

Anatomy and Physiology II
Exam #4 Review

1. Mix and match; note that the mix and match may include diagrams of the lung.
2. What is respiration and what three process are involved in respiration? Why do cells need oxygen?

Respiration - The process of gas exchange in the body

A. pulmonary ventilation - Breathing in/out

B. External respiration - diffusion of gasses in/out of the blood & transport of gasses by the circulation system

C. Internal respiration - cellular respiration

Cells need oxygen to produce energy.

3. How many lobes does the right lung have and how many lobes does the left lung have? Why does the left lung have fewer lobes?

Right lung has three lobes, left lung has two. Left lung is smaller to make room for the heart.

4. What are the plural membranes and what are the layers of the plural membranes (i.e., parietal pleura, plural cavity, and visceral pleura)?

Pleural membranes - The serous membranes that surround the lungs.

Parietal pleura - The layer of the pleura that lines the thoracic cavity, outer most layer of pleura.

Pleural cavity - Space between the Parietal pleura and the Visceral pleura, Filled with lubricating fluid to prevent friction from the movement associated with breathing.

Visceral pleura - The layer of the pleura that lines the lungs.

5. Explain how inspiration and expiration of air into the lungs occurs?

Inspiration: The diaphragm moves down (contraction) and the chest moves out slightly increasing the size (volume) of the thoracic cavity, this causes a lower pressure inside the lungs and air moves into the lower pressure zone. Primary muscles: diaphragm contraction and external intercostals contract to move the chest out.

Expiration: Diaphragm moves up, and ribs close (normally w/o muscles); Contraction of smooth muscle in bronchioles; Elastic recoil of alveoli; attraction of water on alveoli walls.

6. Why is the trachea surrounded by cartilage?
To prevent it's collapse during inspiration.

7. What is surfactant and what does it do?

A lipoprotein secreted by the type II alveoli cells that reduces the surface tension of water on the alveoli walls, preventing them from collapsing.

8. Explain how the vocal cords produce sound.

The larynx houses the vocal cords (glottis) in an opening called the rima glottides.

- Air movement over the vocal cords causes them to vibrate to produce sounds.
- The tighter the vocal cords are pulled the higher the pitch (greater the frequency) is.
- Muscles can be used to pull the vocal cords tighter.

9. How is the breathing rate regulated? What does your body sense to up the breathing rate?

- **Medullary Rhythmicity area** (medulla oblongata):
 - o Controls the basic rhythm of breathing,
 - o normally 2 seconds inspiration, 3 seconds expiration.
 - o inspiratory area that sends the messages to the lungs to inhale.
 - o Normal expiration does not require any messages
 - o expiratory area of the medullary rhythmicity area is responsible for sending message if needed.
- **Pneumotaxic area** (pons): Transmits inhibitory impulses to the medullary rhythmicity area to inhibit it's signals to the lungs before the lungs become overfilled with air.
- **Apneustic area** (pons): Transmits stimulatory signals to the medullary rhythmicity area to activate it and prolong inspiration.
- pneumotaxic override apneustic.

Senses used to control breathing:

- **Respiratory center of the medulla oblongata** has chemosensitive area that senses the CO₂ and H⁺ concentration in the blood and increases the breathing rate if either is high.
- **Aortic bodies** of the aortic arch **carotid bodies** of the left and right carotid arteries also sense the CO₂ and H⁺ concentration in the blood and increases the breathing rate if either is high. They **also sense low oxygen** levels and increase the breathing rate if it drops too low.

10. Be able to explain Boyle's law, Dalton's law, and Henry's law.

Boyle's law:

$$\frac{P_1}{V_1} = \frac{P_2}{V_2}$$

The combination of pressure & volume must remain constant, so as the pressure increases the volume (space) would decrease proportionally, or vice versa. If the pressure doubles the volume would be cut in half.

Dalton's Law:

The total pressure inside a container is made up of all of the pressures of all of the gasses in the container. I.e. if there are three gasses inside a container, then the pressure produced by each (partial pressure) added together is the total pressure applied to the walls of that container.

Henry's Law:

The concentration of a gas dissolved in a liquid is equal to the partial pressure of that gas over the liquid times the

solubility coefficient of the gas. The solubility coefficient is the rate at which a gas will diffuse into a liquid (different gasses have different rates at which they diffuse into liquids). Henry's law is basically saying that the more gas of a particular compound you have (the higher it's partial pressure) and the faster its natural diffusion rate will increase the rate of the gas diffusing into the liquid and vice versa.

10b. Using these laws explain why breathing pure O₂ would increase the amount of O₂ in the blood?

Pure O₂ would cause the person's partial pressure of oxygen to be 100%. The increase of partial pressure would increase hemoglobin's affinity for O₂.

11. Which gas oxygen, carbon dioxide, or nitrogen has the highest solubility coefficient? What does this mean?

N₂ = 0.012

O₂ = 0.024

CO₂ = 0.57

The higher the solubility coefficient the faster the gas will diffuse into a liquid.

12. Explain the effects of partial pressure, temperature, and pH have on hemoglobin's affinity for oxygen.

A. Partial pressure of O₂: The lower the partial pressure, the lower the affinity for O₂.

B. Temperature: The higher the temperature, the lower the affinity for O₂.

C. pH: The lower the pH, the lower the affinity for O₂.

13. Explain the two ways oxygen is transported in the blood.

Hemoglobin - (97%)

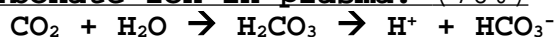
Plasma - (3%)

14. Explain three ways the carbon dioxide is carried in the blood.

Dissolved in plasma: (7%)

Hemoglobin: (23%) bonds w/ amine group

bicarbonate ion in plasma: (70%)

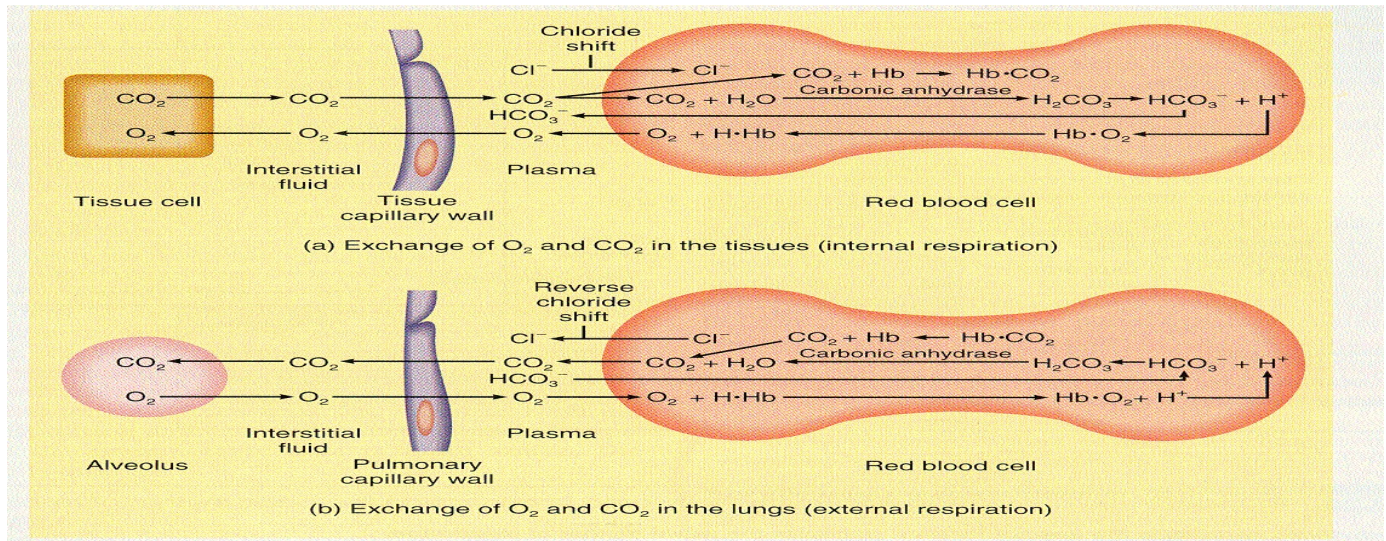


15. Be able to explain in detail the movement of CO₂ through the blood as bicarbonate ion. Know the equations for carbonic acid and bicarbonate ion formation.

Tissue Exchange:

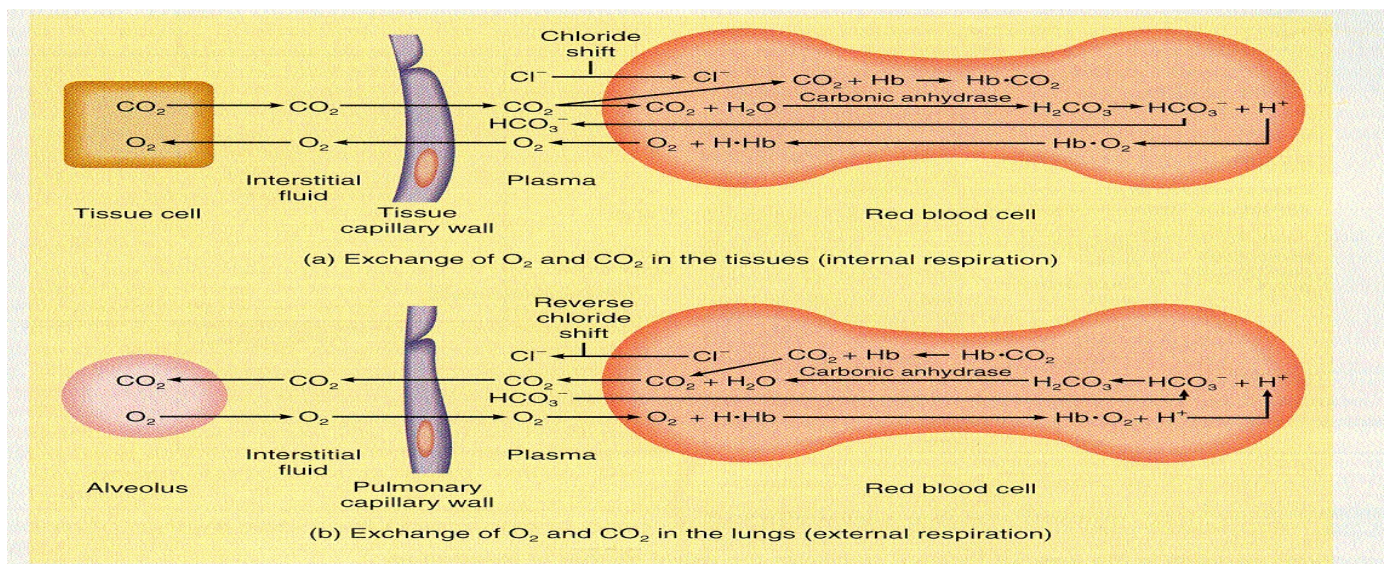
1. CO₂ is taken into the RBC where it forms carbonic acid (CO₂ + H₂O → H₂CO₃ [enzyme Carbonic anhydrase])
2. The carbonic acid then breaks down into a hydrogen ion and a bicarbonate ion (H₂CO₃ → HCO₃⁻ + H⁺)
3. The bicarbonate ion is then moved from the RBC into the blood plasma in exchange for a Cl⁻ ion (chloride shift) this keeps the charge of the cell in balance.

- The free H^+ ion bonds with hemoglobin.
- The bicarbonate ion bonds with a sodium ion making sodium bicarbonate which moves in the blood to the lungs. ($\text{HCO}_3^- + \text{Na}^+ \rightarrow \text{NaHCO}_3$)



In the Lungs:

- The low CO_2 in the lungs causes the carbonic acid to disassociate into H_2O and CO_2 ($\text{H}_2\text{CO}_3 \rightarrow \text{H}_2\text{O} + \text{CO}_2$).
- This causes a drop in the amount of carbonic acid, so the bicarbonate ions combine with a H^+ ion from the hemoglobin ($\text{H}^+ + \text{HCO}_3^- \rightarrow \text{H}_2\text{CO}_3$).
- As the H_2CO_3 moves into the cell, a Cl^- ion moves out of the cell to keep the balance.
- The HCO_3^- moving into the cell is taken from NaHCO_3 , this leaves the Na^+ ion in the plasma where it combines with the Cl^- ion to form NaCl .



16. How does the respiratory system respond to going up in altitude where air is thinner?

As you move to a higher altitude the air is thinner and there is less O₂ available. The body responds by producing more red blood cells (caused by the release of EPO) and increasing the respiration rate.

17. Where is myoglobin found and what is its function? Be able to explain why the saturation curves for hemoglobin and myoglobin are different. Be able to explain the saturation curves for adult and fetal hemoglobin.

Myoglobin: is found in red muscle and like hemoglobin its function is to store oxygen for later use. Myoglobin is only able to store one oxygen molecule therefore it is saturated four times faster.

Fetal hemoglobin: Is found in fetuses for the last 7 months and in newborns for the first 6 months. It has a higher affinity for oxygen than the mother's hemoglobin so that the babies hemoglobin will be able to take oxygen from the mother's hemoglobin.

18. Be able to define and explain the following lung capacity measures: anatomic dead air space, tidal volume, inspiratory reserve volume, expiratory reserve volume, vital capacity, residual volume, minute respiratory rate, and alveolar ventilation rate.

Defined in mix and match list.

19. What two processes occur in the kidney?

Blood filtration and reabsorption/secretion of wanted materials filtered out.

20. Of what benefit is it to have the kidney filter out everything below a given molecular weight?

The filtration of everything below a certain size reduces the energy required to filter out the items that are not wanted.

21. What is the juxtaglomerular apparatus and how does it control the filtration rate.

The juxtaglomerular apparatus is located in the distal convoluted tubule of the cortex of the kidney.

Regulation of filtration rate:

A. If the filtration rate is low, then low Cl⁻ levels near the juxtaglomerular apparatus triggers the production of the enzyme **renin**.

B. **Renin** causes the plasma protein **angiotensinogen** to form **angiotensin I**

C. **angiotensin I** moves through the blood to the lungs where the enzyme **angiotensin converting enzyme (ACE)**, converts it to **angiotensin II**

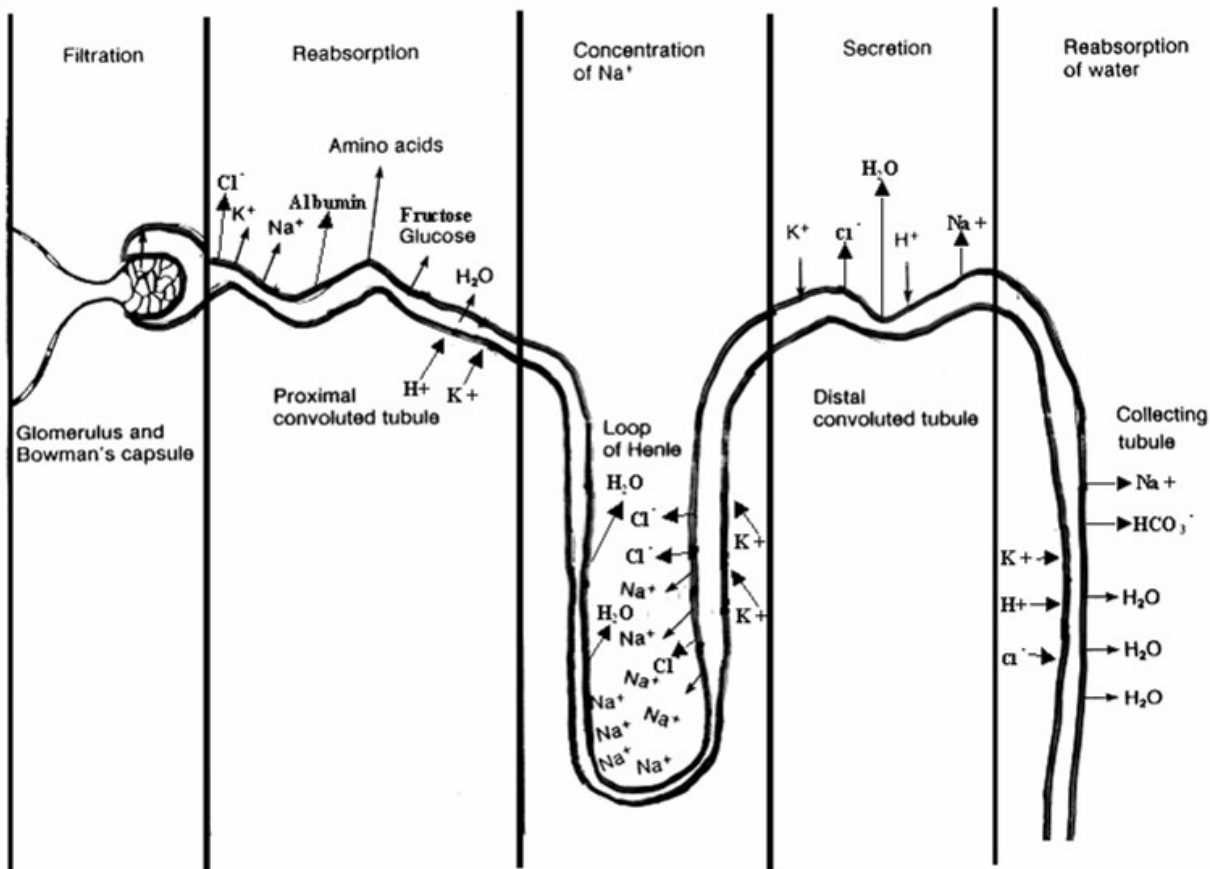
D. **angiotensin II** triggers **aldosterone** release from the adrenal cortex and causes vasoconstriction increasing blood pressure.

→ **Vasoconstriction in the blood vessels that leave the glomerulus increases the blood pressure in the glomerulus**

increasing the filtration rate. ←

22. What is filtered out of the blood?

1. Water
2. Water soluble vitamins
3. Urea
4. Ions
5. Glucose/Fructose



23. What is reabsorbed and what is secreted in the proximal convoluted tubule?

Reabsorbed:

- (PCT Only) Glucose/Fructose
- (PCT Only) Amino acids
- (PCT Only) Albumin (plasma proteins)
- Na⁺: Na/K pump
- Cl⁻
- H₂O

Secreted:

- K⁺
- H⁺

24. What is reabsorbed and what is secreted in the descending and ascending loop of Henle?

Descending reabsorbed:

- H_2O

Descending secreted:

Ascending reabsorbed:

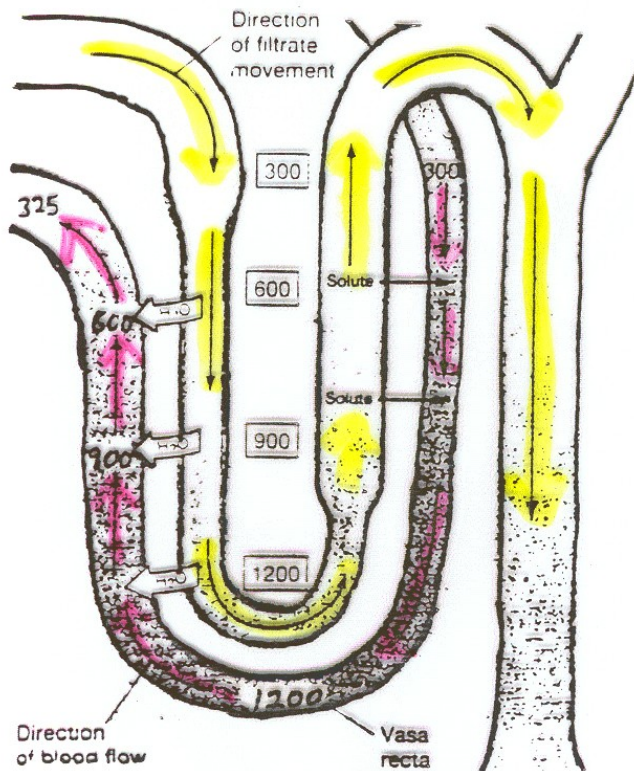
- Na^+ : Na/K Pump

- Cl^- :

Ascending secreted:

- K^+ :

25. How do the loop of Henle and the vasa recta lead to increased water reabsorption by counter current multiplication?



The vasa recta is a blood vessel that runs next to the loop of Henle. The two run in opposite directions. As the filtrate is moving through the ascending loop of Henle ions move from the filtrate into the blood (vasa recta), this causes the blood which is descending to have a higher concentration of ions then the urea. As the blood is ascending in the vasa recta, it has an osmotic effect pulling fluid from the filtrate. The blood in the vasa recta maintains this higher level of ions the entire time

it is passing by the descending loop of henle, keeping the osmotic effect going the whole time.

26. What is reabsorbed and what is secreted in the distal convoluted tubule?

Reabsorbed:

- Na⁺: Na/K Pump
- Cl⁻:
- H₂O:

Secreted:

- K⁺
- H⁺

27. Explain how antidiuretic hormone and aldosterone affect reabsorption in the kidney.

ADH Antidiuretic Hormone: (pituitary gland).

- Makes the distal convoluted tubule and the collecting duct more permeable to water

Aldosterone: (adrenal cortex).

- Regulates Na/K pump, controls the reabsorption of Na⁺ into the blood plasma.
- High levels of aldosterone stimulate the absorption of Na⁺ into the blood and the secretion of K⁺ out of the blood into the filtrate.

28. What is reabsorbed and what is secreted in the collecting duct?

Reabsorbed:

- Na⁺: Na/K pump
- HCO₃⁻: diffusion in exchange for Cl⁻
- H₂O
- Urea

Secreted:

- K⁺
- H⁺
- Cl⁻: diffusion in exchange for HCO₃⁻

29. What is acidosis and why do respiratory acidosis or metabolic acidosis occur?

Acidosis: blood pH below 7.35

Respiratory acidosis: inadequate movement of CO₂ out of the blood causes the blood pH to drop (pCO₂ > 45 mm Hg). Usually caused by: emphysema, pulmonary edema, or a reduction in breathing rate.

Metabolic acidosis: pH drops due to a low level of bicarbonate ion in the blood (HCO₃⁻ below 22 mEq/l). Often caused by diarrhea [bases out the bottom], renal disfunction, accumulation of acids due to ketosis, an accumulation of lactic acid, or a failure of kidneys to secrete H⁺ ions from metabolism of dietary proteins.

30. What is alkalosis and why do respiratory alkalosis or metabolic alkalosis occur?

Alkalosis: blood pH above 7.45.

Respiratory alkalosis: Most common cause is hyperventilation which can be caused by high altitude, pulmonary disease, stroke, anxiety or aspirin overdoses ($p\text{CO}_2 < 35 \text{ mm Hg}$).

Metabolic alkalosis: pH rises due to high levels of bicarbonate ion in the blood (HCO_3^- above 26 mEq/l). Most common cause is vomiting of gastric contents [acids out the top]. Also caused by severe dehydration, endocrine disorders or diuretics.

31. How do the kidney and the lung function to regulate blood pH?

Kidneys: If acidosis the collecting duct dumps H^+ ions, if alkalosis collecting duct dumps K^+ ions.

Lungs: Removal of CO_2 reduces the amount of carbonic acid which influences the pH of the blood.

32. How does carbonic acid buffer the blood?

Carbonic acid / bicarbonate is the primary buffer for the blood made most effective because the body has the ability to remove chemicals at either end.

In the case of acidosis the chemical equations are:



Then in the lungs the CO_2 is converted into a gas and exhaled leaving us with simply water to resolve.

In the case of alkalosis the chemical equations are:



This gives us water (which we know how to deal with effectively) and bicarbonate.

33. Name and explain two other blood buffers.

Hemoglobin acts as a buffer by absorbing H^+ .

certain amino acids can act as buffers by absorbing H^+ or releasing H^+ to neutralize OH^- .

34. What compounds act as urinary buffers?

Phosphate buffers

Ammonia buffers

35. How is water distributed in the body?

Body is 50-60% water

- 2/3 of water is intracellular

- 1/3 of water is extracellular

- 80% of extracellular is interstitial fluid (between cells)

- 20% of extracellular water is in the plasma

36. What hormones regulate water balance at the kidney and what do they do?

ADH Antidiuretic Hormone: (Pituitary gland), released when water content is low (sensed by osmoreceptors in hypothalamus), causes the distal convoluted tubule and collecting duct more permeable to water, increases reuptake of water from urine. Also reduces sweating.

Aldosterone: (adrenal cortex), released when filtration rate is low (low Cl^- in the tubule), Causes Na^+ to be reabsorbed from the distal convoluted tubule to the blood (Na/K pump), resulting ion gradient causes water to be reabsorbed by osmosis.

Atrial natriuretic peptide (ANP): (atria of the heart when right ventricle is stretched), increases fluid loss into urine by increasing the glomerular filtration rate and suppressing the secretion of Aldosterone, ADH and renin.

37. How are the major ions in the body distributed inside and outside cells?

Ions	Intracellular	Extracellular
K ⁺	High	Low
Na ⁺	Low	High
HPO ₄ ⁻²	High	Low
Cl ⁻	Low	High
HCO ₃ ⁻	Lower	Higher (2/3 of total)

Positive charged (+) ions are cations, negative charged anions

38. How are the following ions (Na⁺, Cl⁻, K⁺, HCO₃⁻, Ca⁺⁺, phosphates, Mg⁺⁺) regulated in the body?

Aldosterone: Na⁺, Cl⁻, K⁺.

Kidneys: HCO₃⁻.

Bones: Ca⁺⁺, Phosphates (H₂PO₄⁻, HPO₄⁻², PO₄⁻³), Mg⁺⁺.

39. Explain how dialysis works?

Blood from the body is run through dialysis tubing, which runs through a tank of water that contain the same concentration of ions as normal blood. Toxic material and excess water, diffuse out of the blood through the walls of the tubing into the dialysis water. If the blood is low in ions or low in water, some will diffuse into the blood from the dialysis water. Dialysis doesn't regulate the compounds found in the blood as well as a properly functioning kidney. For example, dialysis removes the hormone erythropoietin, which triggers the production of red blood cells, so people on dialysis may develop anemia.