PHYSIOLOGY

- Sheet No. 2
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الشيت طويييييييل صحيح ، بس سهل مترابطة معلوماته وبمشي بسرعة

بالتوفيق 💚

Excretion → whatever left of filtered fluid after filtration, absorption and secretion processes

Secretion → an active selective process that removes some of the waste products from the Peritubular capillaries that will be eliminated from filtered fluid

how our kidney handles different substances ?

- We have three processes , <filtration , reabsorption and secretion > and the result of these processes is (excretion) ,,,, you have to differentiate between secretion and excretion .

If we look at Na^+ as an important electrolytes in the extra-cellular fluid compartment → only 150 mm will be excreted

Renal Handling of Water and Solutes

	Filtration	reabsorption	excretion
L/day Water	180	179	1
+Na mmol/day	25,560	25,410	150
Glucose gm/day	180	180	0
Creatinine gm/day	1.8	0 Poorly absorbed	1.8

Majority

- Note how our kidneys handle **the water** , we've filtration 180 , absorption 179 ,, so the net excretion is one liter per day ,
  the doctor reads the rest of the table reading .
- Note that the kidney handle the **glucose** in different way , the same amount of filtering is reabsorbed , **leaving NOTHING to be excreted in the urine** . so we don't expect to have any glucose in urine , < except you have disease such as diabetes >
- **Creatinine** is example on waste product in our body , 1.8 gram per day will be filtered , this amount comes from the muscles as a result of the muscular activity as a by product , and there **will be nothing to be reabsorbed** , and all amount will be excreted .and actually the excretion is more than the filtered because of the secretion , the numbers isn't so accurate .

Waste product

- We conclude that the kidney deal in different ways with the substances it doesn't deal with all in the same way .**and this is the function of the kidney , to get away the waste product and keep the needed things < nutrients >**

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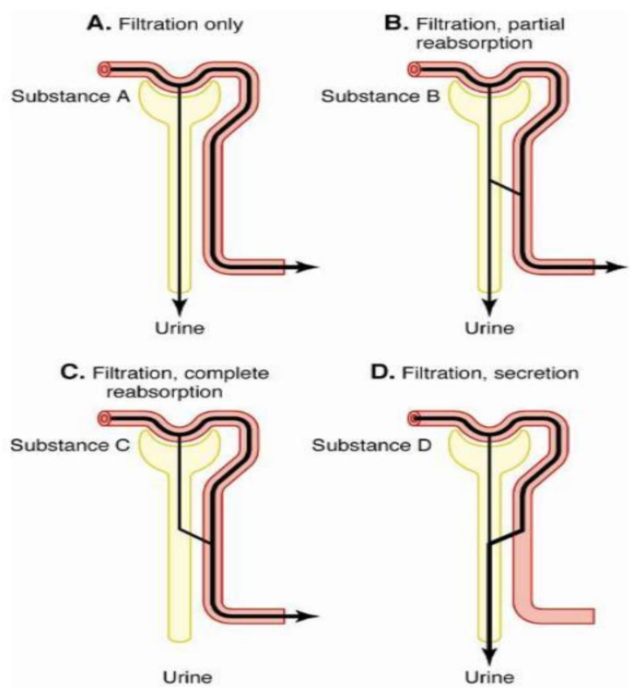
renal handling of different substances :



we have four different choices for how kidney deal with substances :

A. **Filtration only** : the substance will be filtered without any reabsorption or secretion "look at the graph you can't see any arrows between the blood and tubule " it's **very rare** to have substance like that from inside the body , maybe it's expected to give a patient substance like that and get through this pathway . you have to note that not all the blood will be filtered , just 20% .

B. **Filtration and partial reabsorption , part** of the filtered substance will be reabsorped , but part of it stay in urine , this what we called partial reabsorption , in this way we will have some excretion in urine .(**excretion = filtration – reabsorption**) this scenario happen for water and most of electrolytes in our body (Na+ , Cl-)

Filtered at the same rate of filtration in substance A → 20%

C. **Filtration , complete reabsorption :** we don't have any excretion , complete reabsorption for filtered substances , this is an example of all nutrients in our body such as glucose , amino acids , the reabsorption for this substances is so fast , with no excretion of any valuable substances "to avoid the loss of amino acids and glucose" .

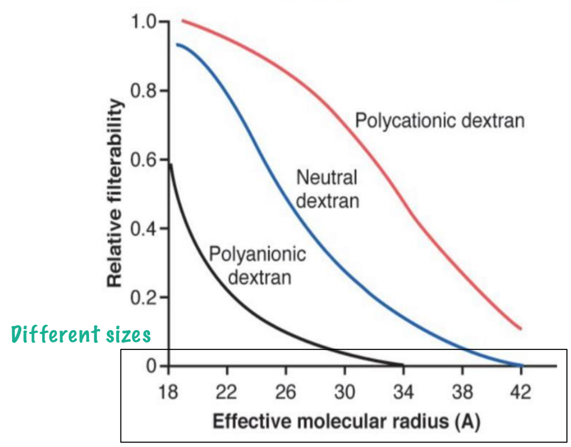
D. **Filtration , secretion :** we have no reabsorption , the body don't want this substance , and it want to get it away from the body by secretion , **(excretion = filtration + secretion),** this is an example of waste products , metabolites of drugs and organic acids and bases that the body excrete to maintain normal PH .

Urinary excretion is very high

....

Factors that affect filtration process :

Effects of size and electrical charge of dextran on filterability by glomerular capillaries.



- Filtration is a passive process , not selective ,and by this experiment enabled us to know the exact factors that affect the filtration .
- This experiment was designed by giving the animal or the patient three kinds of solutions that they know its components: **polycationic dextran , neutral dextran and polyanionic dextran .**
- Dextran is a kind of <u>sugar</u> (Sugar polymers) designed to be either highly negatively charge (anionic) , or neutral (consist of positive and negative) , or highly positively charge (cationic)
- They designed the same dextran **in different sizes** , in each kind it is designed in several radius according to the difference in molecular weight.
- So in conclusion **they change the charges of the dextrin and the sizes** , then they plotted this graph which represents the type of the solution with the different relative filterability (ratio of filtration)
- By looking at the Y axis <u>, when Y=1 , it will be the best filtration with the highest filtration</u> rate .
- Y= 0.5 the half of filtration ,, and by going down it will be less and less .

- As you can see from the figure, the **polycationic dextran** has the highest rate of filterability , it achieved the highest filterability for each size .
- example : for size 22 the **<u>polycationic dextran is the highest</u>** , then going down the neutral dextran is lower , **<u>and the lowest rate is for the polyanionic dextran</u>** (draw a perpendicular line from size 22 and observe the values of the filterability)

- So if you fix the molecular radius in certain number , you will find that the **polycationic has the highest filterability , then neutral , lastly is polyanionic**
- That's actually make sense , because we know the composition of the filtration membrane , and we know that one of the barriers **is highly negatively charge** < the basement membrane > so any negative molecule will be so hard to pass through , so the filterability of it will be very low **(polyanionic dextran)**

  So, the larger size the less filtrability
  The lower molecular radius the higher filterability
- The **neutral dextran** depends mainly on size , the smaller the size , the more the filterability
- The **polycationic dextran is the best filterability in all different sizes**
- The other factor that affect the filterability is the size , **the smaller the molecule the easier and higher the filterability**
- In some solutions " **anionic** " when it reached too large size , **the filtration stops** , and that because of the charge .and some solution the filtration continues but in low manner .
- **From the previous experiment we can conclude that even if the filtration process is a passive process , it's also depends on the size and charge of the molecule .so different molecules has different rate of filterability**

Glomerular Filtration: it's the same process that we have talked about lately .

- To consider if the glomerular filtration is normal or abnormal , scientists measure a rate which is called **<glomerular filtration rate > GFR**
- They found that if we collect all of the solutions that are filtered in both kidneys per day (**total amount of filtered fluid in each day will be equal to 180 liters/day**)and this is according to the ability of the kidney to filtering.
- GFR = 125 ml/min = 180 liters/day (normal rate) there are differences between male and females in this value , depends on age , body weight .
- If you ask yourself : how I can have 180 liters filtered from my body and I have only 5 liters of fluid in the body and sometimes less ! .... the answer :
  1. Plasma volume filtered 60 times per day :
     a) this is very important for our body health , to rapidly get away from the waste products to prevent them staying long in our body .
     b) it's good for monitoring the changes that happens inside the fluid and blood in very efficient way **<osmolarity , electrolytes balance , blood pressure >**

- Glomerular filtrate composition is about the same as plasma, except for large proteins because they won't pass due to the charge of them and the size .
- **Filtration fraction** (GFR / Renal Plasma Flow)= 0.2 (i.e. 20% of plasma is filtered)
- Filtration fraction is the ratio between filtration rate to plasma flow rate
- **Plasma flow rate** , that entre the kidney , represent how much ml of plasma enters the two kidneys <perfuse the nephron> per minute
- Normally the filtration fraction is 20% , which means that **20% of renal plasma flow filtrates**

Clinical Significance of Proteinuria

- Sometimes when proteins leaks outside the barriers that we talked about previously , in this case we will have proteins in the urine we called this case protein urea, and it's important to do early detection for this case , it helps us to detect any renal disease in early times before any symptoms
  - Early detection of renal disease in at-risk patients

a) hypertension: hypertensive renal disease
b) diabetes: diabetic nephropathy , there will be damage in the membranes , podocytes or basement membrane
c) pregnancy: gestational proteinuric hypertension (pre-eclampsia) it helps the proteins to filter because of the high pressure
d) annual "check-up": renal disease can be silent

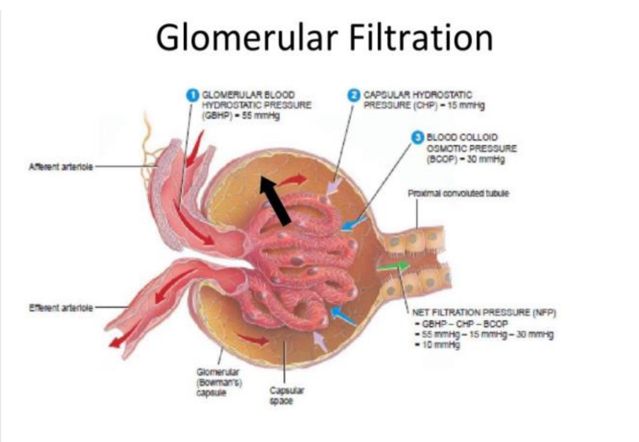
- Assessment and monitoring of known renal disease

Forces that govern filtration

1. Glomerular filtration

Passive process , depends on hemodynamics processes that regulate the filtration process

Blood is coming through the afferent arteriole having hydrostatic pressure that its origin is from the heart (the blood pressure).



Systolic pressure is 120, and the diastolic is 70 or 80, so the mean arteriolic pressure is 100 mmhg. This pressure is decreasing while moving from the heart to other part in the body and when reaching to the afferent arterioles it's gonna be 55 mmhg that is called glomerular blood hydrostatic pressure.

When that pressure entering the glomerulus it gonna push the fluid that is located inside the glomerulus in a pressure equal to 55 to the outside of the glomerulus into the bowman's capsule .- black arrow-

The fluid that has been filtered to the bowman's has hydrostatic pressure (any fluid in container has a hydrostatic pressure) it's called capsular hydrostatic pressure, its opposite in direction to the capillaries pressure (its opposite to glomerular hydrostatic pressure) and its low (15 mmhg)

We have another type of pressure that is called colloid osmatic pressure (oncotic pressure) it exist in a place where there is protein that can't pass the barrier (endothelial cells membrane) it exist in the capillaries (glomerulus) in a high value

Related to presence of large protein inside the glomeruli → that can't leave the capillaries due to it's large size

What happen is that because that protein can't cross the membrane it will build a pressure that is trying to draw the fluid back to the glomerulus in order to make osmatic balance (the direction is from bowman's to glomerulus) and its equal to 30 mmhg

The direction is against filtration

** there is no protein in bowman's capsule, so the osmatic pressure (oncotic) is zero, some books says that it has but the value is very low

Net pressure

1. Net filtration pressure :will give every force with filtration positive sign, and the opposite negative sign.
   -Glomerular hydrostatic pressure : +55
   -Capsular hydrostatic pressure : -15
   -Capillary(glomerular) pressure: -30

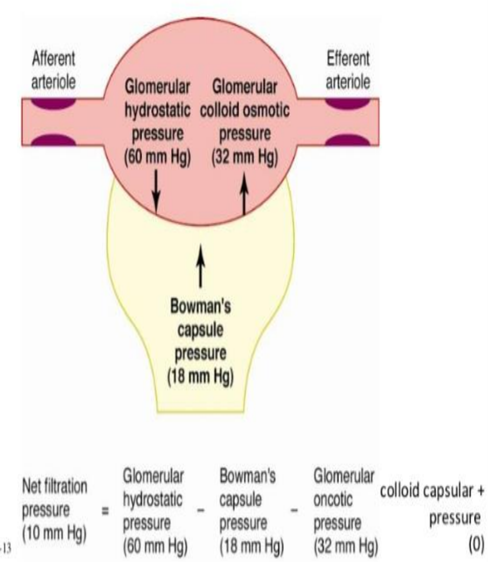


Figure 26-13

So the net = +10 mmhg. Which mean that 10 mmhg favoring filtration from the glomerular into the bowman's capsule , and if we take the colloid capsular pressure in consideration it gonna have positive sign because it is favoring filtration

- In the pic that in the previous paper u can see some differences but that isn't problem

- Filtration fraction: the blood plasma in the afferent arterioles that becomes filtrate (16- 20 %) that we got it by dividing the GFR over the renal plasma flow (RPF)

  ≈ constant

  GFR: The volume (ml) of fluid filtered through all the corpuscles of both kidneys per minute.
  The volume of fluid filtered daily through all the corpuscles of both kidneys per day = 180 L
  GFR= 180 L/24hours * (1000 ml/ L)*(1hour/60 min)= 125 ml/min (Males)
  In females it's a little bit different, but we will consider that the 125 is the normal GFR

- If we know the FF (20%) and the normal GFR (125), we can know how much renal plasma flow should be in order to have normal GFR

  20% = GFR/ RPF = 125/ RPF, RPF = 625

SO there must be entering of plasma flow rate =625 the nephron (both kidney) to have normal GFR, any change (decreasing) in the flow rate will affect the GFR, because the kidney effectiveness in the filtration process will decrease and the waste product in our bodies will stay longer .

- Renal plasma flow is not the same as blood flow
  55% of blood is plasma, so blood flow rate = 1140ml/min
  How to get it? –> 55% * BF= PF; BF= 625ml/min/ (55%)=1140 ml/min
  SO that mean that 1140 ml/min blood should enter the kidney

Renal Blood Flow of 1140 ml/min = 22.8 % of 5 liters (cardiac output) is required to have GFR of 125ml/min. if it decreased the GFR will be affected.

الصفحة كتير فاضية ولا المعلومات هاي رح تنعاد بالصفحة الي بعدها
بس لزوم تعباية البياض🌚

Clinical Application

- ***Edema***
- Some kidney diseases result in a damage of the glomerular Capillaries leading to an increase in their permeability to large proteins .
- Hence, Bowman's capsule colloid pressure will increase significantly leading to drawing more water from plasma to the capsule (i.e more filtered fluid).
- Proteins will be lost in the urine causing deficiency in the blood colloid pressure which worsens the situation, blood volume decreases and interstitial fluids increases causing ***edema***.

In the previous lecture, we talked about the requirements for a normal Glomerular Filtration Rate (GFR). GFR is very important to the function of the kidney.

There must be renal plasma flow of about 625 ml/min in kidneys ,in order to have a normal GFR of 125 ml/min and the filtration fraction ratio is fixed (20%).

So we should have a blood flow of 1140 ml/min to the kidneys ,which is about 20% of the cardiac output .The kidney should get 20% of the cardiac output because its GFR needs this amount , not because the requirements of the tissue are high.

Clinical Applications

Filtration membrane has barriers and the defects in the barriers will lead to loss of proteins in the urine (plasma proteins should not be filtered throw filtration membrane because of size and charge).

If there is a damage in endothelial cells, basement membrane or podocytes there will be a condition called Proteinuria (loss of proteins in urine) and this will Decrease plasma colloid pressure which will lead to accumulation of fluids in interstitial tissues " Edema".

(Plasma colloid pressure is important in absorption in capillary bed).

Regulation Of Glomerular Filtration

Glomerular Filtration is important for the function of the kidney and homeostasis of the body. Homeostasis of body fluids requires constant GFR by kidneys.

If GFR is too high

- the rate of filtration will be more than 125 ml/min
- so the kidney will not be able to reabsorb the necessary substances efficiently because it has constant reabsorption rate.
- Then, there will be loss a lot of substances like water, glucose, and amino acids. <u>So we do not want high GFR</u>.

If GFR is too low

- the filtration will not be as efficient and the waste products which are harmful will stay in the body.

- Also, the reabsorption will be more efficient than filtration so there is a chance for the waste products to be reabsorbed.

Determinates Of Glomerate Filtration Rate

1) GFR is related to Net Filtration Pressure (Direct relationship)

Determinants of Glomerular Filtration Rate

Normal Values:

GFR = 125 ml/min

Net Filt. Press = 10 mmHg

K_f = 12.5 ml/min per mmHg, or 4.2 ml/min per mmHg/ 100gm

(400 x greater than in many tissues)

- Types of capillaries of kidney have larger filtration rate than the rest of capillaries of the body.
- GFR = Net Filtration pressure x Kf
- To compare between the filtration coefficient of different tissues we divide the Kf by 100gm→the kidneys are 400x greater than other tissues

Glomerular Capillary Filtration Coefficient (K_f)

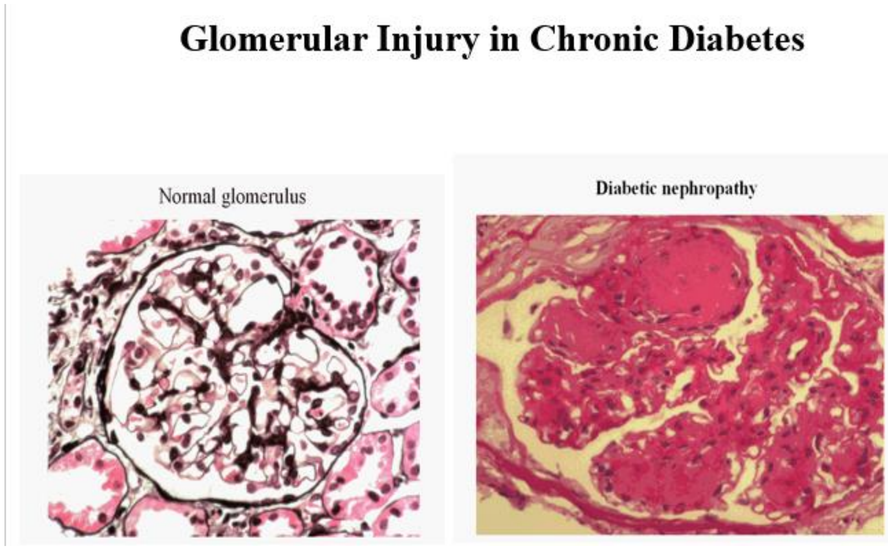
- K_f = hydraulic conductivity x surface area

K_f = GFR/net filt pressure

- Normally not highly variable
- Disease that can reduce K_f and GFR
- damage of capillaries, BM thickens,
  - chronic hypertension
  - obesity / diabetes mellitus
  - glomerulonephritis

Change due to some diseases

Another way to find the coefficient is by multiplying hydraulic conductivity of filtration membrane by surface area of capillaries in two kidneys.



Here is an example on Glomerular injury in chronic diabetes which is called " Diabetic nephropathy" and results from a defect in podocytes, endothelial cells, fibrosis or thickening of basement membrane. Also it causes defect in filteration coefficient and GFR.

2) Bowman's Capsule and hydrostatic pressure

- It results from filtration so if it changes, it will change as a function of GFR not a physiological regulator of GFR (the body doesn't change it to regulate GFR)
- Pathological factors affecting Bowman's capsule and hydrostatic pressure:

1. Tubular Obstruction

It results from collection of crystals or stones in kidney or tubular necrosis.

Bowman's Capsule is connected with tubules and in this case the fluids will not be able to pass because of obstruction thus increasing the hydrostatic pressure.And this a negative factor for the net filtration pressure ;there will be reduction in GFR.

2. Urinary tract obstruction

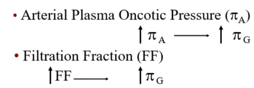
Because of Prostate hypertrophy/cancer

3) Capillary Oncotic Pressure (Π_G)

Capillary oncotic pressure is inversely related to net filtration pressure ,so if capillary oncotic pressure increases, the net filtration pressure will decrease.

- **Factors Influencing Glomerular Capillary Oncotic Pressure (Π_G)**

<u>Conditions which increase oncotic pressure :</u>



Conditions increase oncotic pressure are related to proteins in plasma so:

1. When plasma proteins increase, the arterial plasma oncotic pressure will increase too.
2. Filtration Friction: (Ratio between GFR and plasma flow=20%) ,but for some reasons if filtration fraction increases (which means that the GFR is higher than renal plasma flow), the capillary oncotic pressure will increase.
   - More fluids leave the capillaries ,thus the osmotic pressure in them ↑

Relation between filtration fraction and glomerular oncotic pressure:

- In normal filtration fraction as we move away from afferent end, the colloid pressure will increase.
- If filtration fraction is high, oncotic pressure will be higher than normal in all segments.
- If the filtration fraction is low, oncotic pressure will be less in all segments.

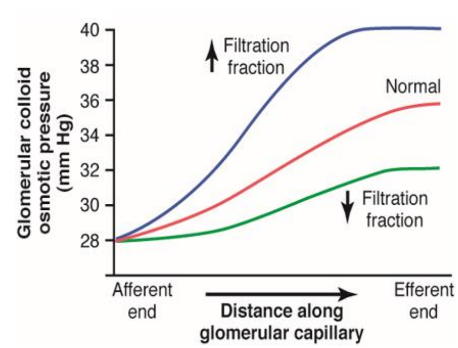


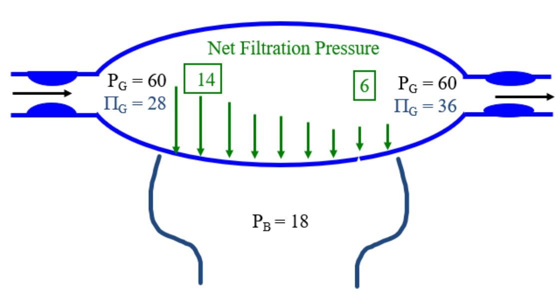
Figure 26-14

The reason of increasing of oncotic pressure:

This represents the glomerular capillary with afferent and efferent ends.

As we move from the afferent to the efferent end more fluids are filtered therefore the oncotic pressure increases

The net filtration pressure decreases as we move toward the efferent end because oncotic pressure increases (they are inversely related)



One of clinical applications on filtration of proteins is Microalbuminuria.

- The most dominant protein in plasma is albumin.
- Microalbuminuria: The urine excretion of albumin is more than 30 and less than 150
- Causes: early diabetes, hypertension, glomerular hyperfiltration
- An early sign of a pathological case.
- Prognostic Value: diabetic patients with microalbuminuria are 10-20 fold more likely to develop persistent proteinuria

The question is can oncotic pressure be easily regulated in the body?

NO , so the body can't use it to regulate the glomerate filtration rate

- It is also a function of GFR it changes if GFR changes

4) Glomerular Hydrostatic Pressure

- It is a physiological regulator , Why?

Net filtration pressure depends on Glomerular Hydrostatic Pressure (direct related) and as we know that pressure can be easily regulated.

- The origin of hydrostatic pressure is the heart.
- And from the net filtration pressure equation :

When the Glomerular Hydrostatic Pressure increases, Net filtration pressure increases and GFR increases too.

Glomerular Hydrostatic Pressure = GHP

- **Factors that influence P_G**

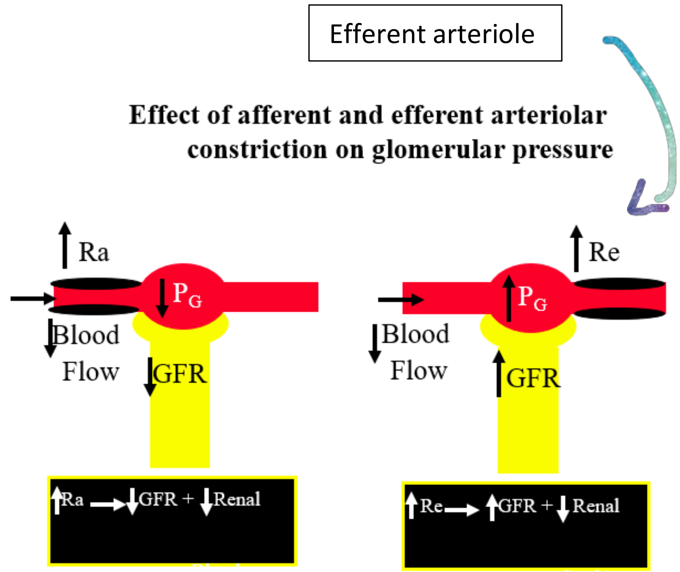
  - arterial pressure theoretically, pressure↑ → GHP↑ → GFR↑

- This is not the case actually, any fluctuations in the arterial pressure wouldn't affect GFR directly.
- (effect is buffered by autoregulation) will be discussed later in this sheet.

- afferent arteriolar resistance

- When the diameter decreases, resistance increases, perfusion decreases and Glomerular Hydrostatic Pressure decreases. So Glomerular Hydrostatic Pressure will increase when we decrease afferent arteriolar resistance.

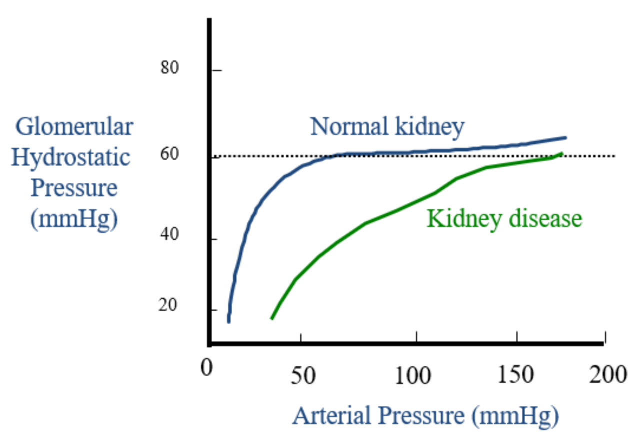
- <u>efferent arteriolar resistance</u>
Look to the image on the left.



- If we increase resistance at efferent arterioles , blood that entered the glomerulus will not be able to pass ; so there will be building up of pressure and the Glomerular Hydrostatic pressure will increase.

- When afferent resistance increases → GHP ↓ → GFR ↓
- When efferent resistance increases → GHP ↑→ GFR ↑
- In both cases the blood flow decreases

As discussed earlier (about the arterial pressure effect on GFR)
From the relation between arterial pressure and Glomerular Hydrostatic pressure: Theoretically, if arterial pressure increases, Glomerular Hydrostatic pressure increases too, but in fact when the kidney is normal and when there is an increase in arterial pressure from 50 to 150 or to 180 the Glomerular Hydrostatic pressure does not increases. (plateau)
This is due to autoregulation that fixes pressure inside capillaries on wide range of arterial pressure.
BUT in kidney disease, there is a proportional relation between arterial pressure and Glomerular Hydrostatic pressure. (no autoregulation)



The figure below represents the relation between renal blood flow, glomerular filtration and mean arterial pressure:

Autoregulation of renal blood flow and GFR but not urine flow

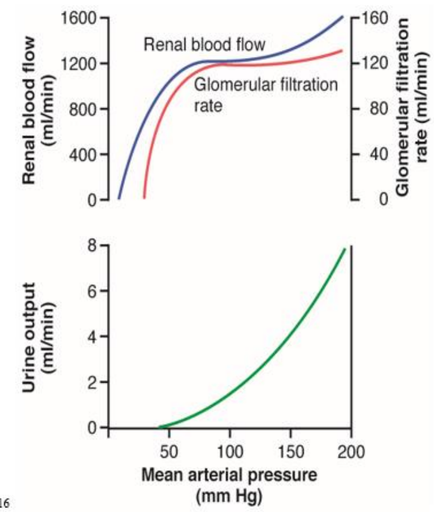


Figure 26-16

Look to the upper graph :

Left Y- axis represents renal blood flow and right Y- axis represents Glomerular filtration rate.

The lower graph represents relation between mean arterial pressure (x-axis) and urine output (y-axis) .

- We are studying both graphs together.

Let's start with the effect of mean pressure on renal blood flow

When mean arterial pressure increases more than 50 until 100, renal blood flow will increase in a direct relation. then plateau starts to 200 or 180.

What about glomerular filtration curve?

From 50 to 90 or 100 there will be increase in glomerular filtration rate then at 90 to 200 plateau phase.

- Plateau in both curves refers to autoregulation.

In the curve below, there is no plateau so there is no regulation on urine output.

- Urine output increases as mean pressure increases.

Look below to the effect of changes in afferent or efferent arterioles resistance on renal blood flow and on glomerular filtration rate.

As we know, there is a difference between resistance changes in afferent end and resistance changes in efferent end.

Effect of changes in afferent arteriolar or efferent arteriolar resistance

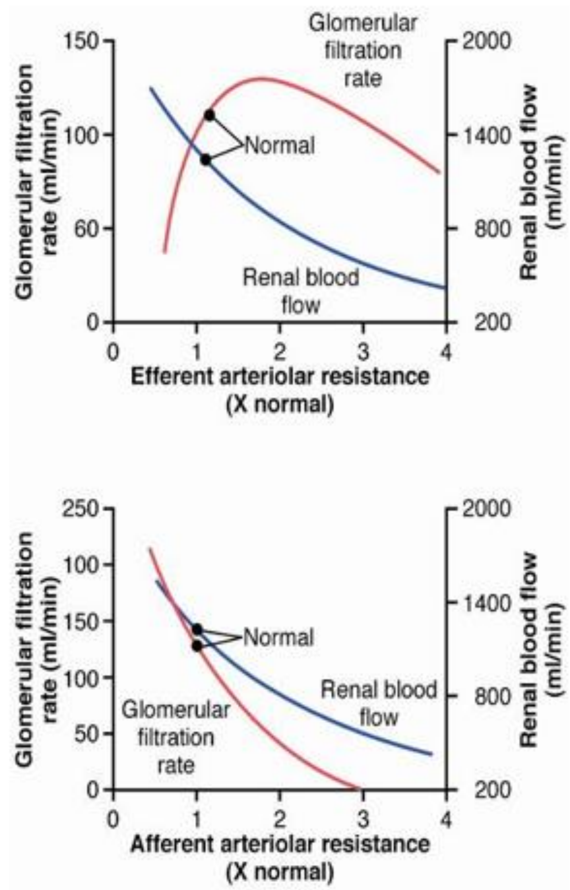


Figure 26-15

When afferent resistance is normal (1):

- the glomerular filtration rate = 125
- renal blood flow = about 1400
- when resistance increases, both glomerular filtration rate and renal blood flow decrease.

Now, lets see the difference in efferent arteriole resistance changing:

At normal condition, glomerular filtration rate = 125 and renal blood flow = about 1400

When we increase efferent arteriole resistance:

- Renal blood flow decreases (inverse relationship)
- As discussed earlier , blood flow ↓ as afferent/efferent resis. Increases.

- glomerular filtration rate increases when efferent resis. Increases up to x2.5 or x3 then there will be reduction in glomerular filtration rate.

Last lecture we talked about the relationship between efferent arteriolar resistance and both glomerular filtration rate & renal blood flow :

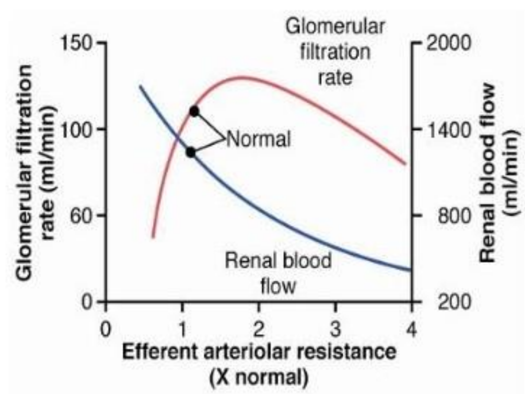
- when efferent arteriolar resistance is increased more than normal (normal =1 in the graph) to x 1.5 or x 2 and sometimes to 3 , **there is an increase in the glomerular filtration rate,** (because glomerular hydrostatic pressure has increased).
- after that (resistance is more than 2x, sometimes 3x) , there is a reduction in the glomerular filtration rate
- we call the behavior in efferent arteriole resistance - glomerular filtration rate → **biphasic behavior**

→ what is the reason of this biphasic behavior , why it gets increased at the beginning then gets reduced after tripling the resistance ? **(** you may think that as we increase the resistance so blood will still accumulating and the filtration will continue to increase as well , **but this is wrong**)

At this level of resistance , the increase in oncotic pressure is more effective than the increase of glomerular hydrostatic pressure :

When resistance of efferent is increased , this will lead to an increase in the oncotic pressure also (not only the hydrostatic pressure) , so the continuous increase in the resistance will lead to high increase in the oncotic pressure which has more effect on the glomerular filtration rate than the increase of hydrostatic pressure.

So at this level of resistance , the increase of hydrostatic pressure is not effective any more in increasing glomerular filtration rate , and it's overcomed by oncotic pressure increase.



So what is the result ? decrease of glomerular filtration rate because high oncotic pressure works against filtration (at resistance more than 3)

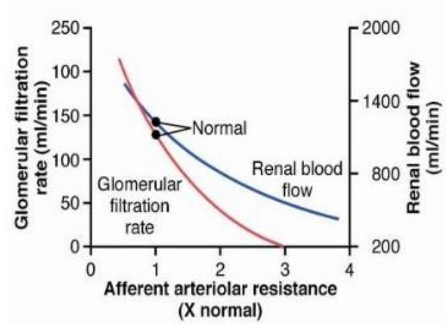
To sum up:

any increase in resistance from 1 to 2.5 or 3 → increased glomerular filtration rate

Any increase in the resistance above 3 → decreased glomerular filtration rate, due to increase of oncotic pressure.

- ✓ **renal blood flow** is going to act the same as long as the efferent resistance increases (as the resistance increases , the blood flow is decreases) and it doesn't have a biphasic behavior.

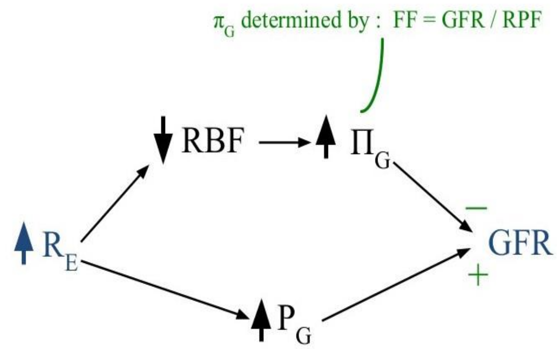
While in ***afferent*** arteriolar resistance , the relationship is the Same in both glomerular filtration rate and renal blood flow (as the resistance increases , both **glomerular filtration rate and Blood flow decrease)**



Summary of the factors that control GFR when the resistance in efferent is increased

Phase 1 (resistance is less than 3)

The effect of hydrostatic pressure is the effective one so GFR will increase



Phase 2 (resistance is more than 3)

1. resistance of efferent is increased
2. Renal blood flow is reduced

(FF=GFR/RBF) → when RBF is reduced , FF will increase (according to the law)

So when the resistance is increased 3 times the normal ,
RBF will be decreased to very low level, So filtration fraction will increase very much (inversely related)

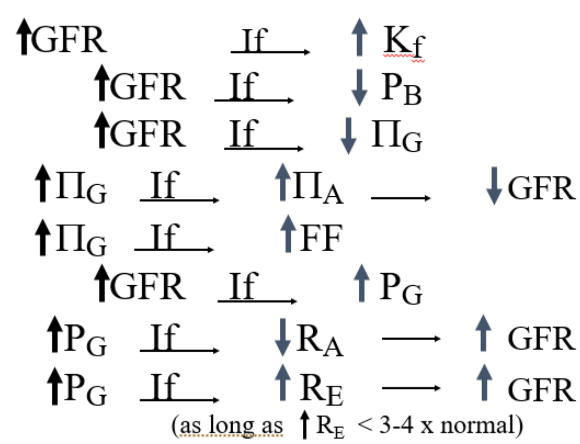
3. This increase in FF will lead to the increase of oncotic pressure : directly related , the more the fluids are filtrated , the more build up of oncotic pressure .

✓ As we said before , the increase in the oncotic pressure is much more than the increase of hydrostatic pressure .

4. GFR is reduced .

✓ **The thing that determine the result (increase or decrease GFR) is the factor that overcomes the other (if hydrostatic pressure overcomes oncotic pressure , GFR increases . if oncotic pressure overcomes the hydrostatic pressure , GFR decreases) .**

Summary of the determinants of GFR



1. GFR is increased if Kf is increased : we talked before than it's not a physiological determinant
   Because if the kidney is normal , Kf will not change
2. If Bowman's capsule hydrostatic pressure is decreased, GFR will increase (inversely related).
   it's not a physiological determinant (body can't control it , it's a function of GFR)
3. GFR is increased if oncotic pressure is decreased (has negative sign in terms of filtration)
   Again it's not a physiological determinant (body can't change is to change GFR)
4. Oncotic pressure increases if **arterial** oncotic pressure increases (proteins in the arterial plasma is increased) → GFR will decrease
5. Oncotic pressure is increased when FF is increased (FF is mainly increased when RBF is reduced according to FF=GFR/RBF)
6. GFR is increased when Glomerular Hydrostatic Pressure is increased (direct relation)

- ✓ Glomerular Hydrostatic Pressure is the physiological determinant

7. Glomerular Hydrostatic Pressure is increased when afferent resistance is decreased (vasodilation of afferent , more blood accumulation in glomerulus (balloon)) → GFR increases
   Focus that in this point we don't talk about arteriolar pressure, we are talking about hydrostatic pressure in glomerulus.

- ✓ Don't be confused with vasodilation of afferent that will result in decrease in the arteriole pressure, also will result in accumulation of blood in glomerulus, so this will increase the glomerular hydrostatic pressure (here we are focusing on glomerular hydrostatic pressure)
- ✓ توضيح للنقطة السابقة : اخدنا قبل انه ال vasodilation رح يعمل انخفاض بالضغط ، و هاد الاشي صحيح بالنسبة لل arteriole الي بتوسع الي هو afferent arteriole اما جوا ال glomerulus الدم رح يتراكم فيه بسبب وجوده بعد ال afferent وبالتالي الضغط داخله بزيد
  اللي ما فهم، يرجع لفيديو المحاضرة للوقت ١٤:٥١ – ١٦:٠٠

8. Glomerular Hydrostatic Pressure is increased if the resistance of efferent is increased →GFR increases (as long as the resistance is less than 3-4 x normal)

Determinants of renal blood flow (RBF)

- RBF = ΔP / R

ΔP = difference between renal artery pressure and renal vein pressure

R = total renal vascular resistance = sum of all resistance in kidney vasculature (in the 2 kidneys)

= R afferent + R efferent + R vein

- Renal blood flow is high (≈22 % of cardiac output) , which is considered high in comparison to the rest of organs
- High blood flow needed for high GFR : we needed high renal blood flow because GFR is needed to be always high (125ml/min)
- Oxygen and nutrients delivered to kidneys normally greatly exceeds their metabolic needs. The high flow isn't due to the high demand of the kidney but because it's **function** (GFR)
- A large fraction of renal oxygen consumption is related to renal tubular sodium reabsorption

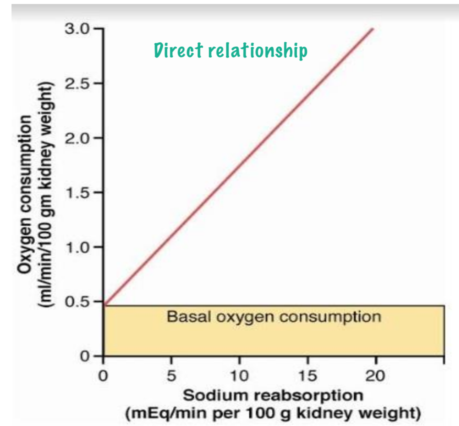
Reabsorption processes usually need energy (especially when we're talking about sodium) , because their movement is against their gradient , to get them back to our body.

sodium isn't absorbed only to get it back to the body , but also to maintain other gradients and absorb other molecules (don't mind this , we will talk about it later) note that renal oxygen consumption (y axis)

is related directly to sodium reabsorption (x axis)

(the more sodium absorbed the more oxygen is consumed ,

because this process needs energy as well as oxygen)



Good luck