Glomerulus →

function: filtration

Glomerular filtrate (from glomerulus → Bowman's Capsule) → ultra filtrate (contain every small constituents of the plasma except proteins - protein free ultra filtrate -

[1] composition of plasma filtrate →
plasma - colloids (plasma proteins)

[2] volume of plasma filtrate → 125 mL / min
7.5 L / hour
180 L / day
99 % is reabsorped

Σ plasma volume = 3 L
180 L / day → plasma filtered
60 times per day

[3] filtration fraction → Effective renal plasma flow = 625 mL / min ⇒ 125 mL will be filtered per min → 20% filtration fraction
= GFR / Effective renal plasma flow

by aging → GFR↓ → plasma createnine↑

but also with aging; muscles (which are the main source of createnine) will also get weaker production → less + Excretion → less

plasma createnin is normal

Glomerular membrane → 3 layers

① capillary endothelium → fenestrated

③ Bowman's capsule epithelium
↓
podocytes → slit pores between its pedicles

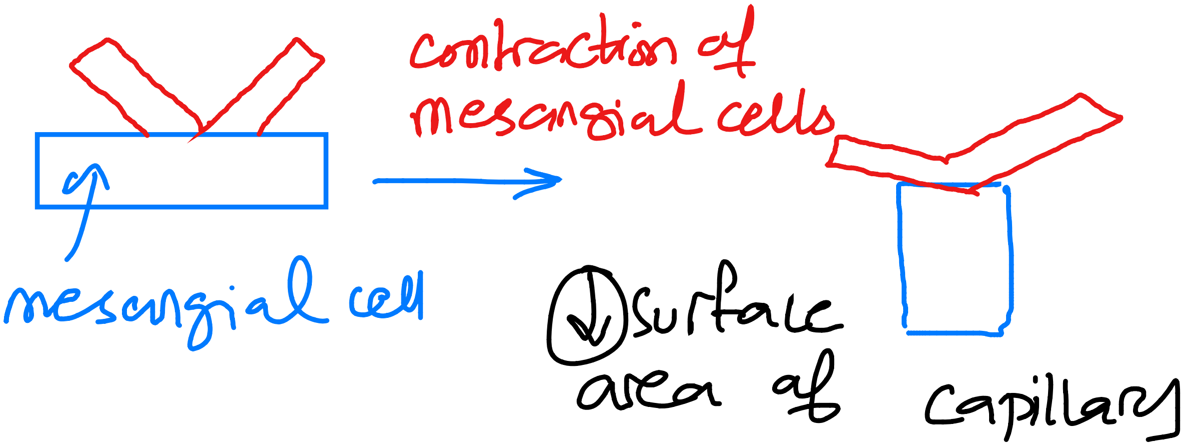
② Basment membrane (negatively charged)

without this negatively charged BM, plasma proteins could pass with the filtrate

plasma proteins (−) & BM (−) = repulsion

So this prevent filtration of plasma proteins

→ mesangial cells → between endothelium and BM at the bifurcation of capillary



Autoimmune diseases → Abs aggregate on the mesangial cells → glomerular disease

surface area of glomerular membrane ↓ 0.8 m^2

permiability of glomerular memb
→ 50 fold more than the permiability of skeletal muscle capillaries.
(moderate permeability)

→ capillaries of glomerulus → highest pressure = 60 mmHg

Passage of substances through the glomerular membrane depends on → size of molecules & charge of molecule

less ← 4 nm ←inbetween→ 8 nm → More

- less than 4 nm: radially filtered → تركيزه في ال filtrate هو نفسه في ال plasma — most of substances in the plasma except colloids
- in between: filtered with ↑ deficulty.
- More than 8 nm: Not fillered at all (colloids)

charges of molecules →
what prevent plasma proteins from being filtered is the negatively charged BM

(-ve) charged < (+) charged

Glomerular filtration rate (GFR) →
- we want to measure (GFR) of 2.6 million nephrons

measured by inulin clearance
(fructose sugar → MW = 5200

featured by → neither reabsorbed nor secreted

what will enter the lumen
↳ will be excreted.

why?! tubular system has no mechanism to reabsorb or secrete inulin

Amount filtered = Amount excreted

V /min × Conc = V × Conc → concentration in urine

V of urine /min

volume filtered = GFR
conc in filtrate = f

All of these are calculated per minute

بتجمعه لـ 24 ساعة وبتحوله لدقيقة

$$GFR = \frac{(V)\ \text{vol urine/min} \times (u)\ \text{concentration in urine}}{(F)\ \text{concentration in filtrate}}$$

بنقدر نقيسه

filtrate?! كيف بدي آخذ عينة من ال

↳ molecular size of inulin < 4 nm

then its concentration in the filtrate is the same as the plasma

باخذ عينة من ال plasma واحسب

تركيزه فيها بطلع هو نفسه تركيز ال

filtrate.

$$GFR = \frac{\text{vol urine/min } (V) \times \text{conc. in urine } (u)}{(F)\ (\text{plasma concentration})}$$

other features of inulin → Not metabolized

Not stored

doesn't Not affect GFR

But still inulin clearance is not used to measure GFR → why?!

لأنه بشكل عام هذه التجربة

لازم أعطي تركيز لل inulin ع الدم وال test هاد

أنا بدي أعمله للشخص مريض كليته مش سليمة

وبالتالي هاي بعطيها exogenous ←

so we add extra work to an already diseased kidney what is used the createnine clearance

الجسم عارفها وبحاول يتخلص منها يعني

يعملها secretion وبالتالي التركيز تبعها في البول

يزيد

Concentration in the urine =

conc in the fitrate + conc secreted

creatinine plasma concentration →

بنقيسها بس بكون معها مواد ثانية يعني مافي

طريقة نقيس تركيزها في ال plasma كثيرًا

وهذا يخلي تركيزها في ال plasma يبين عالي

secretion → زاد التركيز في ال urine

عدم وجود طريقة لقياس ال P. conc → زاد التركيز في ال plasma

وبالتالي

$$GFR = \frac{V \times U\uparrow}{P\uparrow}$$

زيادة بسيطة وطعام

تخلي القيمة ثابتة تقريبًا

forces affecting GFR → 4 forces will

control the filtrate

2 filtring + 2 opposite

reabsorption قوتين تعملوا وقوتين تعملوا filtration قوتين تعملوا

2 of them hydrostatic pressure
2 of them osmotic pressure.

by osmosis water always flows towards regoins in the body that have higher osmolarity (higher concentrations of solute particles)

if we have water surrounding a vessel that have some pores (small holes) that alow some particles to cross and prevent others from crossing → if we put high concentration of some particles with much higher concentration inside the vessel compared to the outside (if this particle is relatively large, like a protein molecule and cannot leave the blood vessel through the small pores) that means that the concentration of that large molecule is going to remain high inside the vessel and remain low at the outside of the vessel → by osmosis → since water always flows toward regoins with higher concentration of particle → then water is going reabsorped back into the vessel towards the higher concentration of particles

In blood we have a higher concentration of proteins (like serum protein albumin compared to outside the blood vessel in the interstetial space) → then water tend to reabsorped back into the blood driven by osmosis and osmotic pressure

for better understanding → https://www.patreon.com/physioflip

back to our point → 2 hydrostatic
2 colloidal osmotic

1 → hydrostatic pressure in glomerular capillary → 60 mmHg

2 → colloidal osmotic pressure of glomerular capillary → 32 mmHg

3 → osmotic pressure of bowman's capsule : but normally because of Negatively charged BM there are no proteins → 0 mmHg

4 → hydrostatic pressure in bowman's capsule = 18 mmHg

filtrating forces → 0 + 60 = 60 mmHg

opposing forces → 32 + 18 = 50 mmHg

Net force equal = 10 mmHg

60 →

← 32

← 18

Starling equation → GFR will increase as the net force increases

GFR ∝ Net force

GFR ∝ filtrating forces − opposing forces

$$GFR \propto (HP_{GC} + \pi_{BC}) - (HP_{BC} + \pi_{GC})$$

$$GFR = K_f (HP_{GC} + \pi_{BC}) - (HP_{BC} + \pi_{GC})$$

K_f ← Constant of filtration

بالكل يلي بتأثر على GFR هم

ال ٤ قوى وال Kf

K_f → Depends on glomerular membrane → Area and thickness

factors affecting GFR

4 forces + K_f → 5 factors

K_f → depends on Area of membrane and permiability →

GFR ↓ → thickness ↑

Area ↓

Diabetes mellitus → Affects Kf

↳ ↑ thickness (permiability ↓)

↓ Area

Uncontrolled DM

Hypertension → ↑ thickness (DM is more dangerous).

imagine if the patient has DM and HTN ⚠

Mesangial cells ⇒ Affect the Area

Relaxation → ↑ Area

Contraction → Area ↓

forces → Most important → Hydrostatic pressure of glomerular capillary

↓

تتأثر ؛ 3 عوامل ←

① Afferent

↳ vasodilation → Blood flow ↑

pressure ↑

filtration ↑

PGs and bradykinins

Afferent → vasoconstriction → filtration ↓

(sympathetic).

Efferent → الدم بطلعش وبالتالي الضغط بزيد

②

⇓

Angiotensin II

Arterial blood pressure → ↑P = ↑GFR
↓R = ↓GFR

نحكي احنا عنا مثبت
تغير الضغط بين 90 – 220
↳ GFR يضل ثابت

<90 → ↓GFR
>220 → ↑GFR

↓ Autoregulation

[1] Tubuloglomerular feedback
dilate Afferent
constrict efferent

[2] myogenic:
↑P → vessel intrensically constrict.

(3) osmotic pressure of glomerular capillary :-

↑water = ↑excretion of water by ADH

↑water = osmotic pressure of glomerular capillary ↓ → More GFR

↓water = ↑osmotic colloid pressure = less GFR

(4) Hydrostatic pressure in bowman's capsule →

Stone in bowman's capsule = ↑HP$_{BC}$ = ↓GFR

لانه بشكل عام وجوده ما بأثر كثيرا
2/ تلاقي مكانا واسع تقعد فيه

لكن لو الحصوة انكشرت في مكان ضيق ← هون إ
GFR↓ → هو فعليا بوقف تماما

⑤ colloidal osmotic pressure in bowman's capsule → 0 mmHg

other factors → [1] Renal vasodilators
PGs / NO

[2] ptn intake
specially in kidney compromised patients

Asprin → will inhibit PGs → ↓ vasodilation
مرضى الكلى يبعد عن اللحم

Ptn intake → Amino acids metabolism
↓
filtration → Reabsorption
↓ لكن مش لوحدها مع Na+ → عالية, جوعي
↓ قلة Macula Densa ← كي تتحسس
NaCl ↓ → filtration ↓ → ↑GFR

vasodilate afferent
constriction of efferent → ↑GFR