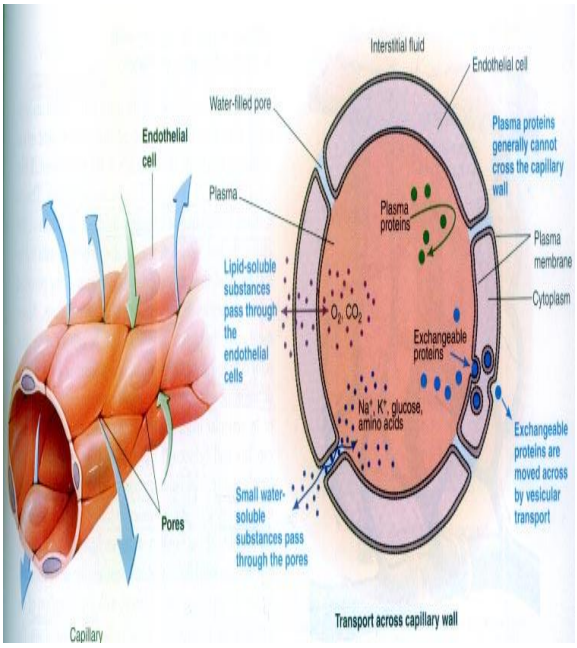
Arterioles & small arteries are called (Resistance vessels).

3- Capillaries:-

Characteristics of capillaries:

- Have very thin wall (unicellular layer of endothelial cells).
- Very small internal diameter.
- Very large surface area for exchange of gases, nutrients, waste products etc. ➔Because their ability to exchange nutrients & gases they are called (exchange blood vessels).

- How gas & nutrients exchange occur in capillaries?



In picture, exchange occur in 3 ways:

1- Between each endothelial cell there are pores which allow small water soluble substances pass through it.(e.g. Na , K , glucose , amino acids) in large amounts.

* Lipid-soluble substances pass through endothelial cell (e.g. O2, CO2, and NO).

*Plasma protein can't cross the capillary wall except exchangeable proteins.

- **Blood flow is intermittent in capillaries, it turn on and off every few seconds or minutes. This is called "vasomotion" (it's an increase or decrease in blood flow according to oxygen demand by tissues)**
- **Blood flow in the capillaries is very slow, this is because of their large surface area (and to allow exchange of substance to take place)** .

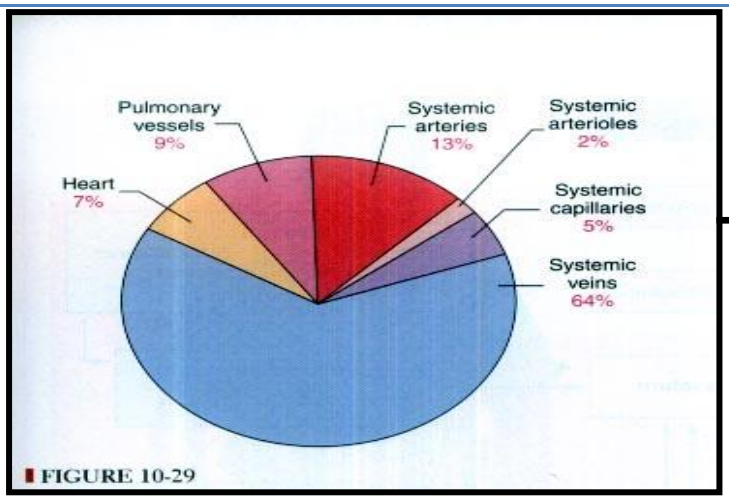
4- Venules & Veins:-

At rest, more than ⅔ rd of total blood volume is found within the venous system. And more than half of it is within venules.

Because of that Venules & Veins are called: Capacitance Vessels (referred to their ability to contain the largest amount of blood)

Remember that :

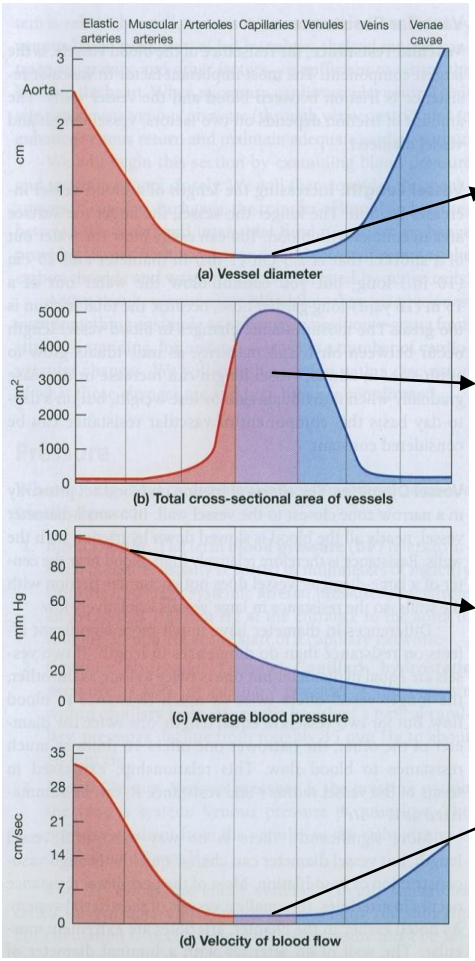
Arterioles & small arteries	Resistance vessels
Capillaries	Exchange blood vessels
Venules & Veins	Capacitance Vessels



Total blood volume in the Capillaries at any time about 5 % of total C.O

In the picture:

Relationships among Vessel Diameter, Cross-Sectional Area, Blood Pressure, and Blood Velocity.

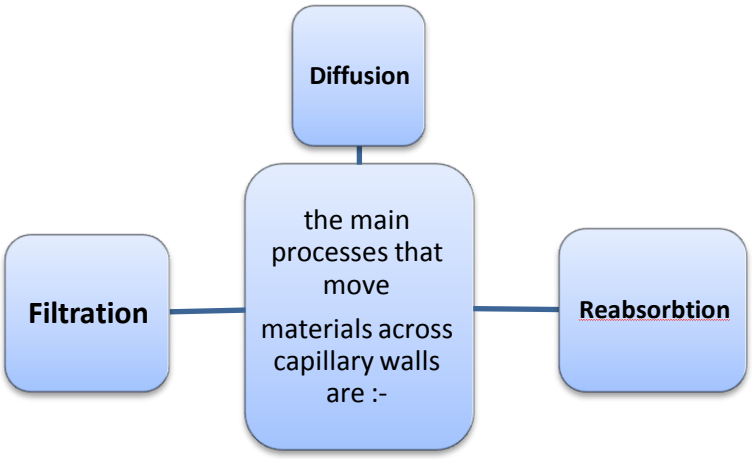


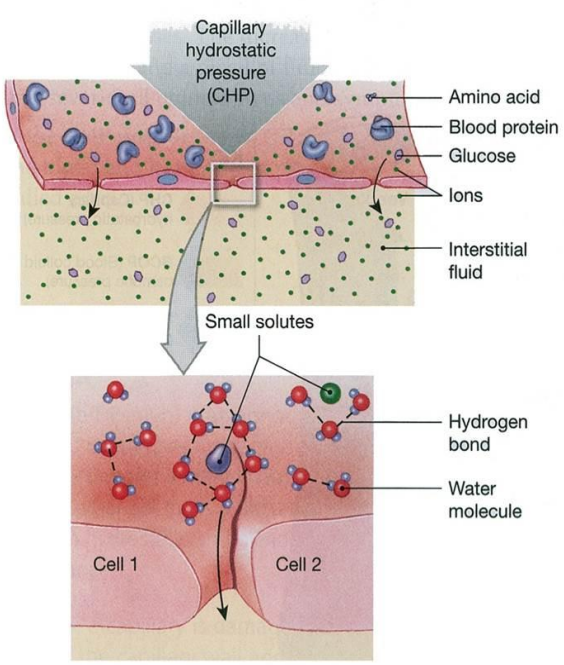
Capillaries have the least diameter, because: the very thin walls (unicellular layer of endothelial cells).

Capillaries have the largest cross sectional area

Pressure is highest in arteries (because of their small internal diameter compaired to

Because of their large surface area and to allow exchange of substance





There are 4 types of pressures:

Capillary hydrostatic pressure (CHP) or (Pc):
a pressure pushes (forces) the nutrients rich fluid, excluding blood, through the gaps (pores) between adjacent endothelial cells in capillaries (arterioles) to extra cellular fluid ECF (in interstetium) to reach cells.

Tissue hydrostatic pressure (Pt) :
the ECF has forces to push fluid rich in wastes to capillaries (venioles).

Capillary plasma oncotic pressure:
this pressure presented by plasma proteins in capillaries, it tend to drag fluids back to capillaries (it present in capillaries and drag fluids to capillaries)

Tissue plasma oncotic pressure:
occur by protiens present in ECF ,pposite to Capillary plasma oncotic pressure

Here is the values of those pressures, and the net of their calculation in arteriolar end and in veniolar end { the doctor said she may give us an equation ! }:

Forces tending to move fluid outward:		
	arteriole	veniole
Capillary hydrostatic pressure	30 mmHg	10 mmHg
Negative interstitial fluid pressure	3 mmHg	3 mmHg
Interstitial fluid colloidal osmotic pressure	8 mmHg	8mmHg
Outward force	41 mmHg	21 mmHg
Forces tending to move fluid inward:		
Plasma colloidal osmotic pressure	28 mmHg	28 mmHg
Net Force:		
41- 28 = 13 mmHg This is an outward force helping filtration at arteriolar end	28 – 21 = 7 mmHg This is an inward force helping absorption at venular end.	

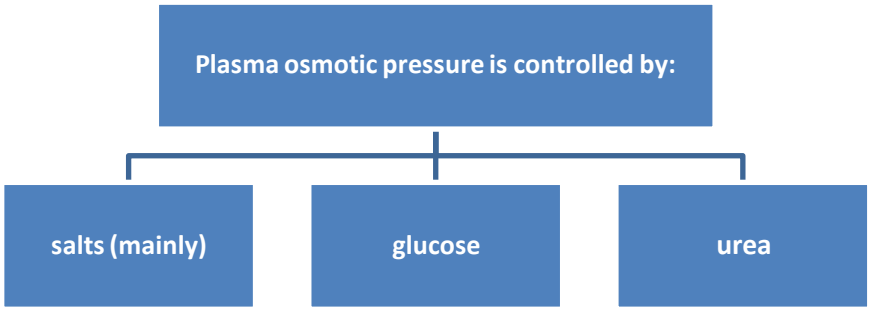
-Net forces in arteriole: move fluid outside of arteriole to ECF, to calculate:
30 - (-3)+ 8= 41 mmHg
then,, 41 – 28 (in capillary it opposite the release of fluid) = 13 mmHg to go to ECF
i.e. in arteriole capillary plasma oncotic pressure is lower than capillary hydrostatic pressure (FILTRATION OCCURS)

-Net forces in venioles: move fluid inside it.. to calculate:
10- (-3)+ 8=21
then,, 21-28 = -7 (negative refers to fluid movement to veneole)
i.e. in veneole capillary plasma oncotic pressure is higher than capillary hydrostatic pressure (ABSORBTION OCCURS)

The extra amount of fluid in the interstitial spaces (after exchange) is carried by the lymphatic Vessels →then to venous circulation. :-

This will help in :-

1- Constant exchange of fluid.
2- Accelerate distribution of substances.
3- Transport insoluble lipids & tissue proteins.
4- Carry bacterial toxins to lymphoid tissues → provide immunity.



Edema: excessive amount of fluid in the interstitial spaces.

Caused by :-

1- ↑ Capillary hydrostatic pressure e.g. Excessive kidney retention of salt and water.
2- ↑ Venous pressure e.g. in heart failure, or damage to venous valves, muscle paralysis or Local venous block.
3- ↓ Plasma proteins e.g. in :-

1-Nephrosis.
2-Burns & wounds
3-Liver disease
4-Malnutrition.

The importance of proteins is they have the power to absorbe fluids back to capillaries site.

4- ↑ Capillary permeability e.g. in allergic reactions & burns. → a lot of fluid in ECF
5- Blockage of lymph return by, e.g. infection or cancer. The lymphatics have ability to drag fluid to lymph nodes and then to veins.