



lecture 21

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# Revision :

There are 2 forces that facilitate (favors) filtration and another 2 favors reabsorption:

➤ **Filtration :**

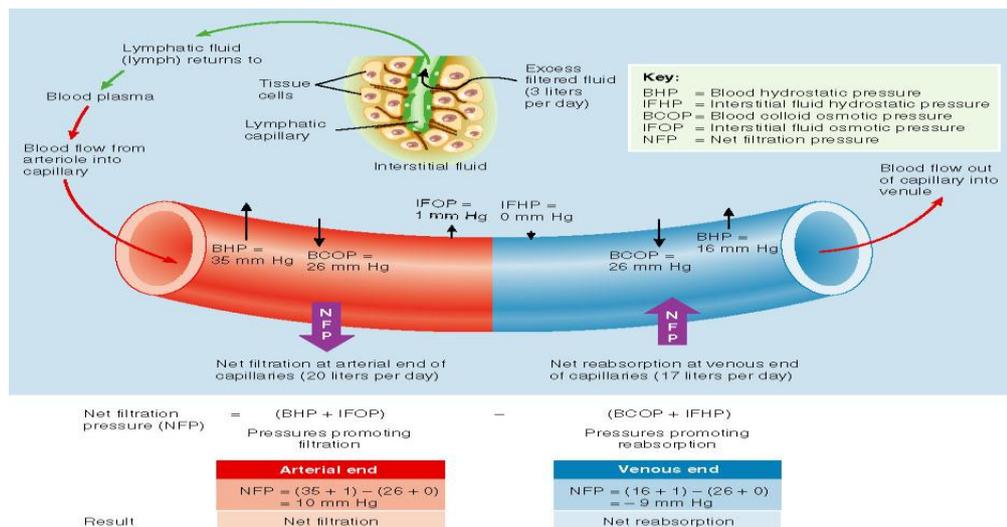
1. Capillary hydrostatic pressure (pc)
2. Interstitial fluid colloid pressure ( $\pi_{if}$ )

➤ **Reabsorption:**

1. Interstitial fluid pressure ( $P_{if}$ )
2. Plasma colloid osmotic pressure ( $\pi_c$ )

$$(NFP) = ((pc) + (\pi_{if})) - ((\pi_c) + (P_{if}))$$

$$\text{Starling's equation} = ((pc) - (P_{if})) - ((\pi_c) - (\pi_{if}))$$



21.07

Instead of taking arterial hydrostatic pressure and venous hydrostatic pressure we take one hydrostatic pressure → Mean capillary hydrostatic pressure "NOTE: the Mean DIDN'T mean ( HP in arterial end + HP in venous end ) / 2 "

When we go from the arterial side to venous side there is a "change in pressure" so the mean capillary HP is :

Change in pressure over distance (Guyton was the first person that measure the value of mean capillary HP )

Note:  $P_{if}$  may be negative "it will cause " **filtration**

## Notes:

The plasma colloid osmotic pressure is caused 75% by albumin because of the low MW and 25% caused by globulins there is some fibrinogen but it don't affect it .

There is some colloid osmotic pressure in the interstitium (small value) due to some protein in the interstitial that cause filtration

### ➤ **Filtration rate :**

It means how much fluid is filtrated per day /or per gram of tissue

Constant filtration coefficient  $K_f$

$$FR = K_f ( (p_c - p_{if}) - (\pi_c - \pi_{if}) )$$

**$K_f$  depends on:**

1. Permeability of the capillary
  - Brain (very low )
  - Kidney (in the middle )
  - Liver (very high )"sinus vessels "
2. Surface area

Ex :

*1-Forces tending to move fluid outward:*

Capillary pressure                      30

Negative interstitial free fluid pressure      3

Interstitial fluid colloid osmotic pressure      8

TOTAL OUTWARD FORCE                      41

- *Forces tending to move fluid inward:*

Plasma colloid osmotic pressure      28

TOTAL INWARD FORCE      28

- *Summation of forces:*

Outward      41

Inward      28

NET OUTWARD FORCE      13

- *2-Forces tending to move fluid inward:*

Plasma colloid osmotic pressure      28

TOTAL INWARD FORCE      28

- *Forces tending to move fluid outward:*

Capillary pressure      10

*Negative* interstitial free fluid pressure      3

Interstitial fluid colloid osmotic pressure      8

TOTAL OUTWARD FORCE      21

- *Summation of forces:*

Outward 21

Inward      28

NET INWARD FORCE      7

- *3-Mean forces tending to move fluid outward:*

Mean Capillary pressure      17.3

*Negative* interstitial free fluid pressure      3.0

Interstitial fluid colloid osmotic pressure      8.0

TOTAL OUTWARD FORCE      28.3

- *Mean force tending to move fluid inward:*

Plasma colloid osmotic pressure      28.0

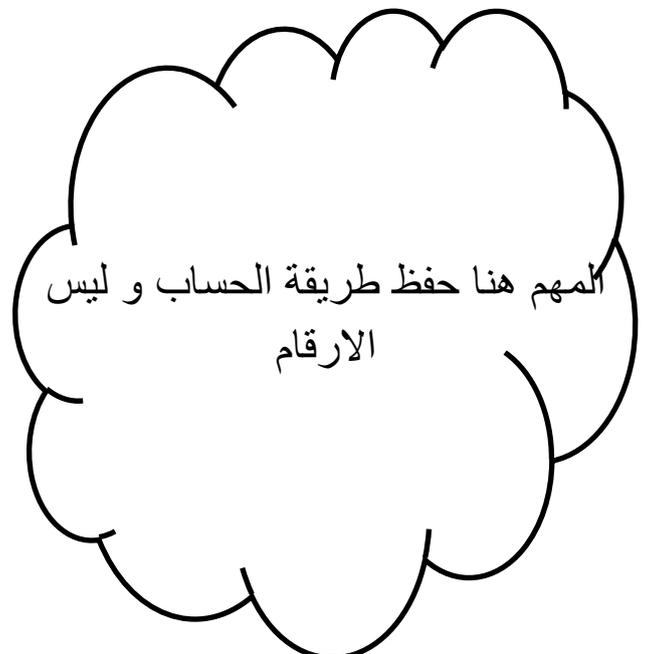
TOTAL INWARD FORCE      28.0

- *Summation of mean forces:*

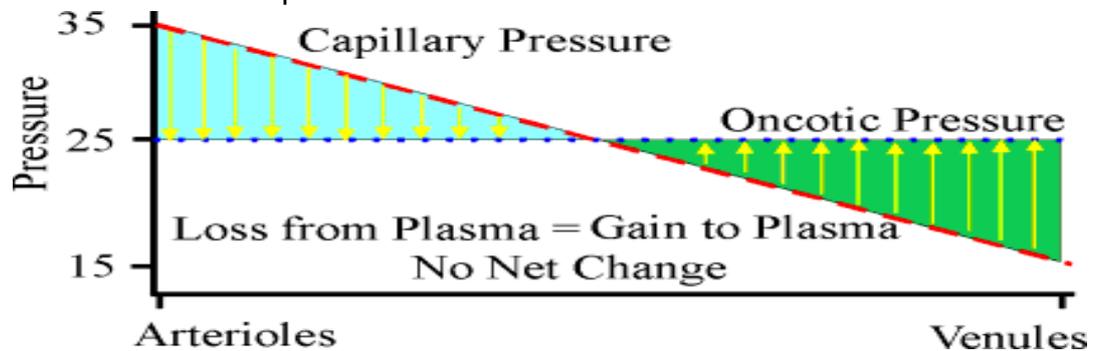
Outward 28.3

Inward      28

NET OUTWARD FORCE      0.3

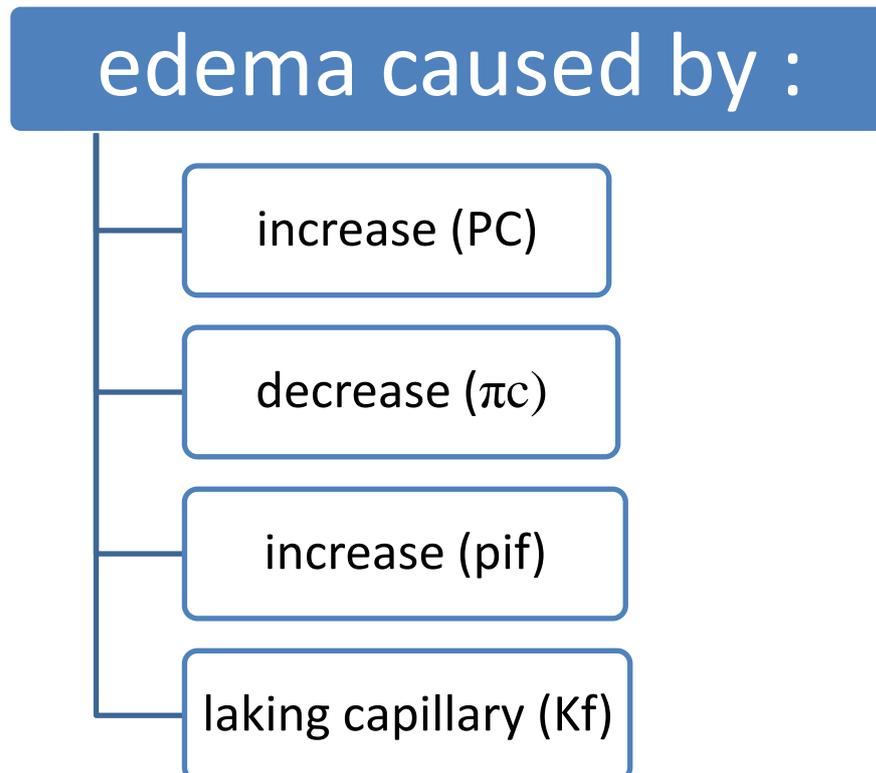


- The loss from plasma in arterioles = gain to the plasma in venous
- Filtration = reabsorption



In this Example there is no edema because the filtration rate is equal to the capacity of the lymphatic .... Any increases in filtration will cause edema

**EDEMA** (extra filtration):



increase (PC)

- **by increase blood pressure**

- this causes increase in filtration
- people with high blood pressure suffer from feet edema when they walk for a small distance

- **by venus block**

- to overcome the block the venus pressure must increase to reach the heart so that the Pc will increase . (زي الدوالي عند الحوامل و غير الحوامل)

- **heart failure**

- unable to pump blood so the blood will accumulate and increases the pc

decrease  
( $\pi_c$ )

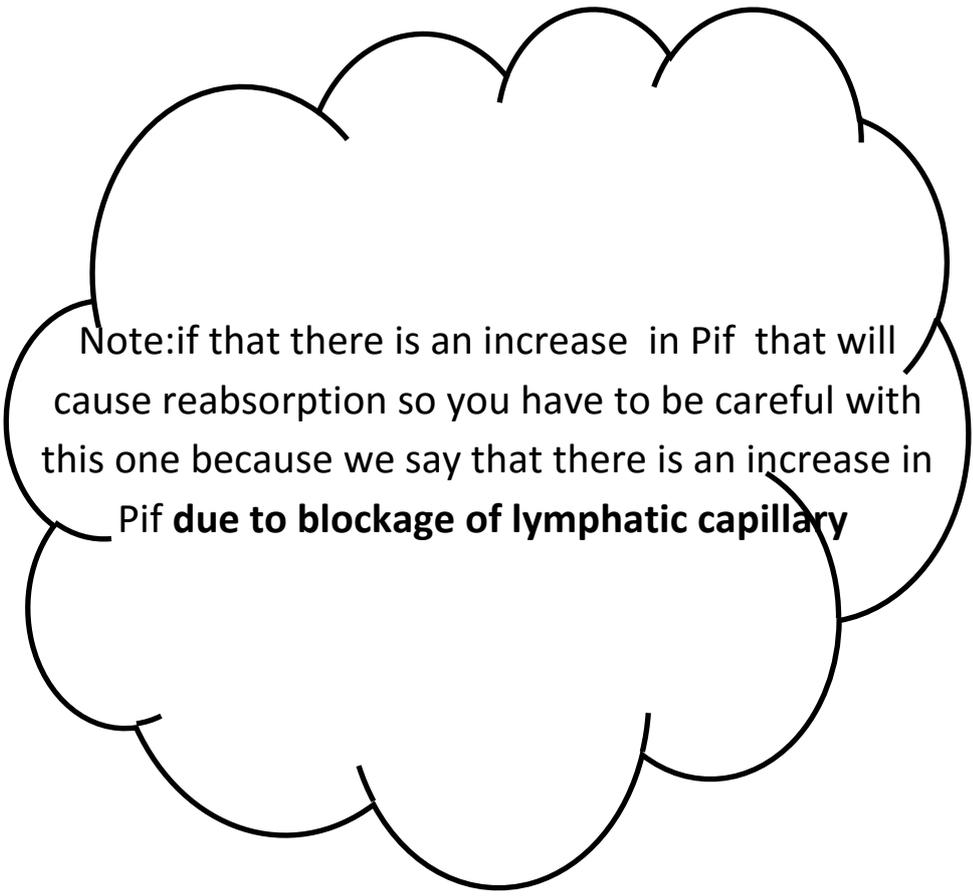
- less reabsorption .. more filtration
- the amount of albumin in plasma is balanced between production and excretion.... any "decrease in production or increase in excretion" will cause decrease of albumin .
- production of albumin from liver decrease (liver disease) (liver cirrhosis or failure)
- excretion of albumin by kidney increase (kidney disease) (nephrotic syndrome)
- malnutrition "abdomen edema" مثال عليهم الاخوان الصوماليين لانهم ما ياكلو غذاء فيه بروتين
- burn injuries (lost of plasma proteins)

increase (pif)

- by lymph capillary blockage .. the fluid will stay in the interstitial .. decrease reabsorption and increase Pif
- ex : breast cancer surgeries (in these surgeries they remove the lymph nodes from breast region to be sure that there is no cancer cells left)
- elephantiasis (a disease caused by lymphatic blockage)

leaking  
capillary Kf

- high permeability of the capillary wall will increase Kf and will increase filtration
- ex: allergy "increase histamine release" which cause increase in the permeability of capillary wall



Note:if that there is an increase in  $P_{if}$  that will cause reabsorption so you have to be careful with this one because we say that there is an increase in  $P_{if}$  **due to blockage of lymphatic capillary**

**End of the slide 😊**

# Sensory Receptors; Neuronal Circuits For Processing Information

Note: in this lecture we will continue talking about what dr. mohammad starts it is (sensory organs)

These organs sense different kind of sensation like : ( pressure, light, heat , touch , smell ,taste, etc....) and we call it a **modality sensation**

We call these receptors "transducer"..... why??

First of all we will talk about the mechanism of sensation starting from the sensation and ending with the reaction or the feel

Lets say that you woke up one day and you wore a summer clothes" you can feel the clothes touching your skin " this kind of sensation we can feel it from a receptor in our skin we can classify them as a **mechanoreceptors** this kind of receptor is responsible for detection of "deformation , touch , and pressure" ,-we give this kind another classification according to the location as an **extroceptor**- you had your breakfast and went outside and suddenly all your body shaken and you realized that you have to wear a jacket "you felt the cold from the **thermoreceptors** " – **extroceptor** too -, and this kind of receptors can detect the temperature change , you take the jacket and you went to the university .. on your way you saw an accident and you Felt sorry about them and continued your way " when you saw the accident you used another type of receptor we call it **electromagnetic receptors** (it is consist of cons and rods ..We will talk about them later) ,you arrived the university and you cross the grill 101 and you smell something "here you used the **chemoreceptors** and its responsible for the taste and smell (co<sub>2</sub>,o<sub>2</sub> ,etc....) , while you are walking you hit your hand and cut it and it starts to bleed and you felt the pain " here you used the last type of receptors it is the nociceptors ;it is responsible for detecting the damaged tissue " .

Believe me when you finish this short story you has the ability to classify the receptors according to the stimulus they can transduce

Now the question here how can we feel it or why we feel it???

We can feel it because it reaches **the conscience Perception**, how?? by reaching the cerebral cortex through a specific pathway for each stimulus that means( every part of our body has its own area in the cerebral cortex) "we will talk about in the next lecture "

Ex : some people how had an amputated part they can feel the pain in this part " we call it clinically (phantom pain ) " because the fibers of the nerve "the specific pathway " are not amputated and it is stimulated in somehow so it reaches the cortex as stimulus from a receptor .that's why they feel these amputated parts .

**Back to our main question (we call these receptors "transducers" why?)**

Because it converts the different kind of energy in to an electrical energy .

We can use another classification of these transducers **according to the location** "which is not specific as the stimulus classification ":

- Exteroceptors – sensitive to stimuli arising from outside the body

"Located at or near body surfaces"

Include receptors for touch, pressure, pain, and temperature

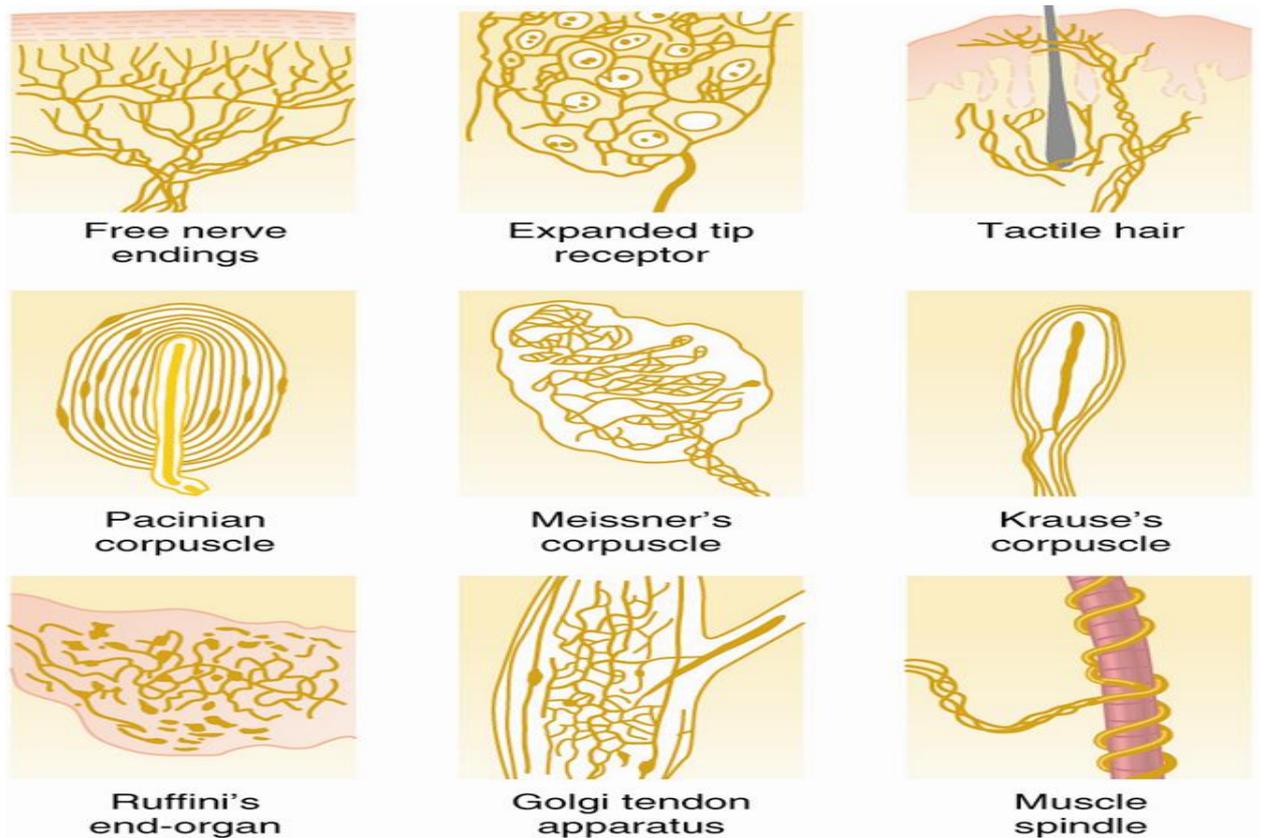
- Interoceptors – (visceroceptors) receive stimuli from internal viscera

Monitor a variety of stimuli (distension of viscera, pain) (kidney ,liver ,gaster, etc...)

- Proprioceptors – sense of position- monitor degree of stretch "Located in musculoskeletal organs (muscle, tendons and skin around joints)"

At the end :

We will talk about the type of receptors (it is not important and you don't have to memories them) 😊 😊

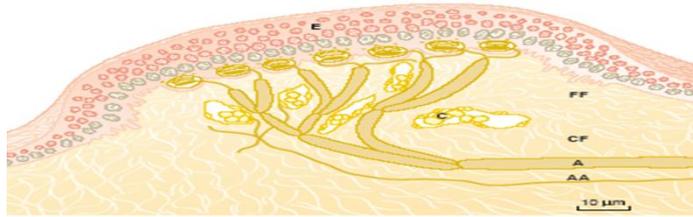


❖ Good to know :

Pacinian "like onion " = pressure sensation

Free nerve ending , Meissner's, = sensation or touch

- Iggo dome receptors :  
A group of receptors connected to a single large myelinated nerve under the epidermis



**Figure 47-1**  
Iggo dome receptor. Note the multiple numbers of Merkel's discs connecting to a single large myelinated fiber and abutting lightly the undersurface of the epithelium. (From Iggo A, MUIR AS: The structure and function of a slowly adapting touch corpuscle in hairy skin. J Physiol 200; 763, 1966.)

We classify the nerve in to myelinated and unmyelinated

- Myelinated: A( $\alpha, \beta, \gamma$ ) B "fast"
- Unmyelinated: only c "slow"

(The details in the next lecture)

Sorry...if we made any mistake 😊