REGULATION OF GFR

Glomerular Filtration Rate (GFR)

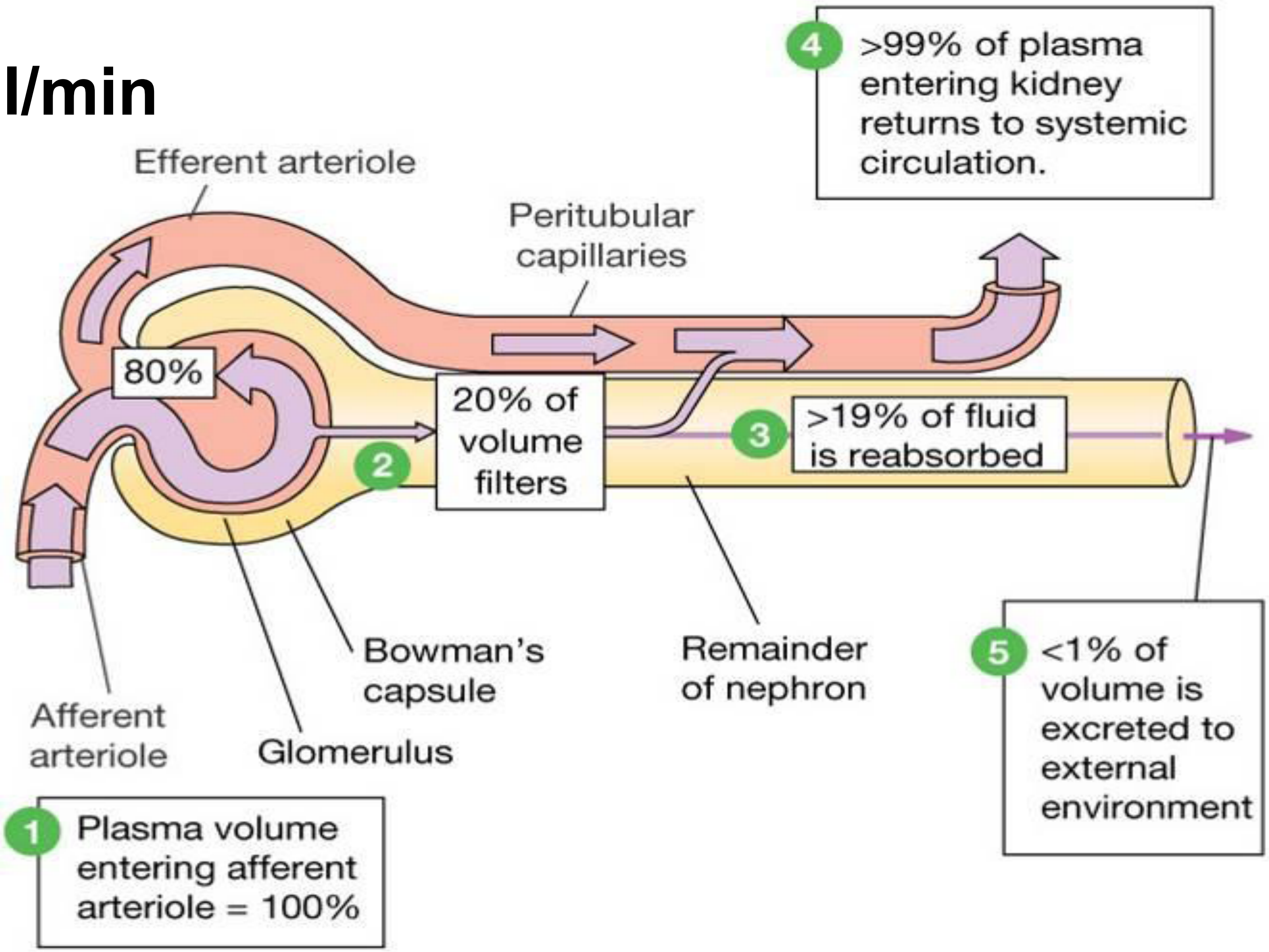
- Defined as: The volume of filtrate produced by both kidneys per min
  - Averages 125 ml/min
  - Totals about 180L/day (45 gallons)
    - So most filtered water must be reabsorbed or death would ensue from water lost through urination
- GFR is directly proportional to the NFP
  - An increase in NFP $\longrightarrow \uparrow$GFR
  - A decrease in NFP $\longrightarrow \downarrow$GFR
- Changes in GFR normally result from changes in glomerular blood pressure.

NFP = net filtration pressure

GFR = 125 ml/min

180 L /day

1% excreted



Why is it important to have the GFR regulated?

Regulation of GFR
Glomerular Filtration Rate

- If the GFR is too high:
  - Fluid flows through tubules too rapidly to be absorbed
  - Urine output rises
    - Creates threat of dehydration and electrolyte depletion
- If the GFR is too low:
  - Fluid flows sluggishly through tubules
  - Tubules reabsorb wastes that should be eliminated
  - Azotemia develops (high levels of nitrogen-containing substances in the blood).

Regulation of GFR

- GFR controlled by adjusting glomerular blood pressure through the following mechanisms:

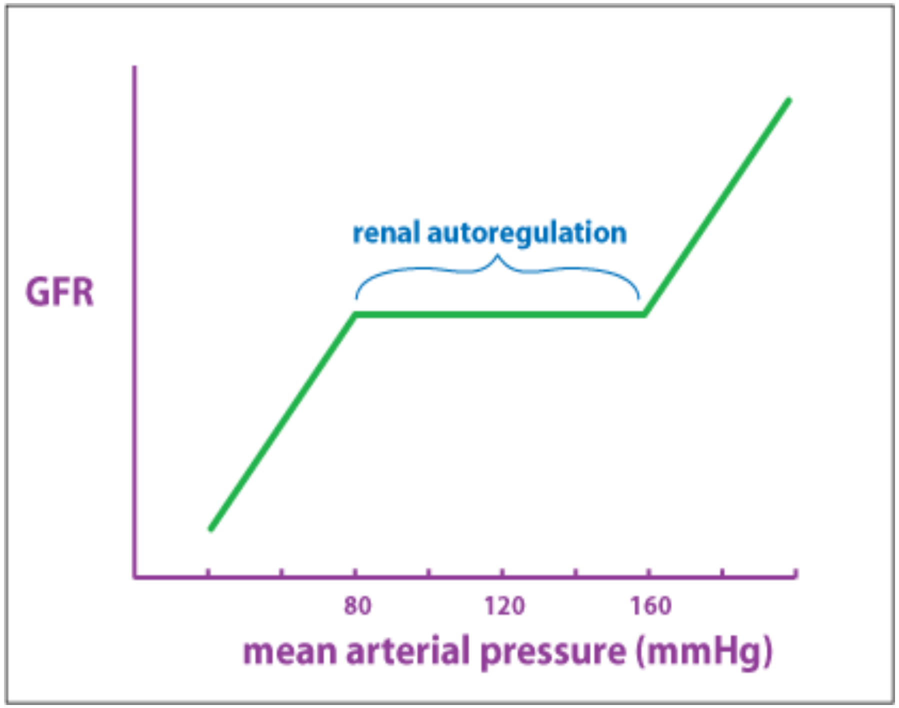
- Autoregulation

- Sympathetic control

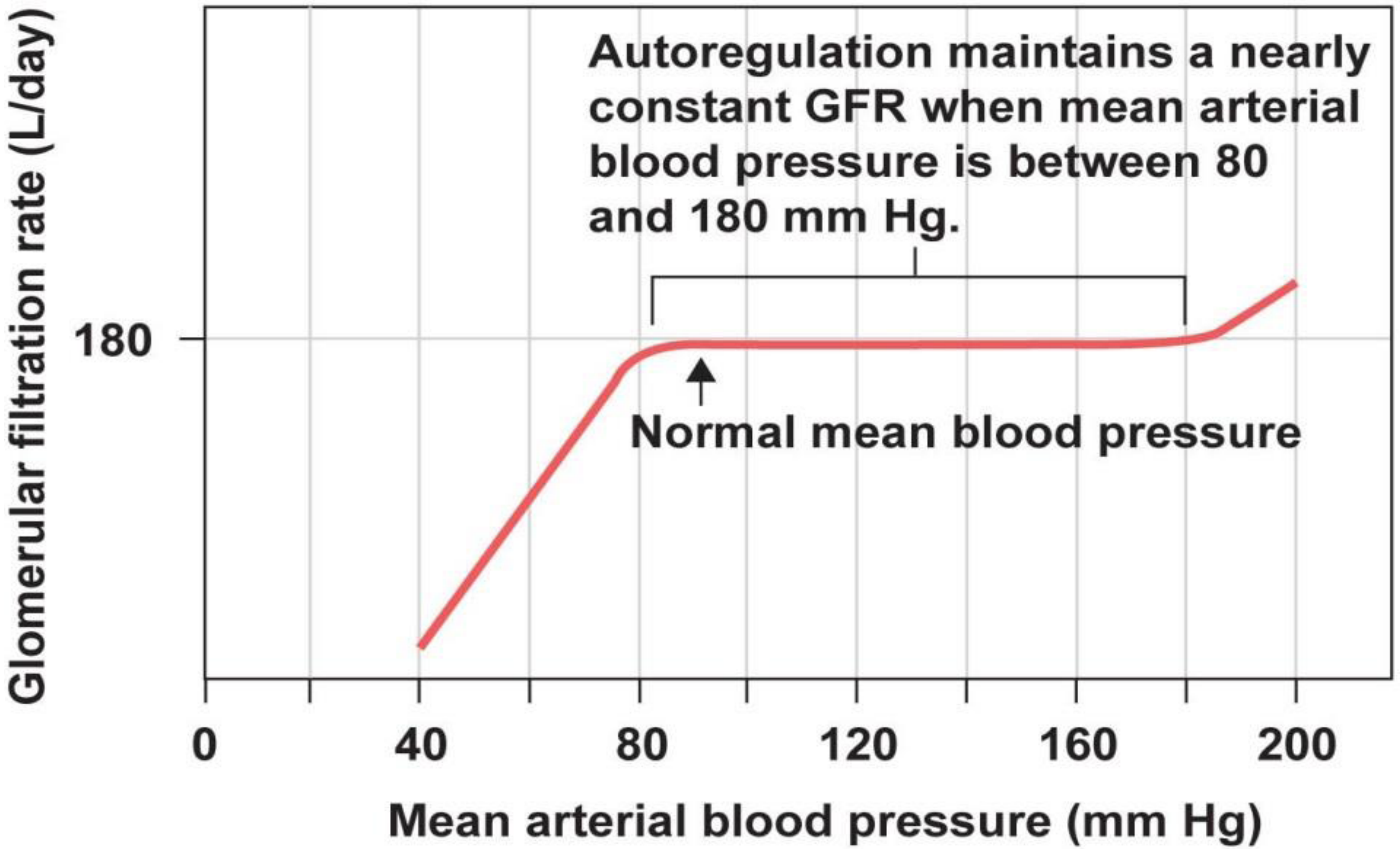
- Hormonal mechanism: renin and angiotensin

Effect of Arterial BP on GFR

- ↑↑ ABP → ↑↑ GFR.
- However, the body maintains **constant GFR** over an ***ABP*** range of ***75-160 mmHg.***
- Why? And how?

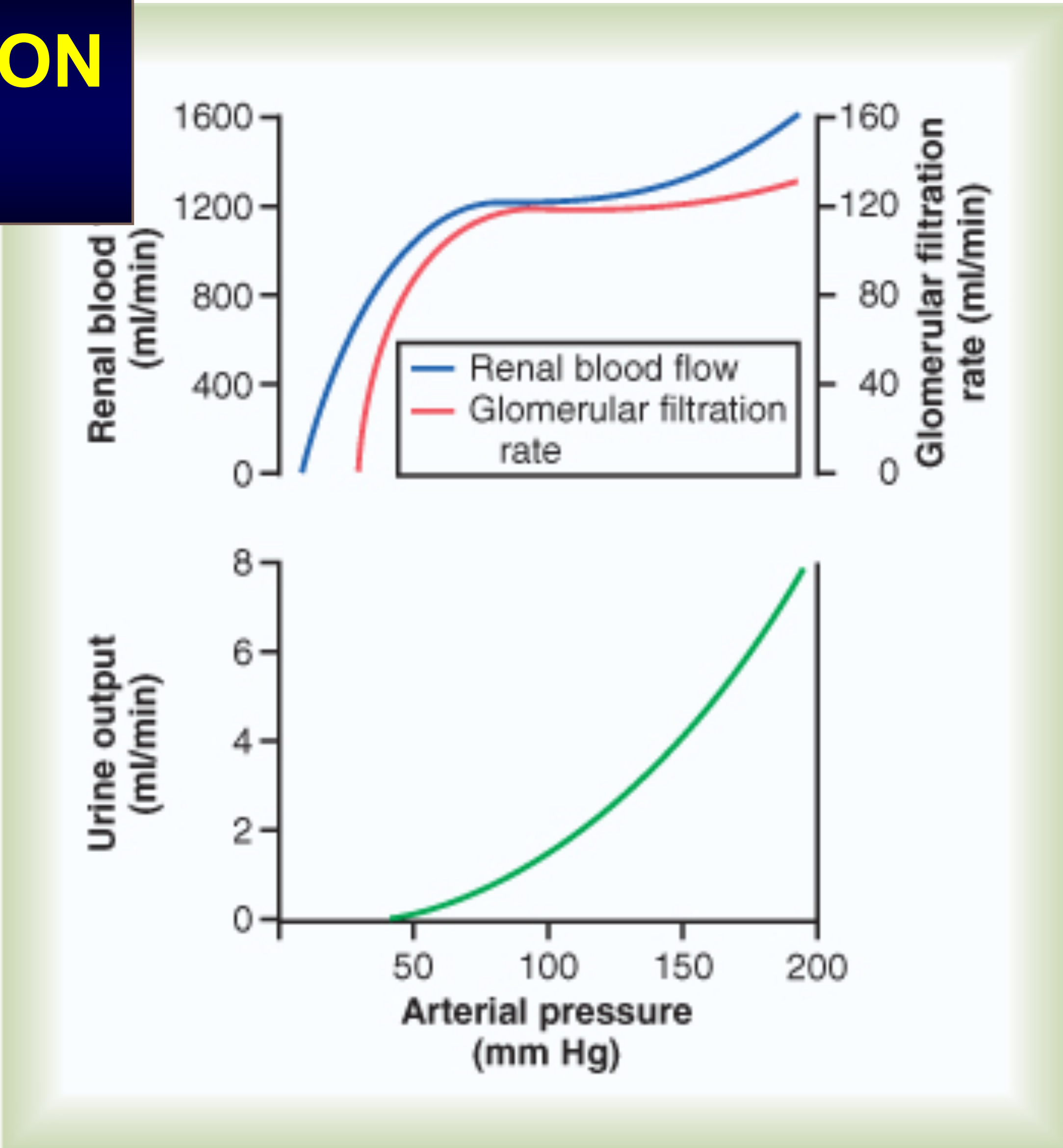


Autoregulation (intrinsic)

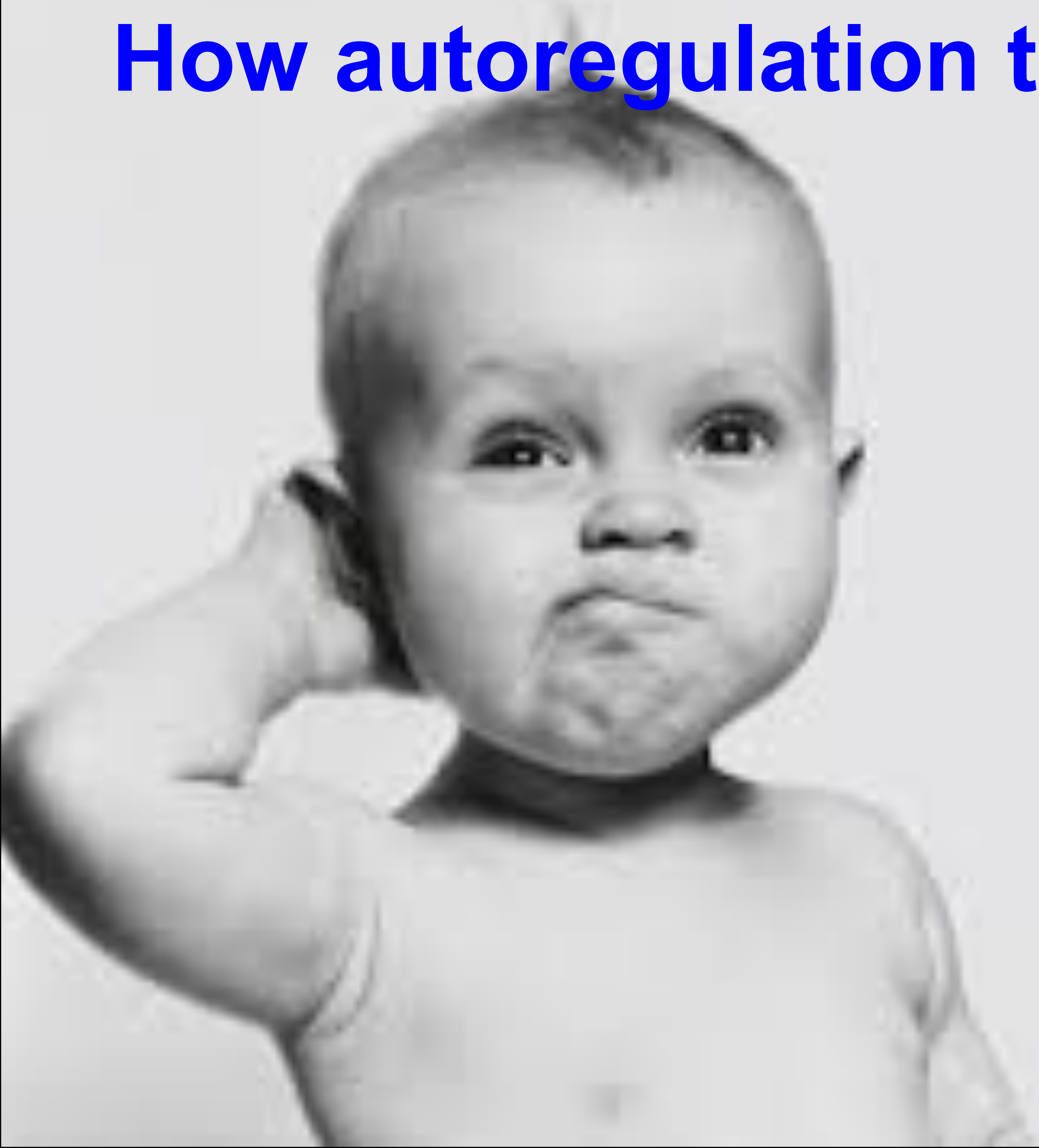


AUTOREGULATION OF GFR

- GFR remains constant over a large range of values of BP
- 75-160 mmHg



How autoregulation takes place?



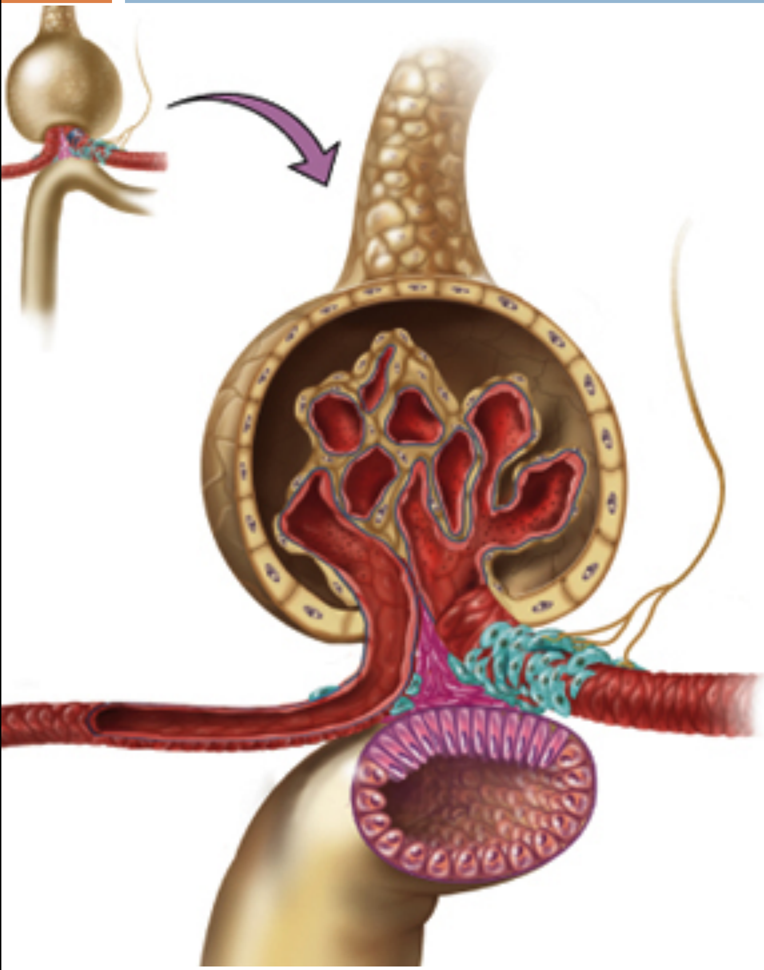
Auto-regulation of GFR

- Refer to feedback mechanisms intrinsic to the kidney that keep the renal blood flow and GFR relatively constant despite fluctuations in ABP.

- These mechanisms operate over an ABP ranging between 75-160 mmHg.

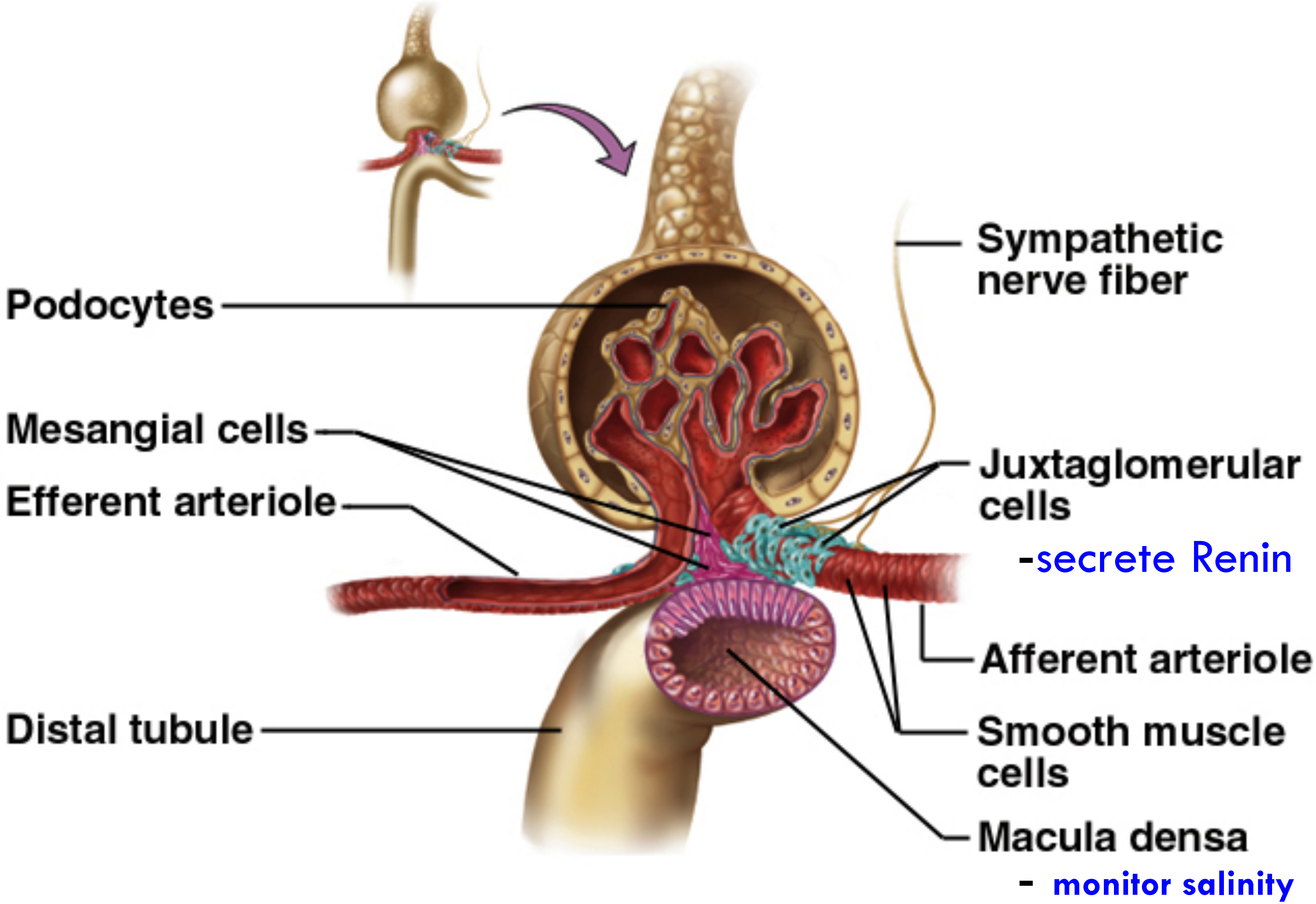
- ***Achieved by 2 major mechanisms***:
  1. Myogenic auto-regulation.
  2. Tubulo-glomerular feedback mechanism.

Renal Autoregulation of GFR

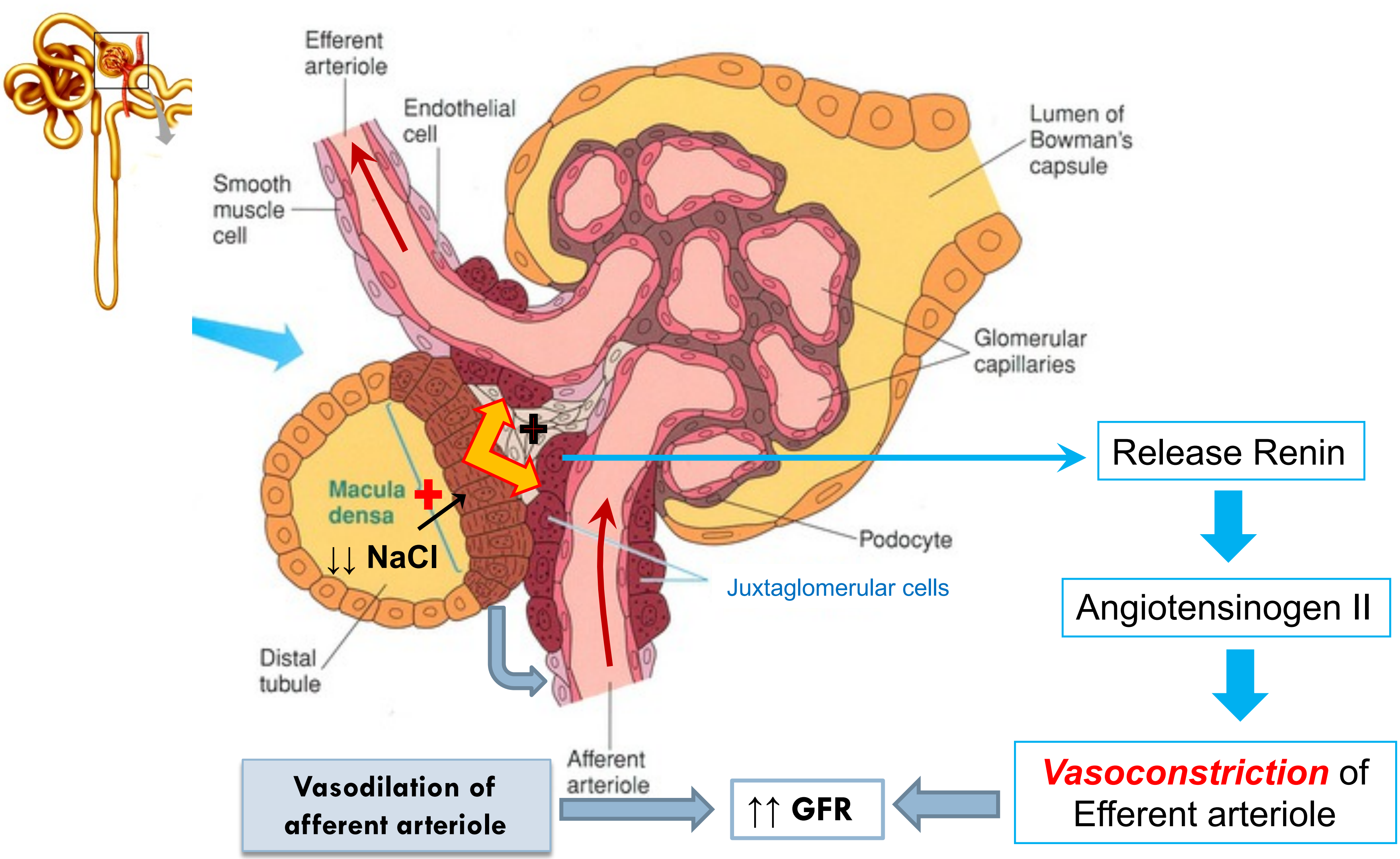


- ↑ BP → constrict afferent arteriole, & dilate efferent
- ↓ BP → dilate afferent arteriole, & constrict efferent
- Stable for BP range of 75 to 160 mmHg (systolic)
- Cannot compensate for extreme BP changes

Juxtaglomerular Apparatus



Tubulo-glomerular Feedback



Mechanism of autoregulation

Tubuloglomerular feedback mechanism:

- ↓ ABP ⟶ ↓ delivery of NaCl to the macula densa cells, which are capable of sensing this change , this will cause two effects:

  1- decrease in resistance of the afferent arterioles (i.e. vasodilatation) ⟶ ↑glomerular hydrostatic pressure to normal levels.

  2- increase in renin release from JG cells → Ang II ⟶ constrict efferent arteriole → ↑glomerular hydrostatic pressure & GFR to normal.

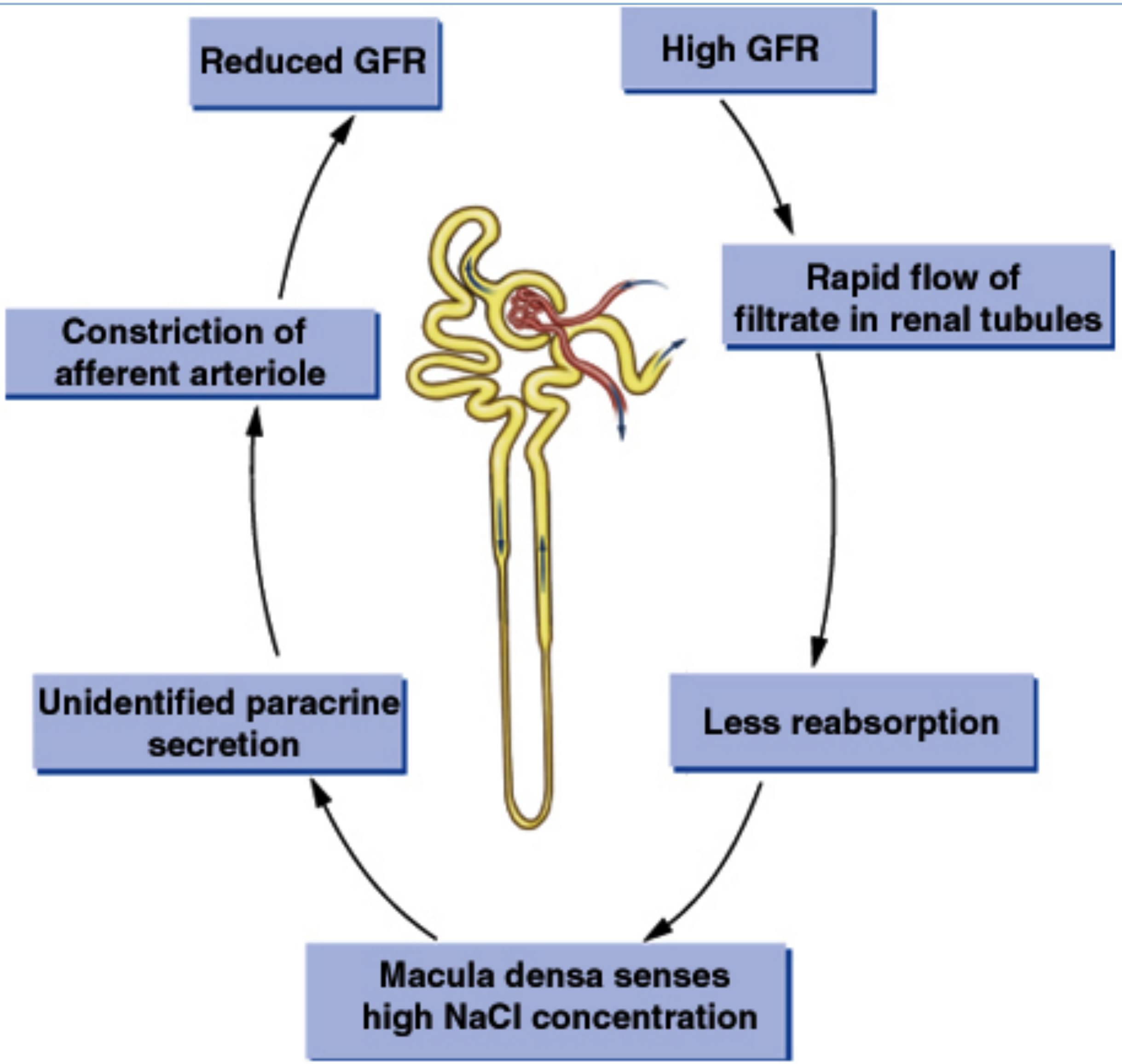
Mechanism of autoregulation, cont…….

Myogenic mechanism:

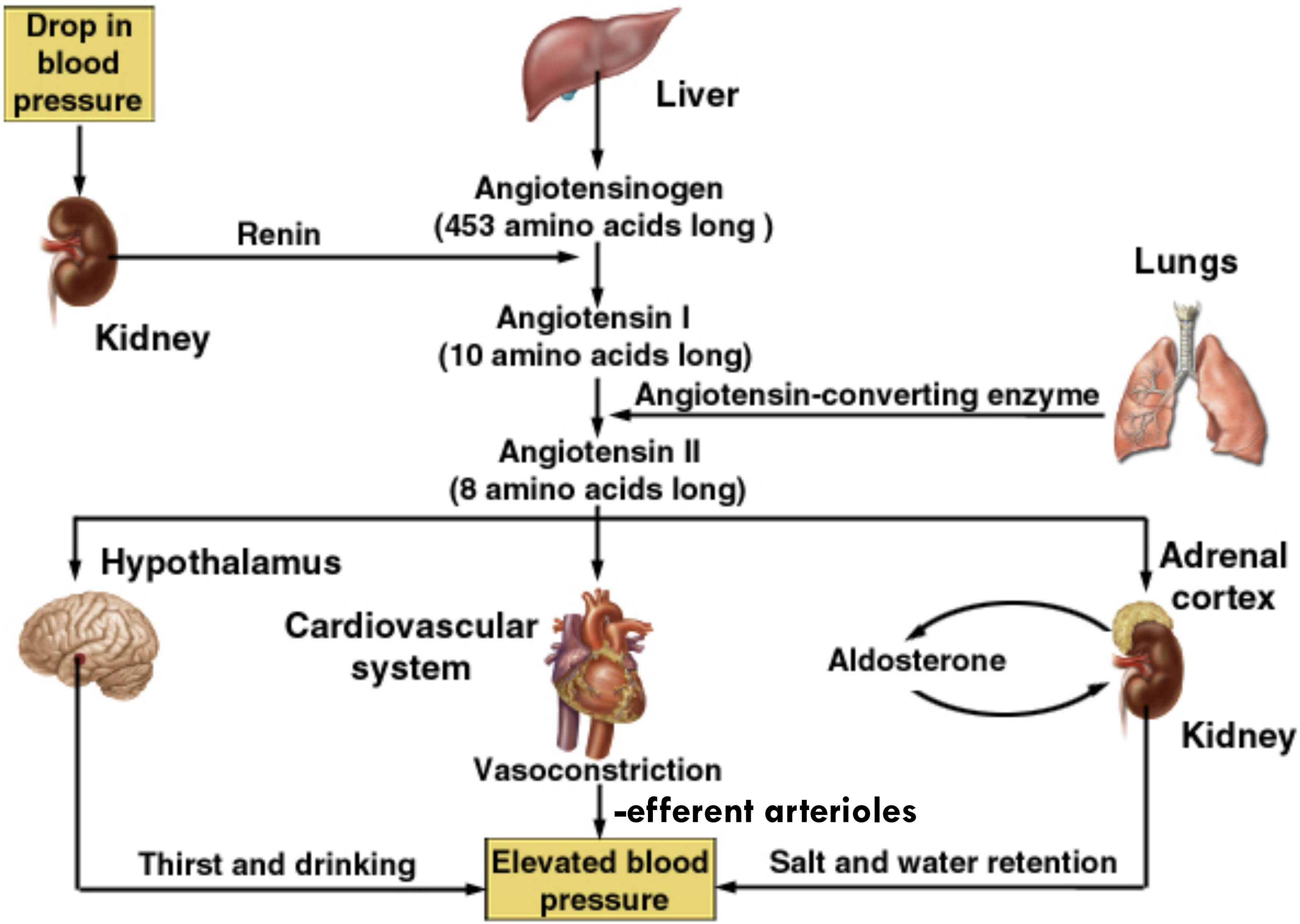
It is the intrinsic capability of blood vessels to constrict when blood pressure is increased. The constriction prevents excess increase in renal blood flow and GFR when blood pressure rises.

When blood pressure decreases the myogenic mechanism reduces vascular resistance and the vessel dilates.

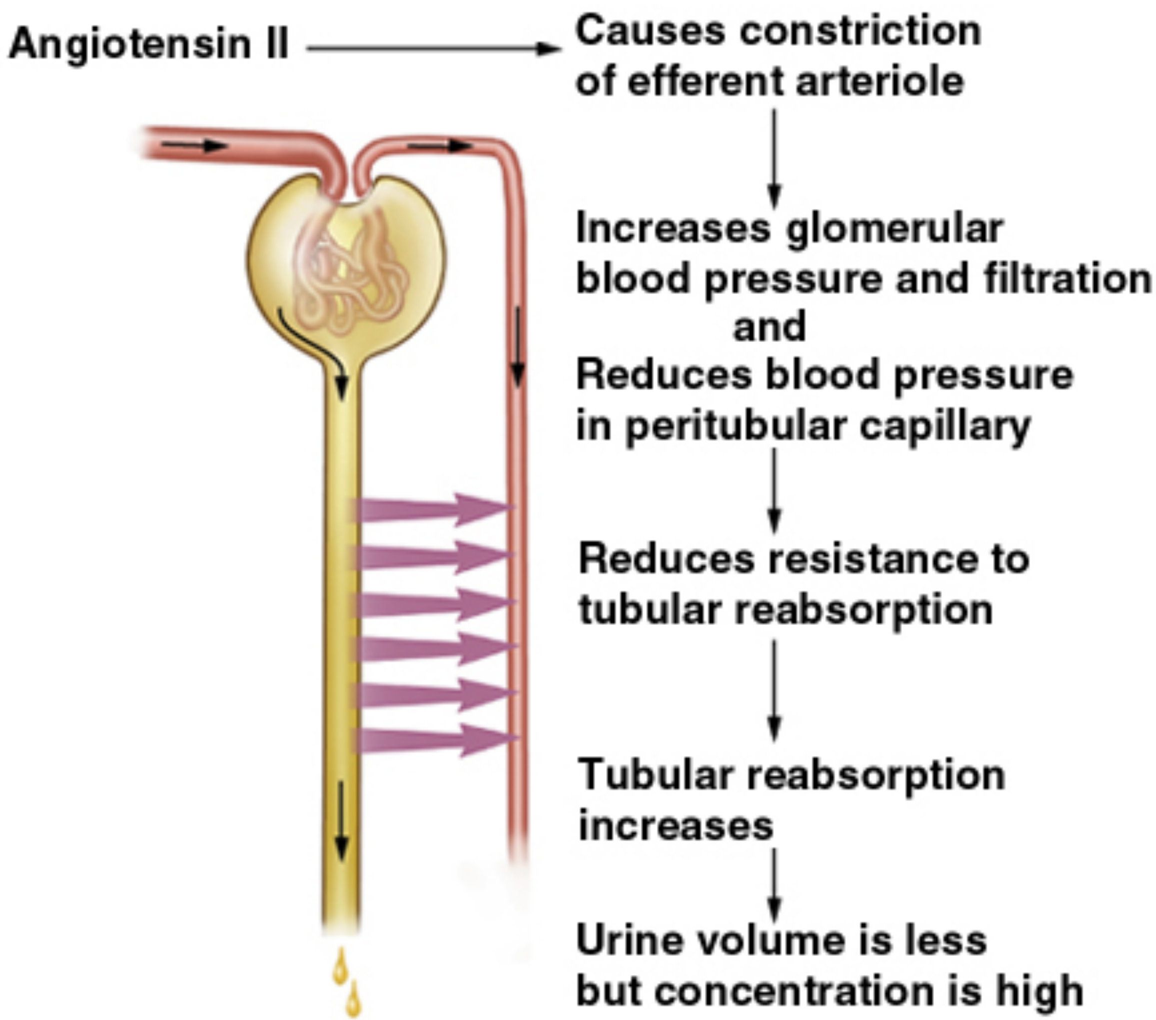
Example of autoregulation



Hormonal Control of GFR



Effects of Angiotensin II



Sympathetic Control of GFR (Extrinsic)

- When the sympathetic nervous system is at rest:
  - Renal blood vessels are maximally dilated
  - Autoregulation mechanisms prevail
- Under stress:
  - Norepinephrine is released by the sympathetic nervous system
  - Epinephrine is released by the adrenal medulla
  - Afferent arterioles constrict and filtration is inhibited
  - Note: during fight or flight blood is shunted *away* from kidneys
- The sympathetic nervous system also stimulates the renin-angiotensin mechanism. This induces vasoconstriction of efferent arteriole.

- إنما يخشى الله من عباده العلماء