Regulation of kidney function

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Overview:

- GFR
- WHY DO WE NEED GFR?
- STARLING EQUATION
- FILTRATION PRESSURES
- Kf, Pc, Pb, πc
- REGULATION OF Pc
- HOW DO WE KEEP RBF/GFR CONSTANT WITH VARYING CO?
- MYOGENIC REFLEX
- SUBSTANCES RELEASED IN RESPONSE TO RAPID DECREASE IN BLOOD PRESSURE & VOLUME EXPANSION
- REGULATION OF Pb
- REGULATION OF πc

GFR (glomerular filtration rate)

GFR= represents the flow of fluid from the glomerulus into Bowman's space

Low GFR (below 60): tells us that metabolites might not get filtered from the blood into renal tubules

Uwaga! GFR under 15= kidney failure!!

Elevated GFR: glomerular hyperfiltration

Normal GFR:

Age	GFR
20-29	116
30-39	107
40-49	99
50-59	93
60-69	85
70+	75

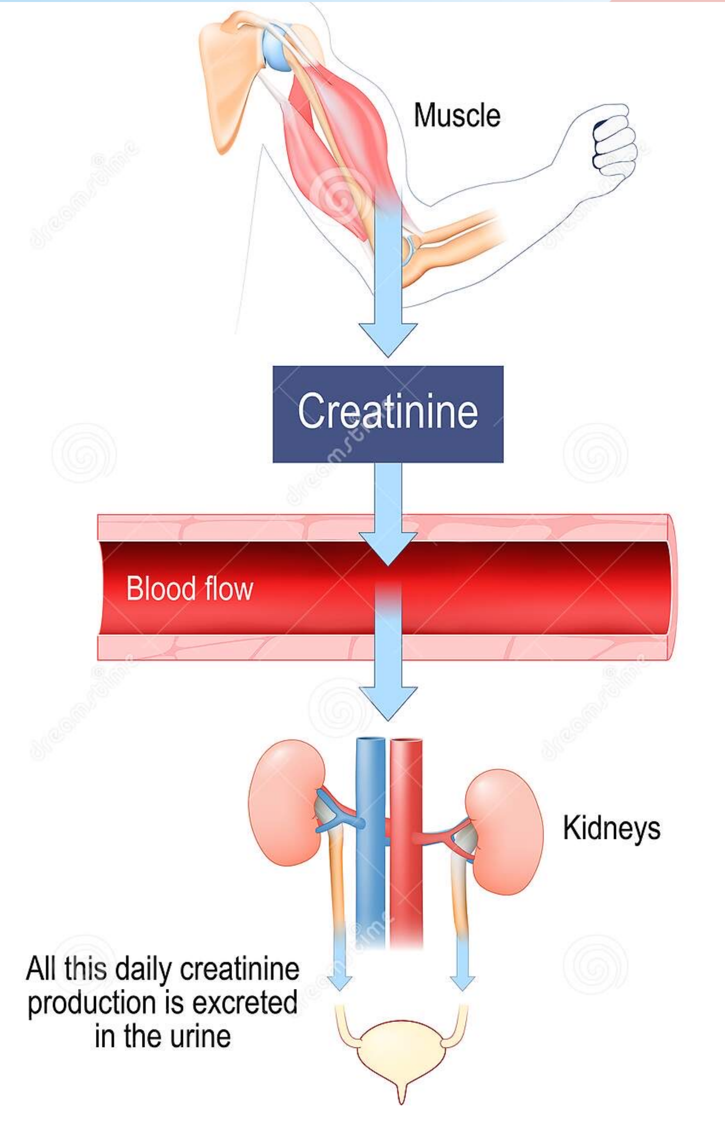
Why do we need GFR?

GFR is the gold standard used to describe a patients kidney function

How?

- Creatinine clearance/ excretion is used to calculate eGFR.

- The value from a sample is put into an equation, and then the estimated GFR (eGFR) is calculated



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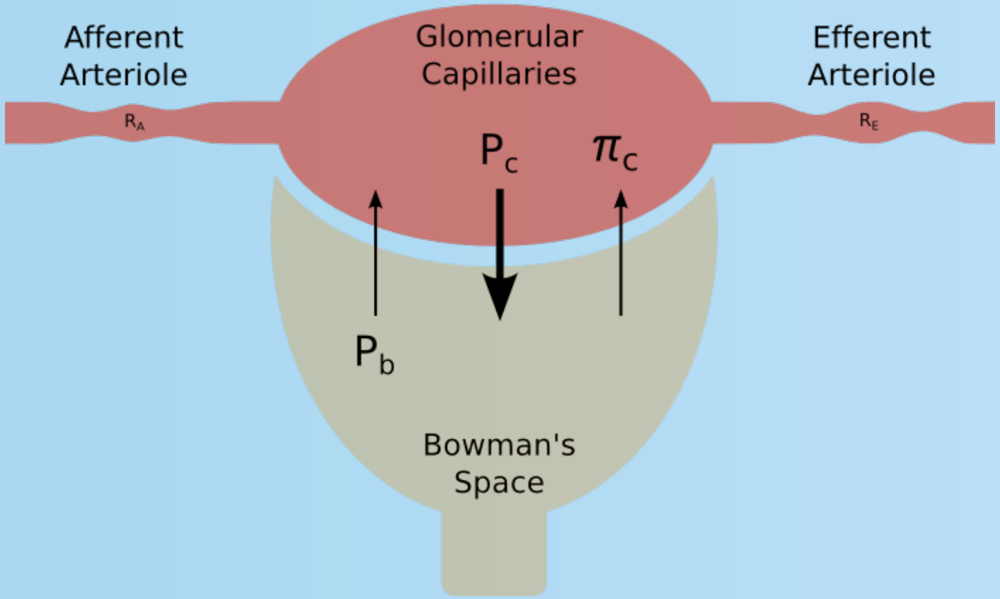
Starling equation

The Starling equation describes the fluid movement inside the glomerulus, which is driven by the Starling forces.

$$GFR = K_f \left[(P_c - P_b) - (\pi_c)\right]$$

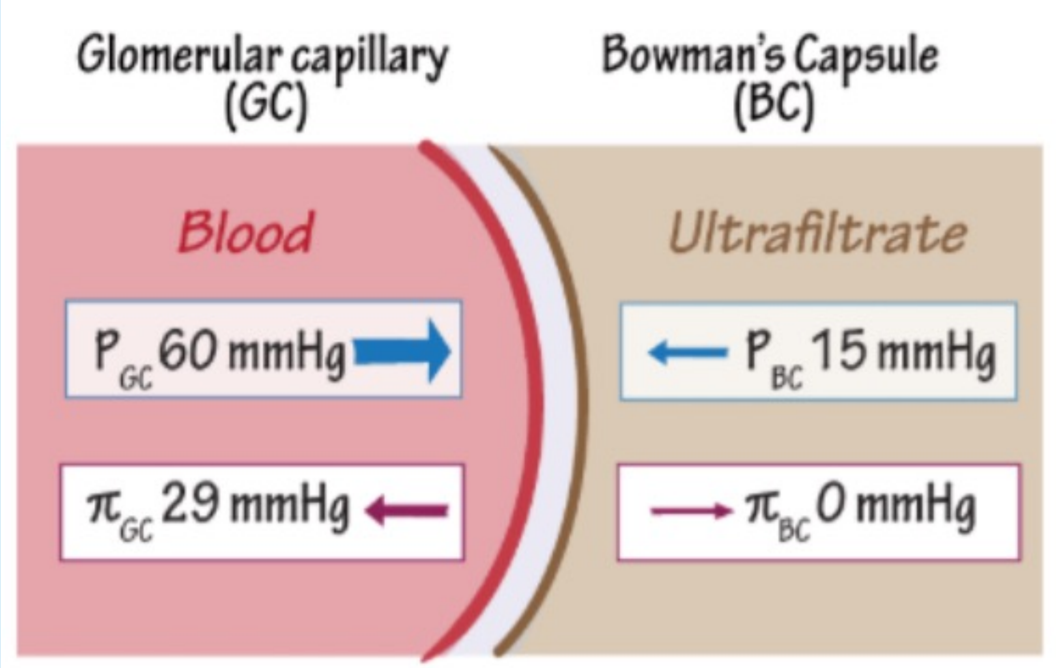


Filtration pressures

$$GFR = K_f\,[(P_c - P_b) - (\pi_c)]$$

- Hydrostatic pressure (P) → push

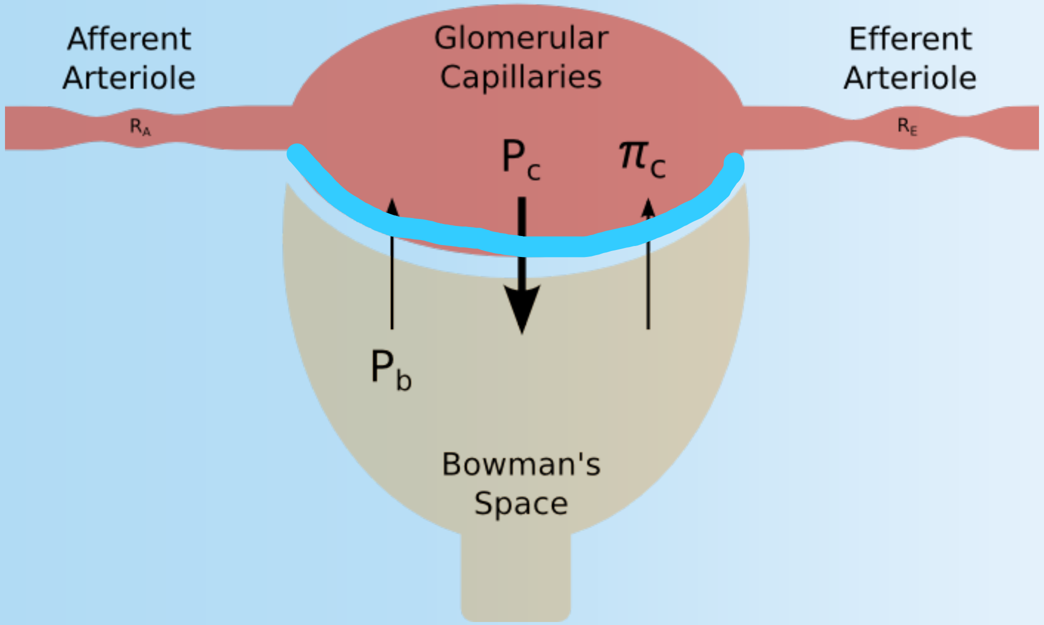
- Oncotic pressure (π) ← suck



$GFR = K_f [(P_c - P_b) - (\pi_c)]$

- K_f = Permeability Constant of glomerular capillaries

- Permeability= the ease of passage over a barrier



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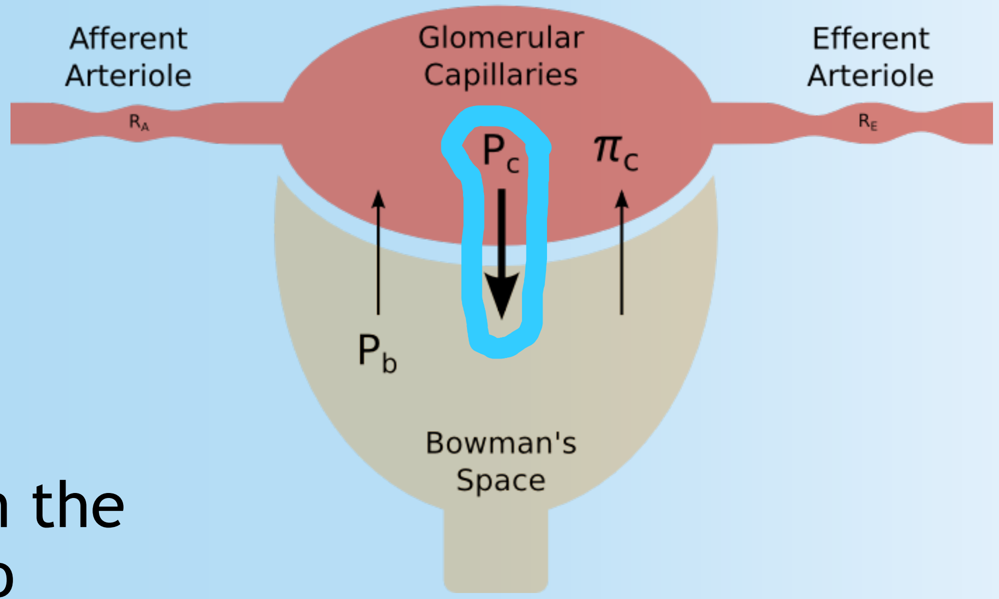
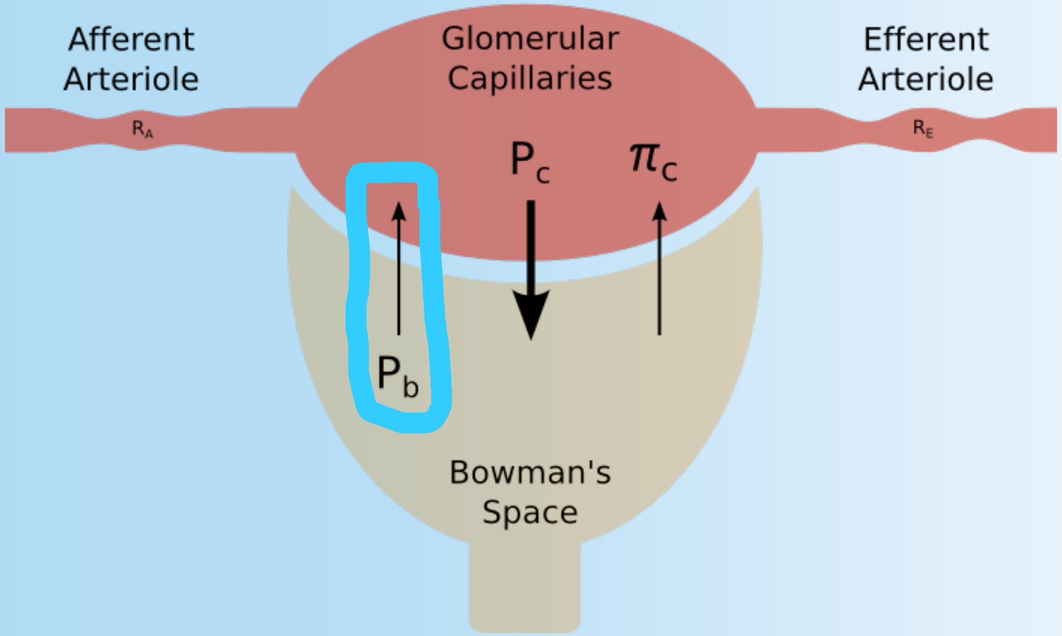
$$GFR = K_f\,[(P_c - P_b) - (\pi_c)]$$

- P_c = Glomerular Capillary Hydrostatic Pressure
- Promotes filtration
- The pressure that pushes fluid from the glomerulus over the membrane into Bowmans space



$GFR = K_f [(P_c - P_b) - (\pi_c)]$

- P_b = Bowman's Space Hydrostatic Pressure
- Opposes filtration
- The pressure that pushes fluid from Bowmans space over the membrane into the cappilaries

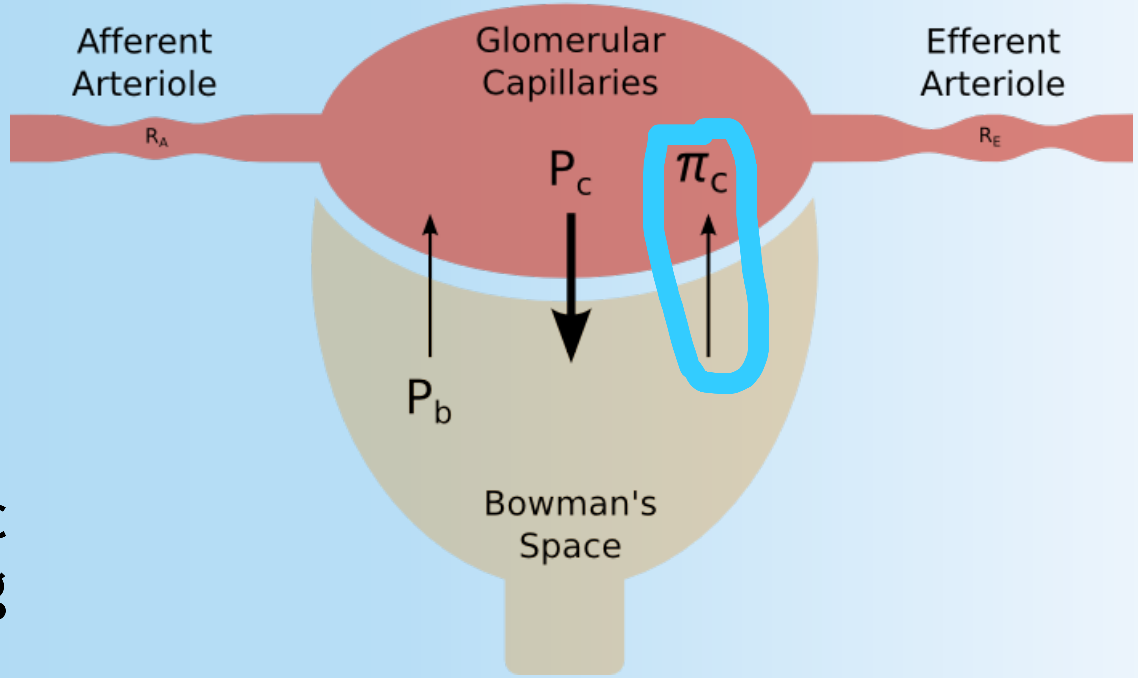


$\text{GFR} = K_f\ [(P_c - P_b) - (\pi_c)]$

- π_c = Glomerular Capillary Oncotic Pressure

- Opposes filtration

- Oncotic pressure= a form of osmotic pressure induced by proteins pulling fluid back into the capillaries



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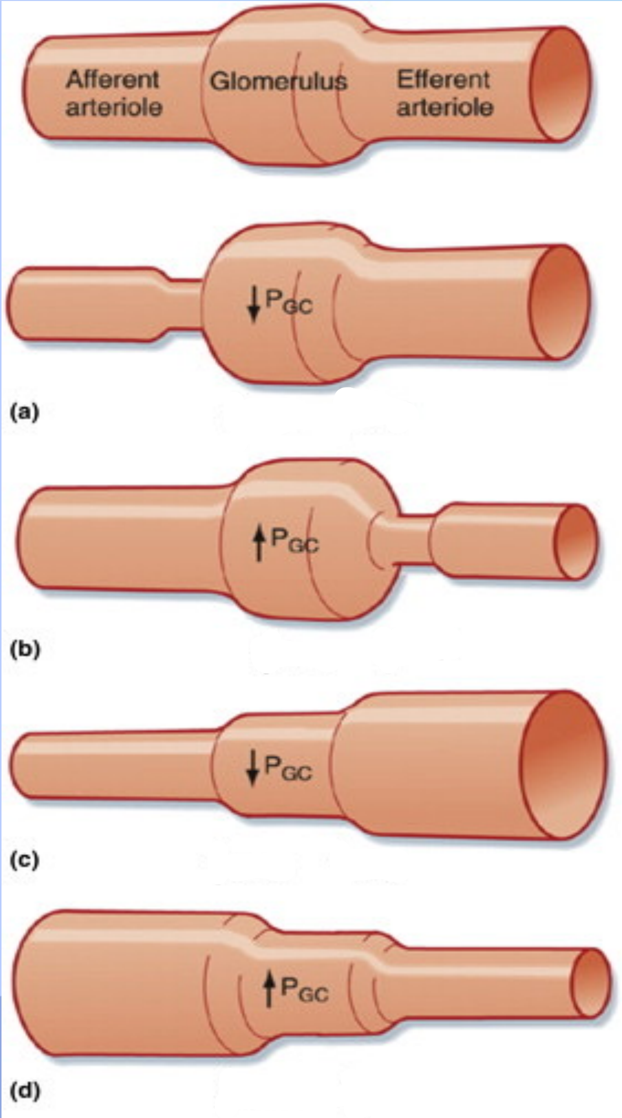
Regulation of glomerular capillary hydrostatic pressure (Pc):



- Constriction
- Dilation

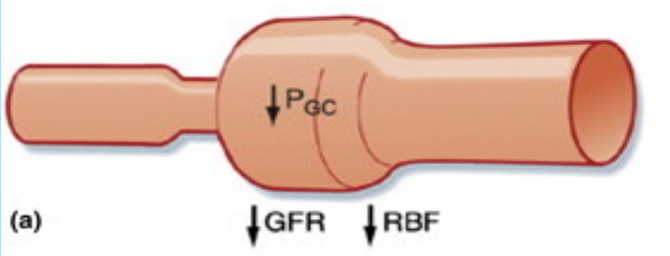
- Let's se what happens to the GFR!

$$GFR = K_f\ [(P_c\text{-}P_b)\text{-}(\pi\ _c)]$$

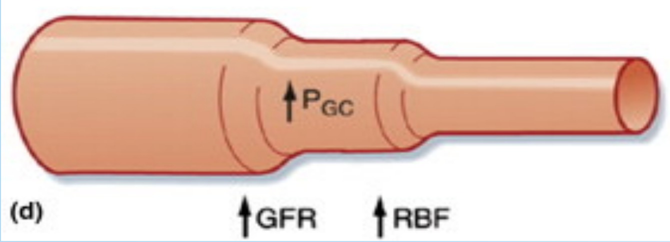
How do we keep RBF/GFR constant with varying CO?

- RBF= constant
- 1.2L/min
- Dependent of cardiac output (CO=HR*SV)

Running→ increased CO→increases RBF/GFR→ constriction of afferent arteriole→ stabilizes RBF/GFR



Dehydration→ decreased CO → decreased RBF/GFR → dilation of afferent arteriole → stabilizes RBF/GFR



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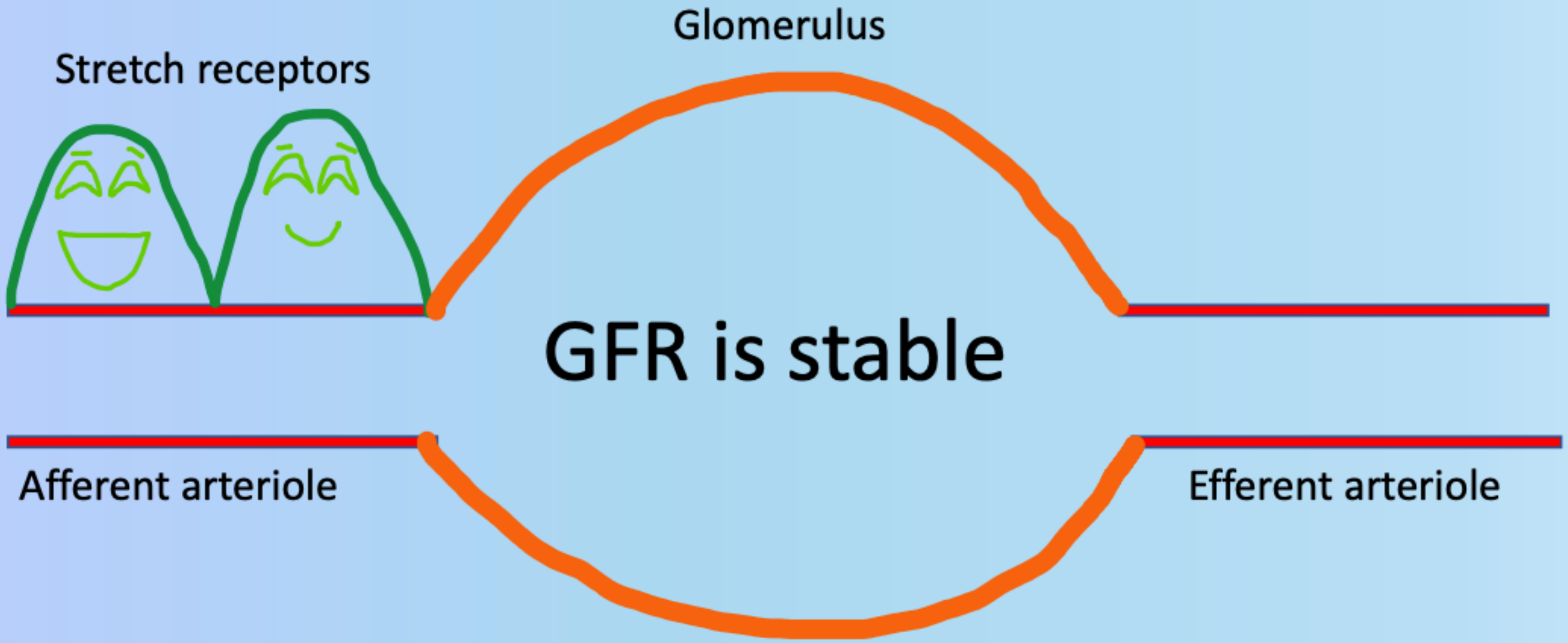
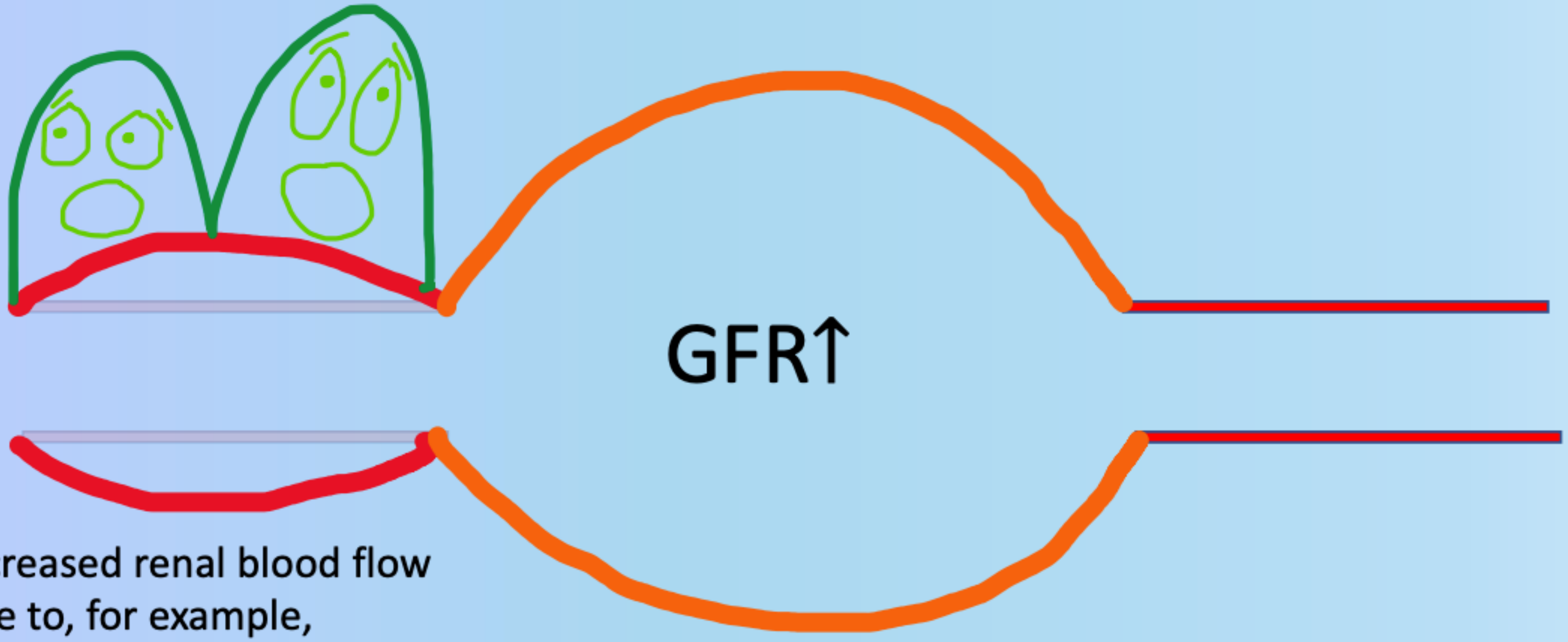
Myogenic reflex

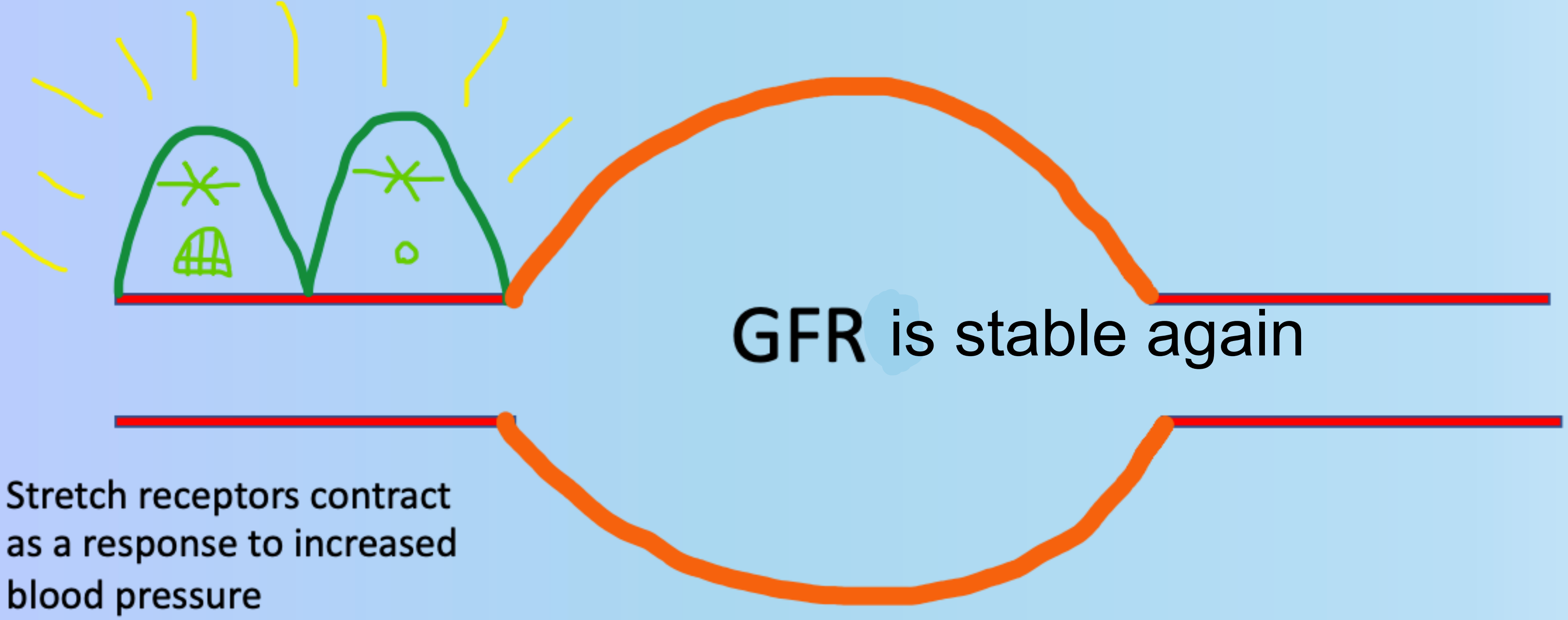


Myogenic reflex



Increased renal blood flow due to, for example, increased systemic blood pressure

Myogenic reflex



Stretch receptors contract as a response to increased blood pressure

GFR decreases and stabilizes again

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Substances released in response to rapid decrease in blood pressure

	Vasoactive substances	Afferent arteriole	Efferent arteriole
Released in response to rapid decrease in BP	Catecholamines	Constrict	Constrict
	Angiotensin II	Constrict	Constrict

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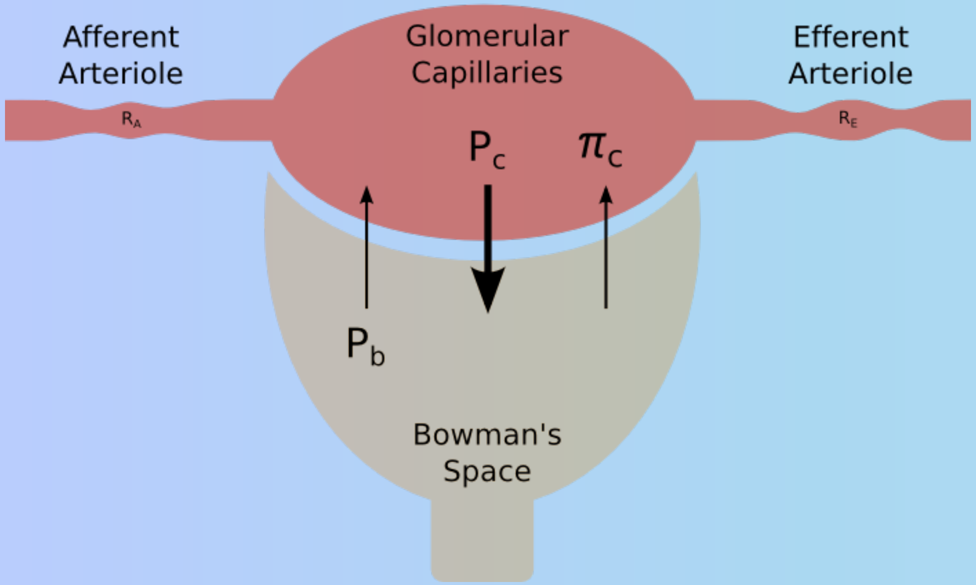
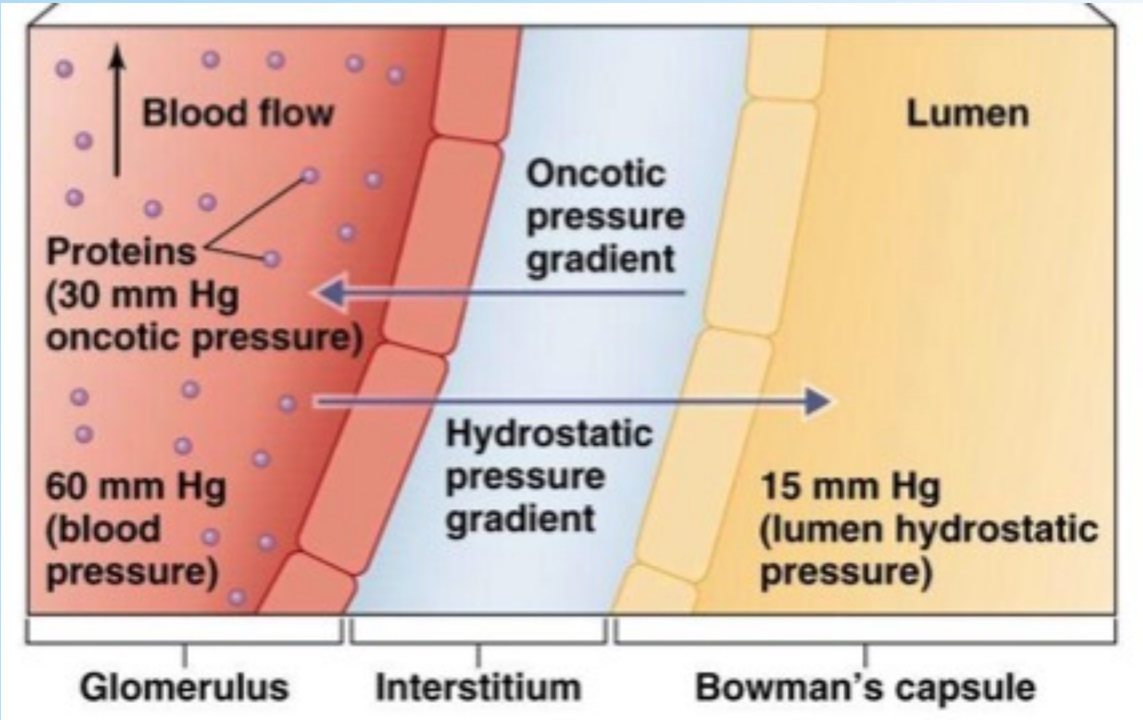
Regulation of hydrostatic pressure in the Bowman space (P_b)



- The hydrostatic pressure exerted by the fluid in Bowmans capsule.
- Can be altered by obstruction of urine flow
- Backflow= ↓ GFR

Regulation of oncotic pressure (π_c)

Dehydration → Increased protein concentration → Increased π_c → Decreased GFR



Get ready for wooclap!