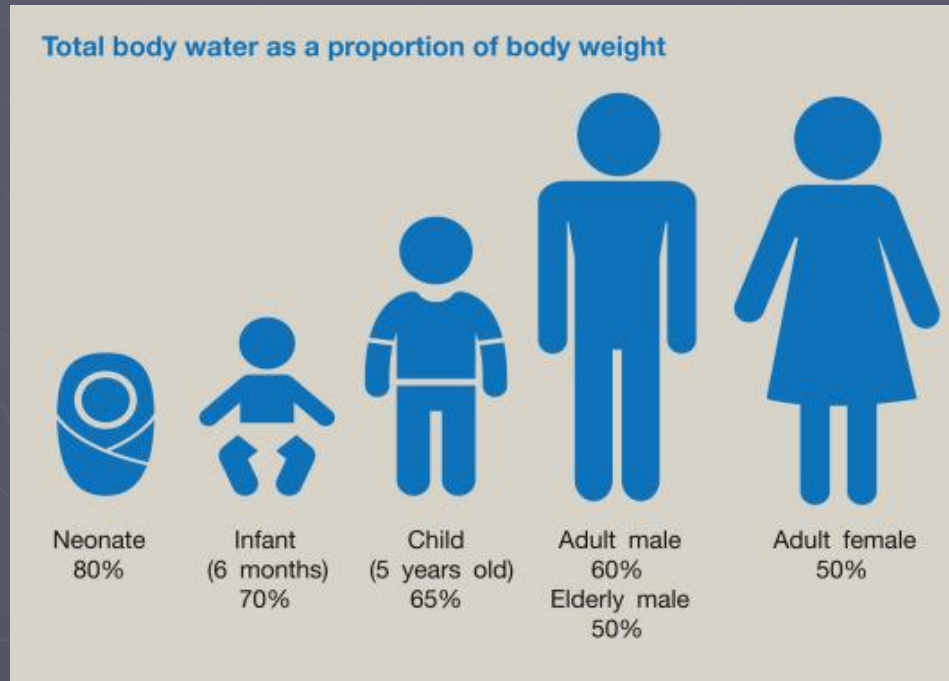


# BODY FLUIDS



DR/ HEBA KAREEM

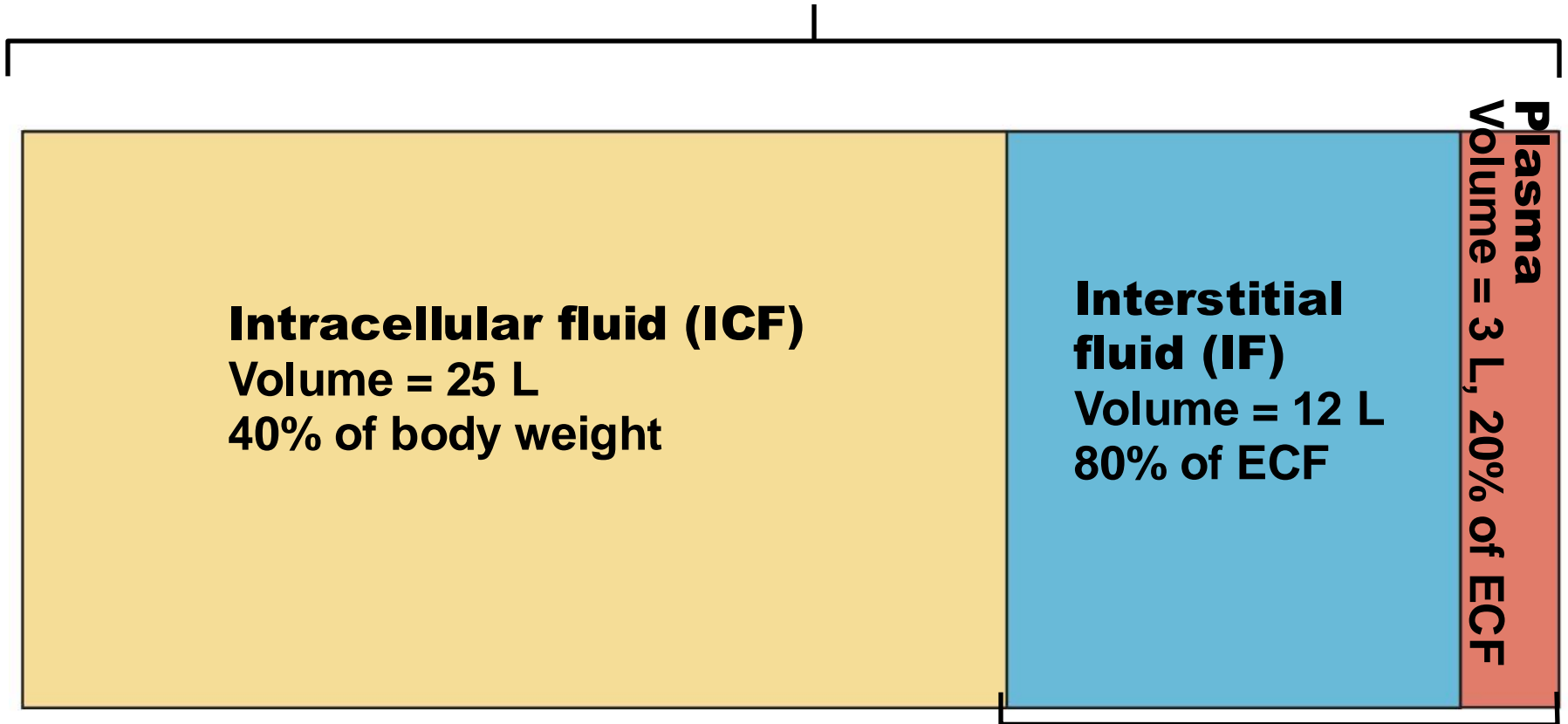
# Body Water Content

- **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

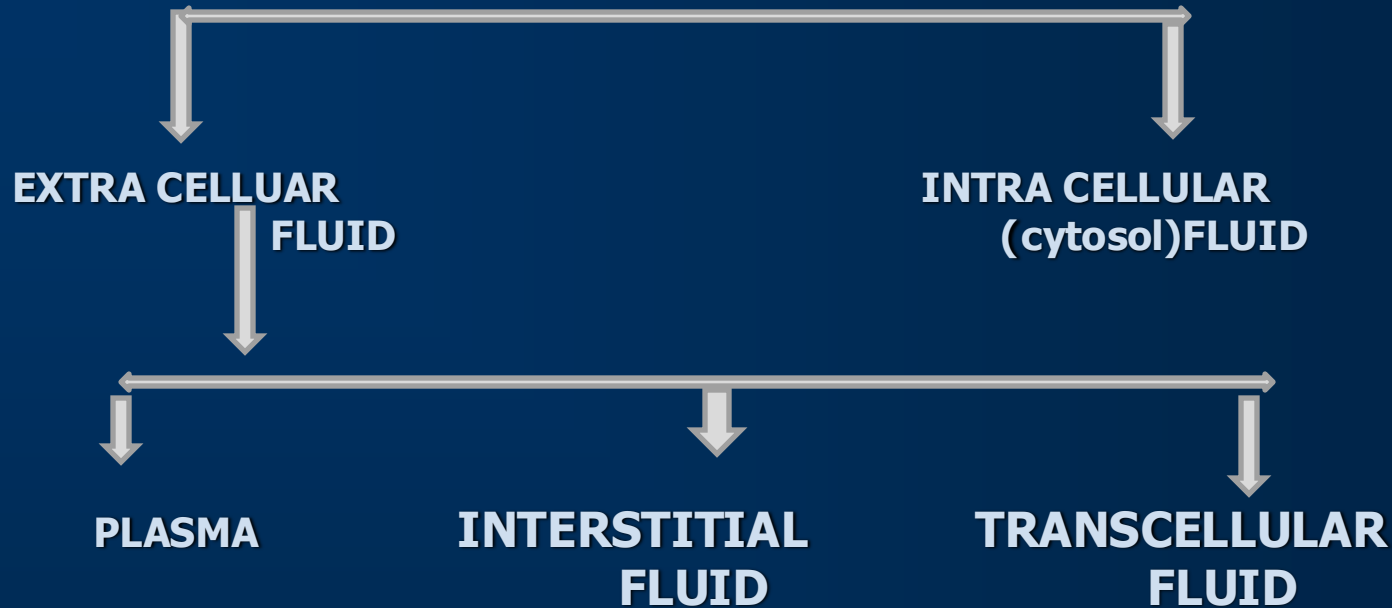
- Total body water = 40 L
- Two main fluid compartments
  - **Intracellular fluid (ICF) compartment: 2/3** in cells
  - **Extracellular fluid (ECF) compartment: 1/3** outside cells
    - **Plasma: 3 L**
    - **Interstitial fluid (IF): 12 L** in spaces between cells
      - Usually considered part of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


**Total body water**  
Volume = 40 L  
60% of body weight



**Extracellular fluid (ECF)**  
Volume = 15 L  
20% of body weight

# FLUID COMPARTMENTS



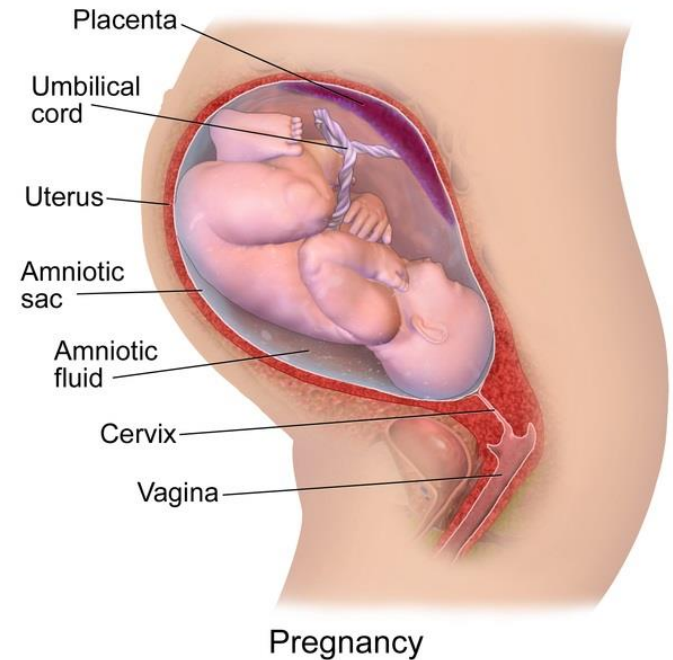
1. CSF
  2. Intra ocular
  3. Pleural
  4. Peritoneal
  5. Synovial
  6. Digestive Secretions
  7. Milk---tears-----sweat-----amniotic fluid
- 

# Amniotic Fluid

- ▶ Liquid produced by membranes and fetus
- ▶ Volume of fluid increases with gestational age
- ▶ Clear with some desquamated fetal cell and a little lipid.

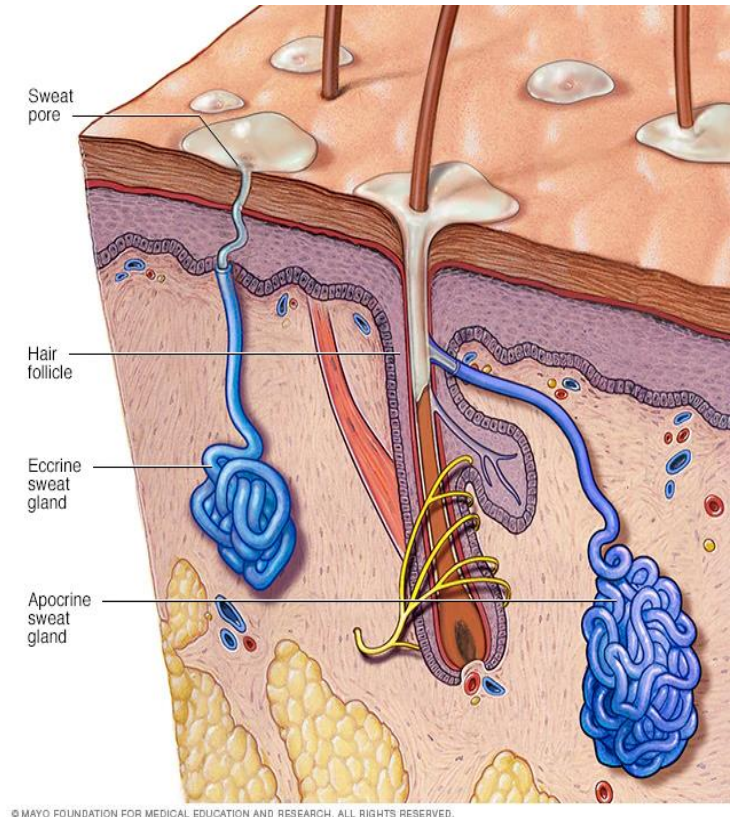
## ▶ Functions of AF

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



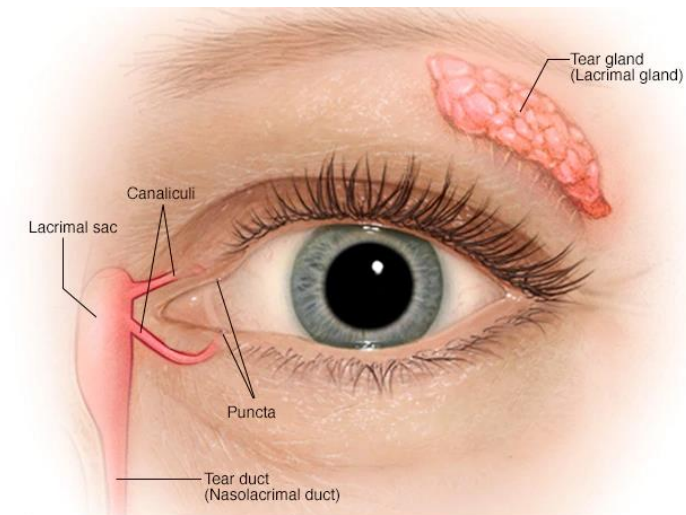
# Sweat

- ▶ Secretion of sweat gland
- ▶ Regulates body temperature by cooling and evaporation
- ▶ Sweat glands controlled by **ANS**, Adrenal cortical steroid - which affect the quantity of electrolyte present
- ▶ Insensible perspiration amounts to 800-1200ml/day
- ▶ Volume of sweat produced/day during muscular exercise at elevated temperature may lead to water and electrolyte imbalance
- ▶ Water content of sweat varies from 99.2-99.7%
- ▶ pH – 4.7 to 7.5



# Tears

- ▶ Produced by lachrymal glands
  - ▶ **Isotonic** but becomes hypertonic due to evaporation as fluid passes over the cornea
  - ▶ When the tear flow is copius, fluid is isotonic
  - ▶ Under stimulus with a slow rate of tear flow, the fluid is about 25m osm hypertonic {**Copius = Rapid tear flow**}
- 
- ❖ pH – 7 to 7.6 due to loss of CO<sub>2</sub>
  - ❖ 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



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# Functions of Tears

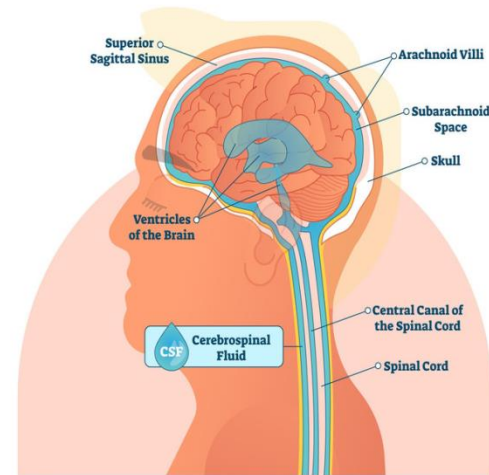
- ▶ Lysozyme protects eye from infectious agents
- ▶ Lubricate the surface of the cornea
- ▶ Fill the irregularities of the corneal surface to improve optical properties
- ▶ Protects eyes from injury

## Cerebrospinal fluid (CSF)

- 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

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

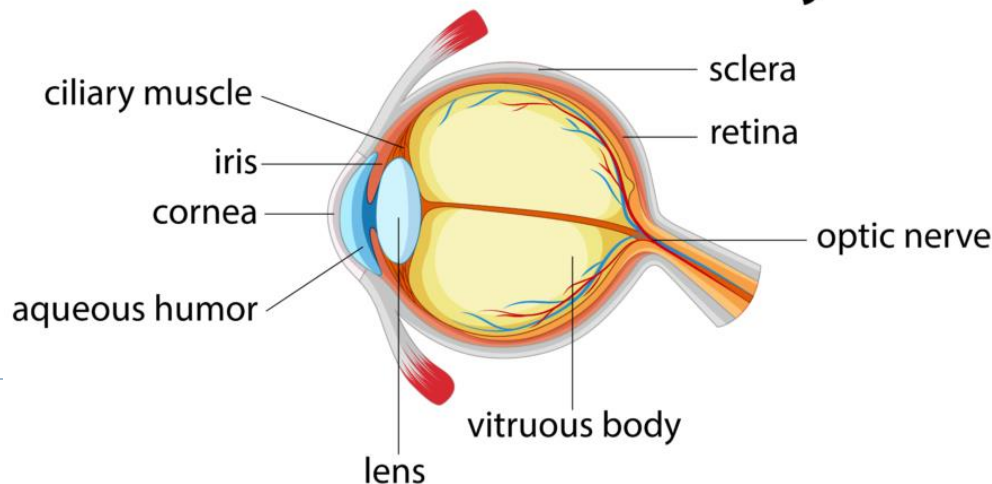


# Aqueous Humor

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- ▶ 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 vitreous humor which contains a gel (vitreous body of hyaluronic acid secreted by retina)

## Parts of the human eye



# MILK

- It is the secretion of mammary glands in human and animals after labour.
- Milk secretion is stimulated by *Prolactin*.
- Milk flow is decreased by *Estrogen* and *Progesterone* while increased by *Thyroxin*. Also *Squalene* present in HELBA increase milk flow.
- Oxytocin (posterior pituitary hormone) responsible for milk ejection.
- 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:

- ▶ Fat globules in emulsion form.
- ▶ Protein in colloidal form.
- ▶ Ca. phosphate and Ca. Casinate.

\* Yellowish (creamy) color → due to:

- ▶ Presence of Carotene and Xanthophyll pigments specially in cow's milk and colostrums.

## 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
- Late period of lactation.

3- 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 (adulteration) the specific gravity decreased due to dilution of total solids.**

#### **4- Taste:**

- *Normal characteristic milky taste. changed in case of :*
- *Souring: 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.*

#### **5- Odor:** *Characteristic milky odor.*

## 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 sulphur test.
  - Casein is the only milk protein that not coagulated on boiling.

## 2- Lactalbumin:

- ▶ Simple protein, Soluble, Easily digested, Represent 87% of whey protein.
- ▶ PPT by full saturation with ammonium sulphate.
- ▶ Rich in cysteine and cystine so give +ve result with sulphur test.
- ▶ Consists of two fractions:
  - ▶  $\alpha$  Lactalbumin: 32% of whey protein.
  - ▶  $\beta$  lactoglobulin: 55% of whey protein.

### 3- Lactoglobulin:

- ▶ Simple protein, Soluble, Easily digested ,Represent 13% of whey protein.
- ▶ PPT by half saturation with ammonium sulphate solution.
- ▶ Rich in cystein and cystin so give +ve result with sulphur test.
- ▶ They carry antibodies causing immunity so called immunoglobulins.
- ▶ They present in higher concentration in colostrum.

## 4- Milk enzymes:

Catalase, Peroxidase, Xanthinoxidase, Alkaline phosphatase.  
Amylase, Lipase, Aldehyde oxidase.

## 2- Lipid:

Human's and cow's milk contain the same amount 3.5 gm/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.

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.

## Importance of lactose:

1. It is less sweet than sucrose so allow the baby to take large amount of milk without causing nausea.
2. It is non fermentable carbohydrate so it doesn't produce  $\text{CO}_2$  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  $\text{CO}_2$  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.