MED439
KING SAUD UNIVERSITY

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Physiology

Regulation of GFR

Black: in male AND female slides
Red : important
Pink: in female slides only
Blue: in male slides only
Green: Notes
Gray: extra information

Editing file

Glomerular Filtration Rate (GFR)

Definition

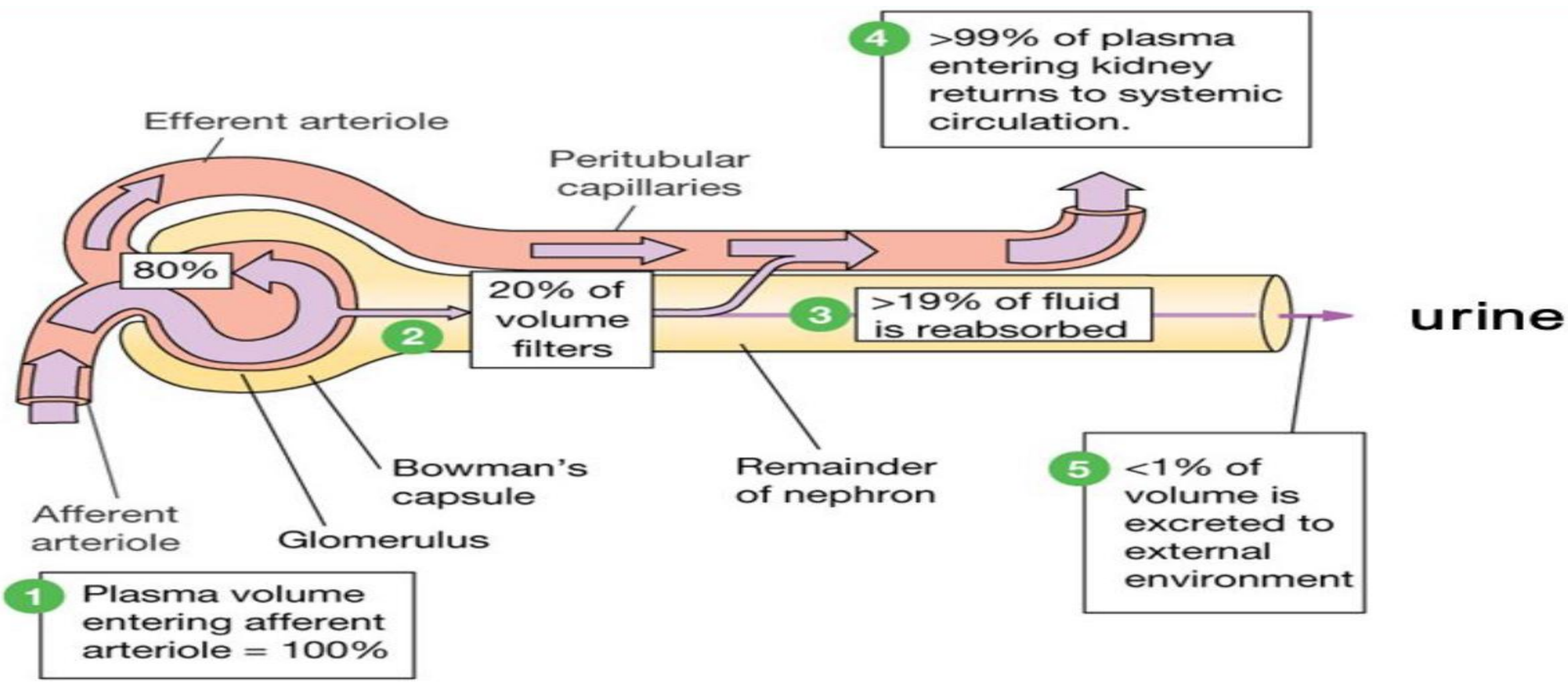
The volume of filtrate produced by both kidneys per minute.

- Averages 125 ml/min.
- Totals about 180 L/day (45 gallons).
- So most filtered water must be reabsorbed or death would ensue from water lost through urination.

As we all know the cardiac output is 5L/MIN or 7200L/DAY so imagine if the amount of plasma that's filtered is lost with urine

By days we would lose a lot of fluid

So most of that fluid is reabsorbed back to the circulation



We know that 20% of the cardiac output goes to the kidneys. So 20% of 5 Liters is 1000 ml of blood. Remember that blood has cells and plasma. And we said that cells don't get filtered because they are large in size. That's why when we talk about GFR, we only care about plasma. So of that 1000 ml of blood, 400 ml are cells, and 600 ml is plasma, and that is where our journey starts!

1. 600 ml of Plasma will go to the kidneys.
2. 80% won't get filtered and will just go to the peritubular capillaries.
   20% will get filtered
   (Note that 600 ml x 20% = 120-125 ml/min, which is the GFR)
3. 19% will get reabsorbed
   (Note that 80% + 19% = 99% of the plasma will get back to the circulation)
4. 1% will be excreted in urine

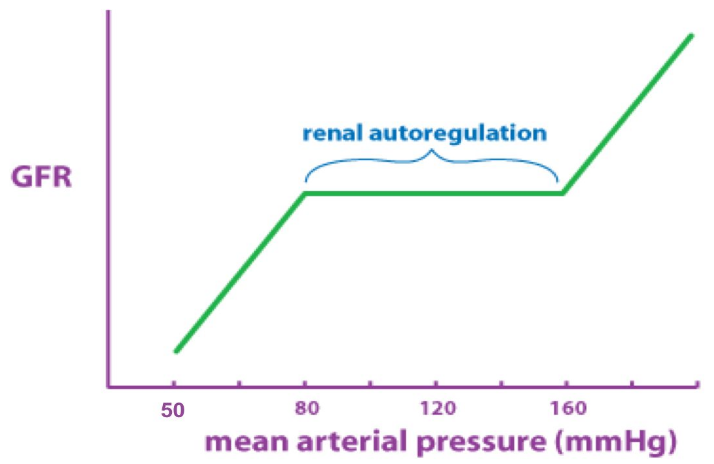
Autoregulation

So we know that an increase in the blood pressure (hydrostatic) will increase the GFR. What if the patient has hypertension? That is very dangerous because it will increase the GFR very significantly, causing dehydration. Thus the kidneys have their own regulation called *Auto-regulation.*

Definition

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.



Notice how the autoregulation works only between the range. If the ABP is out of range, autoregulation will no longer work, and GFR will respond to the change in ABP.

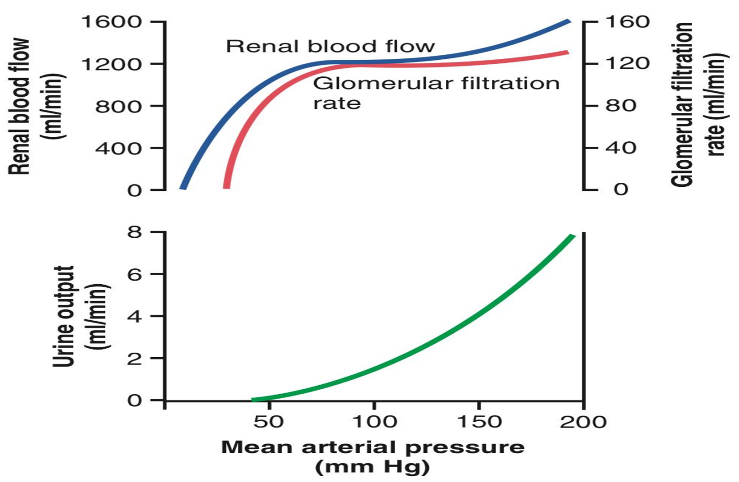


Figure 27-9. Autoregulation of renal blood flow and glomerular filtration rate but lack of autoregulation of urine flow during changes in renal arterial pressure.

From Guyton: In general, renal blood flow is autoregulated in parallel with GFR, but GFR is more efficiently autoregulated under certain conditions.

Myogenic auto-regulation

Achieved by 2 major mechanisms

Tubulo- glomerular feedback mechanism

Tubuloglomerular Feedback

- In the JGA(Juxtaglomerular apparatus), the macula densa were sensory cells that can sense changes in ions and stimulate JG cells to increase/decrease renin production.

GFR ↑

Example:

Increase ABP

- increase in NaCl delivery to DCT
- The macula densa is alerted
- GFR is restored by:

Vasoconstriction of Afferent

Release of adenosine

- GFR is back to normal

GFR ↓

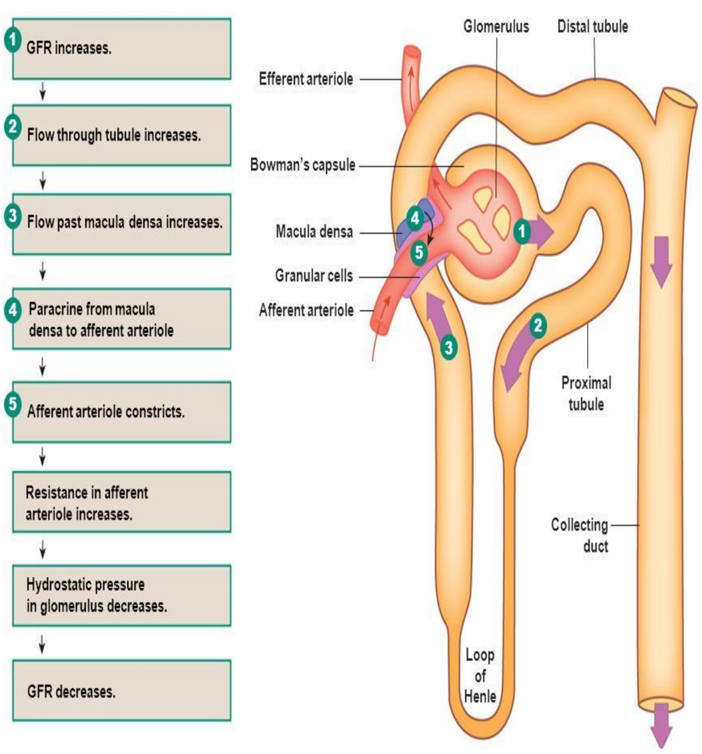
Example:

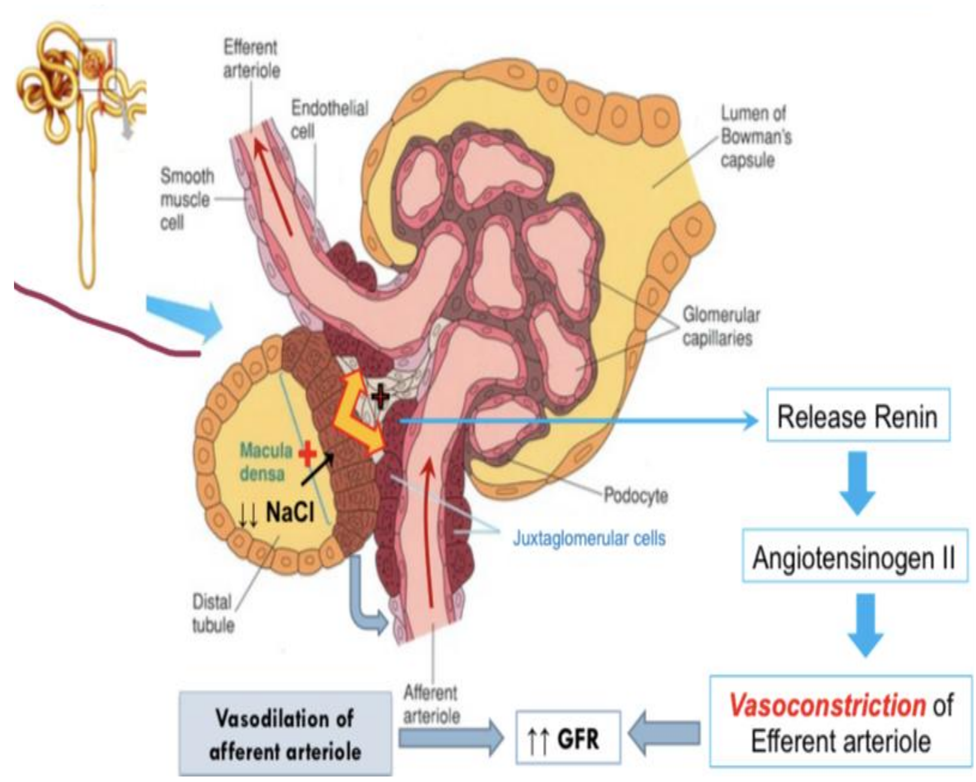
Decreased ABP of high protein diet

- **decrease** in NaCl delivery to DCT
- The macula densa is alerted
- GFR is restored by **two effects:**

1- Decrease in resistance of Afferent arterioles (i.e.Vasodilation) ➡ increase glomerular hydrostatic pressure to normal levels.

2- increase in renin release from JG cells ➡ Ang II constrict Efferent arterioles ➡ increase glomerular hydrostatic pressure & GFR back to normal



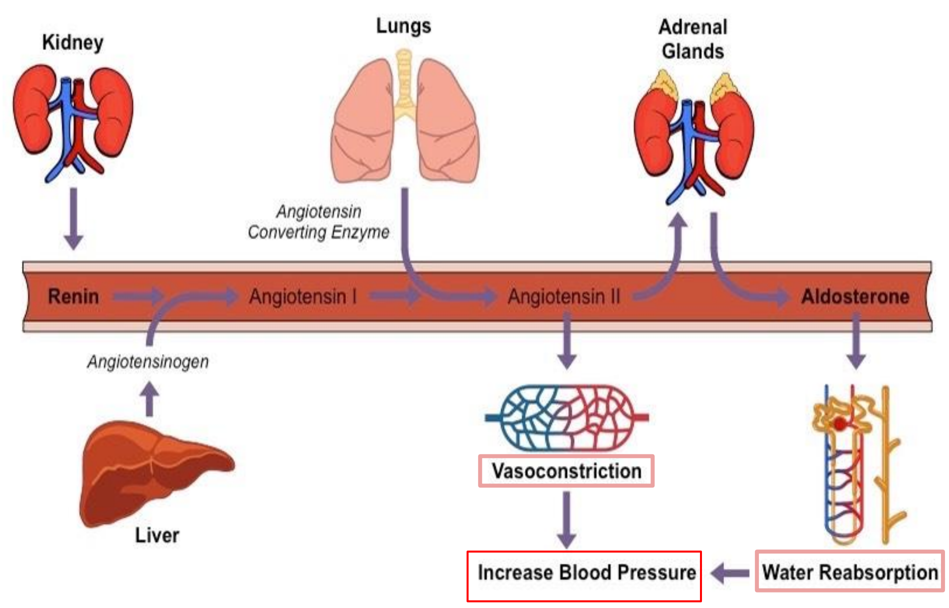


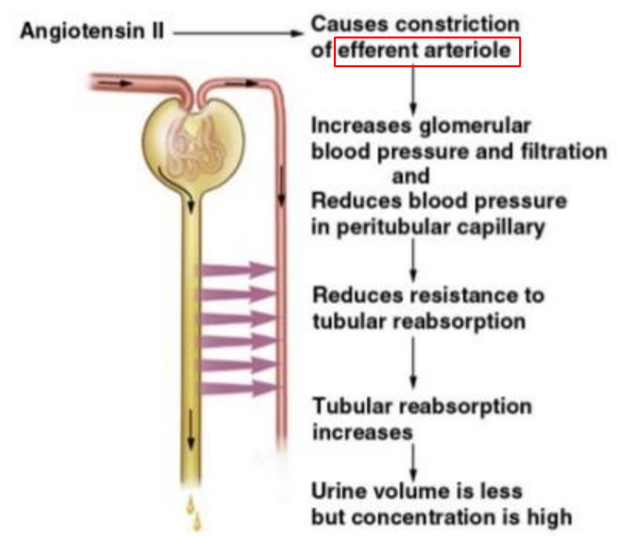
Myogenic system

- It is the intrinsic capability of blood vessels to constrict when **blood pressure is increased.**
- → When BP is high, renal blood vessels **constrict** to prevent an increase in GFR by **decreasing renal flow**
- → When BP is low, renal blood vessels **dilate** to prevent a drop in GFR by reducing arterial resistance and **increasing blood flow.**

Hormonal Control

Renin release ⟶ Renin will convert Angiotensinogen to Angiotensin I ⟶ Angiotensin I will be converted to **Angiotensin II** ⟶ Angiotensin II will do many things but **in the kidney** will do two things:





Vasoconstriction on Efferent arterioles -> decrease fluid that goes to peritubular capillary -> decrease in blood pressure -> increase reabsorption -> fluid will back to the body -> blood pressure back to normal -> GFR also back to normal -> urine will decrease

Sympathetic regulation

When the sympathetic nervous system is
at rest:

-Renal blood vessels are maximally dilated
- Autoregulation mechanisms prevail (overcome)

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 *more blood to your brain and muscles

The sympathetic nervous system also stimulates the renin-angiotensin mechanism *by stimulating B1 receptors in juxtaglomerular cells this induces vasoconstriction of efferent arteriole.

Note: there's no parasympathetic effect on the kidney

[Click here to see Dr.Manan notes as a summary of the lecture](#)

MCQ & SAQ

Q1: Which of the following is NOT a factor in regulating GFR?

A. Renal Autoregulation
B. Renin and angiotensin
C. Sympathetic control
D. Parasympathetic control

Q2: How would the GFR be affected if ABP increases from 80 mmHg to 100 mmHG?

A. Increases 2 folds
B. Increases 3 folds
C. Decreases 2 folds
D. Remains constant

Q3: what is the percentage of cardiac output that enter to the kidney

A. 30%
B. 50%
C. 25%
D. 20%

Q4: Macula densa:

A. monitor salinity
B. secrete Renin
C. constrict efferent arteriole
D. dilate efferent arteriole

Q5: Which of the following is correct:

A. increase in net filtration pressure result in increase glomerular filtration rate.
B. increase in net filtration pressure result in decrease glomerular filtration rate.
C. Net filtration pressure has no effect in glomerular filtration rate.

Q6: Which of the following is correct:

A. 99% of glomerular filtration rate excreted.
B. 1% of glomerular filtration rate reabsorbed.
C. 1% of glomerular filtration rate excreted.
D. 50% of glomerular filtration rate reabsorbed.

answer key:
1: D
2: D
3:D
4: A
5: A
6: C

1- Enumerate the factors regulating GFR.

2- Define autoregulation.

3-The average glomerular filtration rate in healthy person is:

4- The body maintains constant GFR over an ABP range of 75-160 mmHg because of which mechanism:

A1: Renal Autoregulation, Hormonal mechanism: Renin and angiotensin, and Sympathetic control.

A2: Feedback mechanisms intrinsic to the kidney that keep the renal blood flow and GFR relatively constant despite fluctuations in ABP.

A3:. 125 ml/min

A4: Autoregulation

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