TOPIC: RENAL PHYSIOLOGY - REGULATION OF GLOMERULAR FILTRATION

Introduction to Regulation of Glomerular Filtration

◆ GFR is regulated by a number of mechanisms:

	Internal Factors (Renal _____regulation)	External Factors
Purpose	Kidneys regulate renal blood flow. Maintain GFR _____.	Maintain systemic blood pressure. Maintain GFR _____.
Effect on GFR	Keeps GFR consistent through _____ changes in blood pressure.	Adjusts _____ following significant changes in blood pressure, volume, and electrolyte imbalance.
Examples	1. The myogenic mechanism. 2. The tubuloglomerular mechanism.	3. Neural mechanisms. 4. The renin-angiotensin-aldosterone mechanism.

◆ Each of these mechanisms works by controlling the _____ of the afferent and/or efferent arterioles.

EXAMPLE

Generally speaking, renal autoregulation maintains glomerular filtration rate _____, whereas external factors regulate glomerular filtration rate _____.

a) Directly; indirectly.

b) Indirectly; directly.

c) Automatically; consciously.

d) Slowly; quickly.

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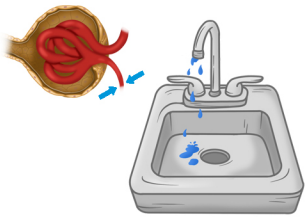
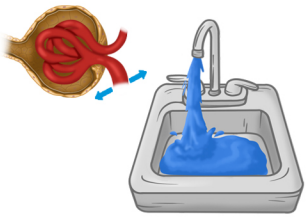
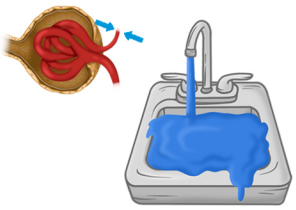
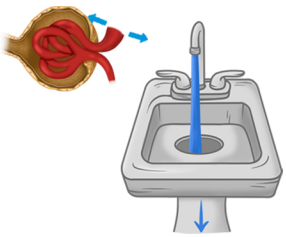
Arteriolar Diameter and GFR

- Changes in arteriolar diameter affect glomerular filtration _____, which in turn affects filtration _____.
- Imagine the glomerular capsule is a sink, where:
  - The faucet is the __fferent arteriole.
  - The basin is the glomerulus.
  - The drain is the __fferent arteriole.

	Vasoconstriction	Vasodilation
Afferent	"Turn the faucet _____"  ↓ Decreased GFP and GFR	"Turn the faucet _____"  ↑ Increased GFP and GFR
Efferent	"The drain is _____" 	"The drain is too _____" 

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Internal Regulation - The Myogenic Mechanism

- Adjusts afferent arteriole in response to minor changes in blood pressure.
- *Recall*: To maintain homeostasis, vascular smooth muscle responds to changes in blood pressure.
  - Contracts when stretched and _____ when not stretched.
- Stimulus: Stretching or decrease of stretch in the _____ arteriole.

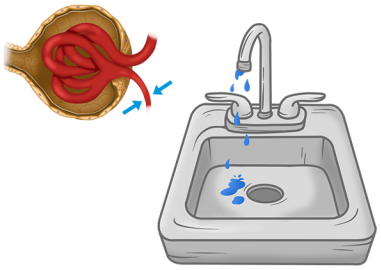
Recall **Prefix Myo-**

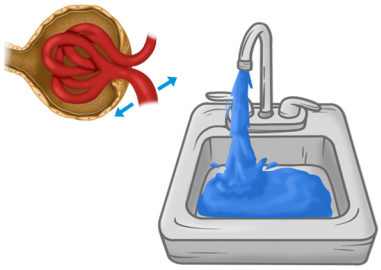
"Myo" means muscle – this mechanism reflects a property of certain muscles.

Key

- Blood Pressure
- Stimulus
- Physiological Response
- Effect on GFR

Increase in _____ blood pressure.	Decrease in systemic blood pressure.
⬇	⬇
Increased stretch in smooth _____ in afferent arteriole.	____creased stretch in smooth muscle of afferent arteriole.
⬇	⬇
Arteriole _____.	Arteriole _____.
⬇	⬇
Restricts blood _____ into glomerulus.	____creases blood flow into glomerulus.
⬇	⬇
GFR maintained at _____ range.	GFR maintained at normal range.





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EXAMPLE

True or False (if false, choose the answer that corrects the statement): The main stimulus that triggers the myogenic mechanism is a high concentration of sodium delivery to the glomerular capillaries.

a) True

b) False: The main stimulus that triggers the myogenic mechanism is an increase or decrease in stretch of the efferent arteriole.

c) False: The main stimulus that triggers the myogenic mechanism is an increase or decrease in stretch of the afferent arteriole.

d) False: The main stimulus that triggers the myogenic mechanism is a low level of sodium in the filtrate.

PRACTICE

The myogenic mechanism is triggered by changes in the stretch of the afferent arteriole. This is the direct result of:

a) Changes in glomerular filtration rate.

b) Changes in glomerular pressure.

c) Changes in systemic blood pressure.

d) Electrolyte levels.

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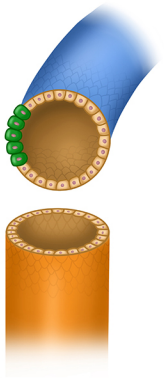
Internal Regulation - The Tubuloglomerular Mechanism

- Secondary mechanism that adjusts afferent arteriole in response to minor changes in blood pressure.
- *Recall*: Macula densa cells in the renal _____ respond to NaCl levels.
- Stimulus: Changes in levels of NaCl near the _____ densa cells.

Note: In this mechanism, the renal **tubule** acts on the **glomerulus**.

Increase in systemic blood pressure.	Decrease in systemic blood pressure.
⬇	⬇
As GFR increases – filtrate _____ increases.	As GFR decreases – filtrate volume ____creases.
⬇	⬇
Increased delivery of _____ to macula densa cells.	Decreased delivery of NaCl to _____ densa cells.
⬇	⬇
Macula densa cells release _____constrictor chemicals.	Macula densa cells _____ releasing vasoconstrictor chemicals.
⬇	⬇
Constriction of _____ arteriole.	_____ of afferent arteriole
⬇	⬇
_____ decreased to normal range.	GFR increased to normal range.



Key

- Blood Pressure
- Stimulus
- Physiological Response
- Effect on GFR

EXAMPLE

Fill in the blanks: Increased delivery of NaCl to the macula densa cells is indicative of _____. This would trigger the tubuloglomerular mechanism, which would cause _____ of the afferent arteriole.

a) Decreased glomerular filtrate rate; constriction.

b) Increased glomerular filtrate rate; constriction.

c) Decreased glomerular filtrate rate; dilation.

d) Increased glomerular filtrate rate; dilation

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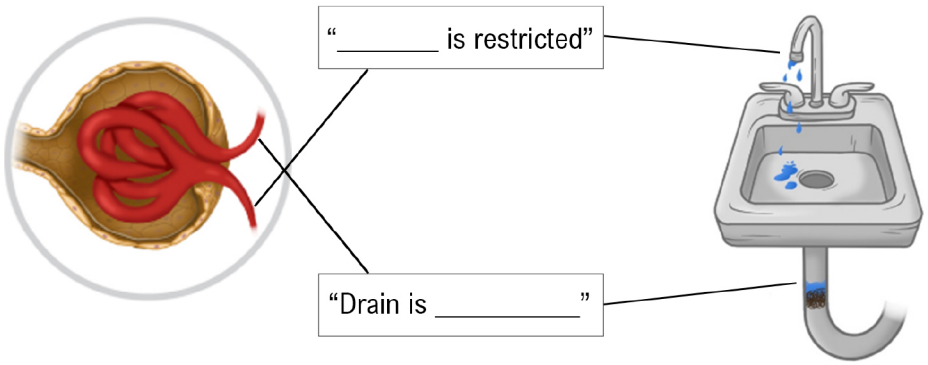
External Regulation – Neural Mechanisms

- Stimulus: _____ sympathetic activity overrides renal autoregulation.
- Sympathetic activation triggers release of _____epinephrine - constricts blood vessels in non-essential organs.
  - Including afferent and efferent arterioles.
- Constriction of **both** arterioles _____ GFR:
  - Helps body minimize fluid loss and preserve blood volume and pressure at _____ organs.



EXAMPLE

Activation of the sympathetic nervous system leads to a decrease in glomerular filtration rate. Why is decreasing GFR advantageous in potentially stressful, dangerous, or arousing situations?

a) By reducing glomerular filtration rate, the body prevents hypertension.

b) By increasing fluid loss, it makes you lighter in case you need to run away from danger.

c) It helps minimize fluid loss and preserves blood volume and pressure at vital organs.

d) It actually isn't advantageous, and seems to be a leftover 'quirk' of evolution.

PRACTICE

The sympathetic nervous system releases _____, which causes constriction of the afferent and efferent arterioles.

a) Acetylcholine.

b) Epinephrine.

c) Norepinephrine.

d) Dopamine.

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External Regulation – Renin-Angiotensin-Aldosterone Mechanism

- *Recall*: The renin-angiotensin-aldosterone mechanism is the body's main mechanism for increasing blood pressure.
- Stimulus: Sympathetic activity or detection of _____ blood pressure.
- This mechanism works as follows:

Systemic blood pressure decreases –macula densa detect low _____

↓

Signals kidneys to release the enzyme _____ into the bloodstream.

↓

Renin converts angiotensinogen into **angiotensin-I**.

↓

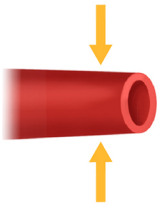
Angiotensin-I travels to lungs – gets converted into **angiotensin-II**.

Increases systemic blood pressure.

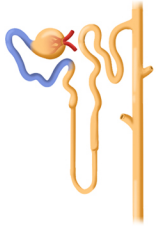
Increases blood volume.

Increases GFP and GFR.

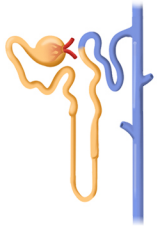
Vasoconstriction of systemic blood vessels.



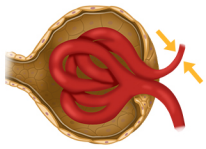
Promotes reabsorption of Na+ in proximal tubule – causes reabsorption of water by _____.



Promotes release of **aldosterone** - increases reabsorption of _____ in distal tubule and collecting duct - causes reabsorption of water by osmosis.



Vasoconstriction of _____ arteriole.



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Which of the following hormones is responsible for increasing reabsorption of Na^+ in the distal tubule and collecting duct?

a) Angiotensin-I.

b) Angiotensin-II.

c) Aldosterone.

d) Parathyroid hormone.

PRACTICE

Angiotensin-II directly increases glomerular filtration pressure by _____ the _____ arteriole.

a) Constricting; afferent.

b) Constricting; efferent.

c) Dilating; afferent.

d) Dilating; efferent.