Introduction to Renal Physiology

Topics for today:
• Review CO$_2$ transport
• Neural controls of ventilation
• Structure of kidneys and nephron
• Clearance concept
• Filtration, reabsorption, and secretion
• Amount of urine produced per day

Modes of Transport of CO$_2$
~65% as HCO$_3^-$ ion
(part of major blood buffer)

~27% complexed with Hb
(in the form of carbamino)

~8% as simple CO$_2$
(dissolved gas)
Neural controls of respiration

Neural center in lower brain control rate and depth of respiration. Cranial and spinal nerves carry impulses from control centers to the diaphragm and intercostal muscles. Lung stretch receptors in lung monitor volume of lung and send feedback impulses to centers in lower brain.

Neural cycle of ventilation control

Sequence of neural control:
- Phrenic nerve stimulates diaphragm
- Inhalation excites stretch receptors
- Feedback impulses inhibit inspiratory center

Special receptors along aortic arch and carotid arteries that monitor plasma 
CO₂ concentration.
**CO₂ Effects on Ventilation**

Carotid and aortic body receptors continuously monitor CO₂ levels.

1% increase in CO₂ causes about two-fold increase in minute volume.

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**Design and Function of Kidneys**

- What essential processes are performed by kidneys?
- How are kidneys designed for these processes?
- How much urine do kidneys produce per day?

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**Overview of kidney function**

- Kidneys receive about 20% of cardiac output
- Kidney function is to continuously clear plasma flowing through them

*Kidneys anatomy is designed for processes they perform.*
Clearance function of kidney

The main function of the kidney is clearance, process by which the kidney removes ('clears') harmful substances from the plasma.

\[ C = \frac{(U \times V)}{P} \]

urine out (with harmful solutes)

Internal structure of kidney

The Nephron (kidney functional unit)

Nephron functional processes:

- Filtration - function of glomerulus
- Reabsorption - function of tubules
- Secretion - function of tubules
Fine structure of renal corpuscle

Monitors input pressure; triggers release of local factors (bradykinin and endothelin) and systemic factors (renin); these local and systemic factors affect blood pressure to modulate glomerular filtration rate.

Design facilitates filtration, the main function of this part of nephron.

SEM view of glomeruli

Urine (and filtrate) Formed per Day

- Renal blood flow: ~24% of cardiac output (1.2 L/min)
- Renal plasma flow: ~700 ml/min
- Glomerular filtration rate: ~125 ml/min (or 180 L/day ... ~3x body mass)
- Urine formation: ~1.25 ml/min (~1.8 L/day)