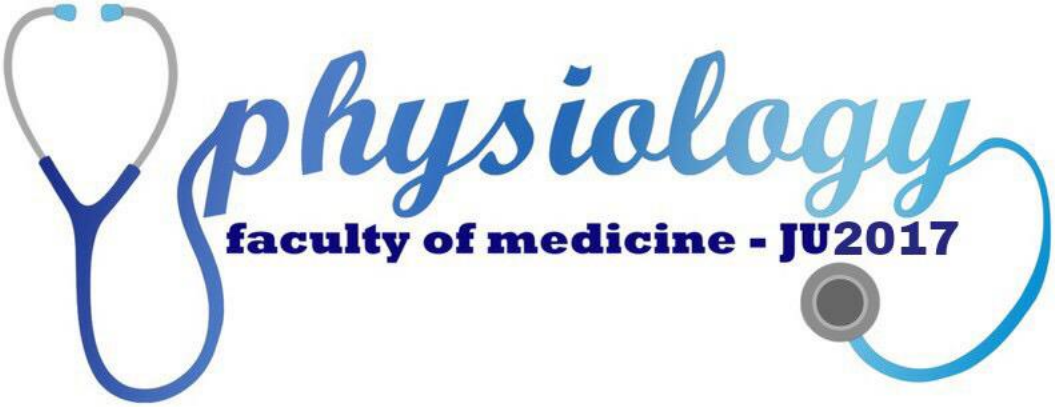

◉ Sheet ○ Slides

Number

28

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Edema…

Edema is accumulation of fluids in the interstitium. There are many types of edema like **pulmonary edema** in the lungs and **cardiac edema** in the heart.

There are two general causes of edema:

1) Excessive capillary filtration is occurring more than reabsorption.
2) Failure of lymphatic vessels to drain the fluid from the interstitium back into the blood.

Sometimes extra filtration is not harmful because of safety factors, like hyperactivity of lymphatics drains the extra fluid, but if it's too high exceeding the capacity of the lymphatic vessel then edema occurs.

Edema can be:

1) **Pitting** ***" most occurring"***

2) **Non pitting** ***"happens with Lymphatic blockage"***

Conditions that can cause edema…

1) **Dilation of arterioles** >> decreased arterioles resistance >> more blood flows >> higher capillary hydrostatic pressure >> more filtration
2) **Venous constriction** >> High venous pressure >> higher capillary hydrostatic pressure >> more filtration

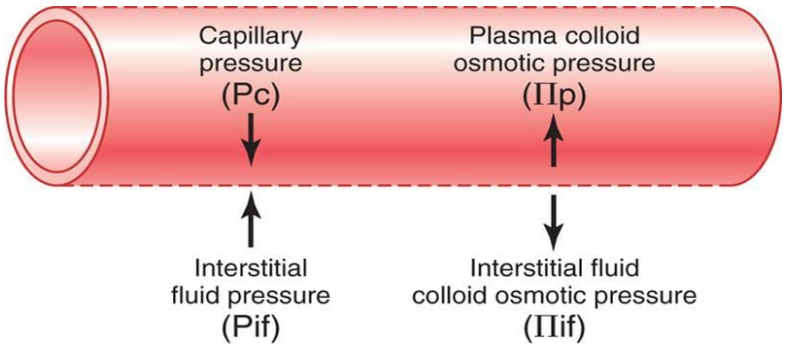
Note: Changes in the venous pressure reflects 5x more than the changes in arterial pressure.

Capillary pressure= 1/6 Arterial pressure + 5/6 Venous pressure

Note: Filtration **increases** as the hydrostatic pressure in the capillary increases.

Starling Forces…

We have **four** primarily forces that determine whether fluid will move out of the blood into the interstitial fluid ***"filtration"*** or in the opposite direction ***"reabsorption"***.



Starling Forces:

1) **Capillary hydrostatic pressure (Pc) :** Tends to force fluid outward from the blood "always positive"

2) **Interstitial fluid hydrostatic pressure (Pi):** tends to force fluids inward into the capillary if positive ***"reabsorption"*** and outward if negative ***"filtration".***

3) **Capillary colloid osmotic pressure (πc):** causes osmosis of fluids inward into the capillary.

4) **Interstitial fluid colloid osmotic pressure (πi):** causes osmosis of fluids outward.

The sum of these forces gives the net pressure, if **positive** there will be net **filtration**, if **negative** there will be net **reabsorption**.

$$\text{Net Force} = Pc - Pi - \pi c + \pi i$$

Note: The doctor will give us the needed numbers to calculate the net force along with their signs "negative/positive"

Colloid osmotic pressure…

Molecules or ions that fail to pass through a membrane exert osmotic pressure. Because proteins fail to pass through the capillary, it is proteins of the plasma and interstitial fluid that are responsible for the osmotic pressure exerted on the capillary's membrane ***"Colloid osmotic pressure"***.

Note: Total protein concentration in the blood = 6-8 g/dcL

Blood has two main types of proteins:

1) Albumin 3.5 – 5.5 g/dcL
2) Globulin 2 -4 g/dcL

The total colloid osmotic pressure of a normal human being is **28 mmHg**; 22 mmHg of this pressure is caused by **Albumin** while the 6 mmHg is caused by **globulin**.

The average molecular weight of albumin and globulin is 70,000 , 140,000 respectively. Therefore, 1g of albumin contains **more molecules** than 1g of globulin.

>> **Albumin** is more important in causing colloid osmotic pressure because it has **higher number of molecules** and its **concentration is twice** the concentration of Globulin.

Relationship between the concentration of albumin and the osmotic pressure is **linear**. However, at a certain point albumin causes **higher** osmotic pressure than expected

Hypoalbuminemia…

Protein's main source is by **ingesting** it, then it is **reabsorbed** as amino acids in the intestine and then the liver **resynthesizes** the proteins again.

Hypoalbuminemia occurs when the level of albumin in the blood is abnormally low **< 3.5 dcL**

> **Note:** Albumin **doesn't get filtered** in the kidney; it is not present in the urine.

Hypoalbuminemia is due to:

1) **Malnutrition**: there is no protein intake
2) **Malabsorption** in the intestine
3) **Problems in the liver** which synthesizes the albumin
4) **Kidney failure**; loss of albumin with urine

> **Note:** Hypoalbuminemia leads to edema.

If someone shows the signs of edema "puffiness of the face" following tests should be made:

1) Urines test to check if there is any proteins which means there is a kidney failure
2) The concentration of albumin in the blood
3) Liver test

> **Note:** Edema can be treated by injecting the patient with **albumin** in the vein, which reabsorbs the extra fluids

Types of edema…

1) **Localized**: edema in a **specific** area occurs in pregnant women ***"uterus compresses veins causing high filtration"***, and lymphatic vessels blockage.
2) **Generalized**: edema happens **all over the body**, as a result of Hypoalbuminemia or a right heart failure.

Lungs…

In the lungs, whilst oxygen is smaller than CO_2, difference in solubility means that **CO_2 diffuses roughly 20x faster than O_2**.

So, if we have **hypoxia** it doesn't actually mean that O_2 is not diffusing, it might be **deficiency** in hemoglobin which helps O_2 in diffusion.

In the lungs:

P_c= 10 mmHg **π_c= 28**

P_i= -5 mmHg **π_i= 14**

Net Force = 10 + 5 -28 +14 = +1 ***"favoring filtration"***

Note: Pulmonary edema safety factor is the **high** presence of lymphatic vessels which prevents edema.

Kidney…

Rate of filtration in the kidney is **180L/day** which leads to unequal distribution of proteins. ***"High in the plasma and almost none in the interstitium".***

In the kidneys:

Pc =55 mmHg **πc=** 30 mmHg **"highly concentrated due to high filtration rate"**

Pi= 15 mmHg **πi=** almost 0

Net Force = 55 – 15 – 30 = +10 ***"filtration"***

Best Wishes ☺