بسم الله الرحمن الرحيم

PYSIOLOGY TEAM

PART 1

FOR MIDE EXAM

(LECTURES : 1,2,3,4,5)

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Lecture : 1

Human Physiology

Introduction to Physiology

- Physiology is one of the cornerstones of medicine.
- Physiology is the study of how the body works, the ways in which cells, organs and the whole body functions, and how these functions are maintained in a changing environment.
- Cellular physiology is the study of the cellular components that primarily determines organ function.
- Systems physiology is the study of the coordinated and networked processes that determine whole body function and adaption to change.

Body Fluids

- Human body contains 50-70% water.
- E.g.:
  70g man has 42 L of water.
  Kg of water = L of water.

Factors affecting:

Infant: 73%
Male adult: 60%
Female adult: 40-50%
Obesity ↓
Old age 45%

Body Water Content

- Infants have low body fat, low bone mass, and are 73% or more water
- Total water content declines throughout life
- In old age, only about 45% of body weight is water
- Healthy males are about 60% water; healthy females are around 50%
- This difference reflects females':
  - Higher body fat
  - Smaller amount of skeletal muscle

*** نسبة الماء تقل كلما تقدم الانسان بالعمر**

*** تكون نسبة الماء في الانسان أعلى ما يكون عند الاطفال حديثي الولادة ، وعند البالغين الرجال أعلى من البالغين النساء وذلك لان النساء يملكن كمية من الدهن أعلى من الرجال وكمية أقل من العضلات .**

*** في حالة السمنة لانعلل نقص نسبة الماء بأن الدهن حل محل الماء ولكن نقول بأن كمية الماء ثابتة وكمية الدهن هي التي زادت وبالتالي ارتفعت نسبتها وبسبب ذلك قلت نسبة الماء في كتلة الجسم كاملة .**

Daily intake of water:

TABLE 20–1 DAILY INTAKE AND OUTPUT OF WATER (in ml/day)

	Normal	Prolonged, Heavy Exercise
Intake		
Fluids ingested	2100	?
From metabolism	200	200
Total intake	2300	?
Output		
Insensible—Skin	350	350
Insensible—Lungs	350	650
Sweat	100	5000
Feces	100	100
Urine	1400	500
Total output	2300	6600

Regulation of water intake

Climate
Habits
Level of physical activity

The hypothalamic thirst center is stimulated:

- By a decline in plasma volume of 10%–15%
- By increases in plasma osmolality of 1–2%
- In steady state water intake= water loss

Factors that affect the TBW

Physiological factors :

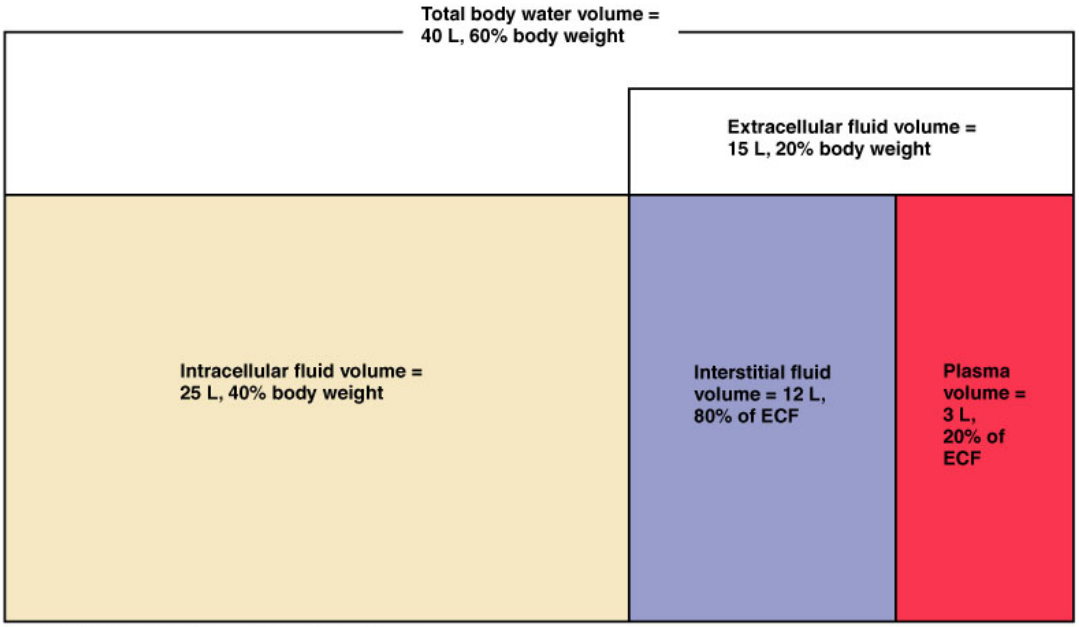
- Age
- Sex
- Body fat
- Climate
- Physical activity

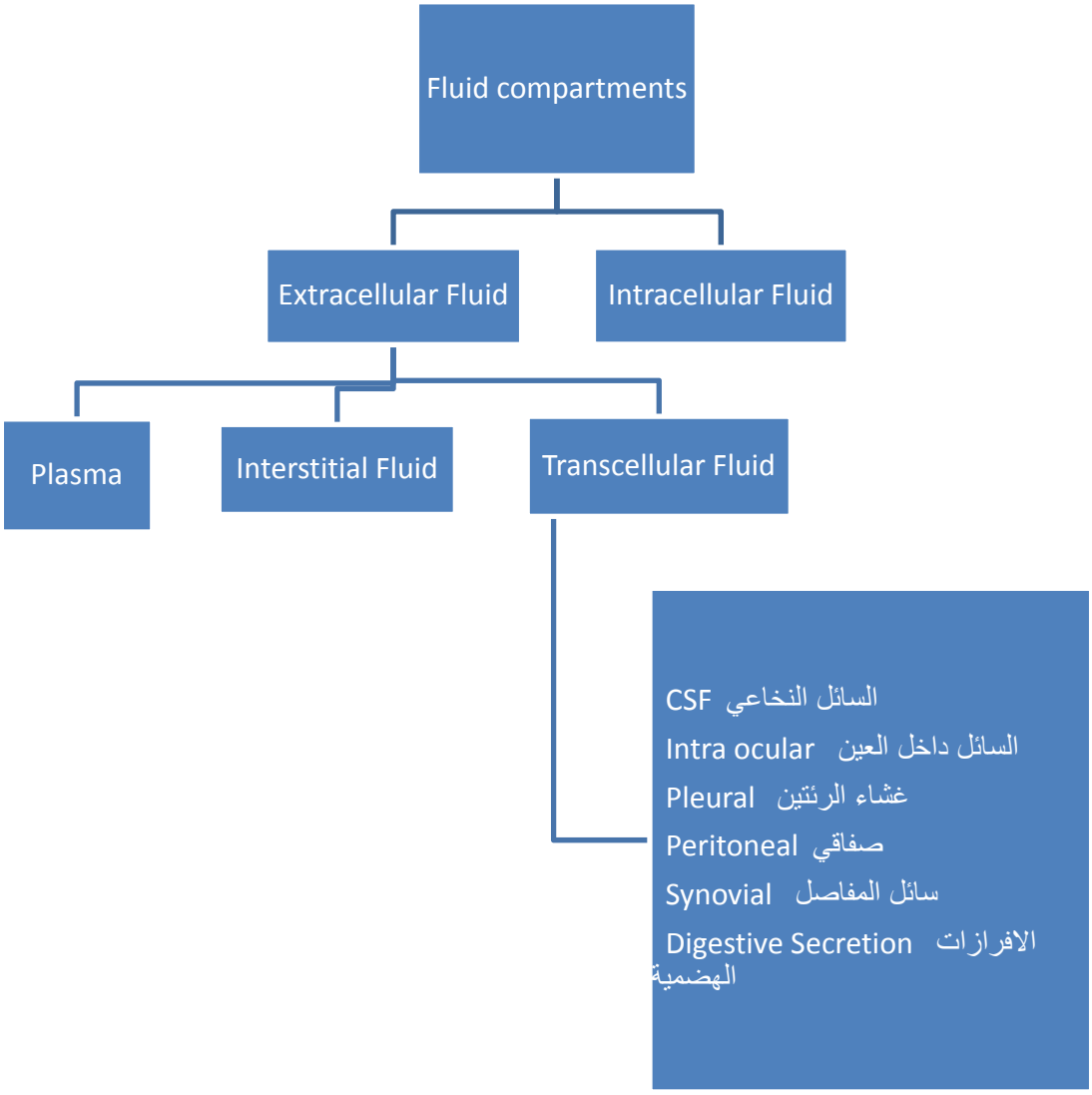
Pathological factors:

Vomiting
Diarrhea
Diseases with excessive loss of water (DM, excessive sweating,….
Blood loss

Fluid compartments

- Water occupies two main fluid compartments:
- Intracellular fluid (ICF)
- Extracellular fluid (ECF)
    - Plasma
    - Interstitial fluid (IF)


Total body water volume =
40 L, 60% body weight
Extracellular fluid volume =
15 L, 20% body weight
Intracellular fluid volume =
25 L, 40% body weight
Interstitial fluid
volume = 12 L,
80% of ECF
Plasma
volume =
3 L,
20% of
ECF


Fluid compartments
Extracellular Fluid
Intracellular Fluid
Plasma
Interstitial Fluid
Transcellular Fluid
CSF السائل النخاعي
Intra ocular السائل داخل العين
Pleural غشاء الرئتين
Peritoneal صفاقي
Synovial سائل المفاصل
Digestive Secretion الافرازات الهضمية

*** Intracellular fluid (ICF)**

- Inside the cell.
- **2/3** of **TBW**.
- High concentration of protein.

*** Extracellular fluid (ECF)**

Out side the cell.

1/3 of **TBW**.

1- Plasma:

Fluid circulating in the blood vessels.

1/4 of **ECF**

2- Interstitial fluid:

Fluid bathing the cell.

Ultra filtration of plasma.

3/4 of **ECF**

- Plasma and interstitial fluid are almost having the same composition except for high protein concentration in plasma

*** Transcellular fluid compartment:**

- small amount.

CSF, GIT fluid, biliary fluid, synovial fluid, intrapelural fluid, intraperitoneal fluid, intrapericardial fluid and intraoccular fluid.

e.g.

- TBW = 42L.
- ECF = 14L.
- ICF = 28L.
- Plasma = 3,5 L.
- Interstitial = 10,5 L.

Composition of body fluids

- Water is the universal solvent
- Solutes are broadly classified into:
    - Electrolytes – inorganic salts, all acids and bases, and some proteins
    - Nonelectrolytes – examples include glucose, lipids, creatinine, and urea
    - Amount = in moles, osmoles.

Concentration

1- Molarity = moles/liter M/L.

2- Osmolarity = osmoles/liter osm/L.

3- Osmolality = osmoles/kg Osm/kg.

*** Interstitial fluid هو السائل الموجود بين الخلايا**

*** تكاد تراكيز المواد الموجودة في السائل الموجود بين الخلايا (Interstitial fluid) والبلازما هي نفسها ، ماعدا تركيز البروتين فهو أعلى في البلازما**

*** المجموع الكلي لتراكيز المواد داخل الخلية مساو للمجموع الكلي للتراكيز خارج الخلية ويساوي تقريبا 300 mosm/L**

*** قد يختلف تركيز المادة الواحدة بين داخل وخارج الخلية ، ولكن يعوض نقص هذا التركيز عنصر أخر مثل العلاقة بين الصوديوم والبوتاسيوم ، فالصوديوم تركيزه عالي خارج الخلية وقليل داخلها والعكس للبوتاسيوم .**

In biological solutions

- Millimoles per liter (mM/L)
- Milliosmoles per (mOsm/L)
- 1mM=1/1000 M
- 1mOsm=1/1000 Osm

Constituents of ICF and ECF :

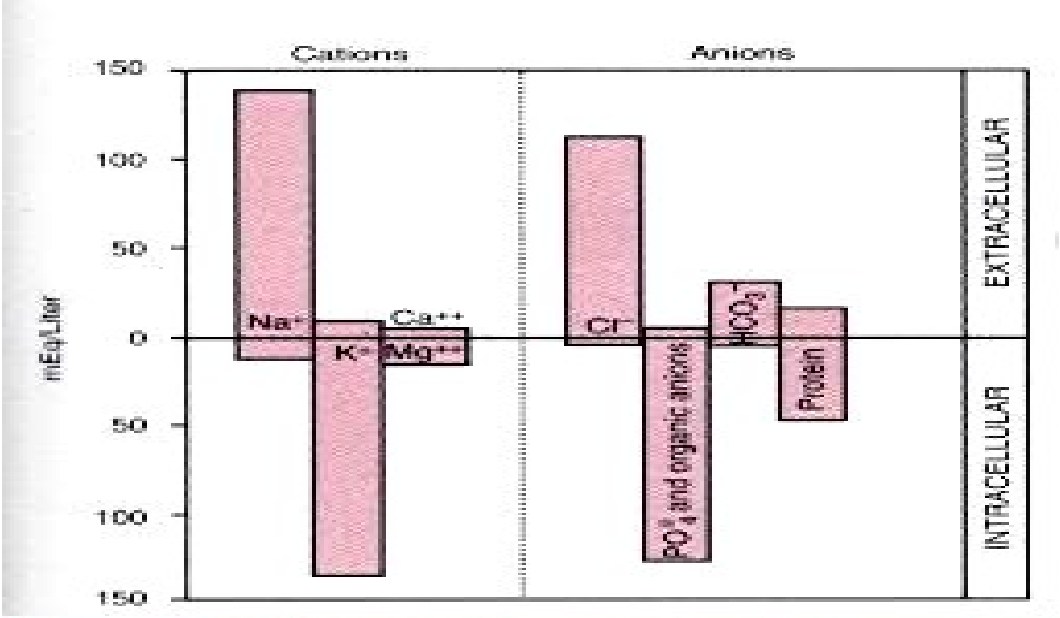
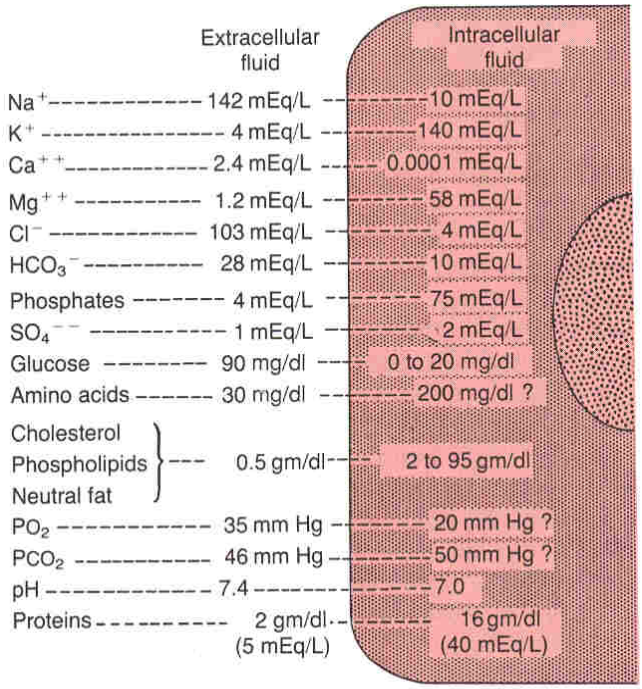


TABLE 20–2 OSMOLAR SUBSTANCES IN EXTRACELLULAR AND INTRACELLULAR FLUIDS

	Plasma (mOsm/liter of H_2O)	Interstitial	Intracellular
Na^+	142	139	14
K^+	4.2	4.0	140
Ca^{++}	1.3	1.2	0
Mg^+	0.8	0.7	20
Cl^-	108	108	4
HCO_3^-	24	28.3	10
HPO_4^{--}, $H_2PO_4^-$	2	2	11
SO_4^{--}	0.5	0.5	1
Phosphocreatine			45
Carnosine			14
Amino acids	2	2	8
Creatine	0.2	0.2	9
Lactate	1.2	1.2	1.5
Adenosine triphosphate			5
Hexose monophosphate			3.7
Glucose	5.6	5.6	
Protein	1.2	0.2	4
Urea	4	4	4
Others	4.8	3.9	10
Total mOsm/liter	301.8	300.8	301.2
Corrected osmolar activity (mOsm/liter)	282.0	281.0	281.0
Total osmotic pressure at 37° C (mm Hg)	5443	5423	5423

Extracellular and intracellular fluids

- Each fluid compartment of the body has a distinctive pattern of electrolytes
- **Extracellular fluids** are similar (except for the high protein content of plasma)
    - Sodium is the chief cation
    - Chloride is the major anion
- **Intracellular fluids**
    - Potassium is the chief cation
    - Phosphate is the chief anion
    - Each compartment must have almost the same concentration of positive charge (cations) as of negative charge (anion). (Electroneutrality)



- Hypokalemia: decrease in K concentration in the **ECF**. 1-2 mEq/L
- Hyperkalemia: increase in K 60-100% a above normal in the **ECF**.
- Hypernatremia: increase in Na concentration in **ECF**.
- Hyponatremia: decrease in Na concentration in the **ECF.**

Regulation of fluid exchange:

- **Intracellular** : cell member

- **Extracellular** : highly permeable to water
  relatively impermeable to small ions.
  i.e. only water is moving.
- (osmotic effect of electrolytes Na,K,cl)

Osmotic equilibrium is maintained between intracellular and extracellular fluids:

- Small changes in concentration of solutes in the extracellular fluid can cause tremendous change in cell volume.
- Intracellular osmolarity = extracellular osmolarity .
- ≈ 300 mosm/L

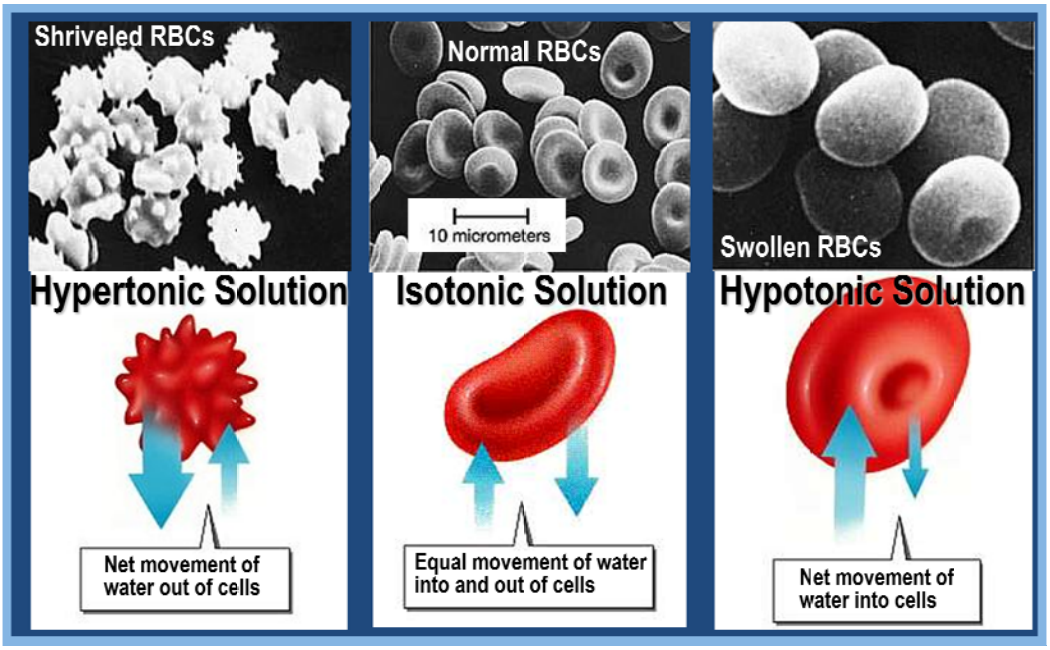
Mechanisms of movement

3 general mechanisms:

1. simple diffusion (passive)
2. Facilitated transport (passive)
3. Active transport

Osmosis

- net diffusion of water from a region of **high** water concentration to region of **low** water concentration.



- **If <u>environment</u> is:**
  - **<u>Hypertonic</u>:**
    - **MORE SOLUTES outside cell**
    - **MORE WATER IN CELL**
    - **over time, cell <u>loses</u> water**
  - **<u>Isotonic</u>:**
    - **same**
    - **No change in cell volume**
  - **<u>Hypotonic</u>:**
    - **LESS SOLUTES outside cell**
    - **LESS WATER IN CELL, more solutes in cell.**
    - **over time, cell <u>gains</u> water**

❖ **Isotonic solution :**
- (no swells or shrink)
- 0.9% solution of sodium chloride or 5% glucose .
- same in and out .

❖ **Hypotonic solution :**
- (swelling) 0.9%
- in is higher than out .

❖ **Hypertonic solution :**
- (shrink) 0.9%
- out is higher than in

Glucose and other solutions administered for nutritive purposes

People who can not take adequate amount of food.

- **Slowly.**
- **Prepared in isotonic solution.**
- **Water is excreted.**

ملاحظات للاسموزية :

الاسموزية : هي انتقال الماء بين تركيزين عبر غشاء منفذ

الناحية التي يكون فيها تركيز المذاب اعلى ما يكون يكون تركيز المذيب فيها اقل ما يكون والعكس صحيح

اذا يمكننا أن نعرف الاسموزية كالتالي :

الاول : (هي انتقال الماء من المنطقة ذات تركيز منخفض للمذاب الى منطقة ذات تركيز عالي للمذاب عبر غشاء منفذ)

الثاني : (هي انتقال الماء من المنطقة التي يكون فيها تركيز الماء عالي الى المنطقة التي يكون فيها تركيز الماء منخفض عبر غشاء منفذ)

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Lecture : 2

Homeostasis

- **Homeostasis is the ability to maintain a relatively stable internal environment in an ever-changing outside world**
- **The internal environment of the body (ECF)is in a dynamic state of equilibrium**
- **All different body systems operate in harmony to provide homeostasis**

Homeostatic control mechanisms

- The variable produces a change in the body
- The three interdependent components of control mechanisms are:
  - Receptor – monitors the environments and responds to changes (stimuli)
  - Control center – determines the set point at which the variable is maintained
  - Effector – provides the means to respond to the stimulus

Regulation of body functions

1. **Nervous system**
   - sensory input.
   - central nervous system.
   - motor out put.

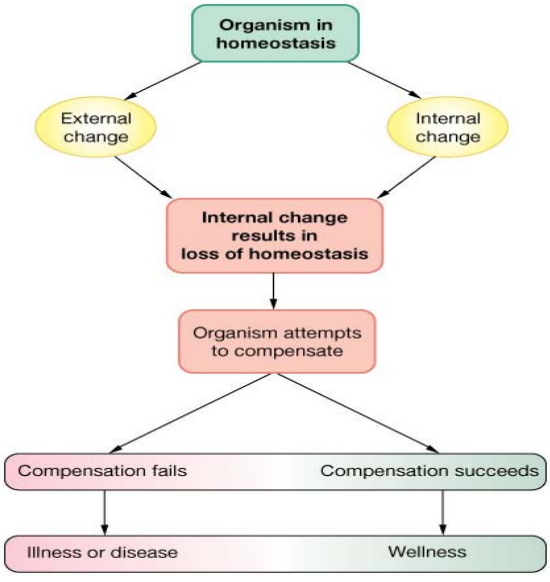
2. **Hormonal system of regulation**.
   - Endocrine gland.
   - Pancreas, thyroid
   e.g. : insulin control glucose level.

Homeostatic imbalance

- Disturbance of homeostasis or the body's normal equilibrium

Homeostasis and controls

- Successful compensation
  - Homeostasis reestablished
- Failure to compensate
  - Pathophysiology
    - Illness
    - Death



Volumes And Osmolarities Of ECF and ICF In Abnormal States

- Some factors can cause the change:
  - dehydration .
  - intravenous infusion.
  - abnormal sweating.
  - etc..

Changes in volume :

1. Volume expansion.
2. Volume contraction.

*** التغير يحدث أولا خارج الخلية ثم يحدث داخل الخلية ، ولا يحدث مباشرة داخل الخلية**

***** مهم لفهم Volume contraction ، Volume expansion :**

*** لا يحدث انتقال للماء إلا عند تغير التركيز بين داخل وخارج الخلية .**

*** عند نقص أو زيادة كمية من السائل (المذيب ، المذاب) خارج الخلية الذي له نفس التركيز داخل الخلية ، لا يحدث تغير بالتركيز وبالتالي لا يحدث انتقال للماء**

*** يحدث انتقال الماء عند اختلاف التركيز وذلك بطريقتين :**

إما زيادة أو نقص المذيب (الماء) بالنسبة للمذاب ، أو زيادة أو نقص المذاب بالنسبة للمذيب

*** عندما نقص السوائل تقل كمية الدم مما يؤدي الى انخفاض الضغط الشرياني**

*** السائل (المذاب والمذيب) نقصه وزيادته لا تؤدي الى حدوث انتقال للماء**

أما الماء (المذاب) النقص والزيادة فيه تؤدي لحدوث انتقال للماء .

*** العلاقة عكسية بين الماء والتركيز فإذا زاد الماء قل التركيز ،وإذا قل الماء زاد التركيز**

**** مثال / عندما ينقص الماء خارج الخلية يرتفع التركيز وبالتالي ينتقل الماء من داخل الخلية لخارجها ليعادل التركيز ، بعد أن تتم معادلة التركيز : تنقص كمية الماء داخل الخلية وينقص ايضا خارجها لأنه من المستحيل أن يزداد عن كميته الطبيعية قبل الفقد اما التراكيز فترتفع في كلاهما .**

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Volume contraction (decrease in the ECF volume) :

1. **Diarrhea**.

(الاسهال ، نقص من كمية السائل خارج الخلية الذي له نفس تركيز السائل خارج الخلية)

osmolarity of fluid lost ≈ osmolarity of ECF

(loss of isosmotic fluid).

- ↓ volume in ECF.
- ↓ arterial pressure

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2. Water deprivation

هو نقص الماء فقط

- Water and NaCl.
- Osmolarity and volume will change .
- Hyposmotic fluid (small NaCl large water)
- ↑ Osmolarity in both ECF and ICF.
- ↓ Volume in both ECF and ICF

3. Adrenal insufficiency:
عدم قدرة الكظر على اعادة امتصاص الصوديوم ، وبالتالي يقل الصوديوم خارج الخلية
- Aldosterone deficiency.
- ↓ Na in the ECF.
- ↓ osmolarity in both .
- ↓ in ECF volume.
- ↑ in ICF volume

Volume expansion :

1. **Infusion of isotonic NaCl**. (عكس **Diarrhea**)
   (اضافة سائل له نفس التركيز خارج وداخل الخلية)

- ↑ ECF volume.
- No change in osmolarity.
- Isomotic expansion

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2. **High NaCl intake**.
   زيادة كلوريد الصوديوم خارج الخلية

- ↑ eating salt.
- ↑ osmolarity in both.
- ↓ volume of ICF .
- ↑ volume of ECF .
- hyperosmotic volume expansion

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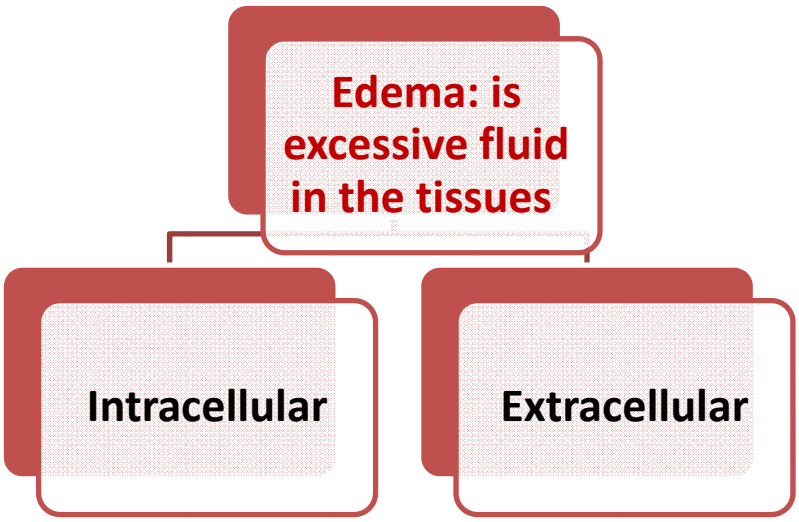
3. **Syndrome of inappropriate antidiurtic hormone (SIADH)**: **عكس Water deprivation**
   عدم القدرة على التخلص من الماء الزائد

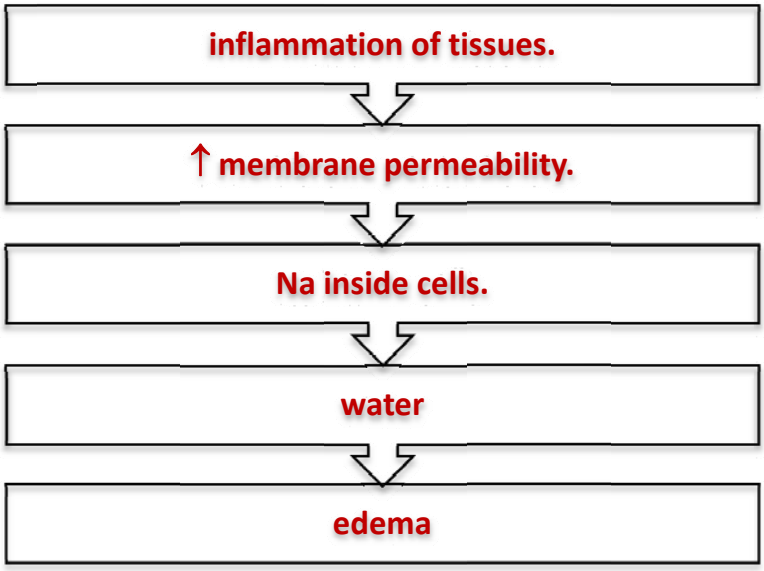
- ↑ volume
- ↓ osmolarity

Edema:



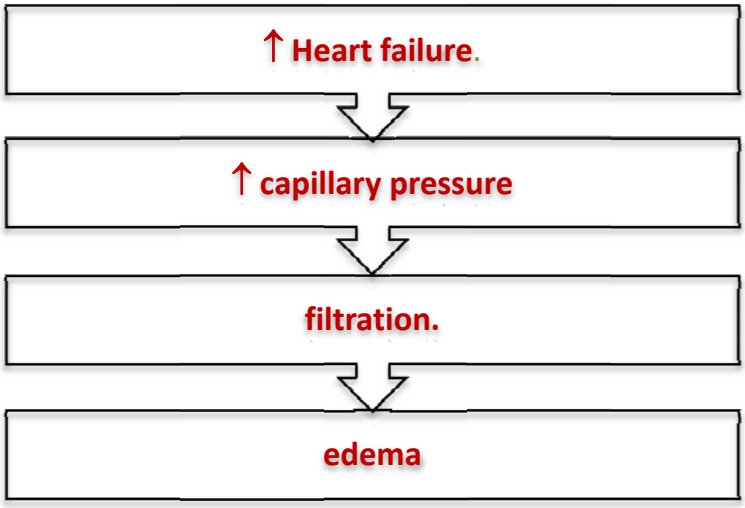
Edema occurs mainly in the extracellular fluid compartment

Intracellular edema :



Extracellular edema

common clinical cause is excessive capillary fluid filtration.



Lecture : 3

Cell membrane structure and transport across cell membrane

Cell membrane

- It covers the cell.
- It is a fluid and not solid.
- It is 10 nanometer thick.
- It is also referred to as the plasma membrane .

Composition

protein 55%
phospholipids 25%
cholesterol 13 % } lipid 42 %
glycolipid 4%
carbohydrates 3%

The Cell Membrane Phospholipids Consist Of :

1. Glycerol head (hydrophilic).
2. Two fatty acid ‘’tails’’ (hydrophobic).

- Heads (hydrophilic) facing ICF and ECF and tails (hydrophobic) face each other in the interior of the bilayer.
- Amphipathic.

The cell membrane proteins

1. Integral proteins span the membrane . Proteins provide structural channels or pores.
2. Peripheral proteins (carrier proteins)
    - Present in one side.
    - Hormone receptors .
    - Cell surface antigens .

The Cell Membrane Carbohydrates:

- Glycoproteins (most of it).
- Glycolipids (1/10)
- Proteoglycans (mainly carbohydrate substance bound together by protein)
- ‘’glyco’’ part is in the surface forming.
- Glycocalyx.(loose coat of carbohydrates.
-

Function of carbohydrates

- Attaches cell to each others.
- Act as receptors substances. (help ligend to recognize its receptor).
- Some enter in to immune reactions.
- Give most of cells overall –ve surface.

Transport through the cell membrane

- Cell membrane is selectively permeable.
- Through the proteins.
- water –soluble substances e.g. ions, glucose ..
- Directly through the bilayer.
- Fat – soluble substance (O_2, CO_2, OH..

Types of membrane transport

1- Diffusion
   a)- simple diffusion.
   b)- facilitated diffusion.
2- Active transport.
   a)- primary active transport.
   b)- secondary active transport.
3- Osmosis.

Diffusion

Random movement of substance either through the membrane directly or in combination with carrier protein down an electrochemical gradient.

1- Simple diffusion.
2- facilitated diffusion.

Simple diffusion

- Non carrier mediated transport down an electrochemical gradient.
- Diffusion of nonelectrolytes (uncharged) from high concentration to low concentration.
- Diffusion of electrolytes (charged) depend on both chemical as will as electrical potential difference.

Rate of simple diffusion depends on:

1- Amount of substance available.
2- The number of opening in the cell membrane for the substance.
   selective gating system
3- Chemical concentration difference.
   net diffusion= P x A (Co-Ci)
4- Electrical potential difference.
   EPD=± 61 log C1/C2
5- Molecular size of the substance.
6- Lipid solubility.
7- Temperature.

Facilitated diffusion

- Carrier mediated transport down an electrochemical gradient.

Glucose, most of amino acids.

Active transport

- Transport (uphill) → against electrochemical gradient.
- Required energy → direct.

→ indirect.

- Required carrier – protein.

1- Primary active transport

-Energy is supplied directly from ATP.
ATP → ADP +P+ energy.

A. **Sodium-Potassium pump (Na-K pump**).

- its present in all cell membranes.
- Na in → out.
- K out → in.

Features of carrier mediated transport

1- saturation:

↑ concentration → ↑ binding of protein

If all protein is occupied we achieve full saturation.

2- stereopecificity:

The binding site recognize a specific substance

D-glucose but not L-glucose

3- Competition:

Chemically similar substance can compete for the same binding site.

D- galactose D-glucose.

Substance → binding site → substance protein complex → conformational changes → release of substance

Characteristic of the pump

1. Carrier protein is formed from α and β subunits.
2. Binding site for Na inside the cell.
3. Binding site for K outside the cell.
4. It has ATPase activity.
5. 3 Na out.
6. 2 K in.

Function

1. Maintaining Na and K concentration difference .
2. It's the basis of nerve signal transmition .
3. Maintaining –Ve potential inside the cell.

- digitals

B. - Primary active transport of calcium

(Ca^{2+} ATPase).

- sarcoplasmic reticulum (SR).
- mitochondria.
- in some cell membranes.

Function:

Maintaining a low Ca^{2+} concentration inside the cell

C. - Primary active transport of hydrogen lons H+-K ATPase.

- stomach.
- kidneys.
- pump to the lumen.
- H+-K ATPase inhibitors (treat ulcer disease). (omeprazol)

2- Secondary active transport

- Co- transport and countertransport:

Is transport of one or more solutes against an electrochemical gradient ,coupled to the transport of another solute down an electrochemical gradient .

- ‘’downhill’’ solute is Na.
- Energy is supplied indirectly form primary transport.

- Co transport:

- All solutes move in the same direction ‘’ inside cell’’.

- Na - glucose Co transport. e.g.
- Na – amino acid Co transport.
- in the intestinal tract, kidney.

Countertransport:

- Na is moving to the interior causing other substance to move out.
- Ca^{2+} - Na^{+} exchange.
  (present in many cell membranes)

  Na –H^{+} exchange in the kidney

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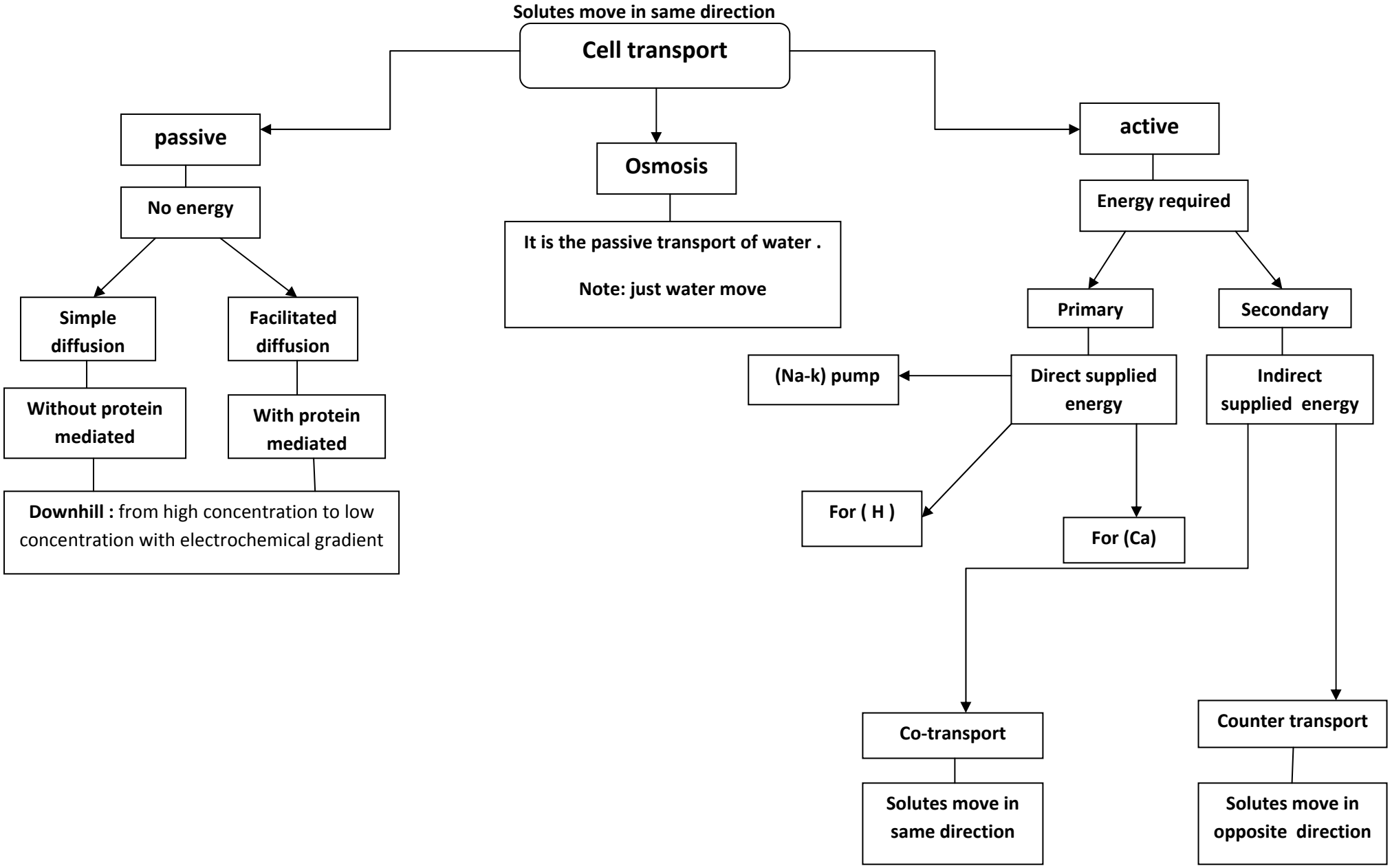
Solutes move in same direction
Cell transport
passive
No energy
Simple diffusion
Facilitated diffusion
Without protein mediated
With protein mediated
Downhill : from high concentration to low concentration with electrochemical gradient
Osmosis
It is the passive transport of water .
Note: just water move
active
Energy required
Primary
Secondary
(Na-k) pump
Direct supplied energy
Indirect supplied energy
For (H)
For (Ca)
Co-transport
Solutes move in same direction
Counter transport
Solutes move in opposite direction

Lecture : 4

Blood Composition

Blood Compositions	
1) Cellular Components	2) Plasma
Red Blood Cells (Erythrocytes)	98% water, ions , plasma proteins (Albumin, Globulin, Fibrinogen)
White Blood Cells (Leucocytes)	
Platelets (Thrombocytes)	Same ionic composition as interstitial fluid

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Functions of Blood :

Function of Blood		
1	Transport	O_2, CO_2, Nutrient, Hormones, Waste product
2	Homeostasis	Regulation of body temperature, ECF pH
3	Protecting	Against infections . WBCs, Antibodies
4	Clotting	Prevent blood loss

.....

Blood Volume :

Blood Volume (5 Liters in adult)	
45% is packed cells volume (PCV)	55% is plasma Volume
RBCs = 44.9% of whole blood	
Buffy Coat = 0.1%	

N.B. Buffy Coat is : *(WBCs and Platelets)*

.....

Blood Cells Formation :

blood Cells Formation	
Erythropoiesis	Formation of RBC (Erythrocytes)
Leucopoiesis	Formation of WBC (Leucocytes)
Thrombopoiesis	Formation of Platelets (Thrombocytes)

RBCs Function :

RBCs Function :	O2 transport
	CO2 transport
	Buffer

N.B. Buffer is : **" substances which enable the blood to absorb much acidity without significant change in pH. The principal ones are the bicarbonate and hemoglobin buffers ".**

.....

Production of RBCs :

Production of RBCs	
Early weeks of embryo	In Yolk Sac
Middle trimester	In Liver & Spleen & lymph nodes
Last months	In Bone Marrow of all bones

N.B. Shaft of long bone stop to produce RBC at puberty while epiphysis continued

N.B. All blood cell are formed from
Pluripotential hematopoietic stem cells ⇒ committed cells:
Committed stem cells for RBC
Committed stem cells for WBC
Growth of different stems cells are controlled by different growth factors

.....

Erythropoiesis :

RBC development	Decrease in cell size
	Disappearance of nucleus
	Appearance of hemoglobin

N.B. Erythropoiesis is stimulated by erythropoietin hormone produced by the kidney in response to hypoxia

Hypoxia :

Hypoxia caused by	Low RBC count (Anemia)
	Hemorrhage
	High altitude
	Prolong heart failure
	Lung disease

N.B. Hypoxia is : *" Low oxygen in the blood "*

.....

Erythropoietin :

* Glycoprotein .
* 90% from renal cortex .
* 10% from liver .
* High level of erythropoietin **causes :**
    - **# Anemia .**
    - **# High altitude .**
    - **# Heart failure** .

……

Lecture : 5

Essential elements for RBCs formation and Maturation

……..

Certain elements are essential for RBC formation and maturation:

1- Amino acid: formation of globin in haemoglobin
- sever protein deficiency → anaemia

2- Iron: formation of haemoglobin
- Deficiency → anaemia

3- Vitamins: Vit B12 and Folic acid
- Synthesis of nucleoprotein
- Deficiency → anemia
- Other :Vit B6, Riboflavin, nicotinic acid, biotin, Vit C, Vit E

4- Essential elements: Copper, Cobalt, zinc, manganese

5- Hormones: Androgens, Thyroid, cortisol & growth hormones
- Deficiencies of any one results in anaemia

……..

Vitamin B12 & Folic acid :

*** Important for DNA synthesis and final maturation of RBC**

*** Dietary source:** meat, milk, liver, fat, green vegetables

*** Deficiency leads to:**
- Failure of nuclear maturation & division
- Abnormally large & oval shape RBC
- Short life span
- reduced RBC count & Hb
- Macrocytic (megaloblastic) anemia

……

Microcytic hypochromic anemia :

The RBC's here are smaller than normal and have an increased zone of central pallor. This is indicative of a hypochromic (less hemoglobin in each RBC) microcytic (smaller size of each RBC) anemia. There is also increased anisocytosis (variation in size) and poikilocytosis (variation in shape)**.**

……

Macrocytic anemia :

Note: the hypersegmented neurotrophil and also that the RBC are almost as large as the lymphocyte. Finally, note that there are fewer RBCs.

…….

Malabsorption of Vit. B12 : (Pernicious Anemia)

*** VB12 absorption needs intrinsic factor secreted by parietal cells of stomach**

*** VB12 + intrinsic factor is absorbed in the terminal Ileum**

*** Deficiency arise from**

*** Causes of deficiencies**
- Inadequate intake
- Poor absorption due to Intestinal disease

……..

Iron metabolism :

Iron is needed for the synthesis of haemoglobin, myoglobin cytochrome oxsidase, peroxidase & catalase

*** Total Iron in the body = 4-5g**

65% ….. Haemoglobin

5% …….. other hems

1% ……. bound to transferrin (betaglobulin) in blood

15-30% …… stored iron in the form of ferritin in the liver, spleen and bone marrow.

……

Iron absorption :

* Iron in food mostly in oxidized form (Ferric, F^{+3})

* Better absorbed in reduced form (Ferrious, F^{+2})

* Iron in stomach is reduced by gastric acid, Vitamin C.

* Rate of iron absorption depend on the amount of iron stored

……..

Transport and storage of iron :

* Iron is transport in plasma in the form of Transferrin (apotransferrin+iron)

* Iron is stored in two forms

- Ferritin (apoferritin+iron)
- Haemosiderin (insoluble complex molecule, in liver, spleen, bone marrow)

* Daily loss of iron is 0.6 mgm in male & 1.3mgm/day in females

…….

Destruction of RBC :

* RBC life span in circulation = 120 days

* Metabolic active cells

* Old cell has a fragile cell membrane, cell will rupture as it passes in narrow capillaries (and spleen)

* Released Hb is taken up by macrophages in liver, spleen & bone marrow

* Hb is broken into its component:

- Polypeptide—amino acids (storaged)
- Iron ---- ferrtin
- Haem (Porphyrin)>>—bilirubin>>—secreted by the liver into bile

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ANAEMIAS :

*** Definiation**

- Decrease number of RBC
- Decrease Hb

*** Symptoms:** Tired, Fatigue, short of breath, heart failure

………..

HAEMOGLOBIN :

* Hb molecules consist 4 chains each formed of heme & polypeptide chain (globin)

* Heme consist of protoporphyrin ring + iron

*Abnormality in the polypeptide chain - abnormal Hb (hemoglobinopathies) e.g thalassemias, sickle cell

…….

Functions of Hemoglobin :

*** Carriage of O2:**

Hb reversibly bind O_2 to form oxyhemoglobin, affect by pH, temperatre, H^+

*** Carriage of CO2**

Hb bind CO_2 = carboxyhemaglobin

*** Buffer**

……

Essential elements for RBCs formationand Maturation

- **Amino acid**
  - Formation of globin in haemoglobin(Hb)
  - Deficiency → anaemia
- **Iron**
  - Formation Hb
  - Deficiency → anaemia
  - Oxidized → Ferric, F+3
  - Reduced → Ferrious, F+2
  - in stomach is reduced by gastric acid, Vitamin C.
  - stored in two forms
    - Ferritin (apoferritin+iron)
    - Haemosiderin (insoluble complex molecule, in liver, spleen, bone marrow)
- **Vitamins B12 and folic acid**
  - Synthesis of nucleoprotein
  - Deficiency → anemia
  - Other :Vit B6, Riboflavin, nicotinic acid, biotin, Vit C, Vit E
  - Important for DNA synthesis and final maturation of RBC
  - source: meat, milk, liver, fat, green vegetables
  - Malabsorption of Vit. B12:
    - * VB12 absorption needs intrinsic factor secreted by parietal cells of stomach
    - Absorbed → Ileum
  - Causes of deficiencies:
    - Inadequate , Poor absorption
  - Deficiency leads to:
    - * Failure of nuclear maturation & division
    - * Abnormally large & oval shape RBC
    - * Short life span
    - * reduced RBC count & Hb
    - *Macrocytic (megaloblastic) anemia
    - Macrocytic anemia
      - Cell appear lymphocyte and be fewer
    - Microcytic hypochromic anemia
      - Less RBC
      - Less Hb
- **Essential elements**
  - Copper, Cobalt, zinc, manganese
- **Hormones**
  - Androgens, Thyroid, cortisol & growth hormones
  - Deficiencies of any one results in anaemia

ANAEMIAS

- Definiation:
  - Decrease number of RBC , Hb
- Symptoms:
  - Tired, Fatigue, short of breath, heart failure

Heme — Hb broken — polypeptide

Hb broken — Iron

Carriage of O2 — Hemoglobin — Buffer

Hemoglobin — Carriage of CO2