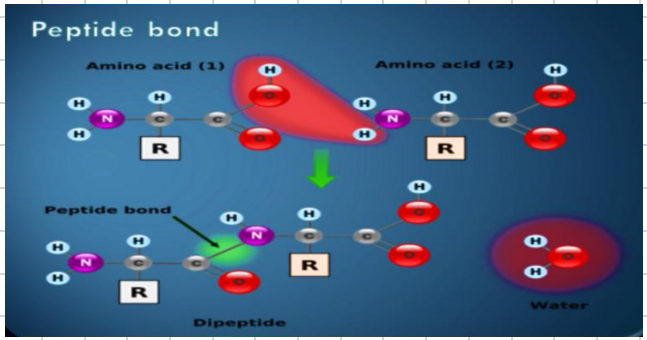
Lap 1 : DETECTION &QUANTITATION OF PROTEINS

What is protein ?
Amino acid chains linked by peptide bonds in condensation reactions



peptide bond is formed by dehydration of carboxylic group from the first amino acid and amine group in the second amino acid

Ninhydrin Test qualitative method

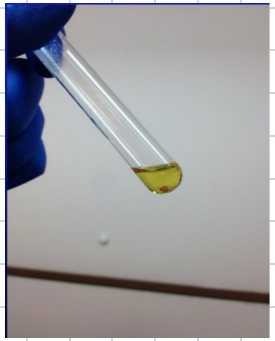
فحص يستخدم للكشف عن المينو اسد و البروتين

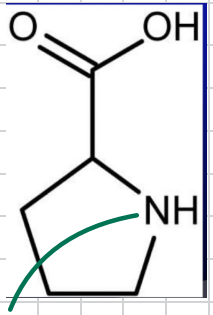
■ Ninhydrin is a chemical used to detect free amino acid and proteins
■Amino acids(NH2) also react with ninhydrin at pH=4.
Q/what is the proper PH for amino acid to react with ninhydrin
ans: PH=4
■The reduction product obtained from ninhydrin then reacts with NH3 and excess ninhydrin to yield a dark blue or purple violet colored substance.

reduction product (ninhydrin reacts with NH3) + excess ninhydrin = dark blue or violet colored substance

■This reaction provides an extremely sensitive test for amino acids.

Q/ why With all amino acids will give purple violet or deep blue with exception Proline gives yellow not violet ?
ans/ this is because Proline reacts with ninhydrin, but in a different way. While most ninhydrin tests result in a purple violet color, the proline reaction is more yellow due to substitution of the alpha amino group that ninhydrin reacts with carbon rings





NH group not NH2

Bradford method qualitative and quantitative method

■ *use of coomassie brilliant blue dye in a colorimetric reagent كاشف قياس الألوان for the detection and quantitation of total protein.*
■*it's unstable but when react with protein it becomes stable*
■ *In the acidic environment of the reagent protein binds to the coomassie dye*
■ *This results in a special shift from the reddish/brown form of the dye absorbance maximum at 465 nm to the blue form of the dye absorbance maximunm at 610 nm*

coomassie brilliant blue dye(reddish/brown) + protein = *blue form of the dye*

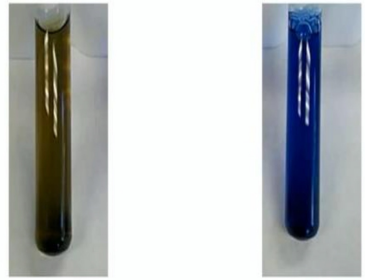
456n/m
unstable
610n/m
Stable

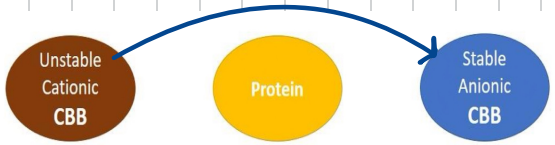
👀👀595nm best wavelength to see(measure) change in colour

■*the differences between the two forms of the dye is greatest at 595nm, so that is the optimal wavelength to measure the blue color from the coomassie dye protein complex.*
■ *development of color in coomassie dye based bradford protein assays has been associated with the presence of certain basic amino acids primarily arginine, lysine ,histidine in the protein.*

■ **Advantages of the method include that:**
it is highly sensitive,
it is able to measure 1-20 µg of protein
it is very fast.

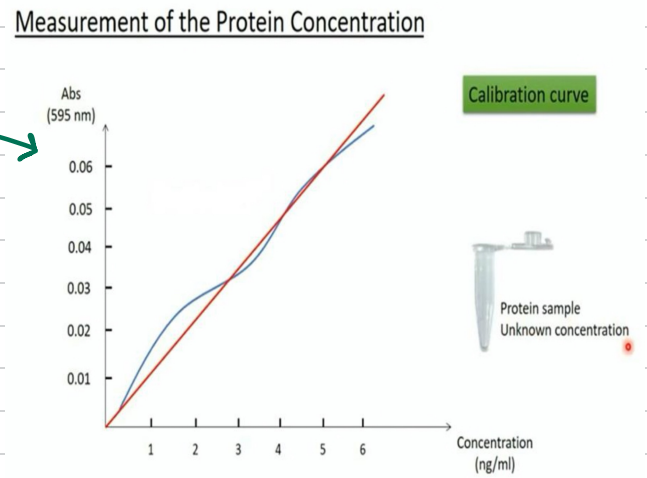
Principle of Bradford Assay



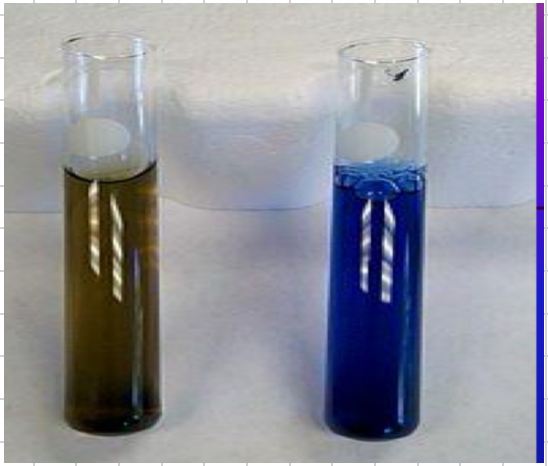


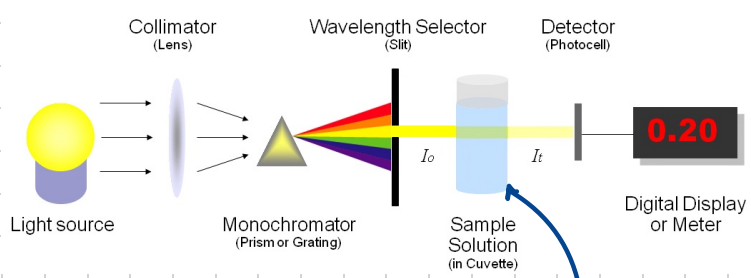
Spectrophotometer

جهاز يستخدم لقياس تركيز المحلول الذي يحتوي بروتون عن طريق قياس مقدار امتصاص هذا المحلول للضوء ويتم قياس تركيز هذا المحلول بالمقارنه مع CBB وهو يمثل التصفير



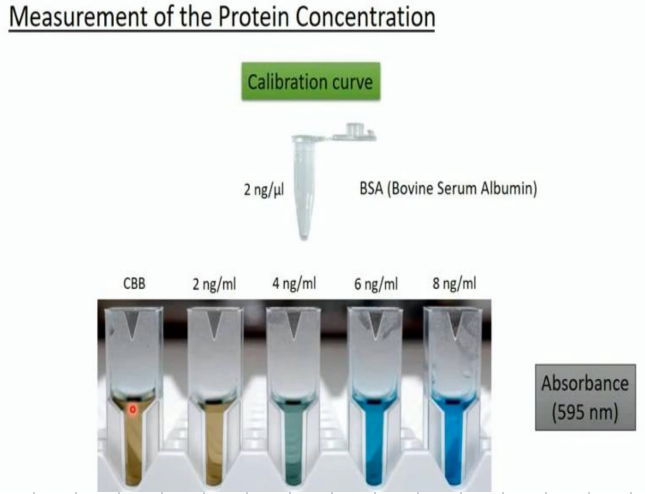
Samples treated with the Bradford assay. The brown sample (lower absorbance) contains no protein, while the blue sample (higher absorbance) contains protein. The amount of protein in the second sample can be determined by comparison to a standard curve





المحلول اللي اريد اقيس مقدار امتصاصه للضوء

و تتم قياسها بالنسبة لمواد معلومة :



lap 2: Mineral metabolism

Functions of Minerals

- *Some participate with enzymes in metabolic processes (cofactors, e.g. Mg, Mn, Cu, Zn, K)*
- *Some have structural functions (Ca, P in bone; S in keratin)*
- *Acid-base and water balance (Na, K, Cl)*
- *Nerve & muscle function (Ca, Na, K)*
- *Unique functions: hemoglobin (Fe), Vitamin B12 (Co), thyroxine (I).*

Classification

Macro or Major minerals

– Sodium (Na), potassium (K), magnesium (Mg), calcium (Ca), phosphorus (P), sulfur (S), chloride (Cl)

- *Present in body tissues at concentrations >50 mg/kg*
- *requirement of these is >100 mg/day*

Cl P S K Na Ca Mg

• Micro or Trace minerals (body needs relatively less)

– Manganese(Mn), iron(Fe), cobalt(Co), chromium(Cr), molybdenum(Mo), copper(Cu), zinc(Zn), fluoride(F), iodine(I), selenium(Se)

- *Present in body tissues at concentrations <50 mg/kg*
- *requirement of these is <100 mg/d*

Minerals in Foods

- *Found in all food groups.*
- *More reliably found in animal products.*
- *Often other substances in foods decrease absorption (bioavailability التوافر البيولوجي) of minerals*

– Oxalate, found in spinachسبانغ, prevents absorption of most calcium in spinach.

– Phytate, form of phosphorous in most plants makes it poorly available

Calcium (Ca)

- *Most abundant mineral in animal tissues*

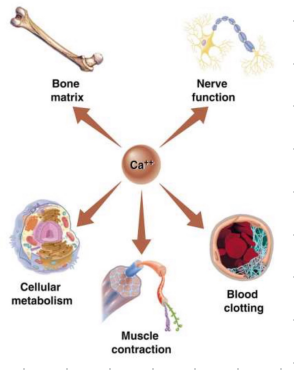
– 99% Ca in skeleton – 1% Present in: • Blood & other tissues

- **Lots of functions**

– Bone structure – Nerve function – Blood clotting

– Muscle contraction

– Cellular metabolism



Dietary requirements

- **Dietary requirements:**

– Infants: (< 1 year): 300-500 mg /day
– Adult : 800 mg/day;
– Children (1-18 yrs): 0.8-1.2 g/ day;
– Women during pregnancy, lactation and post-menopause: 1.5 g/day;

- **Food Sources:**

– Best sources: milk and milk product;
– Good sources: beans🫘🫛, leafy vegetables🥬, 🐟 , cabbageلهانه🥬, egg yolk🍳.

Absorption of calcium:

in small intestine (duodenum), first half jejunum against electrical and concentration gradient, by an energy dependent active process, which influenced by several factors.

mechanism

-Simple diffusion
-An active transport involving Ca pump

Factor promoting Ca absorption

1. Vit.D induce the synthesis of Ca binding protein in the intestinal epithelial cells and promotes Ca absorption.

2. Parathyroid hormone (PTH) enhances Ca absorption through the increased synthesis of calcitriolد الاسم العلمي للفيتامين.

3. *Acidity (low pH)* is more favorable for Ca absorption.
4. *Lactose* promotes calcium uptake by intestinal cell.
5. *Lysine and arginine* facilitate Ca absorption.

Factor inhibiting Ca absorption

1. *Phytates and oxalates form insoluble salts and interfere with Ca absorption.*
2. *The high content of dietary phosphate results in the formation of insoluble Ca phosphate and prevent Ca uptake.*
3. *The free fatty acids react with Ca to form insoluble Ca soaps.*
4. *The alkaline condition (high pH) is unfavorable for Ca absorption.*
5. *High content of dietary fiber interferes with Ca absorption.*
6. *Low estrogen levels (postmenopausal women)*

• Plasma calcium:

normal range: 9-11 mg% (2.25-2.75 mmol/L)

Three forms of plasma calcium:

1-Ionized Ca (diffusible): about 50% is ionized from which functionally the most active.

2-Complex Ca with organic acid (diffusible): about 10% is found in association with citrate or phosphate.

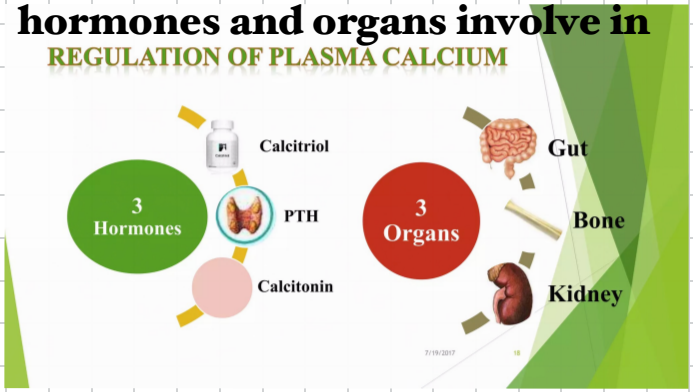
3-Protein bound Ca (non-diffusible): about 40% is found in association with albumin and globulin.

Factors Regulating Plasma Ca Level

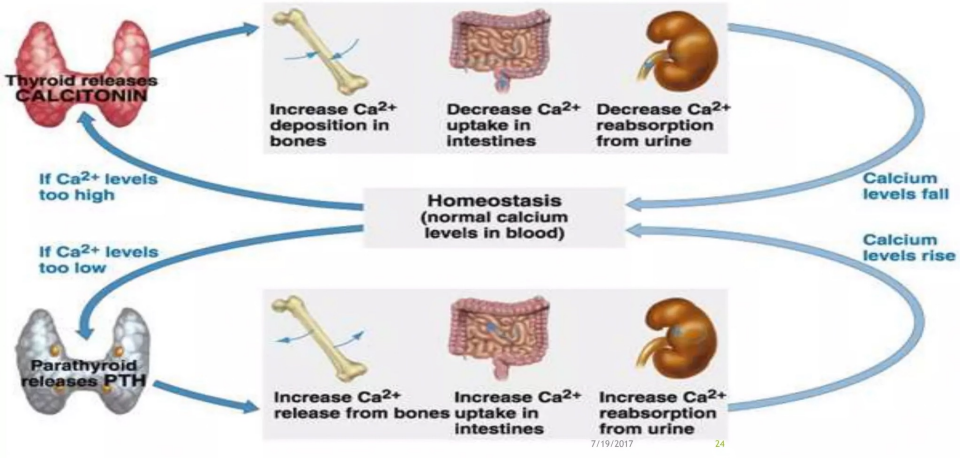
- Plasma Ca is regulated variable
- Three hormones involved in regulation

– **Calcitriol (1,25-(OH)2 VitD3, or 1,25 DHCC) · from kidney**
– **Parathyroid hormone (PTH) · from parathyroid gland**
– **Calcitonin(CT)· from thyroid gland**

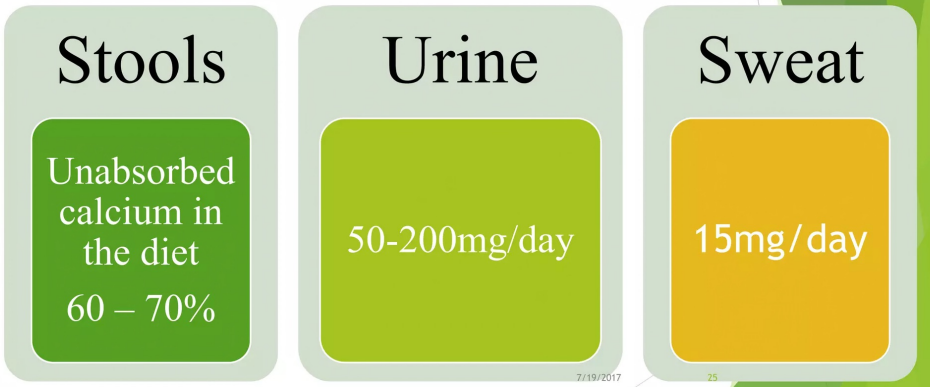
- Vitamin D3 (**Calcitriol**)and PTH : increase plasma Ca ↑
- Calcitonin : decrease plasma Ca ↓



Regulation of Calcium Homeostasis



EXCRETION OF CALCIUM



Calcium Deficiencies -Rickets

يحصل عن الاطفال اي قبل مرحلة البلوغ

- weakness and deformity تشوه of the bones that occurs from ***vitamin D deficiency or dietary غذائي deficiency of Ca and P in a growing person or animal.***

Calcium Deficiencies -Osteoporosis

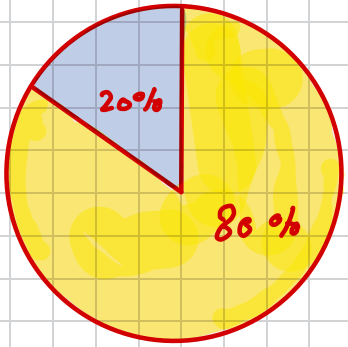
- progressive loss of bone density, thinning of bone tissue and increased vulnerability to fractures in the elderly people of both sexes.

- ***Characterized by demineralization لاتحتوي معادن of bone resulting in the progressive loss of bone mass.***
- ***After the age of 40-45, Ca2+ absorption is reduced & Ca2+ excretion is increased; there is a net negative balance for Ca2+***
- ***After the age of 60, osteoporosis is seen***
- ***There is reduced bone strength & an increased risk of fractures.***
- ***Decreased absorption of vitamin D & reduced levels of androgens/estrogens in old age are the causative factors.***

Phosphorous (P)

- ***80% of P occurs in combination with Ca in the bone and teeth.***
- ***About 10% is found in muscles and blood in association with proteins, carbohydrate and lipids.***
- ***The remaining 10% is widely distributed in various chemical compounds.***

- ***Human body contain about 840gm of phosphorus***
  - 80% present in bone and teeth
  - 20% in other tissue
- ***NORMAL RANGE Serum phosphate level-3-4 mg/dl*** كلش مهم



regulation of plasma phosphate

Vitamin D3 (**Calcitriol**)and PTH : increase plasma P ↑

- Calcitonin : decrease plasma P ↓

Functions of Phosphorus

- Essential for the development of bones and teeth
- Phospholipids, Phosphoproteins
- Component of: – DNA & RNA – ATP, NAD+, NADP+
- Energy metabolism: ATP, GTP
- Maintenance of blood pH: phosphate buffer system

Dietary requirements

- ***The recommended dietary allowance (RDA) of phosphate is based on the intake of calcium.***

– For adult, the ratio of Ca:P of 1:1 is recommended (800mg/day);

– For infant, however, the ratio is around 2:1, which is ratio found in human milk.

- ***Sources:***

– milk, cereals, leafy vegetable, meat, eggs.

Absorption and Excretion

Absorption: Phosphate absorption occur from jejunum

1. ***Calcitriol promotes phosphate uptake along with calcium.***
2. ***absorption of P and Ca is optimum when the dietary Ca:P is 1:2-2:1.***
3. ***acidity favors while phytate decreases phosphate uptake by intestinal cells.***

Excretion: About 500 mg phosphate is excreted in urine per day. The reabsorption of phosphate by renal tubules is inhibited by PTH.

Serum phosphate

phosphate in blood: 40 mg/dl and in serum: 3-4 mg/dl

※ RBC and WBC have very high content of phosphate.

※ The serum P may exist as free ions (40%) or in a complex form (50%) with cation as Ca2+, Mg2+, Na+, K+. About 10% is bound proteins.

Importance of Ca:P ratio

– The ratio of plasma Ca:P is important for calcification of bones.

• The product of Ca×P (in mg/dl) in child is around 50 and in adults around 40. This product is less than 30 in rickets.

• Phosphorus Deficiency

– Rickets, osteomalacia, osteoporosis

Iron

• The total content of iron in an adult body is 3-5 g.

1. About 70%: in the erythrocytes of blood as a constituent of Hb.

2. At least 5%: in Mb of muscle.

3. Heme is the most predominant iron containing substance: e.g. Hb, Mb, cytochromes.

4. Non-heme iron: e.g. transferrin, ferritin.

Functions

• O2 and CO2 transport via hemoglobin
– Thus, necessary for ATP production!
• Essential component of many enzymes
• Immune function
• Brain function
– Iron deficiency/toxicity thought to slow mental development in kids.

Dietary requirements

• Dietary requirements:
– Adult man: 10 mg/day
– Menstruating woman: 18mg/day
– Pregnant and lactating woman:40 mg/day

• Sources:
– Rich source: organ meats (liver, heart, kidney).
– Good source: leafy vegetables, pulses, cereals, fish, apple, dried fruits, molasses.
– Poor sources: milk, wheat, polished rice.

• Iron transport in the plasma

– The iron enters the plasma in ferrous state (Fe2+), then oxidized to ferric form (Fe3+) by a copper-containing protein, ceruplasmin.

– Fe3+ binds with a specific iron binding protein, namely transferrin. Each transferrin molecule can bind two atoms of ferric iron.

Iron storage

– Iron can be stored by ferritin (a protein) or hemosiderin
• Stored in liver, bone marrow (why here?), intestinal mucosa, and spleen
• A apoferritin molecule can combine with 4,000 atoms of iron.

Iron absorption

• Iron is mainly absorbed in the stomach and duodenum.
– mostly found in the food in ferric form (Fe3+), bound to protein or organic acid.
– In the acid medium provided by gastric HCl, the Fe3+ is released from food.
– Reducing substances such as ascorbate (Vitamin C) and cystein reduces ferric form (Fe3+) to ferrous form (Fe2+).
– Iron in ferrous form (Fe2+) is soluble and readily absorbed.
• How much do we absorb?
– We absorb iron from the diet only when we need it
– In normal people, about 10% of dietary iron is usually absorbed.
– Those with LOW stomach acid secretions absorb less.

Disease states

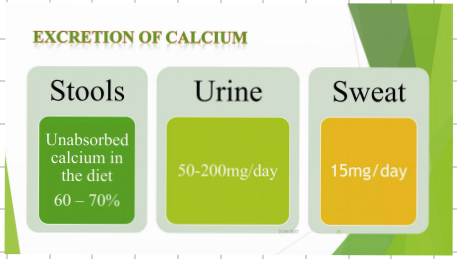
1. Iron Deficiency Anemia: The most common dietary deficiency worldwide is iron, affecting half a billion persons. However, this problem affects women and children more.

a) A growing child is increasing the RBC mass and needs additional iron.

b) Women who are menstruating require double the amount of iron that men do, but normally the efficiency of iron absorption from the gastrointestinal tract can increase to meet this demand.

c) A developing fetus draws iron from the mother, totaling 200-300 mg at term, so extra iron is needed in pregnancy.

2. Hemosiderosis: this is less common disorder and due to excessive iron in the body.
– It is commonly observed in subjects receiving repeated blood transfusions over the years, e.g. patients of hemolytic anemia, \hemophilia.
3. Hemochromatosis: this is rare disease in which iron is directly deposited in the tissue (liver, spleen, pancreas and skin).
– Bronzed-pigmentation of skin, cirrhosis of liver. pancreatic fibrosis are the manifestations of this disorder.

character of compare	*Ca*	P	Fe
abundance	• ***Most abundant mineral in animal tissues*** ***– 99% Ca in skeleton – 1% Present in: • Blood & other tissues***	***Human body contain about 840gm of phosphorus*** 80% present in bone and teeth 20% in other tissue	• The total content of iron in an adult body is 3-5 g. 1. About 70%: in the erythrocytes of blood as a constituent of Hb. 2. At least 5%: in Mb of muscle.
Dietary requirements	• Dietary requirements: – Infants: (< 1 year): 300-500 mg /day – Adult : 800 mg/day; – Children (1-18 yrs): 0.8-1.2 g/ day; – Women during pregnancy, lactation and post-menopause: 1.5 g/day; • Food Sources: – Best sources: milk and milk product; – Good sources: beans, leafy vegetables, , cabbage لهانه, egg yolk.	**• The recommended dietary allowance (RDA) of phosphate is based on the intake of calcium.** **– For adult, the ratio of Ca:P of 1:1 is recommended (800mg/day);** **– For infant, however, the ratio is around 2:1, which is ratio found in human milk.** **• Sources:** **– milk, cereals, leafy vegetable, meat, eggs.**	**• Dietary requirements:** **– Adult man: 10 mg/day** **– Menstruating woman: 18mg/day** **– Pregnant and lactating woman:40 mg/day** **• Sources:** **– Rich source: organ meats (liver, heart, kidney).** **– Good source: leafy vegetables, pulses, cereals, fish, apple, dried fruits, molasses.** **– Poor sources: milk, wheat, polished rice.**
absorption	**in small intestine (duodenum), first half jejunum against electrical and concentration gradient, by an energy dependent active process, which influenced by several factors.** 	***Absorption: Phosphate absorption occur from jejunum*** ***1. Calcitriol promotes phosphate uptake along with calcium.*** ***2. absorption of P and Ca is optimum when the dietary Ca:P is 1:2-2:1.*** ***3. acidity favors while phytate decreases phosphate uptake by intestinal cells.*** ***Excretion: About 500 mg phosphate is excreted in urine per day.*** ***The reabsorption of phosphate by renal tubules is inhibited by PTH.***	**Iron is mainly absorbed in the stomach and duodenum.** **– mostly found in the food in ferric form (Fe3+), bound to protein or organic acid.** **– In the acid medium provided by gastric HCl, the Fe3+ is released from food.** **– Reducing substances such as ascorbate (Vitamin C) and cystein reduces ferric form (Fe3+) to ferrous form (Fe2+).** **– Iron in ferrous form (Fe2+) is soluble and readily absorbed.**
function	***Bone structure – Nerve function – Blood clotting*** ***– Muscle contraction*** ***– Cellular metabolism***	• Essential for the development of bones and teeth • Phospholipids, Phosphoproteins • Component of: – DNA & RNA – ATP, NAD+, NADP+ • Energy metabolism: ATP, GTP • Maintenance of blood pH: phosphate buffer system	• O2 and CO2 transport via hemoglobin – Thus, necessary for ATP production! • Essential component of many enzymes • Immune function • Brain function – Iron deficiency/toxicity thought to slow mental development in kids.
diseases	**Rickets ,osteoporosis**	***– Rickets, osteomalacia, osteoporosis***	***Iron Deficiency Anemia*** ***Hemosiderosis*** ***Hemochromatosis***

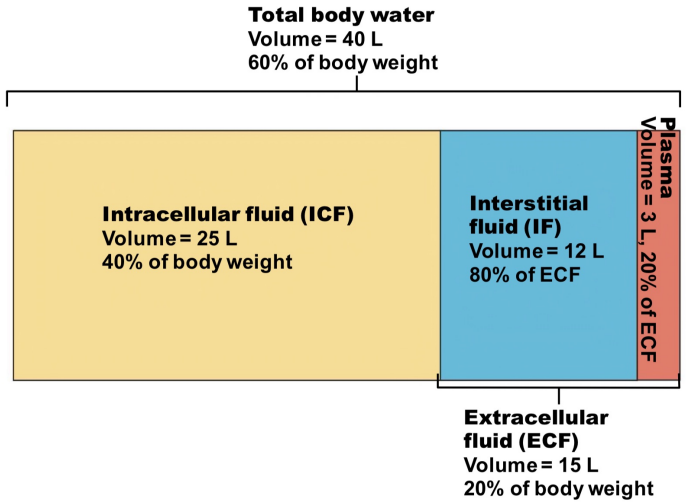
lap3 Hemochromatosis

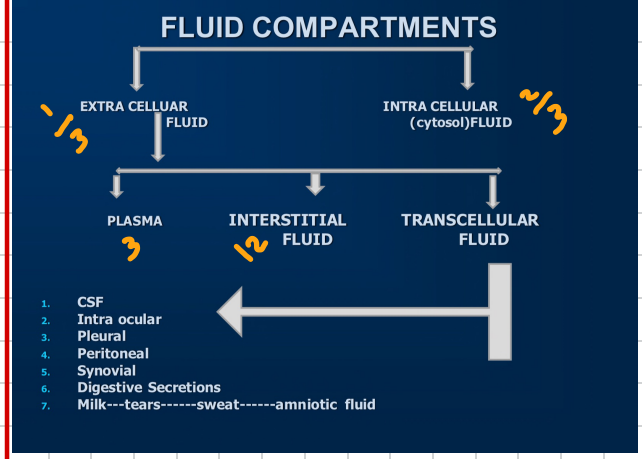
Body Water Content

- **Infants: 73% or more water (low body fat, low bone mass)**
- **Adult males: ~60% water**
- **Adult females: ~50% water (higher fat content, less skeletal muscle mass)**
  - **Adipose tissue least hydrated of all**
- **Water content declines to ~45% in old age.**

Fluid Compartments

- **Total body water = 40 L**
- **Two main fluid compartments**
  - **Intracellular fluid (ICF) compartment: 2/3 in cells**
  - **Extracellular fluid (ECF) compartment: 1/3 outside cells**
- **Plasma: 3 L**
- **Interstitial fluid (IF): 12 L in spaces between cells**
  - **Usually considered part of IF: lymph, CSF, humors of the eye, synovial fluid, serous fluid, and gastrointestinal secretions**





Amniotic Fluid

the fluid that surrounds your baby during pregnancy

- Liquid produced by membranes and fetus
- Volume of fluid increases with gestational age فتره الحمل
- Clear with some desquamated fetal cell and a little lipid.
- نضيف ويحتوي بعض خلايا الجنين المتقشرة وقليل من الدهون.

Functions of AF

- Physical protection to the fetus
- Medium for exchange of various chemicals

sweat

- it's Secretion of sweat gland
- Regulates body temperature by cooling and evaporation
- Sweat glands controlled by ANS (automatic nervous system الجهاز العصبي التلقائي), Adrenal cortical steroid - which affect the quantity of electrolyte present
- Insensible perspiration عرقamounts to 800-1200ml/day
- Volume of sweat produced/day during muscular exercise at elevated temperature may lead to imbalance water and electrolyte
- Water content of sweat varies from 99.2-99.7%
- pH – 4.7 to 7.5

Cerebrospinal fluid (CSF) السائل النخاعي

- **Clear, colorless liquid formed within the cavities of brain and around spinal cord**
- **100 ml CSF is formed everyday**
- **At any given time, there is 120-150 ml CSF in the system**
- **CSF is completely replaced about three times a day.**

Functions of CSF

- **Hydrolic shock absorber**
- **Regulation of intracranial pressure**
- **Influences the hunger sensation and eating behaviours**

Tears

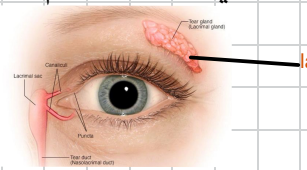
- Produced by lachrymal glands
- Isotonic but becomes hypertonic due to evaporation as fluid passes over the cornea
2. متوازنة النسبة الملحية، لكنها تصبح أكثر تركيزاً (هايبرتونيكية) نتيجة للتبخر أثناء مرورها فوق قرنية العين.
- When the tear flow is copious, fluid is isotonic
3. عندما تكون الدموع تتدفق بكميات كبيرة، يكون سائل الدموع متوازن النسبة الملحية.

(Copious = Rapid tear flow)

- Under stimulus with a slow rate of tear flow, the fluid is about 25m osm hypertonic

- تحت التحفيز الذي يسبب تدفقًا بطيئًا للدموع، يكون سائل الدموع متركزًا بنسبة تصل إلى حوالي 25 ملي أوسمول لكل كيلوغرام (نوع من الوحدات المستخدمة في قياس التركيز)، وهو ما يعرف بالتركيز الزائد (Copious = سريان الدموع بوتيرة سريعة)

- ❖ pH – 7 to 7.6 due to loss of CO2
- ❖ Protein content is 0.6 to 0.18 g/dl
- ❖ Lysozyme – lyses the cells of a number of micro-organisms by breaking down the polysaccharides of their outer layer
- ❖ الليزوزيم - يقوم بتحطيم جدران الخلايا لعدد من الكائنات الدقيقة عن طريق تفكيك البوليساكاريدات التي تشكل طبقتهم الخارجية.

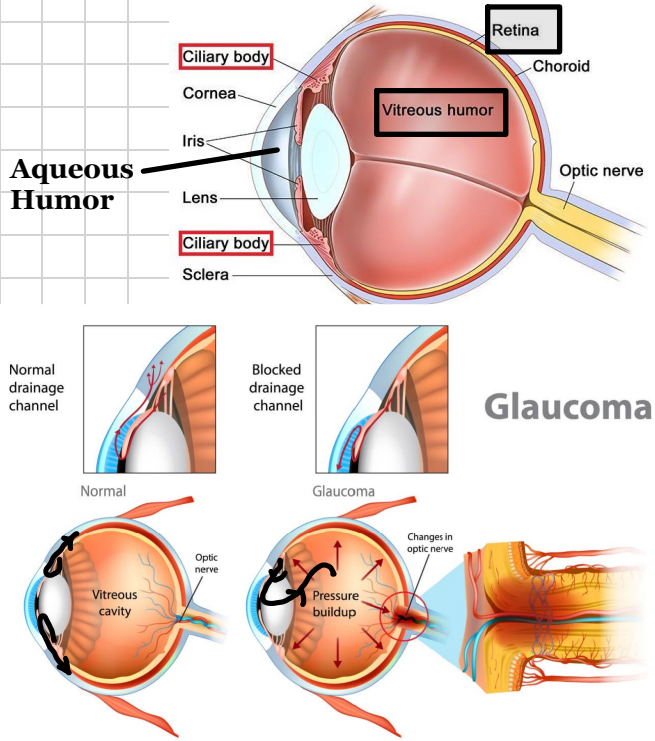


Function of tears

- Lysozyme protects eye from infectious agents
- Lubricate the surface of the cornea
- Fill the irregularities of the corneal surface to improve optical properties
- Protects eyes from injury

Aqueous Humor

- ► Fluid that fills the anterior chamber of eye
- ► Secreted by ciliary body, enters anterior chamber
- ► Blockade in the flow of aqueous humor causes glaucoma due to increased intraocular pressure.
- ► Posterior chamber of eye is filled with vitrous humor which contains a gel (vitrous body of hyaluronic acid secreted by retina)



اسئله مهمه

١-منو ينتج Aqueous Humor

٢شنو يصير اذا انسد طريق الر Aqueous Humor

٣-مكان ال Aqueous Humor

٤-شنو يحتوي الجزء الخلفي من العين

٥-منو ينتج vitrous humor

MILK

- It is the secretion of mammary glands in human and animals after labourالولاده.

- ***Milk secretion is stimulated by Prolactin hormone .***

- Milk flow is decreased by ***Estrogen*** and ***Progesterone*** while increased by ***Thyroxin***. Also ***Squalene*** present in HELBA نباتات الحلبهincrease milk flow.

- Oxytocin (posterior pituitary hormone) responsible for milk ejection.

الأوكسيتوسين هو هرمون يتم إفرازه من قبل الغدة النخامية الخلفية ويلعب دورًا حيويًا في تفريغ الحليب أو ما يُعرف بالاستجابة للإفراز أثناء الرضاعة الطبيعية. عندما يمتصّ الطفل من الثدي، يتم إفراز الأوكسيتوسين ردًّا على التحفيز الناتج عن تحريك نهايات الأعصاب في الحلمة. يتسبب هذا الهرمون في انقباض العضلات المحيطة بالغدد الثديية، مما يتيح للحليب المخزّن في الغدد أن يتحرر إلى القنوات، مما يسمح للطفل بالرضاعة.!

- Milk is considered as a complete diet_as:- It contains all of the components necessary for growth, maintenance of life and reproduction.

- But it is deficient in: Vitamin C, Vitamin D, Vitamin K, Iron, Copper.

Physical Properties of Milk

1- Color:

⚪White color → due to presence of:
1-Fat globules in emulsion form.
2-Protein in colloidal form.
3-Ca. phosphate and Ca. Casinate.
دهن و بروتين و كالسيوم

🟡Yellowish (creamy) color → due to:
1-Presence of Carotene🥕 and Xanthophyll pigments specially in cow's milk and colostrums=اول حليب تفرزه الام بعد الولاده

2- Reaction:

💢Fresh milk is amphoteric in reaction as it contains acid and base.
💢** PH of fresh milk:
6.6-6.8 Cow's milk.
6.8-7.4 Human's milk

Milk pH changed to alkaline in case of:
-Mastitis(inflammation of mammary gland)
-Late period of lactationالام ترضع لفتره طويله.

3- Taste:

💢Normal characteristic milky taste.
changed in case of:
🍋Souringحامض: due to increased acidity.
🥛Mastitis: inflammation of udder
♨️Boiling: due to certain biochemical changes and evaporation of volatile fatty acids.
🍼Late stage of lactation: due to increase chloride percent.

4- Specific Gravity:

💢It is the ratio between weight of a given volume of milk compared with the same volume of water at a specific temperature.
💢It measure total solids of milk, and determine if any constituent added or removed from milk..

Normal specific gravity:
1020-1030:Cow's milk.
1030-1035:Human's milk.
Fat is the only constituent in milk with specific gravity lower than 1000, so, when fat present in milk in high amount, specific gravity decrease than normal values.

■When milk is skimmed (removal of fat content), the specific gravity increased due to: Removal of light constituents of milk.

■ When water is added to milk (adulterationغش) the specific gravity decreased due to dilution of total solids.

5-Odor: characteristic milky oder

6- Freezing point of milk:

The freezing point of cow or buffalo milk ranges from (-0.53) to (-0.57) °C with average (-0.55) °C
Milk freezes at a temperature slightly lower than that of water due to the soluble constituents in milk.

7- Boiling Point:

Milk boiling point is 100.5 °C, more than water due to presence of dissolving substances

Chemical composition:

Milk is formed of:
1) Water: form 87%. 2) Solids: form 13%.

A- Organic Constituents

1- Protein:

💢Milk protein less in human than in cow's milk.

Characterized by:
1- Protein of high biological value as:
►It contains all essential amino acids.
►Easily digested, absorbed, metabolized
2- Contain moderate amount of non essential amino acids to decrease stress on body cells.
3- Essential to keep positive nitrogen balance (nitrogen intake more than nitrogen output).

Types of Milk Proteins are:
Casein., Lactalbumin., Lactglobulin., Milk enzymes.

1) Casein

💢It is the main and most dominant milk protein. represents 25% in human's milk and 83% in cow's milk.
💢It is a compound protein (Phospho-protein) of high biological value.
The high phosphate content of casein allows it to associate with calcium and form calcium phosphate salts.
■ So, at normal PH of fresh milk (6.6 PH) casein present as insoluble Ca. caseinate phosphate complex.
■ Casein is deficient in cystiene and cystin so give negative result with sulpher test.
💢Casein is the only milk protein that not coagulated on boiling.

2- Lactalbumin
3- Lacglobulin
4- Milk enzymes: Catalase. Peroxidase, Xanthinoxidase, Alkaline,phophatase. Amylase, Lipase, Aldehyde oxidase.

2- Lipid:

Human's and cow's milk contain the same amount 3.5gm/dl but buffalo's milk is a little higher 7 gm/dl.
Easily separated on standing.
Responsible for white color of milk

It consists mainly of triacylglycerol distributed as coarse emulsion which contains oleic, myristic, palmitic and stearic fatty acids.
يتكون بشكل رئيسي من ثلاثي الجليسرين موزع على شكل مستحلب خشن يحتوي على الأحماض الدهنية الأوليك والميريستية والباليتية والدهنية.
Also contain small amounts of:
💢phospholipids 0.1%.
Milk phospholipids are lecithin, cephalin, sphingomyelin (9:5:1).
Phospholipids in cow's milk twice that of human milk.
💢 Cholesterol 0.01%.
Cow's milk contains higher proportion (mainly free form) than human milk mainly (ester form)

3- Carbohydrates:

Lactose (milk sugar) is the only carbohydrate of milk.
It is a reducing disaccharide consists of glucose and galactose.
Human's milk contains 7% lactose while cow's milk contains 5% lactose.
Lactose may be excreted in urine during last third of pregnancy physiologically so it should be differentiated from glucose by osazon test لان اذا كان كلوكوز لازم تاخذ علاج مال سكر.

Importance of lactose:

1. It is less sweet than sucrose so allow the baby to take large amount of milk without causing nauseaغثيان.
2. It is non fermentable لا يتخمر carbohydrate so it doesn't produce CO_2 in GIT and the baby doesn't suffer from abdominal colic or distention.
3. Lactose help growth of lactic acid producing bacteria so help in absorption of Ca, P, Fe, Cu which prefer acidic medium for their absorption.
4. Lactose inhibits growth of putrefactive bacteria which cause abdominal distention by increasing the acidity of the intestine.

N.B:
If the milk is taken by the adult in large amount result in diarrhea due to decrease in lactase enzyme so lactose is hydrolyzed by intestinal bacteria to glucose and galactose.

- Glucose is fermented producing CO2 and abdominal distention.
- Non fermentable galactose and unhydrolyzed lactose increase osmotic pressure of the intestine leads to diarrhea.

-Inorganic constituents of milk

1-*Minerals*: Human milk contain less mineral elements (0.4%) than cow's milk (0.8%).
Milk rich in Ca and P which are present in their proper ratio for absorption (2:1) in human milk while in cow's milk (1:2) which is not suitable for their maximum absorption.
Milk is deficient in Fe and Cu which are supplied by their storage in liver during prenatal life (this store is sufficient till weaning time).
N.B:Milk is deficient in Iron but it is more in human milk than cow's milk Thus anaemia in breast feeding is less common.
Milk contain adequate amount of Na, K, Mg. Human milk contains Na:K (1:2) which is suitable for the optimal growth of newborn.

***2- Vitamins:* Milk is deficient in : Vitamin C., D.,K.**
Milk contain adequate amount of vitamin B complex which are sufficient for first week of life e.g: Pantothenic acid, Riboflavin (gives the whey the greenish tint in sunlight).
Vitamin C must be supplied to the growing baby in the form of fruit juices to withstand infection.
Fortified vitamin D milk is used in order to supply the baby with vitamin D requirement which is added from cod liver oil.
Exposure to sunlight in the early morning or before sunset help in formation of active vitamin D from cholesterol.