4

Physiology sheet

Doctor 2021 -mercy- I medicine I MU

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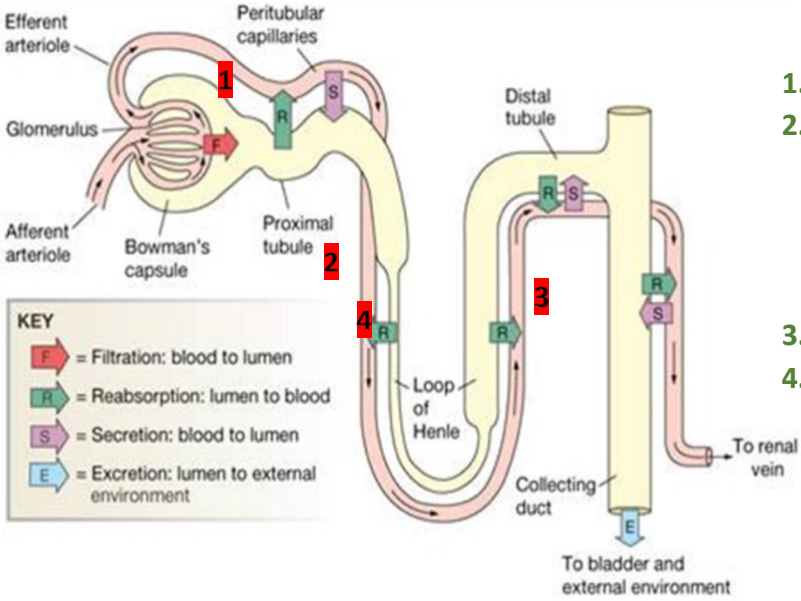
Overview of the renal system and acid base balance

Urine formation



1. Filtration across glomerular capillaries
2. that important in formation of urine 2 Kind of process:
   1. reabsorption 2. Secretion
   also 2 kind of process happen followed by Collecting duct (very large)
3. Thick ascending
4. Thin descending

. Filtration: Start in glomerulus

It is directly proportional to renal blood pressure and renal blood flow. Water and solutes is filtered across glomerular capillaries

. Reabsorption: In proximal & distal & loop of henle

Is the removal of water and solutes from the renal filtrate.

Secretion: Just in proximal &distal tube

Transport of solutes from peritubular fluid into the tubular fluid

Excretion: the end process of removing wastes (urine) from the body (out of the body). It is done in collecting duct

Each nephron has a glomerulus, the site in which blood filtration starts

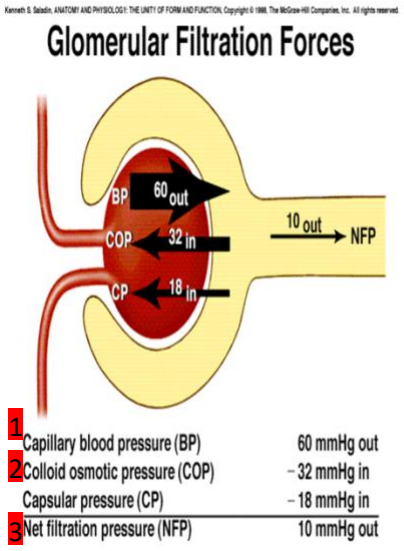
-The first process in urine formation begins in the glomerulus

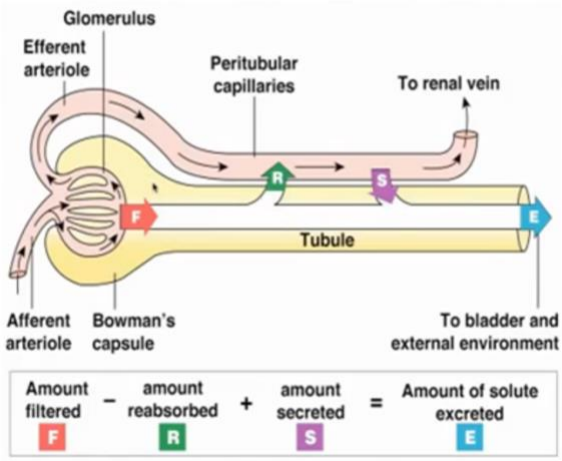
-In proximal tubule 2 kind of process that is important in formation of urine

1. reabsorbed into capillaries. [The filtrate that enter inside the proximal tube will be taken again into bloodstream]

2. secretion into the renal tubule. [some substances in blood will be secreted selectively into tubules (taking out of the blood)

- In Loop of Henle Just one kind of process Reabsorption (to the blood)





calculate
*amount of urine secreted (How ??)
(total amount that is going out side the environment)

by determine amount of filtered, amount absorbed & amount of secreted then apply to this equation

The factor is

1. **amount of hydrostatic (p) so that is the favorite from glomerulus into bowman capsule.**
2. **Movement the water in opposite directions from tubules to the blood.**
3. **Amount that will move out from the blood into the nephron.**

the movement of substance (water) affected into two kind of pressure

-hydrostatic pressure favorite to water to move outside

-Oncotic pressure favorite to water to move inside

Factors that alter filtration pressure change GFR

(oncotic) pressure indicates the concentration of proteins in a fluid (water). Therefore high oncotic pressure means high osmotic pressure.

The amount of urine formation, it is determined by the amount that is going into efferent arteriole in to the glomerulus (the sum of blood coming to glomerulus)

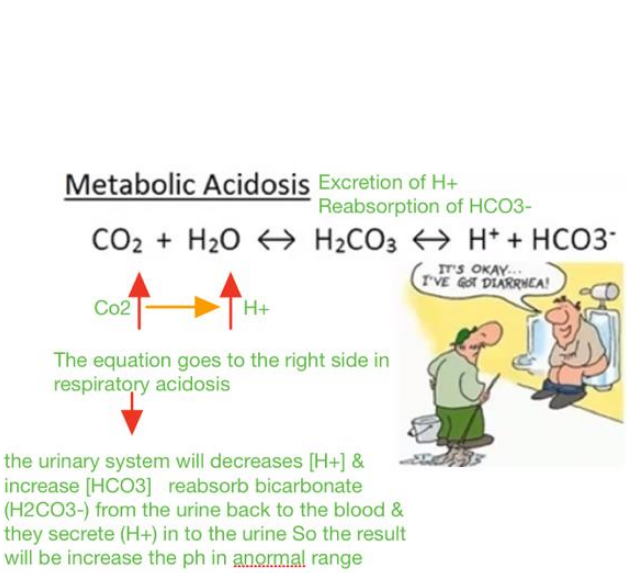
Do you think the glomerular filtration function rate will be affected by:

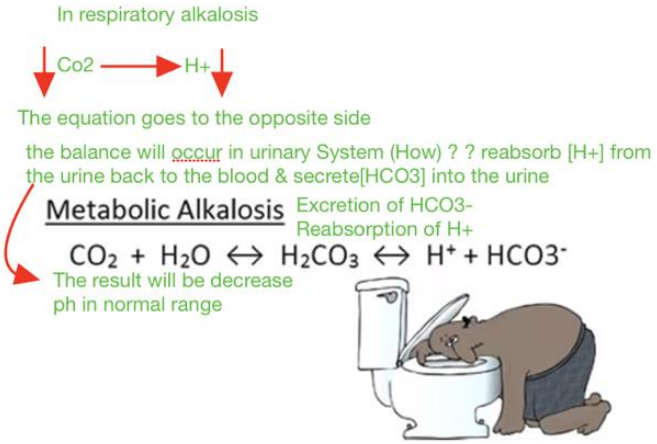
These factors include:

- **Increased renal blood flow → Increased GFR**
- **Decreased plasma protein → Increased (5)GFR → edema**
- **Hemorrhage → Decreased capillary hydrostatic pressure → Decreased GFR**

5. why? Because decreased plasma proteins means low oncotic pressure (responsible for moving water and solutes from glomerulus into blood stream). On the other hand, hydrostatic pressure rises as there is low protein concentration in blood (responsible for moving water and solutes from blood stream into glomerulus). As a result, flow rate from blood into glomerulus increases.((blood fluids will move into the interstitial fluid causing edema))

Respiratory compensation





Respiratory Rate will.

- **Increase when blood H+ is increased (acidic pH)**

  CO2is "blown off"

  Amount of acid in blood is decreased

- **Decrease when H+ is decreased (alkaline pH)**

  CO2 is retained

  Amount of acid in blood is increased

- **the symptom of acidosis case is diarrhea.**
- **the symptom of Alkalosis case is vomiting.**

Buffer system: proteins found intracellular like [HCO3-, Hemoglobin found inside RBCs Can bind with Co_2 in the Cases of increased Co2 called { carbamino acid or linked with [H+] & form HB rather why than HBH} [The only intracellular protein gives immediate extra Cellular effect] why? They can bind with H+ & CO2.

This means

- **Metabolic acidosis causes an increase in rate and depth of ventilation as the body attempts to get rid of acid (CO,)**

Hyperventilation the compensation of respiratory

- **Metabolic alkalosis causes a decrease in rate and depth of ventilation as the body attempts to retain acid (CO,)**

This is hypoventilation

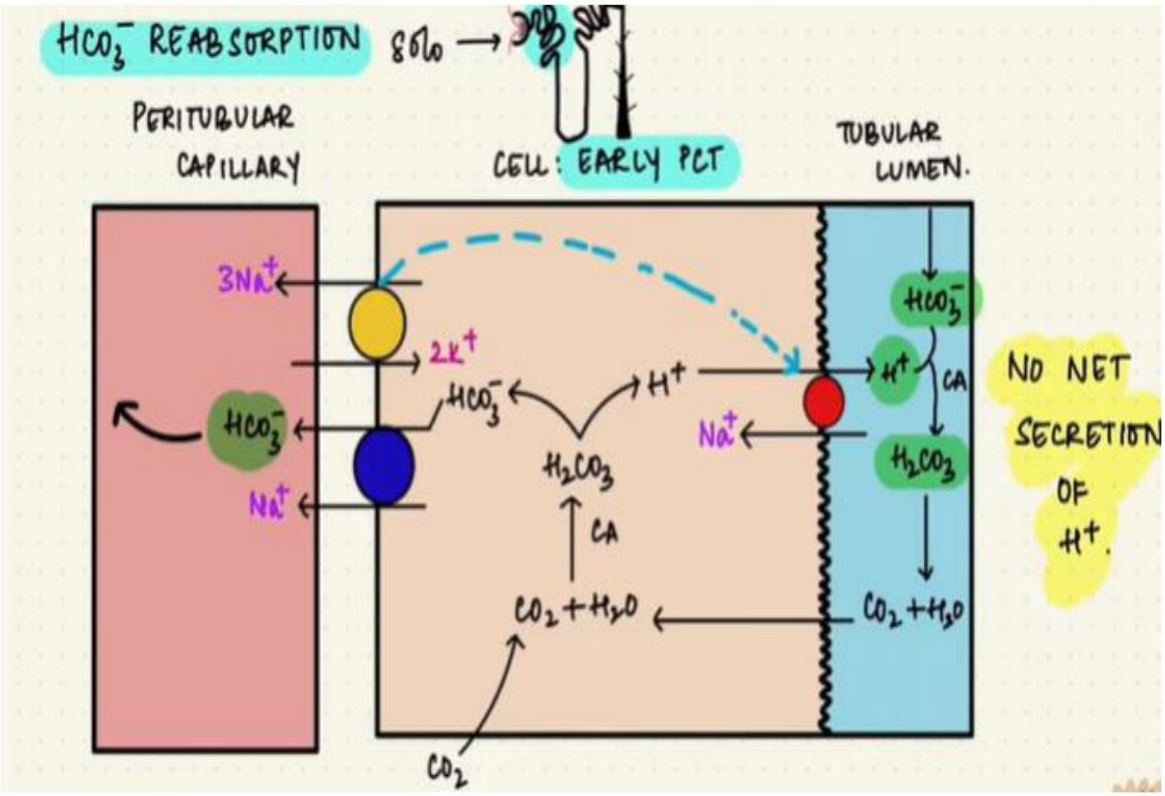
- **Respiratory mechanisms take several minutes to hours**

*** volatile acid excreted by lung (Respiratory system) [co_2 & H2CO3- etc]**
***Nonvolatile acid excreted by urinary system eg[uric acid & phosphoric acid…… any fixed acid that produce as product from metabolism (catabolism) protein or Phospholipid**

* the first diffensive mechanism of proton concentration is protein buffer mechanisms. it is very fast but not affected not practical in cases of acidosis & alkalosis to do regaining ph balance.

* the respiratory effective but is just for volatile acid [to get rid of the Co2&H2CO3]

* the urinary system the most effective & powerful one get rid of only fixed acid but it takes along time (days, week)



-Firsts - proximal convoluted tubule between bowman's capsule & the loop of henle followed to Glomerulus.

inside the tubule according to the-

CO2 + H2O —> H2CO3 —> H+ + HCO3-

- transport Na+ & K+ across the cell membrane in a ratio of 3 Na+ out & 2 K+ in that produce energy [primary active transport]

this energy used by Na+ / H+ pump [secondary active transport]-

- the H+ goes inside the tubular lumen & (excretion of H+ from the renal tubule). the Na+ is reabsorbed from the renal tubule goes outside the tubular lumen

the H+ will bind with HCO3- in tubular lumen then-

$H_20 + Co_2$ [No Net secretion H+]

in the capillary the exchange happen between HCo3- & Na+-

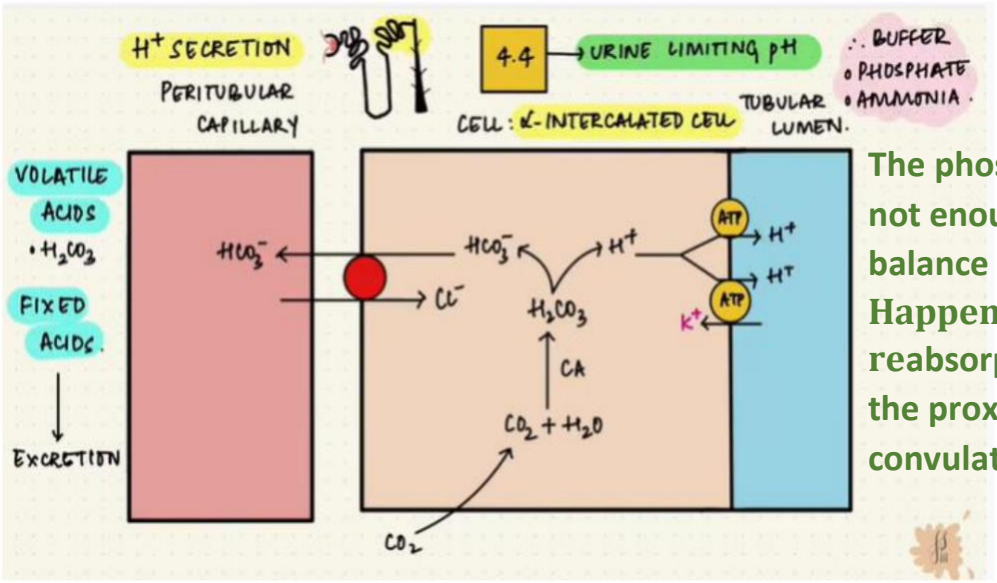
No secretion H+ & recycling process-

inside the cell-

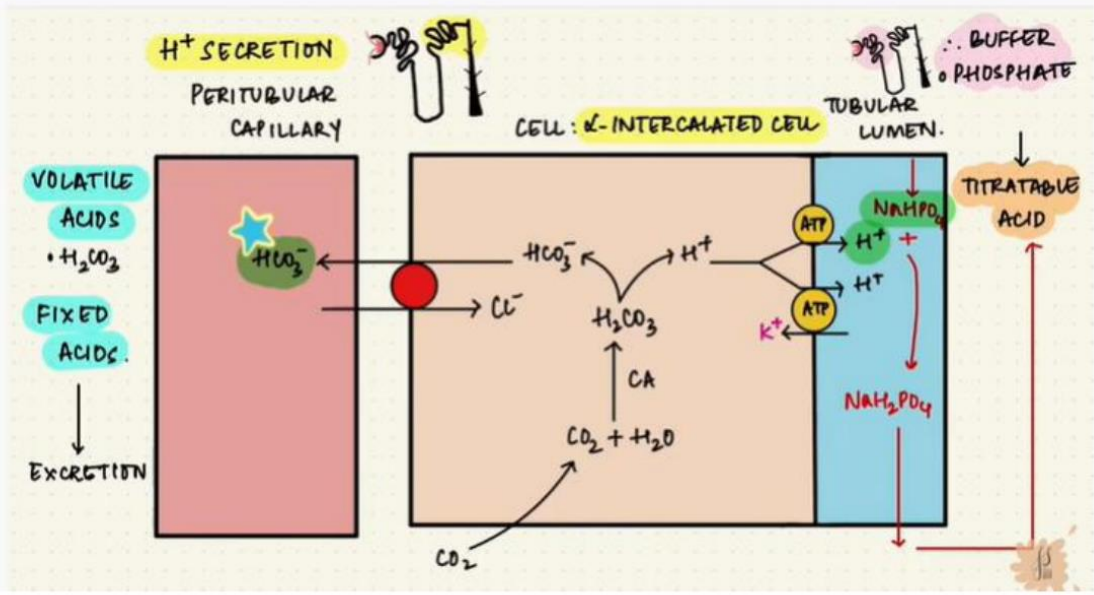
$Co_2 + H_2O \rightarrow H2CO3 \rightarrow H+ + HCo3-$

1. the [H+] exchange with K+ by primary active transport [H+] goes to the tubular lumen (happen (secretion H+)) k+ goes to intercalated

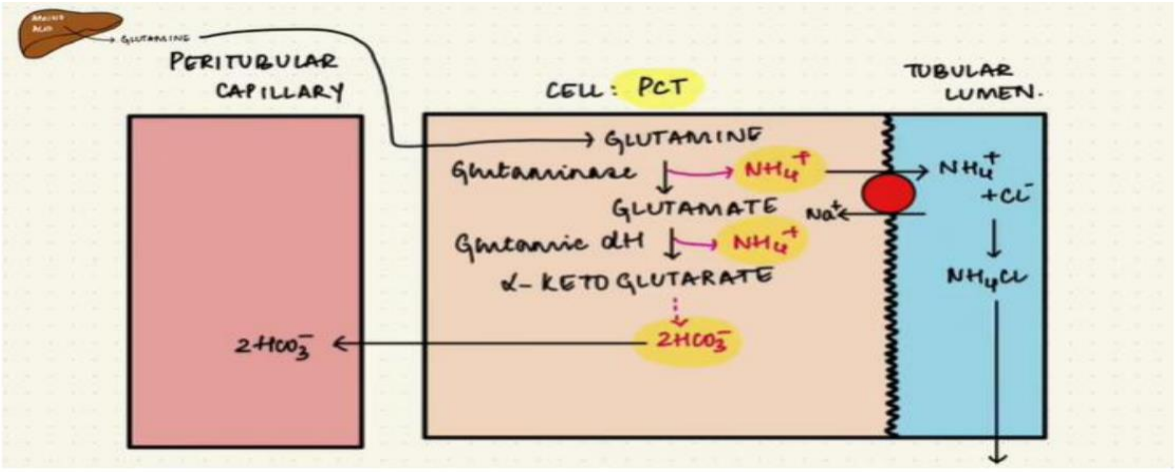
2. a bicarbonate chloride exchanger exchanges HCO3- with Cl-, Cl- Leaves the capillary to enter the cell & HCO3- Leaves cell to enter the capillary. No recycling to the Hco3-. most of the time the secretion of H+ is associated with NaHpo4 to produce NaH2PO4 all this compound will be secreted to preserve acid limit not less than 4.4. [any buffer bind with H+ called titratable acid].



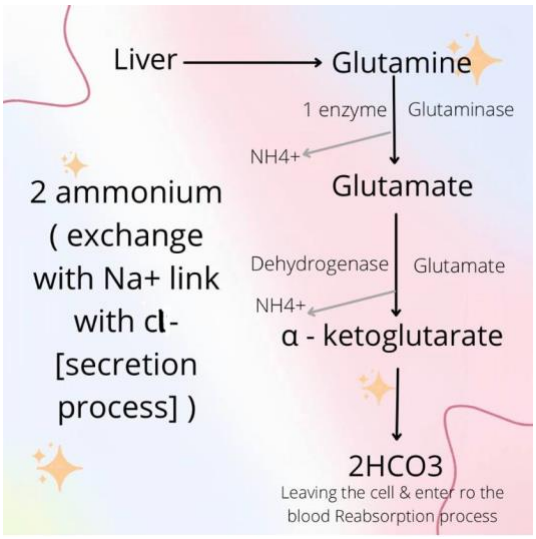
The phosphorus is not enough to balance the pH will Happened reabsorption from the proximal convulated tubule



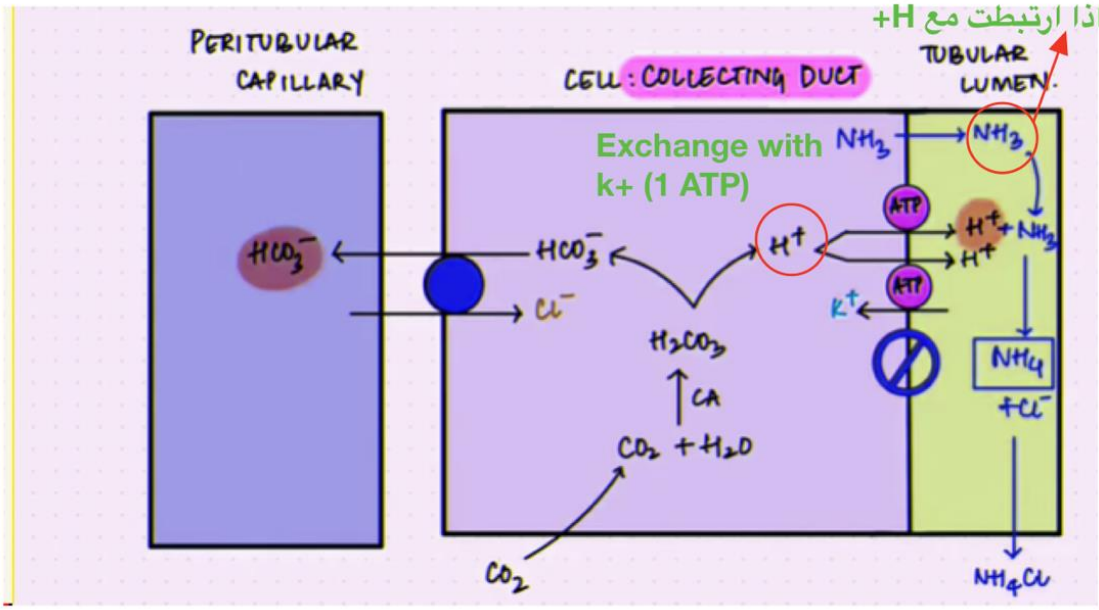
Type of buffer 1. Ammonia buffer 2. Phosphate buffer



Starting from the glutamine synthesis by liver inter to the proximal convoluted [in facilitated diffusion]



لا يمكن التخلص منها الا
اذا ارتبطت مع H+



NH3 ammonia + proton H+ —> ammonium NH4 + cl- —> then secreted NH4Cl

SUMMARY

	pH	CO_2	HCO_3^-	H^+
Normal				
Respiratory Acidosis				
Respiratory Alkalosis				
Metabolic Acidosis				
Metabolic Alkalosis				

Easy way to remember:

1.

2.

Normal Values for ABG's:

pH : 7.35 - 7.45
CO_2 : 35 to 45 mmHg
HCO_3^- : 24 to 28 mEq/L

Carbonic Anhydrase

$$CO_2 + H_2O \leftrightarrow H_2CO_3 \leftrightarrow H^+ + HCO3^-$$

	pH	CO_2	HCO_3^-	H^+
Normal				
Respiratory Acidosis	↓	↑*	↑	↑
Respiratory Alkalosis	↑	↓*	↓	↓
Metabolic Acidosis	↓	↓	↓*	↑
Metabolic Alkalosis	↑	↑	↑*	↓

Easy way to remember:

1. "Respiratory" values are "Re"versed
2. CO_2 + HCO_3^- always same direction

Normal Values for ABG's:

pH : 7.35 - 7.45
CO_2 : 35 to 45 mmHg
HCO_3^- : 24 to 28 mEq/L

PRACTICE QUESTIONS

1) Hypoventilation leads to
A) respiratory acidosis.
B) respiratory alkalosis.
C) metabolic acidosis.
D) metabolic alkalosis.

2) In response to respiratory acidosis,
A) kidneys secrete more hydrogen ions ONLY.
B) kidneys excrete more bicarbonate ions ONLY.
C) kidneys excrete fewer bicarbonate ions ONLY.
D) kidneys secrete more hydrogen ions and more bicarbonate ions.
E) kidneys secrete more hydrogen ions and fewer bicarbonate ions.

Name the disorder (choices for #'s 3 and 4 below):

- Respiratory acidosis (with or without renal compensation)
- Respiratory alkalosis (with or without renal compensation)
- Metabolic acidosis (with or without respiratory compensation)
- Metabolic alkalosis (with or without respiratory compensation)

3) ABG's: pH 7.31 PCO_2 55 mm Hg HCO_3^- 28 mEq/L

4) ABG's: pH 7.31 PCO_2 55 mm Hg HCO_3^- 35 mEq/L

وقيمة المرء ما قد كان يُحسنه
بعلم ولا تطلب به بدلاً

والجاهلون لأهل العلم اعداءُ فقم
فالناس موتى واهل العلم احياءُ.

- علي بن ابي طالب