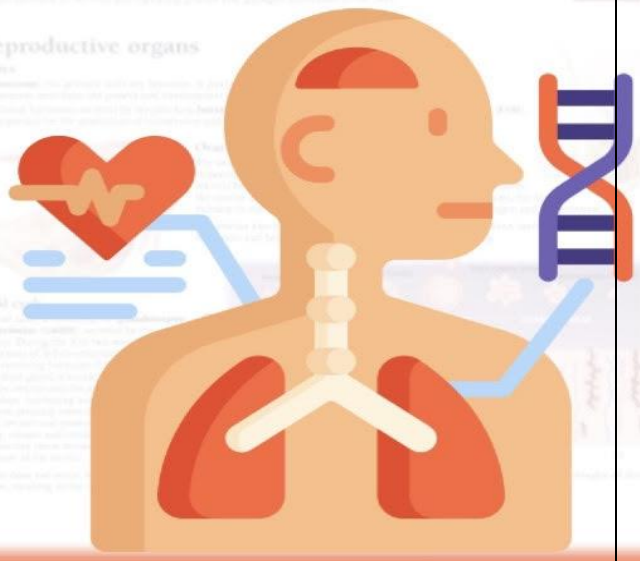
Doctor 022

Physiology

Sheet no.



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Microcirculation [14]

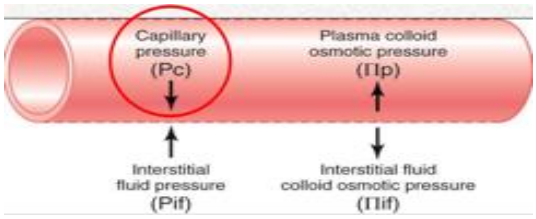
We study about the Microcirculation in the previous lecture and about the forces and pressure that determine flow or movement of fluid from and to the capillaries, as we know it isn't Random, so it must be physical laws that control this movement.

To know or to figure at what kinds of forces or pressures …..?

Of course they are several types.

1-Capillary Hydrostatic pressure

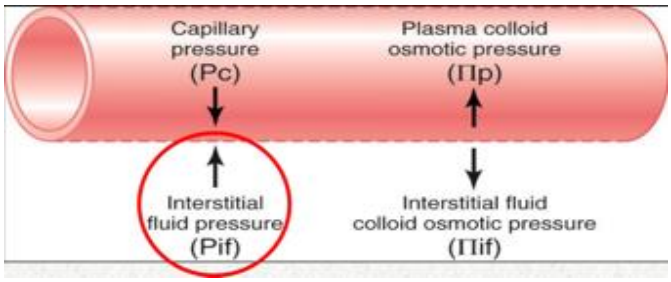
It makes pressure (it is caused by the heart pumping blood) and it's less than 120 mmHg ; when it reaches to tissue becomes declining (The reason is the resistance and long distance that traveled) , this pressure called (C H P), It will apply pressure against the wall of the capillaries. It will tend to draw fluid outside the capillaries that pushes the fluid out and it's direction in the same direction of filtration.



وكأن السائل سيفلتر ويطلع من مصفاة

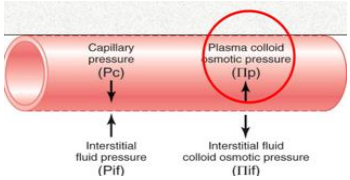
2-Interstitial fluid pressure

Results from volume of the fluid it is already in the interstitial it will also exert the pressure on the wall of the capillary against filtration and push the fluid (go back to the capillary).



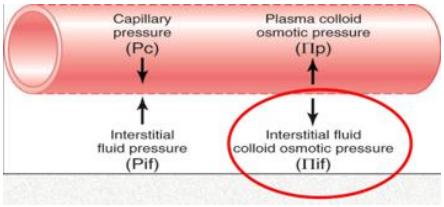
3-Plasma colloid osmotic pressure

It is caused by existence of proteins and particles inside the capillaries. This large particles cannot exit the capillaries because it's size, it will apply pressure towards them to make equilibrium because the plasma proteins.



4-Interstitial fluid colloid osmotic pressure

There is a little C O P in the liquid due to the presence of a few proteins, so you will do the same thing and will try to withdraw the liquid to it from the capillaries with filtration direction.



Now, with a different values and directions , the pressure is necessary to calculate the net and it's direction .

Net movement of filtration (F)

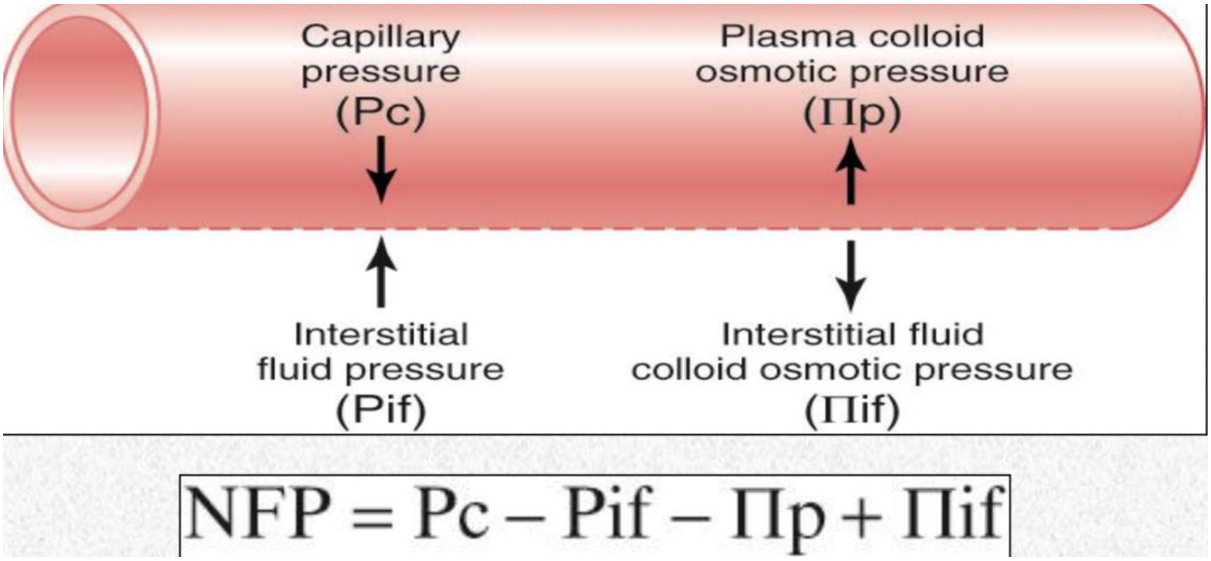
Every pressure prefers (F) >> (+) sign / Every pressure pushes the fluid in opposite of (F) >> (-) sign.

NFP = (BHP + IFOP) – (BCOP + IFHP)

= + "Net filtration " Fluid out from (capillaries)

= - " Net reabsorption " Fluid entry into (capillaries)

LOOK TO THE PECTURE BELOW



Starling Forces : The 4 driving forces of the filtration that we mention earlier

We will talk about Factors and control of these forces

What are the determine of the capillaries pressure? Two things: -

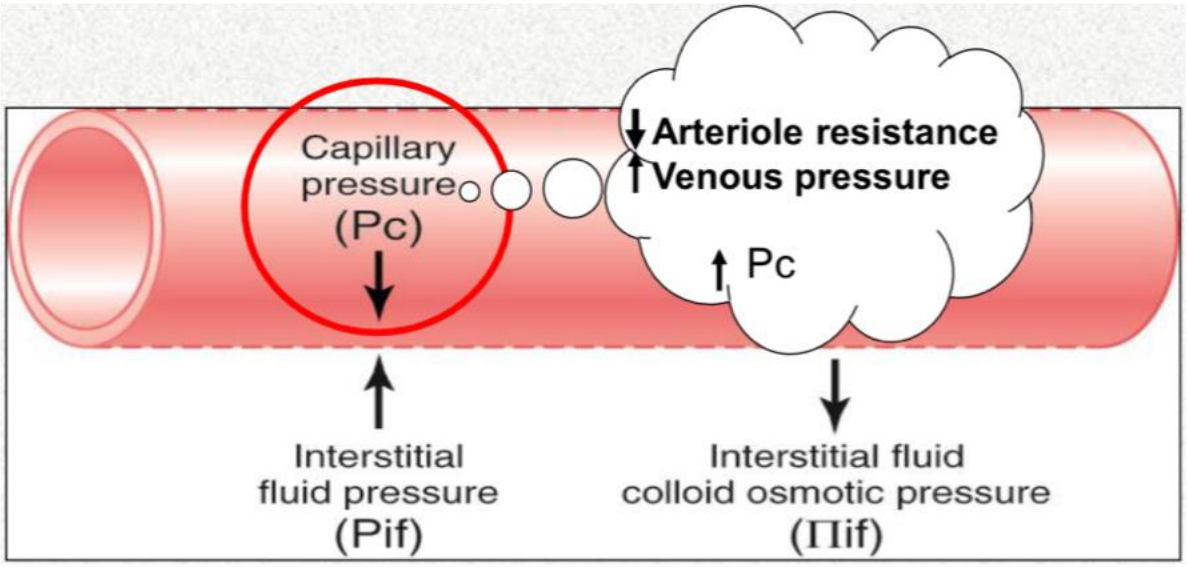
1- Arteriole resistance

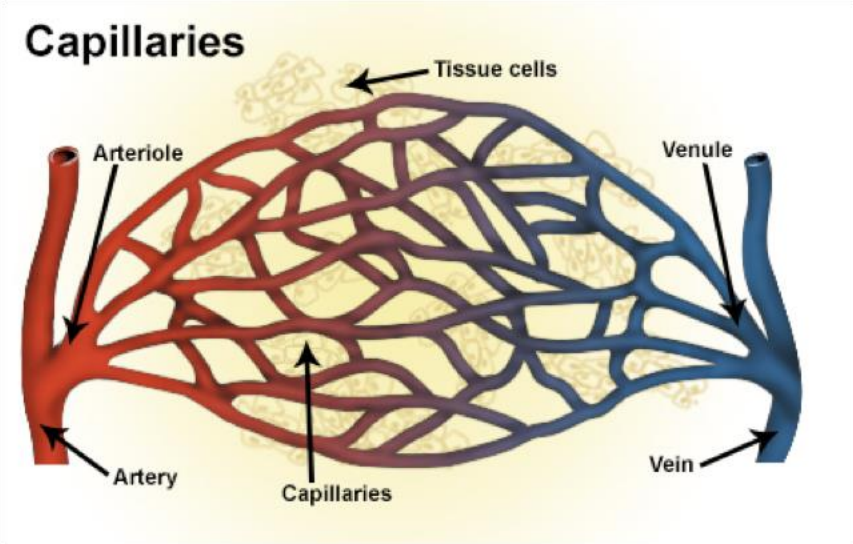
Arteriole: very small blood vessel that branches off from your artery and carries blood away from your heart to your tissues and organs.

Arterioles are small arteries that link up to capillaries, which are smaller yet. With their very thin walls, your capillaries act like an exchange station where oxygen and nutrients trade places with waste from your tissues. Your smallest veins (venules), which take blood back to your heart, also link to your capillaries to make these exchanges.

the smallest arteries, vessels called arterioles, ... metarteriole is not continuous but forms rings of smooth muscle (sphincters)
If the sphincters are closed it makes constriction of arteriole>> high resistance >> low blood flow in the capillary (BF) >> Low capillary pressure (PC)

dilated the rings in the Arterioles (low R) >> High (BF) into the capillaries >>high (PC)





2- Venous Pressure

High VP>> High venous pressure (continuous tube)
#factors that affect the (PIF)

a) Filtration (positive relationship) [high F >>high P]

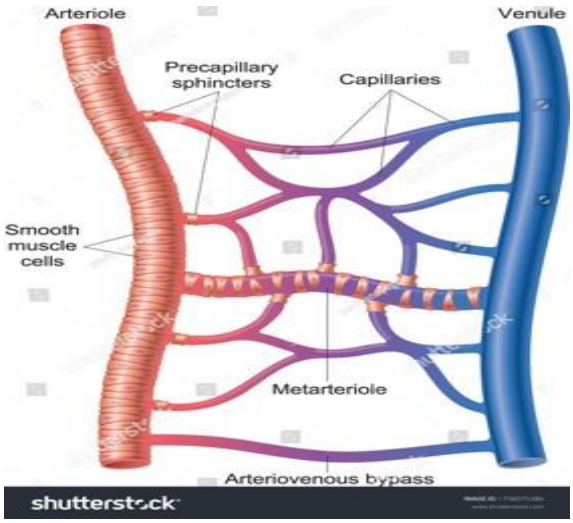
b) PIF

NF = (BHP + IFOP) – BCOP – IFHP

P [- sign] >> - - (+) >> with filtration
P[+ sign] >> - + (-) >> opposite filtration

We will continue to talk about **Veinous pressure :**

When we talk about it we talk about (**blood vessels**) come after capillary , we know that the veins connected with capillary as one tube too, notice this image…



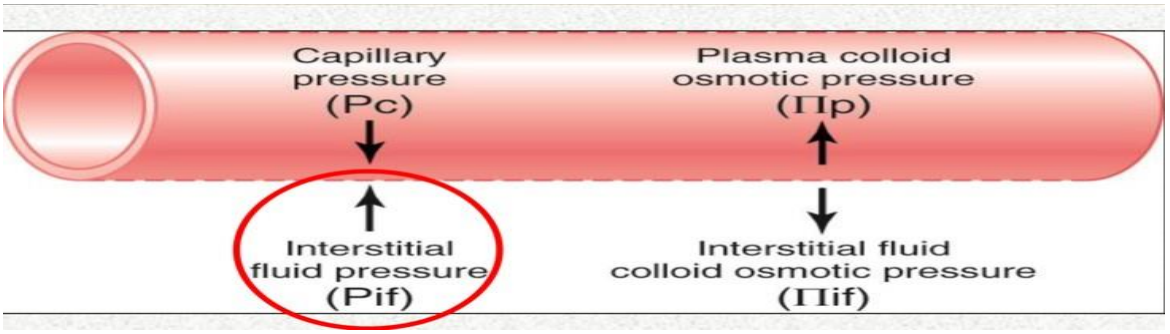
If we have high veinous pressure , it will affect thepressure in the capillary subsequently ,high pressure arises in it.

Information mentioned by the doctor may not beimportant, but it is okay to know it …

When is the veinous pressure high ?!

When a person take units of blood Or when he/she have problem in veins return (back flow of blood to Heart) Because he/she doesn't move and the blood accumulation in foots for example ,so it doesn't help the blood go up ,this is lead to make the capillary pressure high because it connected to each other.

3.Interstitial fluid pressure (Pif)



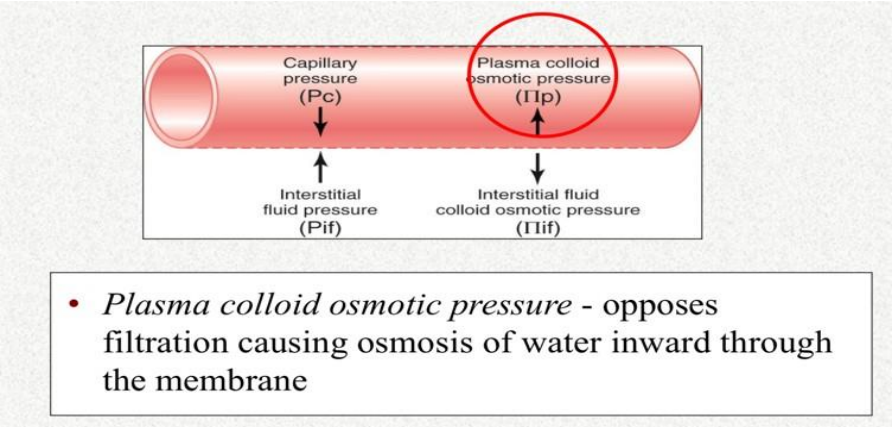
It depend on the filtration , positive relationship , it value in different places of the body may be (+ve)or (-ve), but in most places in the body it (-ve).

Remember this equation :

$$NF = CHP + IOCOP - IFHP - PCOP$$

Notice that IFHP -ve (that means it against filtration) , and in an experience told me that this pressure (IFHP)in a certain tissue is -4 …when we substituting the value in the above **eq** , this pressure becomes +ve (remember -ve with -ve =+ve) meaning it added to the net filtration Unlike if it was +4 and we substituted it would be -ve (+ve with -ve = -ve) which means the opposite of filtering.

4.Plasma colloid osmotic pressure (IIP)



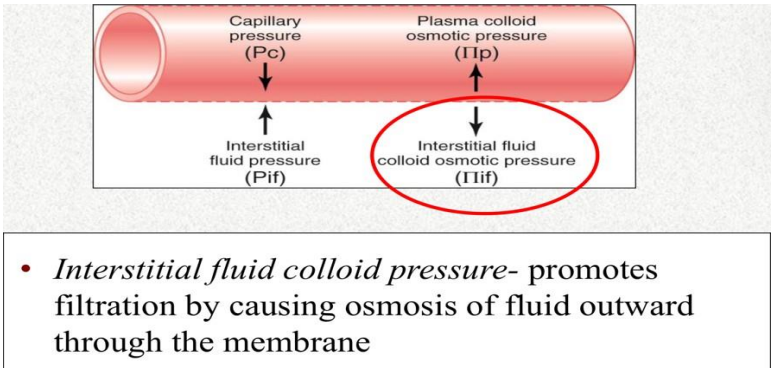
It related to the presence of protein which is synthesized in the liver ,such as (albumin , globulins).

If we have problems in synthesized protein in liver or loses protein or the concentration of protein decreased the plasma colloid osmotic pressure will drops, But it isn't supposed to change naturally or physiologically unless certain diseases change it .. because the **IIP** against the filtration, When **IIP** increased it stimulates **reabsorption** this is another process allow the fluid to return from other side when it exist from capillary from one side , this show the important of reabsorption as the important of filtration ..because it must happen a recirculation for fluid after exchanged happened

Assuming that **IIP** decreased ,What will happening?

The filtration increases and the reabsorption decreases ,this will lead to edema (this mean thatthe fluids will collect in the interstitial fluid and cause swelling).

5.Interstitial fluid colloid osmotic pressure (Iiif).



- *Interstitial fluid colloid pressure-* promotes filtration by causing osmosis of fluid outward through the membrane

It's value is really small

** Pay attention to the value given by the question, we don't change it's sign.

** As a matter of inclusiveness, this is a summary of what we talked about above, which the doctor quickly commented on, inside each picture an explanation about it.

Starling Forces (Part I)

- Normal *Capillary hydrostatic pressure* is approximately 17 mmHg
- *Interstitial fluid pressure* in most tissues is negative 3. Encapsulated organs have positive interstitial pressures (+5 to +10 mmHg)
- Negative interstitial fluid pressure is *caused by pumping of lymphatic system* against filtration
- *Colloid osmotic pressure* is caused by presence of large proteins

Plasma Proteins and Colloid Osmotic Pressure

- 75% of the total colloid osmotic pressure of plasma results from the presence of *albumin* and 25% is due to *globulins*

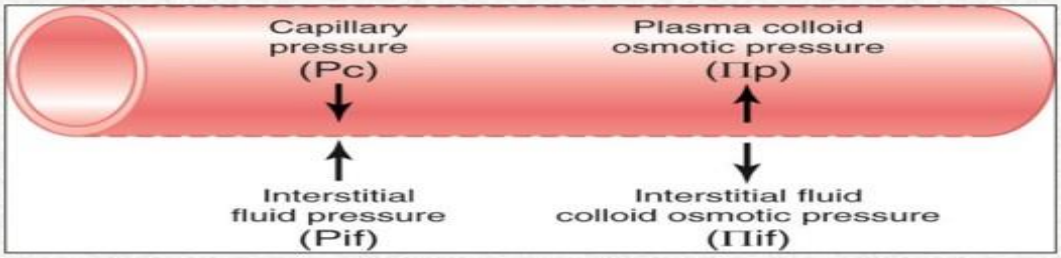
	gm/dl	πp(mmHg)
Albumin	4.5	21.8
Globulins	2.5	6.0
Fibrinogen	0.3	0.2
Total	7.3	28.0

** values aren't for verbal, but are given in the question

Interstitial Colloid Osmotic Pressure

- *Interstitial protein conc.* is approx. 3gm/dl
- The interstitial colloid osmotic pressure is normally 8mmHg

Determinants of Net Fluid Movement Across Capillaries



$$NFP = Pc - Pif - \Pi p + \Pi if$$

- *Filtration rate* = net filtration pressure *(NFP)* multiplied by the filtration coefficient
- *Filtration coefficient (Kf)* is a product of surface area times the hydraulic conductivity of membrane

Filtration rate : the amount of liquid that filters through thecapillaries per unit time. ml/minute.

- There is a direct relationship between filtration rate &NFP.

Solute and fluid exchange across capillaries:

We shall differentiate between the two ends of the blood capillary because of the difference of the hydrostatic pressure . (the initiation is the arterial end and thetermination is the venous end)

Note : the hydrostatic pressure value decreases while moving fromthe arterial end to the venous end because of the branches.

Now we'll calculate the NFP of the two end and compare the results :

1) The arterial end:
    a) Forces tend to move the fluid outward:

    Capillary pressure=30

    Negative interstitial free fluid pressure=3 Interstitial

    fluid colloid osmotic pressure= 8

    Total outward force = 41 (the summation of theforces above)

    B) Forces tend to move the fluid inward:

    Plasma colloid osmotic pressure=28

    Total inward force =28

    Summation of forces = 41(outward so its +) + (-28 (inward so its -)) = +13 (the positive sign means that the fluid will move outward).

2) The Venous end :

a) Forces tend to move the fluid outward:

Capillary pressure=10

Negative interstitial free fluid pressure=3 Interstitial

fluid colloid osmotic pressure=8

Total outward force=21

b)Forces tend to move the fluid inward:

Plasma colloid osmotic pressure= 28

Summation of forces above=21+(-28)=-7 (notice the negative sign which means that there is

reabsorption on the venous end and no filtration)

- The difference can't prove that this is true unless we calculate the mean of the hydrostatic pressure to the whole capillary tree.

Mean forces tending to move outward:

Mean capillary pressure=17.3 (found by experiment)Negative interstitial free fluid pressure=3

Interstitial fluid colloid osmotic pressure=8

Total outward force=28.3

Mean force tending to move inward:

Plasma colloid osmotic pressure=28 = total inward force

Summation of mean forces =28.3 +(-28) =

0.3 (note that the out is higher than the inward meansthat there is excess outward rather than inward)

- Net filtration pressure of 0.3 mmHg which causes a net filtration rate of 2ml\min for the entire body . (which don't happen in real , why ? Because of the lymphatic system .

90% of the filtrated fluid is reabsorbed on the venous end while the remaining 10%of the filtrated fluid is returned to the circulation via lymphatics .

Lymphatic system:

- An accessory rout by which fluid and protein can move from interstitial spacesto the blood
- Important in preventing edema
- Lymph is derived from interstitial fluidthat flows into the lymphatics
- Major rout for absorption of nutrientsfrom GI tract
- Plays important role in the immunesystem
- Works along with cardiovascular systemand helps in digestion and absorption
- It works with the microcircular system toreturn back the unreturned fluid or unabsorbed fluid
- In some tissues it maintains the negativesign of the pressure in the interstitium and develop filtration process.

The lymphatic pump :

Existed in the lymphatic vessels which work as a pump having valves , squeezes the fluid from the bottom to the top of the vessels , there also muscles surround the lymphatic vessels help in the flow of the fluid or the lymph upwards which cause the lymph to pour into the blood circulation.

The of activity of the lymphatic pump :

- The increased interstitial fluid hydrostatic pressure causes the lymph flow to increase.
- When the fluid quantity in the interstitium increases the pumping or lymph flow increases and becomes more effici