Important..

VALUES

RENAL PHYSIOLOGY

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1.Renal function &GFR

Urinary excretion rate = Filtration rate- reabsorption +secretion

So;

(Urinary excretion rate- filtraition rate)direct proportion

(Urinary excretion rate-secretion)direct proportion

(Urinary excretion rate-reabsorption)inverse proportion

Kidney: Size Clenched Fist

Weight 150 grams

kidney has 1 million nephrons(different in anatomy lecture)

kidney recive 20 % of cardic out put(High blood flow rate (1200 ml/min).

GFR is normally 125 ml/min = 20% renal plasma flow.

Types of nephrons:

Cortical nephrons: (85%)

Juxtamedullary nephrons: (15%)

glomerular membrane Allows passage of molecules up to 70,000 D

GFR = Kf x Net filtration pressure.

GFR = Kf x [(PG-PB)-(πG- πB)]

PG :Hydrostatic pressure inside the glomerular capillaries, which promotes filtration =60mmHG

PB :The hydrostatic pressure in bowman's capsule , which opposes filtration=18mmHg

Πg:The colloid osmotic pressure of the glomerular capillary plasma proteins, which opposes filtration=32

Πb: The colloid osmotic pressure of the proteins in bowman's capsule ,which promotes filtration

$$= Kf \times [(60-18)-(32- 0)]$$

= 12.5 X 10 = 125 ml/min or 180 L/day

Kf=glomerular capillary filtration coefficient depends on permeability and surface area of filtration barrier

99% of filtrate reabsorbed, 1 to 2 L urine excreted

2.Regulation of GFR

GFR is directly proportional to the NFP

net filtration pressure

Renal Autoregulation of GFR→Stable BP range of 75 to 160 mmHg (systolic)

3.Renal clearance

Cx x Px = Ux x V so→

Cx = (Ux X V)/ PX

Cx = Renal clearance (ml/min)

(Ux X V) = excretion rate of substance X

Ux = Concentration of X in urine

V = urine flow rate in ml/min

Amount of substance excreted = (filtered –

reabsorbed + secreted)

Ux X V = GFR x Px ± Tx

1)Inulin or creatinine : amount filtrated= amount excreted

GFR (C ..inulin..) =U(inulin) X V / P (inulin)

(ml/min)

2)PAHA: 90% cleared from the plasma

Renal plasma flow (RPF)(C pah) =U(pah) X V /P(pah)

(ml/min)

3)To measure renal blood flow we will have to measure renal plasma flow first and then from the hematocrit we calculate the actual blood flow

plasma =55%of blood volume

blood cells =45 %of blood volume so→

renal blood flow(RBF) =(RPF X 100) /55 (ml/min)

4) Comparison of clearance of a substance with clearance of inulin:

= inulin clearance; only filtered not reabsorbed or secreted

< inulin clearance; reabsorbed by nephron tubules

> inulin clearance; secreted by nephron tubules

5)glucose &amino acids →complitly re absorbed →zero secretion →zero urinary excretion →zero clearance

6)plasma ions (sodium,chloride ,bicarbonate)→highly reabsorbed (variable depending on body needs) →<1%clearance of GFR

7)waste products (urea &creatinine)→poorly reabsorbed →highly excreated→high clearance

8) Reabsorption rate can be calculated=

Filtration rate- excretion rate

= (GFR X P*)-(U* X V)

*** The substance needed to be assessed.**

9) Secretion rate * = excretion rate –filtration rate

= (U* X V)- (GFR X P*)

10)Filtration fraction: It is the ratio of GFR to renal plasma flow

Filtration fraction = GFR /RPF

10) TUBULAR TRANSPORT MAXIMUM of glucose(Tm) =375 mg/min , renal threshold=200mg/dl

Glucose Filtered Load(quantity of substance filtraited at the glumerli per minute)

filtered load = GFR x [P]glucose

start of excreation of glucose(some nephrons leaking)→200ml /dl

allthe nephrons leaking glucose →350ml/dl

4.Physiology of Micturition

The movement of the peristaltic wave its origin at the pelvis down to the bladder is about 2-6 cm/sec It will propel the urine along the ureter, generating a pressure head of which changes from a baseline of 2-5 cm H2O up to 20-80 cm H2O.

Increasing bladder volume by 50 ml increases pressure. As volume increases further, the interavesical pressure increases, but not much until you get above 300 ml. then the pressure rises steeply with additional volume

Urinary bladder distension reaches the conscious level at urine volume of 150-200 ml

Rflex center: sacral segments S2,S3,S4

In adults the volume of urine that initiates a reflex contraction is about 300-400 ml

5&6 tubular Reabsorption & secretion:

- **In proximal tubules :**
- **65% of (Na,WATER and chloride)reabsorbed**
- **100% Glucose & amino acids**
- **90% of bicarbonate, calcium and K+ reabsorbed**
- **Loop of henle :**
- **25% of the Na and water reabsorbed**
- **Early distal tubule:**
- **5-8 % of the Na reabsorbed**
- **In the late distal tubule &coolicting tubule**
- **3-7% of Na reabsorbed**
- **medullary collecting ducts Reabsorb <10% of sodium & H_2O**

Water Reabsorption

Percentages Of Reabsorbed Filtered Water Across The Nephron

Structure	Percentage
Proximal convoluted tubule	65 %
Descending loop of Henle	20 -25 %
Ascending limb	Zero
Distal tubules & collecting tubules	Under ADH control

7. Urine Concentration & Dilution

- human urine osmolality may rise to ~1,200 mOsm/kg H2O, about 4-times plasma &ECF osmolality (normal 290~300 mOsm/kg H2O)& may decrease to ~50 mOsm/kg H2O

mechanisms for excreting a dilute urine in absence of ADH

. PCT:

•Solutes & H2O absorbed in equal proportion (tubular fluid =iso-osmotic with plasma).

2. Descending loop:

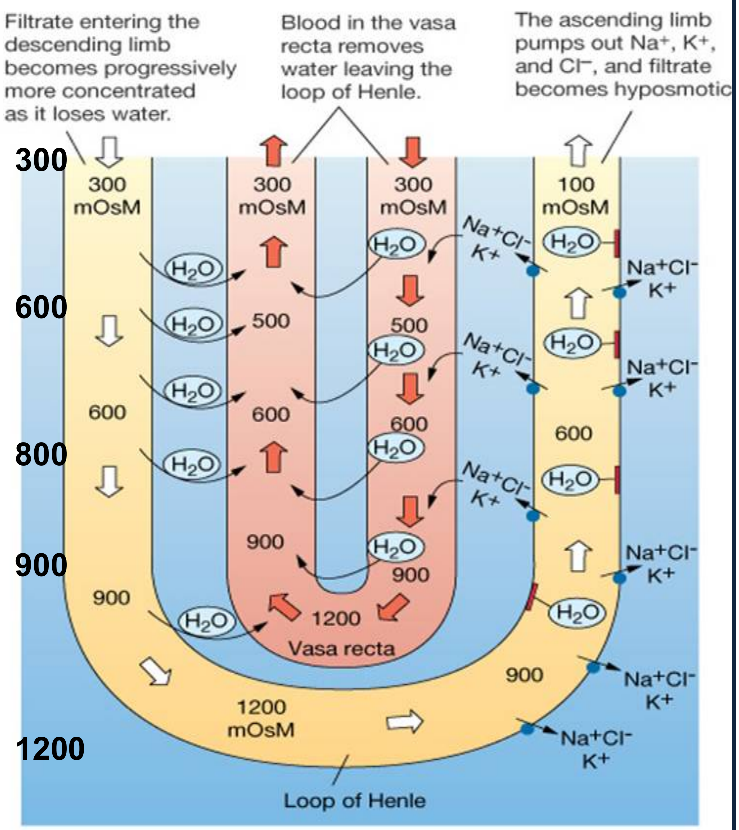
•H2o reabsorbed by osmosis (tubular fluid hypertonic in equilibrium with renal medulla interstitium 1200 mOsm/L).

3.Thick Ascending loop of Henle & early distal:

•tubular fluid diluted due to 1Na-1K-2Cl. This segmnet is impermeable to H2O even in presence of ADH (tubular fluid osmolality =100 mOsm/L).

4. Distal & collecting tubule:

•Tubular fluid become further diluted due to absence of ADH + additional absorption of solutes (NaCl). Tubular fluid become more diluted (50 mOsm/L) and a diluted urine will be excreted.

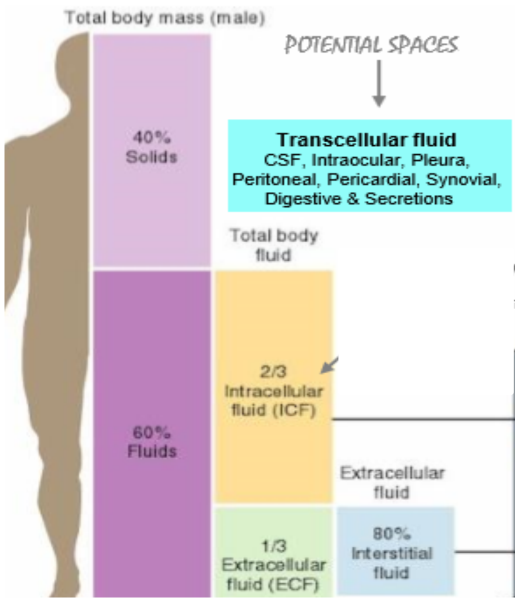


8 . Renal Regulation of Body Fluid

Normal Plasma Na = 140 – 145 mEq/L

Normal osmolarity ≅ 300 mOsm/L

Input =output= 1500 ml/day



9&10 .Basics of Acid Base & Buffer System

- **$pH = -\log [H^+]$**

Range is from 0 - 14

If [H+] is high, the solution is acidic; pH < 7(are H+ donors)

If [H+] is low, the solution is basic or alkaline ; pH > 7(are H+ acceptors, or give up OH- in solution.)

- **Extracellular fluid pH= 7.4**

Acidosis : below 7.35

Alkalosis : above 7.45

< 6.8 or > 8.0 death occurs

1)bicarbonate buffer

Its concentration in blood = 27mEq/L and is called alkali reserve.

Maintain a 20:1 ratio :

HCO_3^- : H_2CO_3

2- Phosphate buffer

It,spKa = 6.8

- **>90% of bicarbonate reabsorbed in proximal tubule**
- **Primary active secretion of H+ in the intercalated cells of distal & collecting tubulesrids the body of 80 mEq of H+ per day which comes from the metabolism.**
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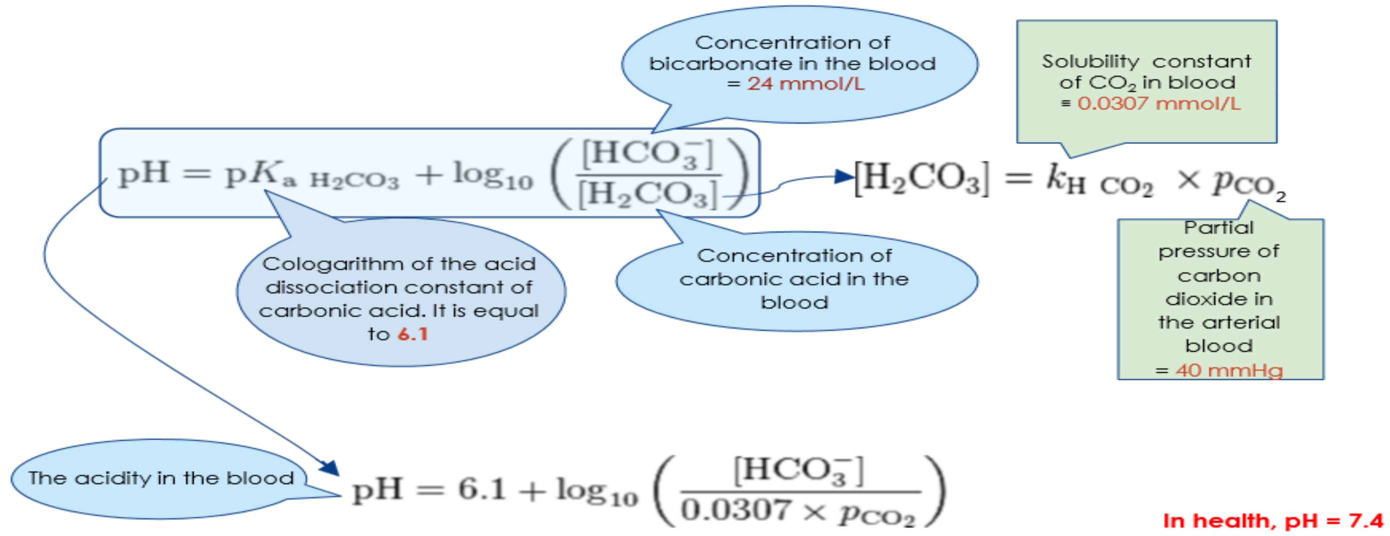
This secretion can decrease pH of tubular fluid to 4.5, which is the lowest pH achieved in normal kidney. It is responsible for urine acidity.

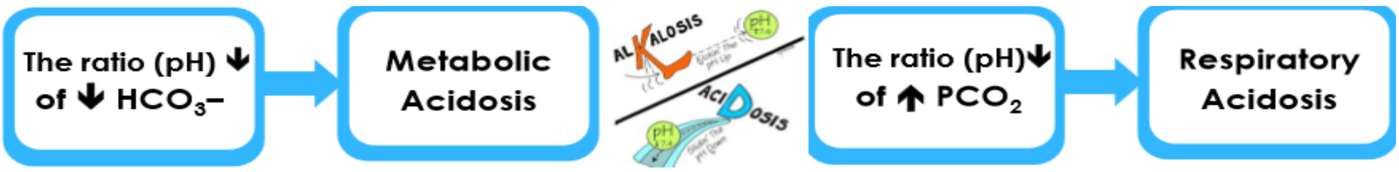
11. DISTURBANCES OF ACID-BASE BALANCE (FROM TEAM WORK)

The Henderson–Hasselbalch Equation

It can be applied to relate the pH of blood to constituents of bicarbonate buffer system.



❖ **So, Disturbances of Acid-Base Balance occurs when theratio of HCO3– to CO2 in the extracellular fluid**



The opposite occurs in **alkalosis.**