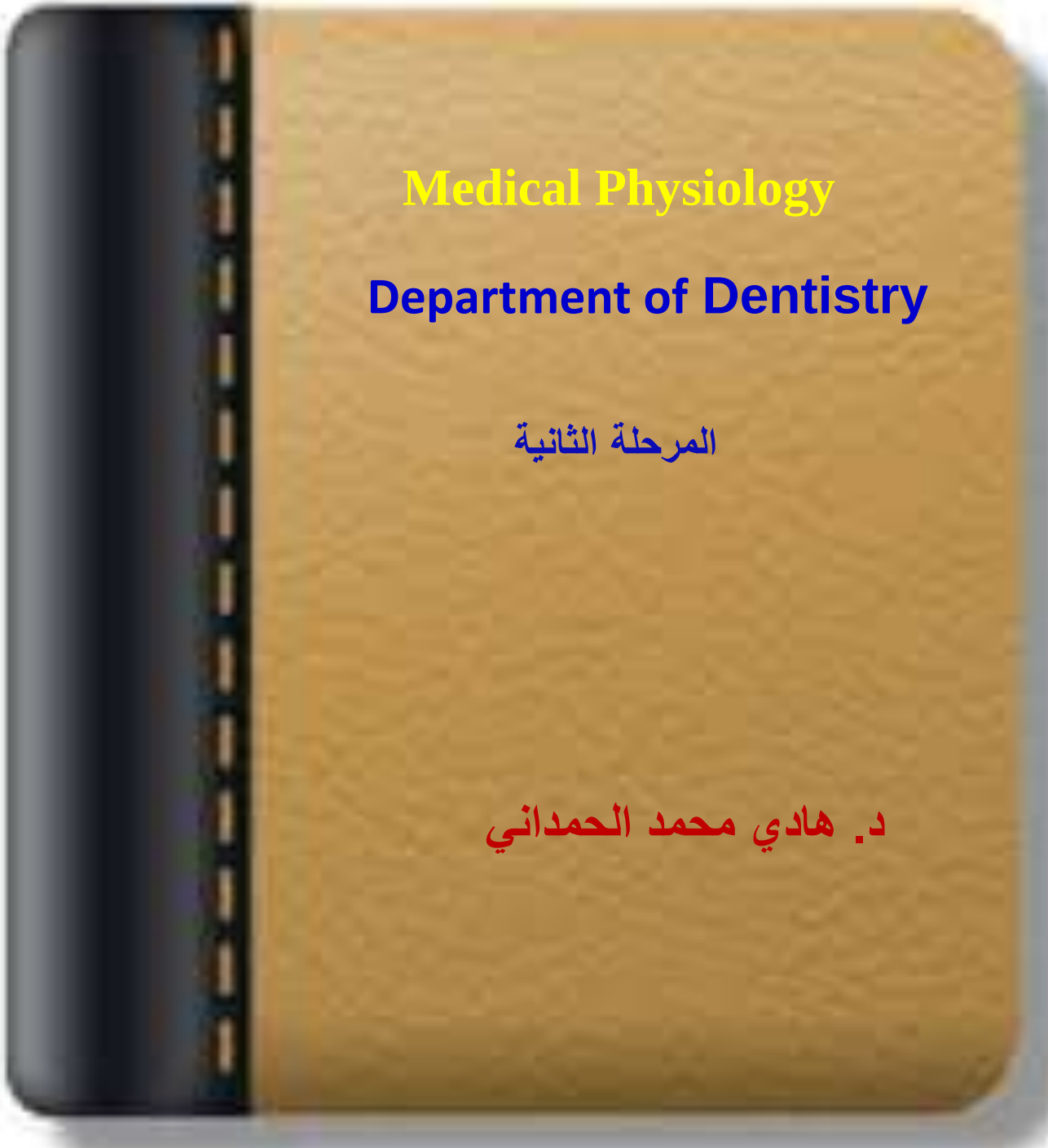
مرحبا بكم.. طلبتنا الاعزاء

welcome



1 - Introduction (Function organization of the human body, Cell physiology, Cell membrane , Cell components , Cell Junction)
2 - Body fluid (Type of body fluids, Intracellular and extracellular, Daily intake of water, Daily loss of body water, Constituents of extracellular and intracellular fluids, Major factors contribute to the movement of fluid, Specialized Fluids of the Body)Edema (Types of Edema, Causes of edema, Measurement of body fluid volume, Dehydration, Types of dehydration, Classification, Causes, Signs and Symptoms of Dehydrations)
3 - Homeostasis and Transport across cell membrane (Diffusion(passive), Carrier-mediated transport (passive or active), Vesicular transport).
4 - ORAL CAVITY and Salivary Glands (Functions of Mouth, Salivary Glands (Structure, Development, Major glands, Minor glands, Clinical correlations, Regulation of Salivary Secretion, Factors Influencing Salivary Flow and Composition) (Mastication, Deglutition, Bolus Formation for Swallowing, Digestion), (speech):
Definition, Mechanism, Nervous Control, Applied Physiology)
5 - Salivary functions and Regulation of Salivary Secretion (Composition of Saliva, Saliva Components, Properties of Saliva, Functions of Saliva, Effect of Drugs and Chemicals on Salivary Secretion, Maintenance of Tooth Integrity, The Diagnostic Applications of Saliva and forensic uses of saliva, Disadvantages/Limitations of Saliva)
6 - BLOOD (Composition of blood , Hematocrit, Plasma , Functions of blood), Red blood cells (Genesis of R.B.C, polycythemia, Anemia, Destruction of R.B.C.s)
7 - White Blood Cells (Types of W.B.C. , Genesis of the leukocytes, Life span of the W.B.C, Phagocytosis, Inflammation, Leukemia's, Leukopenia)
8 - Hemoglobin (Formation of Hemoglobin , Iron Metabolism , Hb Compounds , Destruction of Hb , The common causes of jaundice)
9 Blood groups (Agglutination, Agglutinins, The Rh Group, Formation of Anti-Rh, agglutinins, Erythrobastosis Fetalis , Effect of the Mother's Antibodies on the Fetus, Transfusion Reactions resulting from mismatched Blood Types , Nature of Antibodies)
10 - Hemostasis and blood coagulation(Vascular Spasm , Formation of a Platelet Plug , Mechanism of the
Platelet Plug , Mechanism of Blood Coagulation , Prevention of Clotting in the Normal Vascular System , Prevention of Blood Coagulation outside the Body , Blood Disease)
11 - Cardiovascular system: Blood vessels (Heart: Layers, Valves, Actions of heart, Blood Vessels, Division of circulation, Properties of Cardiac Muscle, Action Potential and Ionic Basis, Conductive system of Human Heart)

12 - Cardiovascular system: Blood pressure (Cardiac Cycle, Heart Sounds, Cardiac Output, Heart Rate and Regulation, Arterial Blood Pressure and Regulation of ABP Venous Pressure and Capillary Pressure, Arterial Pulse and Venous Pulse, Regional Circulation)

13 - Cardiovascular system (Electrocardiogram, Hemorrhage, Circulatory Shock and Heart Failure, Cardiovascular Adjustments during Exercise)

14 - Respiratory system (Types of Respiration, Stages of Respiration, Respiratory tract, Non respiratory functions of respiratory tract, Mechanics of Pulmonary Ventilation, Types of Respiratory pressures, Factors causing and preventing collapsing tendency of lungs)

15 - Respiratory system: Lung volumes and capacities (Compliance, Variation in Compliance, The resistance and the work of breathing, Dead space, Lung volume and Lung capacity, Ventilation, Respiratory Protective Reflexes , Pulmonary function tests, Regulation of Respiration, The relationship between oral health and respiratory disease) 2

16 - Half-year Break

17 - SPECIAL SENSATION: Vision, Hearing, taste & smell (Structure of Eye, Visual Process and Field of Vision, Visual Pathway Pupillary Reflexes, Color Vision, and Errors of Refraction. Structure of Ear and Auditory Pathway ,Mechanism of Hearing and Auditory Defects, Sensation of Taste and Smell)

18 - Temperature of the Body (Normal body Temperatures, Physiological Variations of body temperature, Heat Balance, Heat gain or heat production in the body, Heat loss from the body, Insulator System of the Body, Blood flow to the skin from the body core provides heat transfer, Regulation of body temperature, Mechanisms to decrease or increase body temperature, Sympathetic “Chemical” Excitation of heat production)

19 - Urinary system (**Parts of Renal system**, The Kidney, Functions of kidneys, Components of kidney, Parenchyma of kidney, Nephron and Juxtaglomerular Apparatus, Renal corpuscle, Structure of renal corpuscle, Tubular portion of nephron, Collecting duct)

20 - Urinary system: Urine formation (Mechanism of urine formation, Glomerular Filtration, Pressure determining filtration, Tubular Reabsorption, Tubular secretion, Micturition, Nerve supply to urinary bladder and sphincters, Renal Function Tests, Relation between renal disease & oral health)

21 - Endocrine System (Introduction, Endocrine glands, Hormones, Nature of Hormones, Classification of hormones, Hormone Secretors, Hormonal action Hormone receptors, Synthesis and storage of hormones, Mechanism of hormonal function, Measurement of Hormone Concentrations in the Blood)

22 - Major Endocrine Glands (Oral manifestations of endocrine dysfunction, Control Systems Involving Hypothalamus and Pituitary glands, The pituitary gland, Thyroid gland, Pancreas gland, Adrenal glands)

23 - Digestive system (The Functions of the digestive, Structural layers of digestive, Stomach, Secretions of the Stomach , Regulation of Stomach Secretion , Mixing of Stomach Contents, Stomach Emptying

24 - Digestive system (small intestine , Secretions of the Small Intestine, Movement in the Small Intestine, Liver, Functions of the Liver, Pancreatic Secretions, Regulation of Pancreatic Secretion, Large Intestine, Movment in the Large Intestine Digestion, Absorption, and Transport)

25 - Muscular system: Muscle structure (Types, Structure, Microscopic Structure, Muscle Physiology, Properties, Contraction and contractile elements, Tone, Electrical and Molecular Changes during Muscular Contraction)

26 - Muscular system: Tone , contraction (Molecular Changes During Muscular Contraction, Neuromuscular Junction- Neuromuscular Transmission and Blockers, Nutrition and Metabolism (Energy Requirements))

27 - Nervous System: Nerve impulse, synapses (Nervous System Division, Cranial nerves , Neuron and Neuroglia, Receptors, Nerve impulse, Synapse and Neurotransmitters)

28 - Nervous System (Reflex Activity, Somatosensory System and Somatomotor System, Physiology of Pain)

29 - Reproductive system: Aging & reproductive system (Male Reproductive System Female Reproductive System, Meiosis, Aging and Reproductive system.

30 - Aviation and Deep physiology (Body Response in high altitudes, physiological Changes in the Sea deep). Nutrition and metabolism (daily energy requirement, obesity and fitness

Functional Organization of the Human Body

Lect. 1

Physiology

Is a sub-section of biology.
It is the **scientific study** of the human body and **how** **and** **why** **the organs works** and also **how** and **why** the **systems work together under normal and abnormal conditions** at the cellular and molecular levels(**chemical** and **physical functions)** .

The **Physiology** field can be divided into:-
Medical physiology,
Animal physiology,
Plant physiology,
Cell physiology,
Sport and Comparative physiology.

Cell physiology

biological study - **activities that take place in a cell to keep it alive.** - Like **physiology of membrane transport, neuron transmission, and muscle contraction.**
Where cover the : -
digestion
circulation
contraction of muscles.

Signal **transmission**

General function of the cell

A **cell** , is the **structural** and **functional** **unit of the body** and the **continuity of its life**.
1 - provide **structure** and **support**.
2 - facilitate **growth** through mitosis.
3 - allow passive and active **transport**.
4 - produce **energy**.
5 - create **metabolic reactions**.
6 - aid in **reproduction**.

Functional Organization of the Human Body

The **goal of physiology,** is the science that seeks to explain the **physical and chemical factors** that are **responsible for** the **origin**, **development**, and **progression of life**.

Each type of life, from the **simple virus** to the **largest tree** or the **complicated human being**, has its **own functional characteristics**.

Alive is the result of complex control systems (for **hunger** make us **seek food** and **fear** makes us **seek refuge**. **Sensations of cold** make us **look for warmth**, **oxygen reacts with carbohydrate, fat, and protein to release the energy** required for cell function).

Each type of cell is specially adapted to perform one or a few **particular functions**.

when cells of a particular type are **destroyed, the remaining cells** of this type usually **generate new cells**.

The entire body, then, contains about **100 trillion different cells**.

In addition to human cells, trillions of **microbes** **inhabit the body**, living on the **skin** and in the **mouth**, **gut**, and **nose**.
The gastrointestinal tract, for example, normally contains a **complex and dynamic population of 400 to 1000 species of microorganisms** that outnumber our human cells.
Communities of microorganisms that inhabit the body, often called **microbiota**, **can cause diseases**, but **most** of the time they **live in harmony with their human hosts** and **provide vital functions** that are essential for survival of their hosts.

Disease is often considered to be **a state of disrupted homeostasis.**

The "Internal Environment" of the body — Extracellular Fluid

The **conditions** within the body, **including temperature**, **blood pressure**, **blood-sugar level**, and **acid–base balance,** that is **maintained in a constant state**, as required for the normal functioning of the body's tissues and organs, by mechanisms of **homeostasis**. **(IE-Which is represent by Extracellular fluid state)**

About **60 percent** of the adult human body **is fluid**, **mainly a water solution of ions** and other substances.

Although **most of this fluid is inside the cells** and is called ***intracellular fluid,*** about **one third** is in the spaces **outside the cells,** which is called ***extracellular fluid*.**

1 - Extracellular fluid contains **large** amounts of *sodium*, *chloride*, and *bicarbonate ions* plus nutrients for the cells, such as (***glucose, fatty acids***, and ***amino acids***). It also contains ***oxygen,*** and *carbon dioxide.*

2 - Intracellular fluid **differs** significantly from the extracellular fluid; for example, it **contains large** amounts of *potassium*, *magnesium*, *protein* and *phosphate ions*

The term ***homeostasis*** is used by physiologists to **mean** ***maintenance of nearly constant conditions in the internal environment*.** Essentially **all organs and tissues** of the body **perform functions that help maintain** these relatively **constant conditions.**

Extracellular fluid is **transported** through the body in two stages. The first stage is **movement of blood through the body in the blood vessels**. The second is **movement of fluid between the blood capillaries and the intercellular spaces** between the tissue cells

Functional Organization

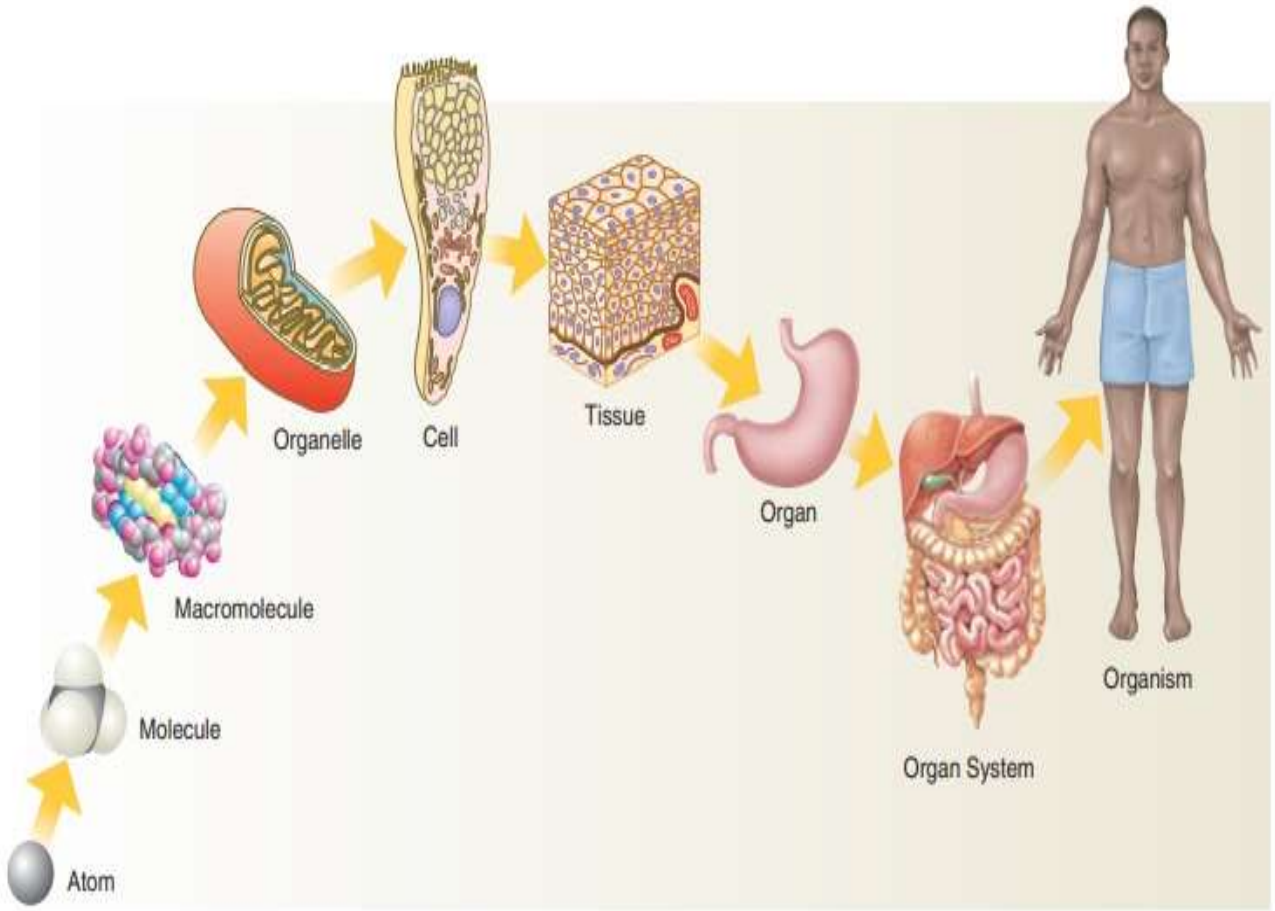
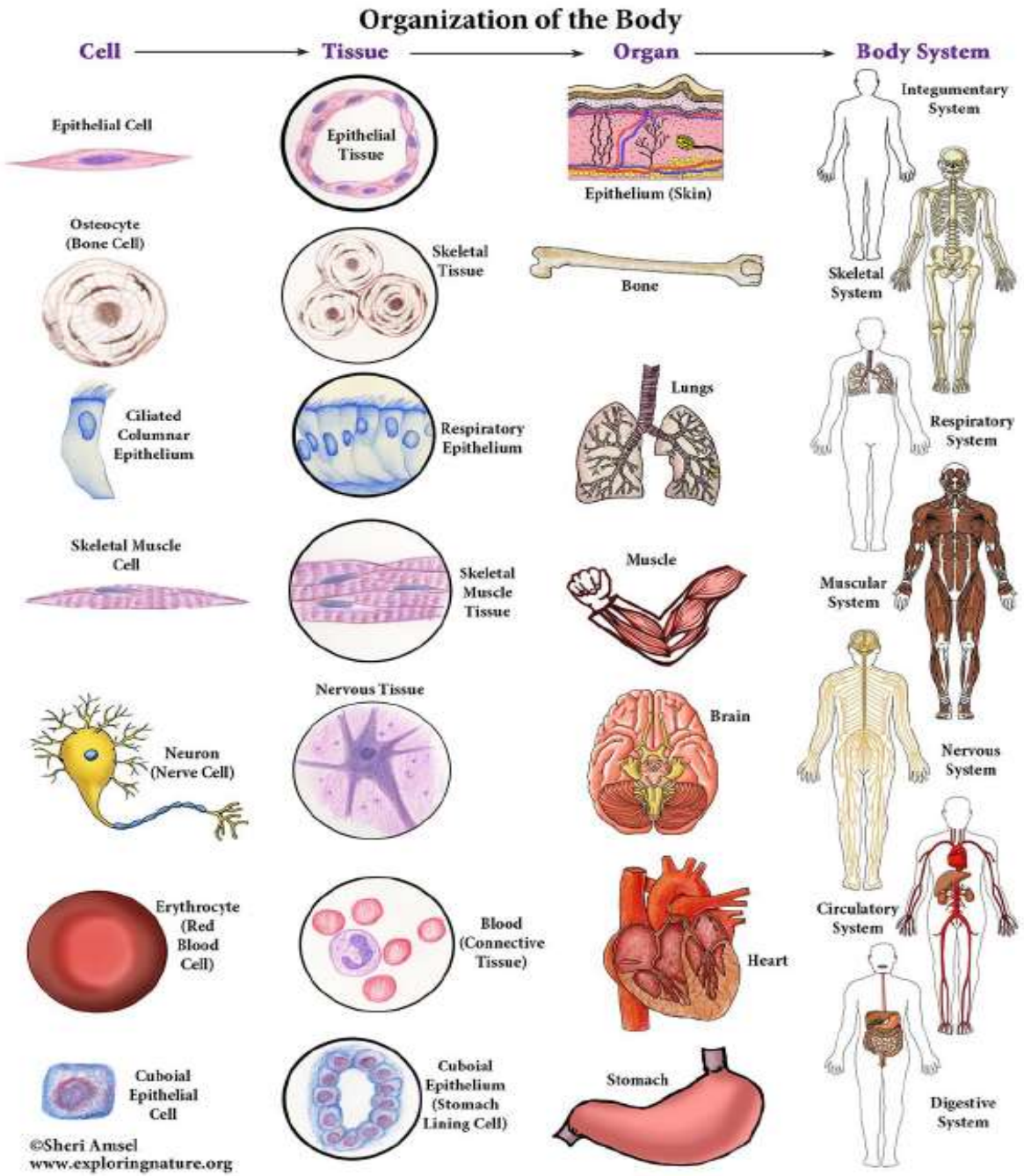
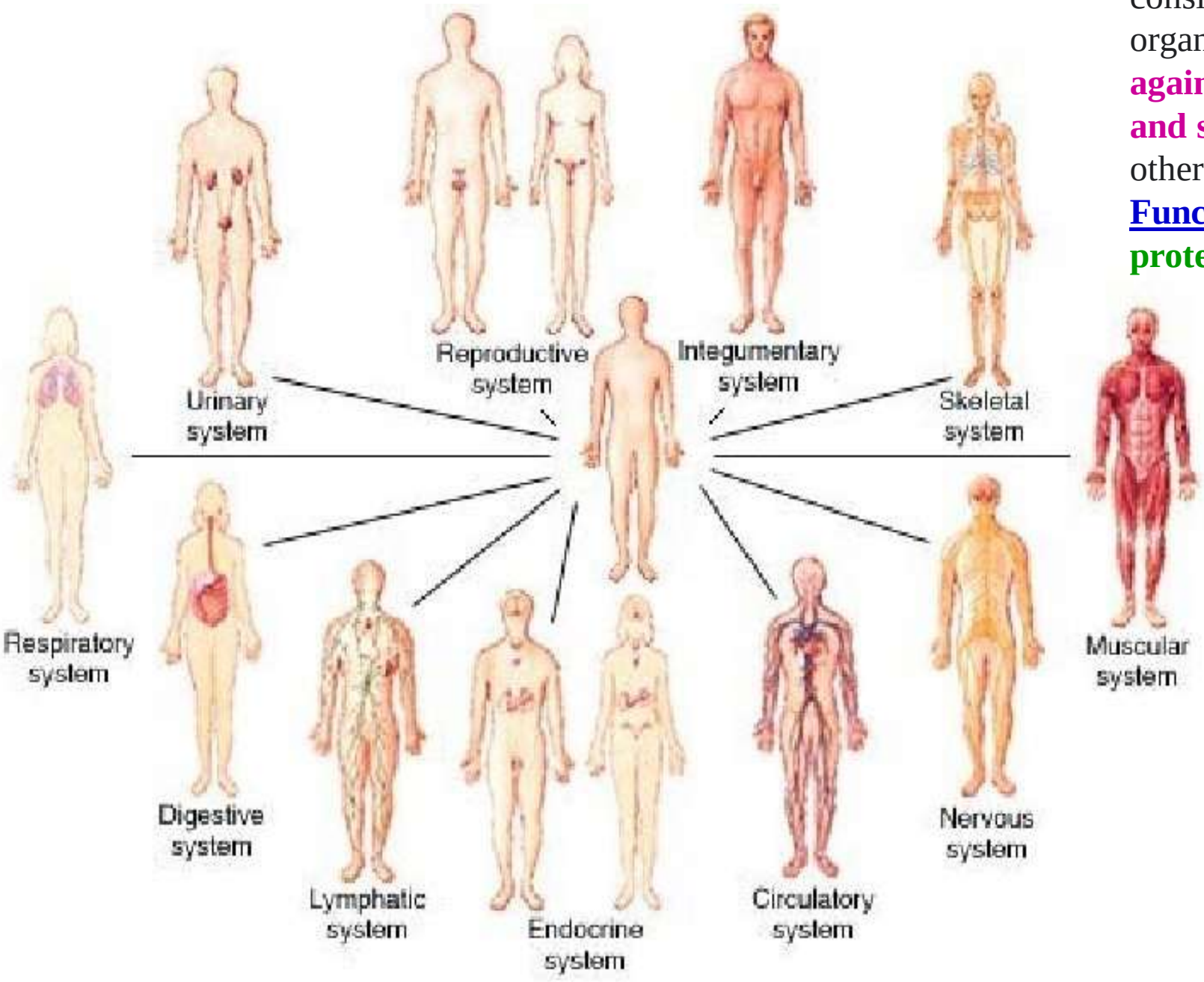


FIGURE 1-1 Organization levels of the body.

Adapted from Shier, D.N., Butler, J.L., and Lewis, R. Hole's Essentials of Human Anatomy & Physiology, Tenth edition. McGraw Hill Higher Education, 2009.



Functional Organization of the Human Body

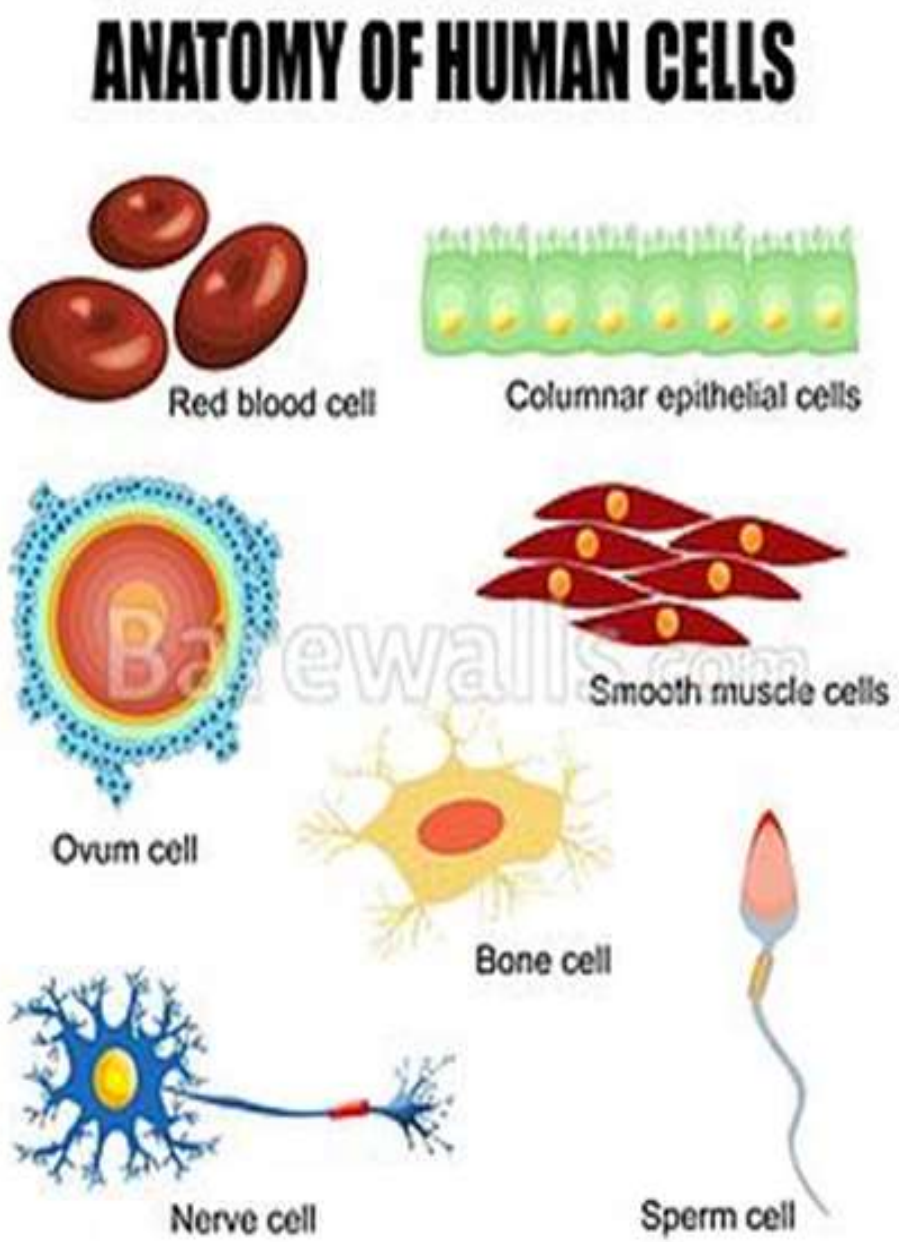


Integumentary system, it is **body's outer layer**. It consists of **skin, hair, nails and glands**. These organs and structures are **first line of defense against bacteria and help protect you from injury and sunlight.** The integumentary system works with other systems in the body to keep it in balance.

Functions:

protection, regulation and **sensation**

- Cell physiology: Cell – structural and functional unit
  - Cell
    - Cell membrane
    - protoplasm
      - Nucleus
      - Cytoplasm
        - Cytosol
        - Organelles
- Each cell type: adapted — structuraly → accordine to it's function
- Cell build up from atoms of chemical, as protein, Fat and carbohydrates
- protein
  - structural (cytoskeleton, Gillia, mitoticspindle, microtubules)
  - functional (enzymes, hormone, receptor, neurotransmitter)
- Living organisms composed one or more cells
- Human body contain more than 40 trillion cells



Cell components: Contain essential **organelles**

Nucleus. Contains the cell's DNA. It is the **library** of the cell

Endoplasmic reticulum. Transport materials within cell; **Lipid production; Detoxification**.

Mitochondria. Breaks down food to **release energy** for the cell.

Cell membrane. Protection, Controls what goes in and out of the cell.

Help in **conduction of action potential.**

Ribosome. Protein synthesis

Cytoplasm. Fluid contain **organelles** and **metabolites**

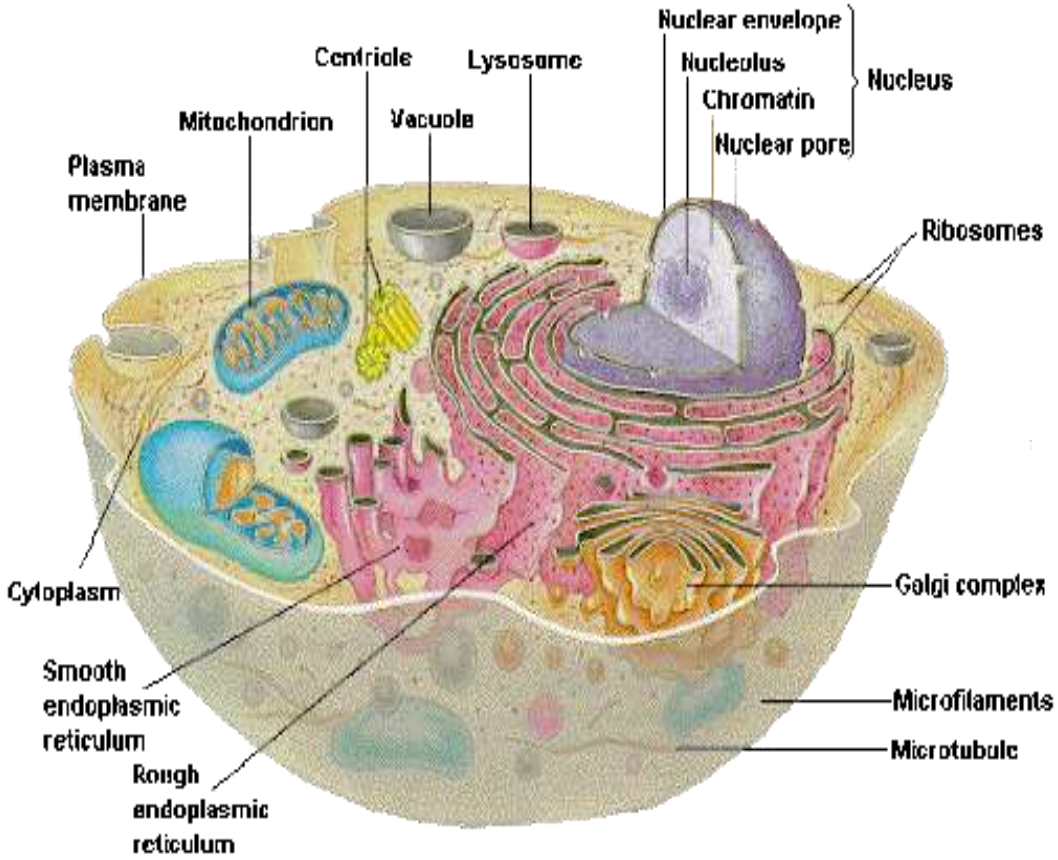
Golgi body. Store, modified and **package** the secretion

Lysosome. Contain **hydrolytic enzymes.**

Center of **"autolysis"** or intracellular break down.

Centriole. Help in **cell division**

Microtubules. Help in **movement**, **support** of the cells



Cell membrane

It is a **biological membrane** that **surrounds the cytoplasm** of a cell.

*Serves to **separate** and **protect** a cell

* **regulates** the **transport** of materials entering and exiting the cell

* **made** mostly from a **(1) double layer of phospholipids**, which are **amphiphilic** and **(2) protein**.

***Embedded within** this membrane is a variety of **protein** molecules - act as :

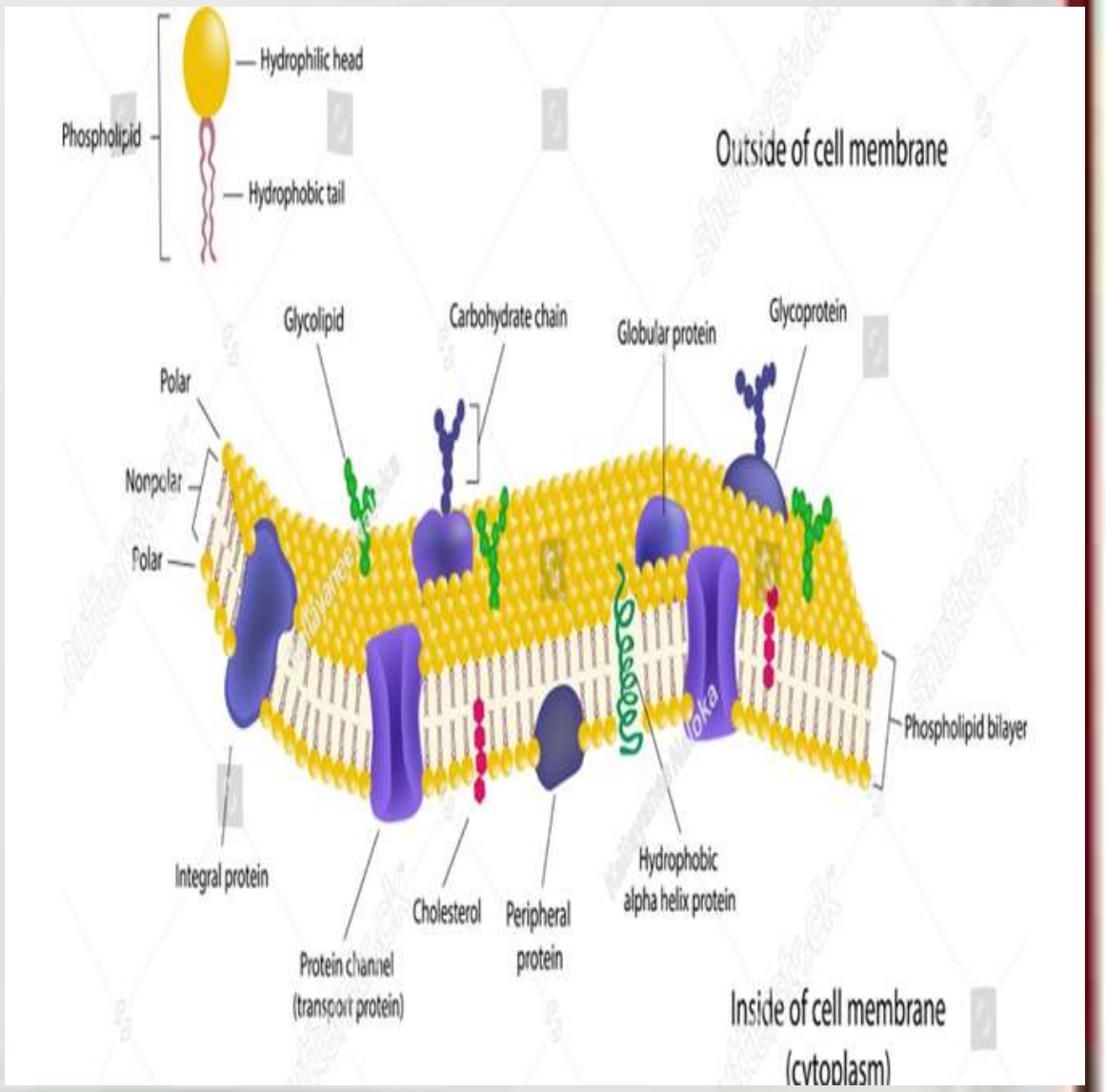
(1) channels and **pumps** that **move different molecules** into and out of the cell.

On surface also contain **proteins act as**

(2) **receptor** – allow the cells to **detect external signaling molecules** such as **hormones**.

*It is **SEMIPERMABLE** membrane - let a substance (molecule or ion) pass through **freely**, pass through to **a limited extent** or **not pass** through at all (**selective**).

* cell mobility, secretions, and absorptions of substances.



• Cell membrane:

- Very thin (Barrier)
- Elastic
- Dynamic
- Semipermeable

- Compse: ptns 55%
  Lipids 42% — phospholipid 25% (active part)
  cholesterol 17%
  CHO 3%

① Lipid: Bilayer of

A- phospholipid molecules (flexibility)

Head	Tail
Exterior	Internal
Hydrophilic	Hydrophic
$PO_4^{\equiv}$	Fatty acid
Charged	uncharged

B- Cholesterol (toughness)

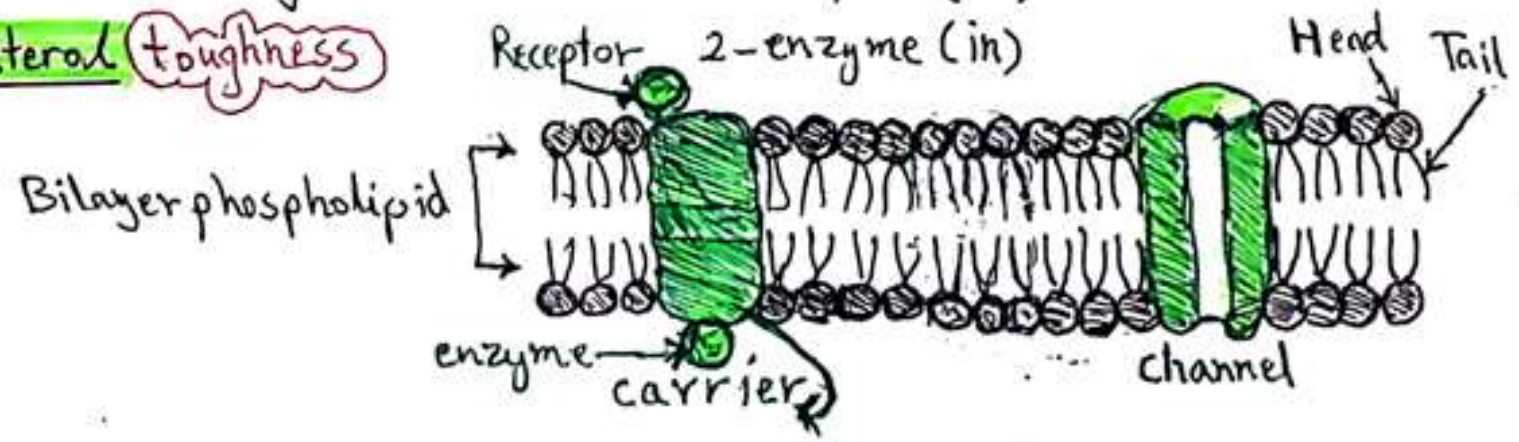
② proteins

@Integral: whole thickness
- Carrier
- channels

ⓑ Peripheral
1- receptor (out)
2- enzyme (in)

③ CHO- glycoprotein, glycolipid

Function:
1- Recognition site
2- Adhesion



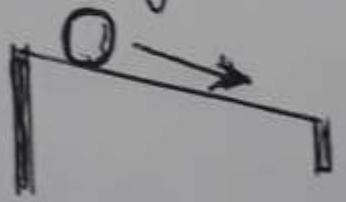
• Function of protien in cell membrane :

Structural protein 55% of cell membrane

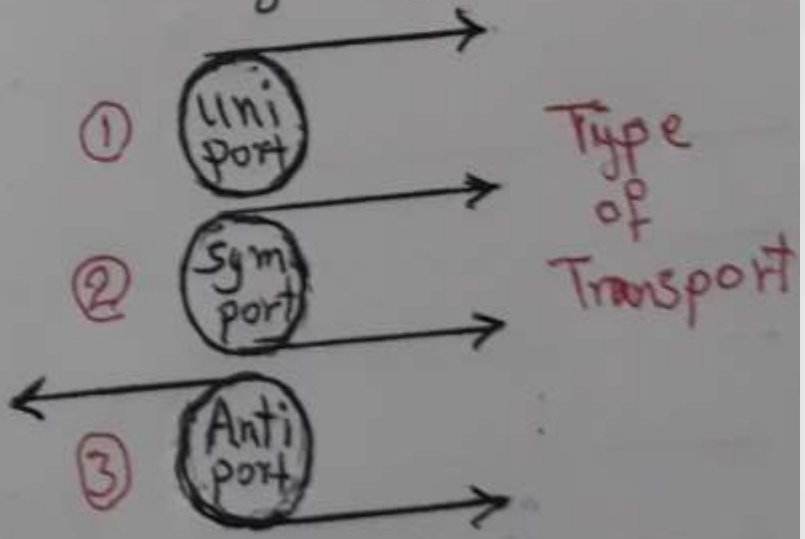
1- Integral protein

- channels
  - Non gated
  - Gated
    - Voltage gated
    - Ligand gated

- Carrier in FD
  - No ATPase activity
  - No need ATP
  - With gradient



- Carrier in active Transp.
  - ATPase activity
  - Need ATP
  - Against gradient



2- peripheral protein

1- Receptor (inactive) - only R-ligand complex is active

Number & Sensitivity $\propto \frac{1}{\text{Ligand conc.}}$

(i.e: ↑ ligand ⟶ ↓ R (Down regulation)

2- Enzymes

- G protein: Regulatory protein – Connect R to Enzyme
- Identify protein:- Glycoprotein (CHO+ptn)

help immune system to recognize self from nonself cells

3- Connection and Adhesion

- Connection – Binding Junction – bind cells layer

(e.g: Tight junction or Desmosome)

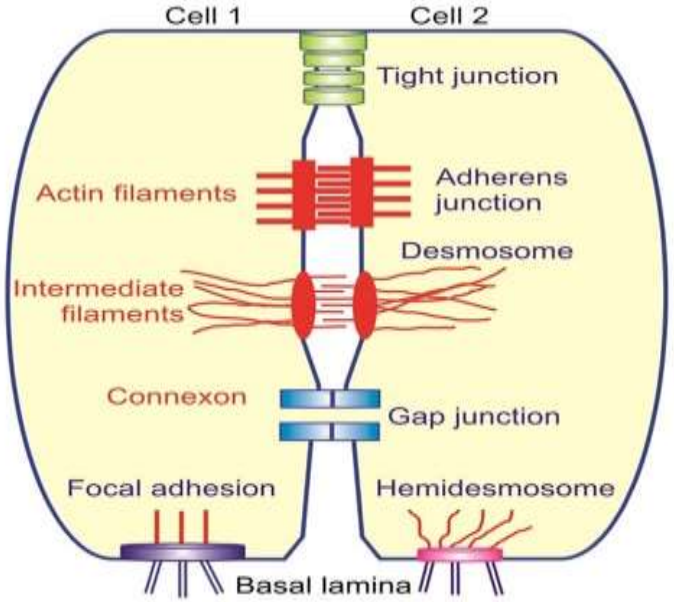
– Gap Junction (channel) - Hexagonal protein

- Adhesion molecules – Adher cells to basement membrane and to each other.

Important in embryonic development and wound healing

Cell junctions (or intercellular bridges):

Are a class of **cellular structures** consisting of **multiprotein complexes** that **provide contact** or **adhesion** between neighboring cells.



Cell junctions are especially **abundant in epithelial tissues.**

Function: **1 - Enabling communication between neighboring cells**

2 - **reducing stress placed upon cells.**

Types: **1 - Gap junctions** are **channels between adjacent** animal cells, permit material passing

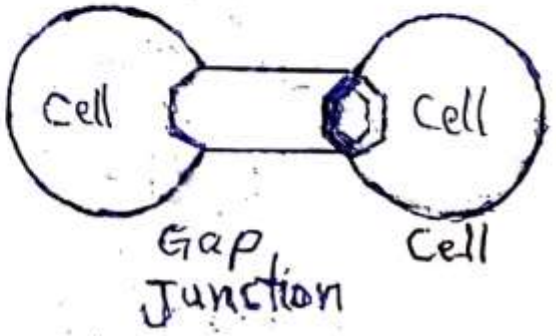
2 - Tight junctions, is a form of **water tight seal** and **prevent material from passing between cells.**

3 – Desmosomes, is a form of **links between cells**, and **provide a connection between intermediate filaments** of the cell cytoskeletons of adjacent cells.

- There are also **'hemi desmosomes' junctions that lie on the basal membrane of the cell, to help stick** the cells to the **underlying basal lamina.**

• Intercellular communication : (chemical massenger)

① Gap Junction – Ions , only for adjucent cells , via channel junction (i.e. protein unit called "Connexon" of hexagonal arrengment)

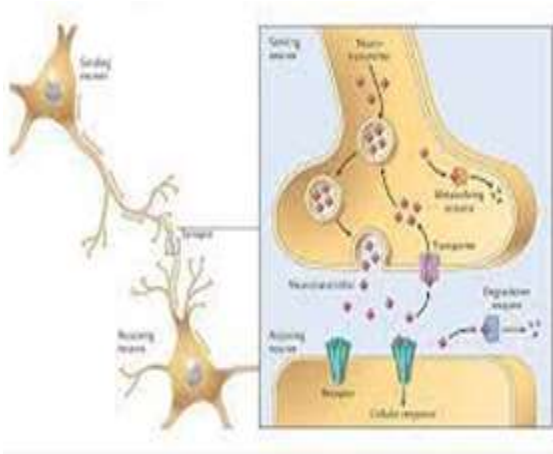


1- Intracellular Ca^{++}
2- pH
3- Hormone
4- Drug

② Neuronal : chem. trans. unit with specific receptor of (cell membrane, Cytoplasm, or nucleaus). Only receptor (inactive), ch.masenger (inactive) - The complex is active, result in: 1- Openning channels
2- Activation of enzyme
3- ↑ intracellular Ca^{++} conc.

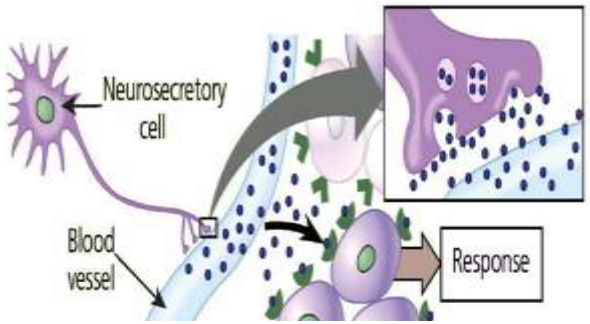
③ Hormonal : ① Endocrine – blood (to all body cells)
② paracrine – tissue fluid (cells of certain tissue)
③ Autocrine – same cell

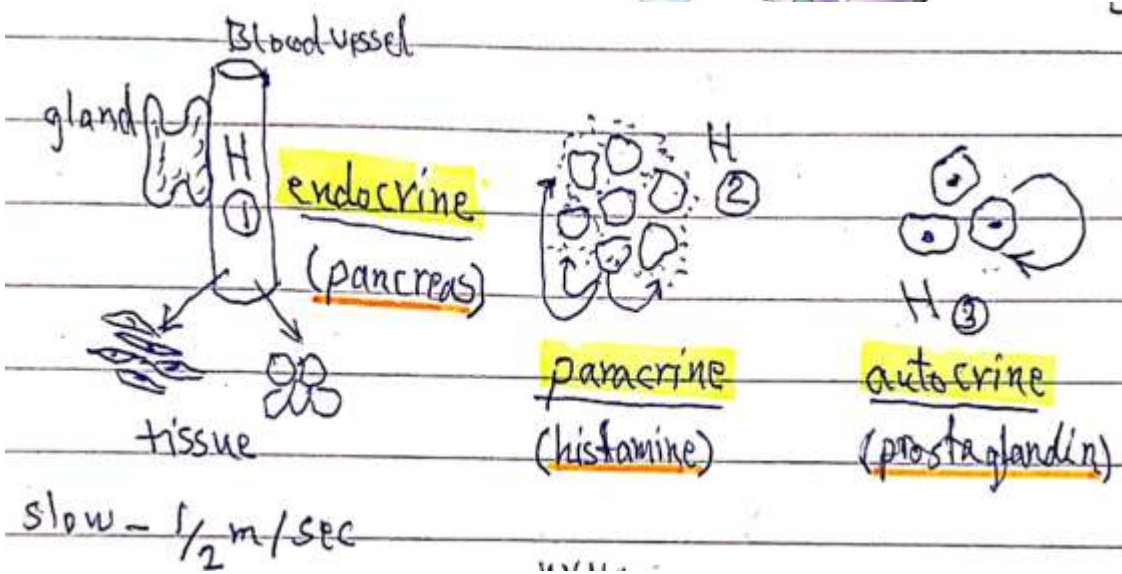
Coordination of Body Functions by Chemical Messengers



The multiple **activities of the cells**, **tissues**, and **organs** of the body are **coordinated by** the several types of **chemical messenger** systems which are:

1. **Neurotransmitters:** released by neurons terminals, act to control nerve
2. **Endocrine hormones :** released by endocrine glands into the blood.
3. **Neuroendocrine hormones:** secreted by neurons directly into blood.
4. **Paracrine:** secreted by cells into the extracellular fluid and affect neighboring cells.
5. **Autocrine:** secreted by cells and affect function of same cells that produced them.
6. **Cytokines:** secreted by cells, function as autocrine, paracrine, or endocrine hormones.





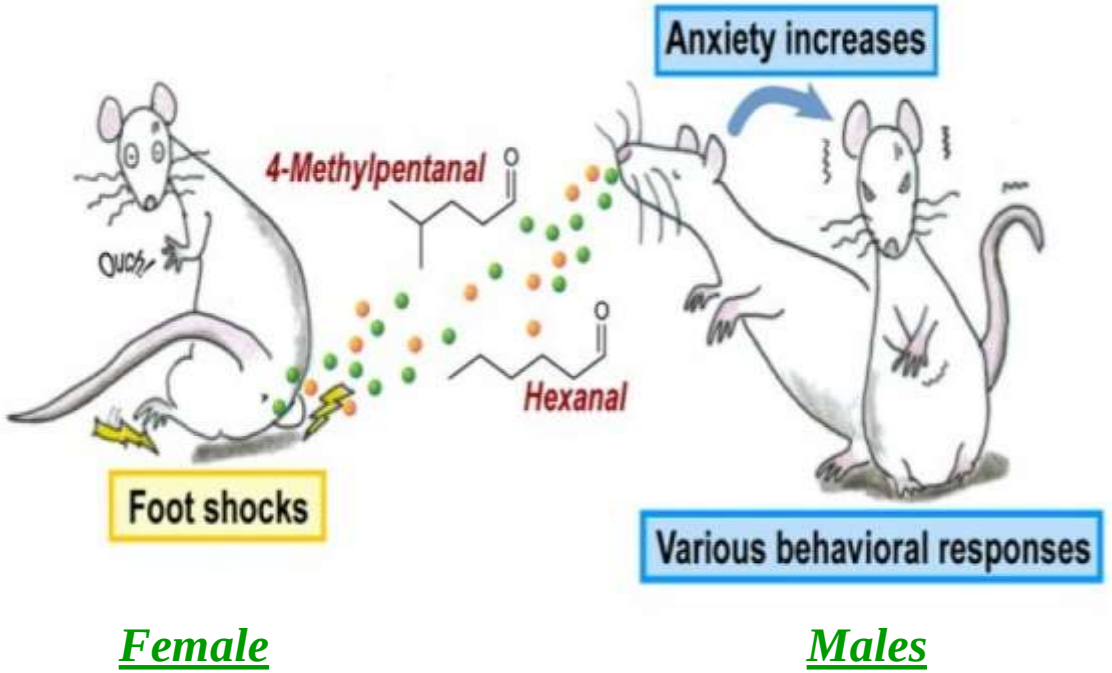
pheromones :

It is a secreted or excreted chemical factors, capable of **acting like hormones outside the body of the secreting individual**, **to affect the behavior of the receiving individuals**.

There are ***alarm*** , ***food trail*** , ***sex pheromones***

alarm , ***food trail***

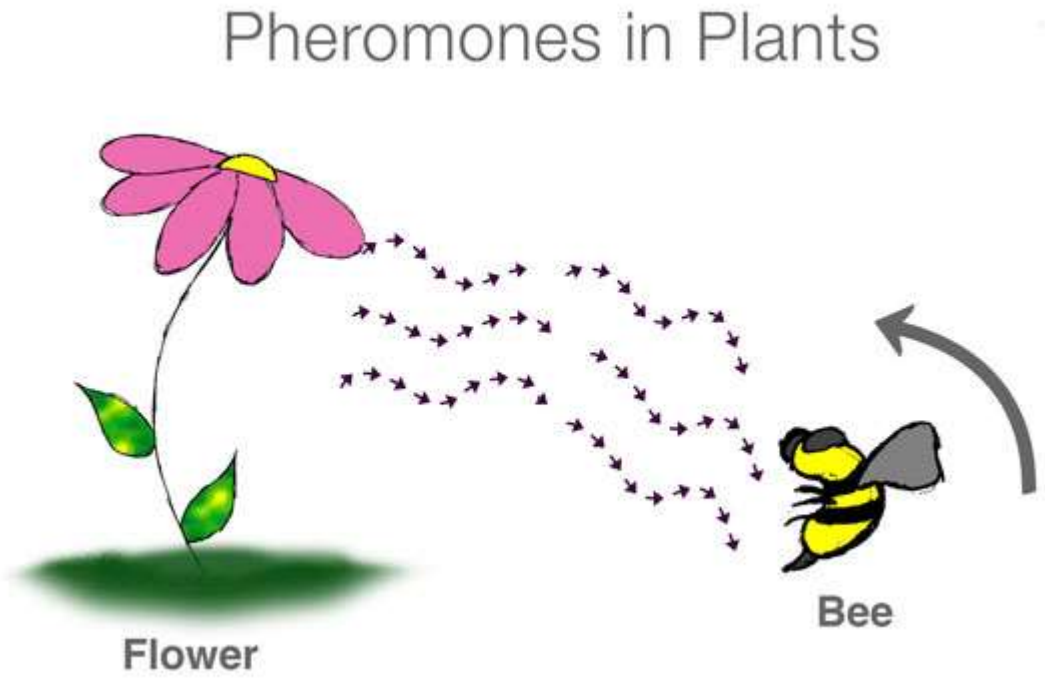
individual **Individuals of same race**



Female ***Males***

sex pheromones

(mating period)



Body fluid

Lect. 2

Body fluids

- Are **liquids** within the human body that contain **water, ions, antibody ,cell product** and **wastes,** are :-

1 **- Fluid inside the cells.(Intracellular fluid (ICF))**

2 – Fluid outside the cells: (Extracellular fluid (ECF))

A – Fluid excrete out side, secrete inside system or inside vessels: Saliva, Tears, Gastric juices, Milk, Bile, Urine, Blood, Lymph, Tissue fluid,Vaginal fluid, Semen.

B - Special fluids : (Transcellular fluid) Contain:

The **cerebrospinal fluid** that bathes the brain and spinal cord,

The **synovial fluid** in joints.

The **pleural fluid** in the pleural cavities.

The **peritoneal fluid** in the peritoneal cavity.

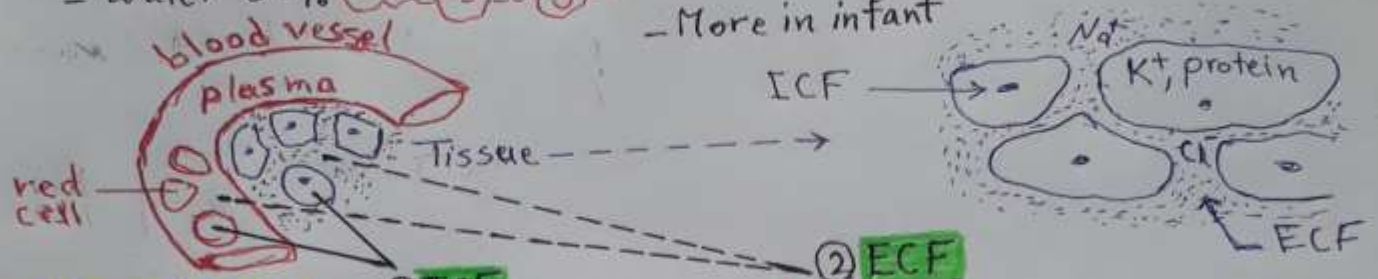
The **aqueous humor** of the eye.

- In healthy adult man, the **total body water** is about **60-67%** of the total **body weight**.
- Is **slightly lower** in women. **About 75 % of body mass in infants** and **as low as 45% in old .**
- A **man 70 kg**, for example, has about **42-47 liters** of water in his body. **(Q)**
- our **brain** and **kidneys** have the **highest proportions of water,** which composes **80–85 percent of their masses.** In contrast**, teeth** have the **lowest proportion of water, at 8–10 percent. (Q)**

Body fluid distribution

Body Fluid and Electrolyte:

- water 60% of body weight
  - less in old and obase person and female
  - More in infant



	① ICF	② ECF
① Compartment:		
② Volume:	40%	20%
③ PH:	More acidic	Less acidic
④ Elements: (found in all compartments)	potassium(K^+) 140 mEq/L	Sodium(Na^+) 145 mEq/L
	protein	Cl^- 115 mEq/L
	PO_4^-	HCO_3^- 28 mEq/L
		Ca^+ (more than in ICF)

- Cathod (Negative pole) — attract → positive elements = Cation (Na^+, K^+)
- Anode (positive pole) — attract → Negative elements = Anion (Cl^-, HCO_3^-, protein)

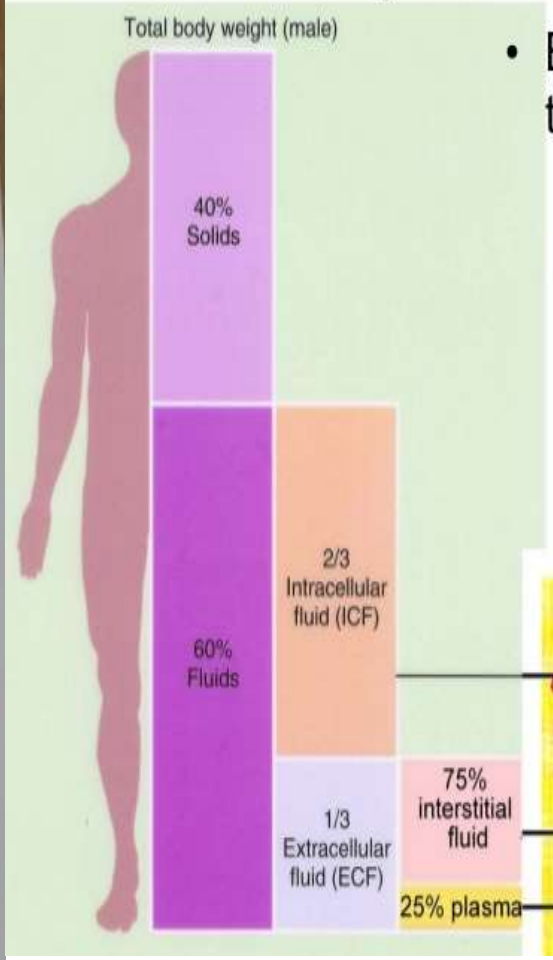
Note: Sodium(Na^+) – natrium, potassium(K^+) – Kalium

Note: K^+ in ECF < 5 mEq/L (i.e: 4.5 mEq/L)

If increase than 5 mEq/L – the person need dialysis

If reach about 9 mEq/L or more – Cause stop of the heart during diastole

2. Body fluid distribution



- Body fluids are distributed in two distinct area:
  - intracellular fluid (ICF)
    40% body weight
  - Extracellular fluid (ECF)
    20% body weight
    - Interstitial fluid -15% body weight
    - Plasma -5% body weight

•Fluid compartment are seperated by membranes that are freely permeable to water.
•Movement of fluids due to hydrostatic pressure and osmotic pressure

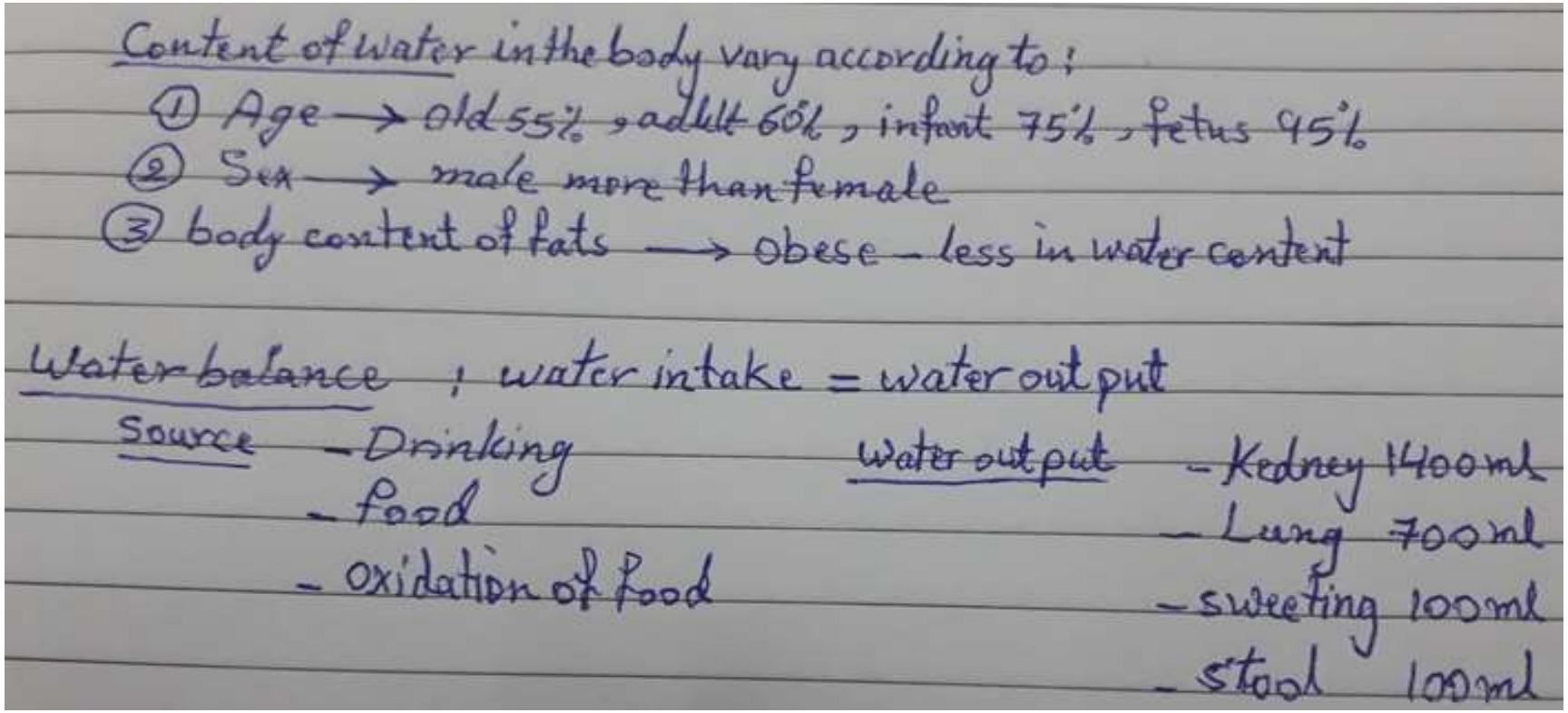
(5) Osmotic pressure are same in two compartments = 290 mOsmole / L

(6) – Fluid in each compartments are Dynamic

Water balance

Total water output per day averages 2.5 liters.

This **must be balanced with water input**: Our **tissues produce** around **300 milliliters** of water per day through metabolic processes. The **remainder** of water output must be balanced by **drinking fluids** and **eating solid foods**.

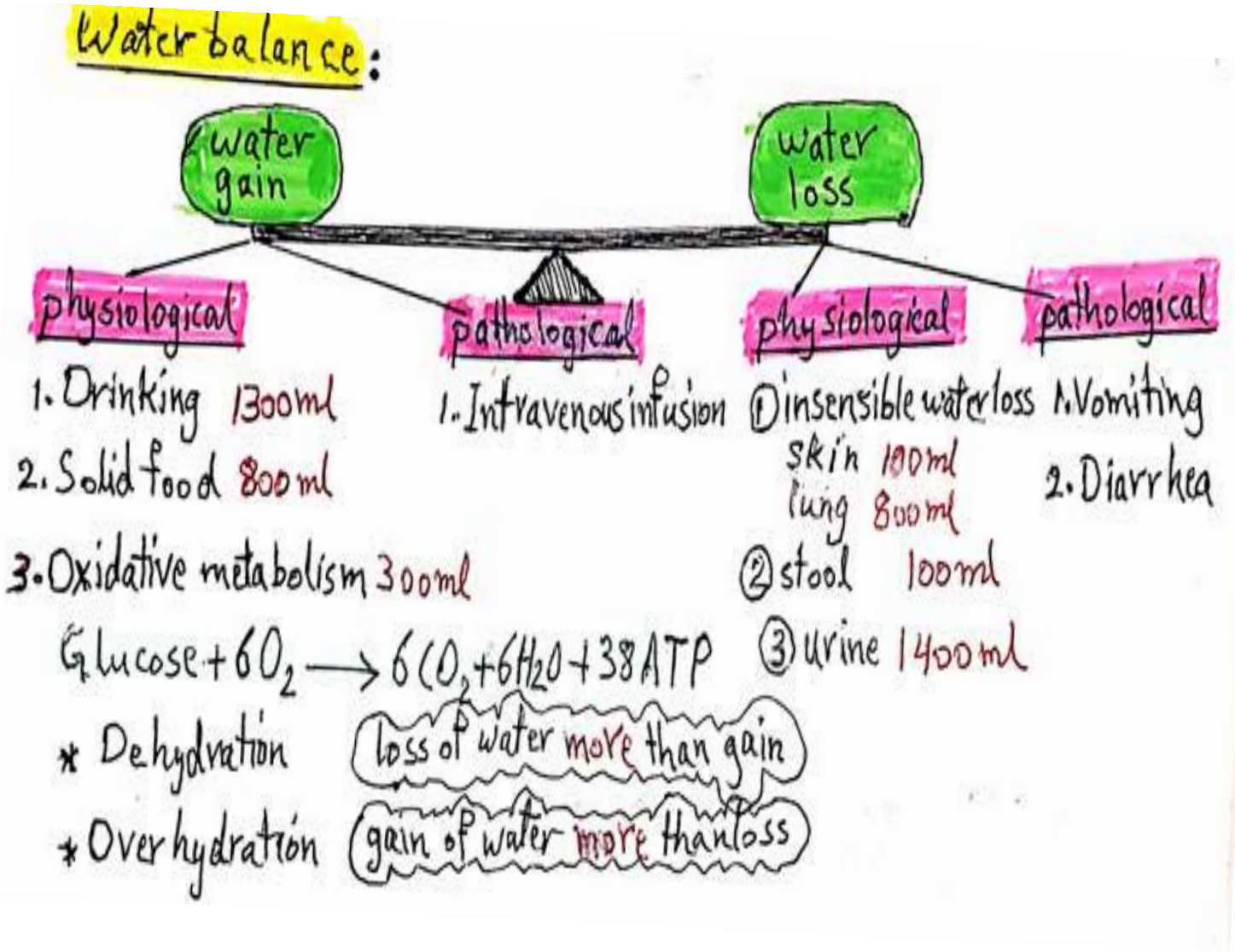


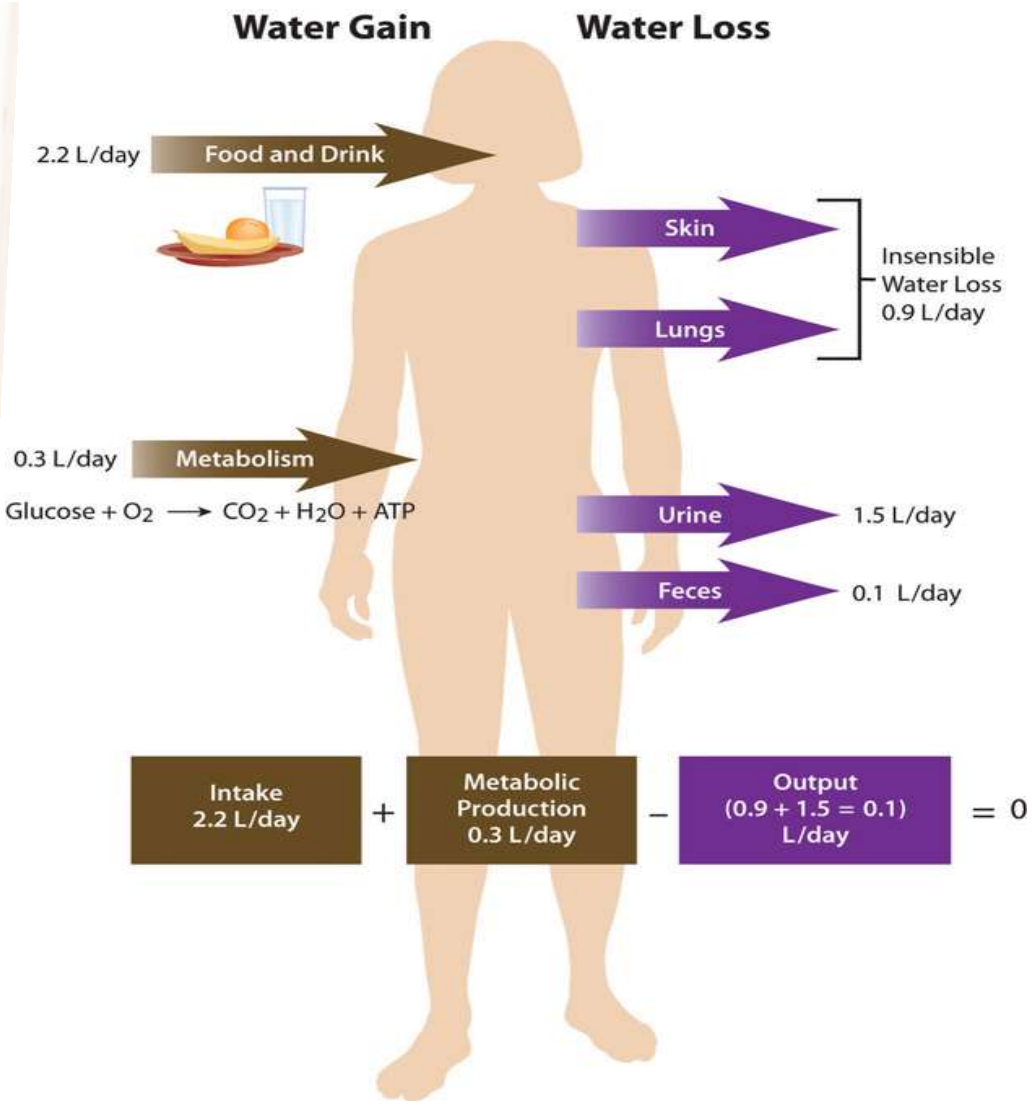
Water Content Regulation: regulated by **a high-gain feedback mechanism involving the hypothalamus, the neurohypophysis, and the kidneys** :

1- the **renal : (Kidney " nephron")**

2- neuro-endocrine systems: (Hypothalamus + Endocrine glands)

- important parts of homeostasis due to its **influence on blood pressure and cardiac output**. **- regulation is mediated** by **hormones**, including **: anti-diuretic hormone , renin, angiotensin II, aldosterone** and **atrial natriuretic peptide**.



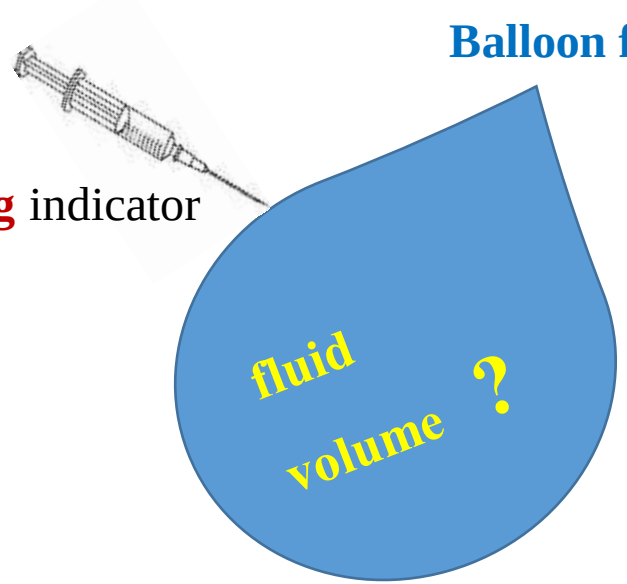


Why is **regulation** of water content **important**?

Fluids are important for **healthy heart function** and **keep blood pressure within the healthy range**.

Dehydration decreases cardiac output which **may lead to increases in heart rate** and a **fall in blood pressure**.

Determination of fluid volume compartment : Dilution principle



(1) Inject **6 mg** indicator

(2) After mixing well, **then draw a sample** and if the concentration of indicator appear about **2mg/ L**

$$\text{Volume of fluid} = \frac{\textbf{Amount} \text{ of indicator injected}}{\textbf{Concentration} \text{ of indicator in sample}} = \frac{\textbf{6 mg}}{\textbf{2 mg / L}} = \textbf{3 L}$$

- Character of indicator: inert , not toxic , not use by tissue
- Compartment measured by Indicator

1- Total body H_2O (TBW)	Heavy H_2O (D_2O) , aminopyrine
2- Extracellular water (ECF)	Inulin , Nathiocyanate
3- plasma (vascular fluid)	Evans blue dye
	plasma protein labelled with radioactive iodine

- Calculated:
  1- ICF = TBW − ECF
  2- ISF = ECF − plasma

The total body fluid is divided between(TBW):

1 - Intracellular fluid (ICF) (a fluid inside the cells)

2 - Extracellular fluid (ECF) (a fluid outside the cells)

Their volumes in the body are *two-to-one ratio*:

ICF - 30 (28-32) liters are **inside cells**

ECF - 15 (14-16) liters are **outside cells**.

- **The extracellular fluid** - the fluids found **outside the cells** and that found **inside the blood vessels** is divided into the:-

1 - Interstitial fluid - the fluid outside the cells.

1 - **between the cells** compartment.

2- **lymphatic fluid** compartment.

3 - **transcellular fluid** compartment

2 - Intravascular fluid (Vascular) - (Plasma) - the fluid inside the blood vessels .

In a *three-to-one ratio*:

Interstitial fluid volume - about **12 liters**

Vascular volume is about **4 liters.**

Components of bodily fluids:

The **composition of tissue fluid** depends upon the **exchanges** of substances between the **cells** in the tissue and the **blood**.

A - Intracellular Fluid Components: (fluids inside the cell)

Intracellular fluid (cytoplasm) consists**:**

Water, dissolved ions, small and large **molecules, water-soluble molecules** (such as **proteins**).

- Water, which **makes up about 70% of the total volume of a typical cell.**

-The **pH** is **7.4**.

The **concentrations of some ions** in intracellular fluid are **quite different from those in extracellular fluid. -** intracellular fluid has a **high concentration of potassium ions** and a **low concentration of sodium ions**.

also **contains much higher** amounts of **proteins and nucleic acids, than the outside of the cell.**

B - Extracellular Fluid Components (fluids between the cells and blood plasma)

The extracellular fluid is mainly contain **cations** and **anions**.

The cations include: sodium (Na+), potassium (K+ low conc**.) and calcium (Ca2+).**

The anions include: chloride (Cl-) and hydrogen carbonate (HCO3-).

These **ions** are **important for water transport** throughout the body.

1 - Vascular fluid: (in the blood vessels)

It is the **plasma** - **water** (**93%** by volume)
- **dissolved proteins** (**fibrinogens**, **globulins**, and **albumins**)
- **glucose**
- **clotting factors**
- **mineral ions** (Na+, Ca++, Mg++, HCO3- Cl- etc.)
- **hormones** and **carbon dioxide**.

These **dissolved substances** - **involved** (share) in many varied **physiological processes:**
- **gas exchange**
- **immune system function**
- **drug distribution**.

2 - Interstitial fluid: (fluids between the cells)

Interstitial fluid is the **body fluid between blood vessels and cells**, containing **nutrients** from capillary by diffusion and holding **waste products discharged out** by cells due to metabolism.

Plasma and **interstitial fluid** are very **similar** *because* **water, ions,** and **small solutes** are **continuously exchanged between them** across the walls of capillaries.

Interstitial fluid **consists** of a **water solvent containing** **sugars**, **salts**, **fatty acids**, **amino acids**, **coenzymes**, **hormones**, **neurotransmitters**, **white blood cells** and cell **waste-products**.

3 -Transcellular Fluid Components

- **Transcellular fluid** is formed from the **transport activities between the cells**, and is the smallest component of ECF. These fluids are **contained within epithelial lined space**

Examples of this fluid are:

1 - **Cerebrospinal fluid**

2 - **Aqueous humor** in the eye.

3 - Endolymph in the inner ear.

4 - Joint fluid.

5- Serous in the serous membranes lining cavities.

Due to the **varying locations** of transcellular fluid, the **composition changes dramatically.** Some of the electrolytes present in the transcellular fluid are sodium ions, chloride ions, and bicarbonate ions.

Cerebrospinal fluid is **similar** in composition to **blood plasma**, **but lacks** most **proteins**, such **as albumins**, because they are **too large to pass** through the **blood–brain barrier.**

Ocular fluid in the eyes **contrasts with cerebrospinal fluid** by **containing high concentrations of proteins**, including antibodies.

• **The constancy of the composition** of the blood is **made possible by** the **circulation**, which conveys blood through the organs that regulate the concentrations of its components. As follow:

1 - **In the lungs**, blood **acquires oxygen** and **releases carbon dioxide** transported from the tissues.

2 - **The kidneys remove** excess **water** and dissolved **waste products**.

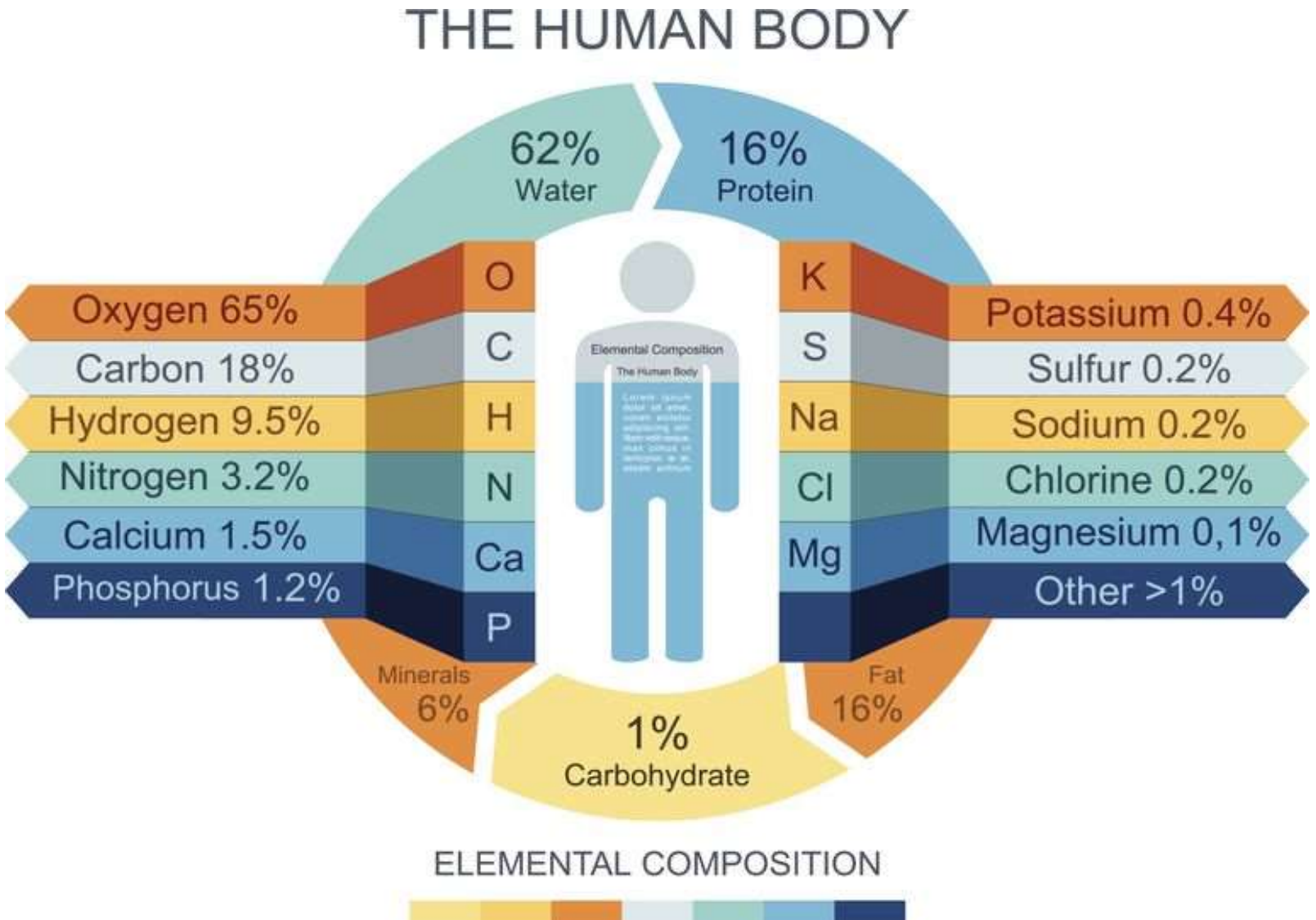
3 - **In gastrointestinal tract , ** absorbed **nutrient** substances derived from food reach the bloodstream .

4 - **Glands of the endocrine system release their secretions into the blood**, which transports these **hormones** to the tissues in which they exert their effects.

5 - Many **substances are recycled through the blood;** for example, **iron** released during the destruction of old red cells is **conveyed by the plasma** to sites of new red cell production where it is re-used.

Electrolytes

It is **a substance** (**chemicals**) that **conducts electricity** **when dissolved in water.** They are **essential** for a number of **bodily functions**.



Electrolytes

- **The important electrolytes in human bodies include:**

Sodium , potassium , calcium , bicarbonate , magnesium , chloride , phosphate

- **Sources** of electrolytes are **fruits** and **vegetables**.
- **Function:**
  1 - **Regulate nerve function**
  2 - **Muscle function**
  3 - **Hydrate the body**
  4 - **Balance blood acidity**
  5 - **Balance pressure**
  6 - **Help in rebuild damaged tissue**.
- **For example**, a **muscle** needs **calcium**, **sodium** and **potassium** **to contract**.
  When the quantity of these substances **become imbalanced**, it can lead to either **muscle weakness** or **excessive contraction.**
  The **heart**, **muscle**, and **nerve** cells **use electrolytes** **to carry electrical impulses** to other cells.

- Must be compensate some important electrolytes because:

  1 - **Lost in sweat during exercise, including sodium and potassium.**

  2 - Concentration of electrolytes can be affected by **rapid loss of fluids,** after **diarrhea or vomiting.**

- **Regulation:**
  - The **(1) kidneys** and **(2) several hormones regulate the concentration** of each electrolyte.
  - If levels of a **substance are too high**, the **kidneys filter** it from the body, and **different hormones act to balance the levels.**

- **A harmful concentration** of magnesium, sodium, potassium, or calcium can **produce one or more of the following symptoms:**

irregular heartbeat , weakness , bone disorders , twitching , changes in blood pressure , confusion الارتباك , Seizures نوبات , numbness خدر , nervous system disorders , Convulsions التشنجات, excessive tiredness , muscle spasm

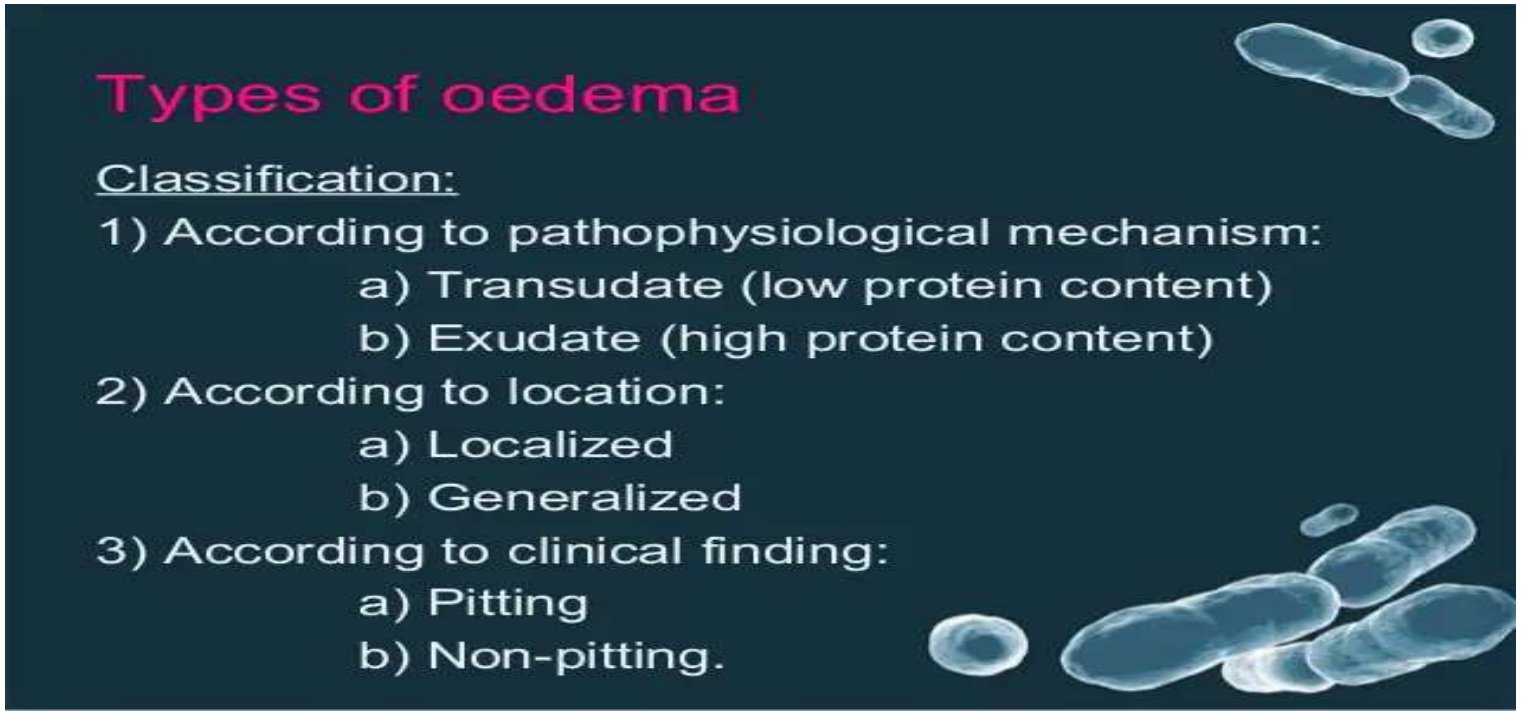
- **Signs and symptoms of excessive calcium** may include:

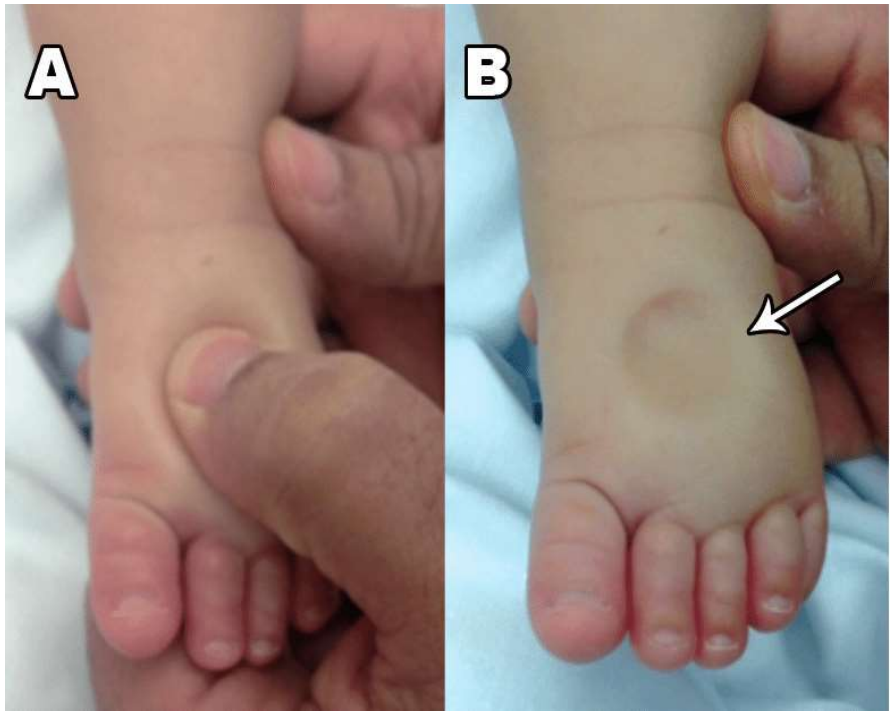
frequent urination , irregular heartbeat , lethargy الخمول, fatigue الإجهاد, moodiness and irritability , nausea غثيان, stomach pain , Vomiting , extreme muscle weakness , thirst , dry mouth or throat , total loss of appetite , Coma , confusion , constipation.

Edema

Edema: It is an **abnormal accumulation** of the **fluid** in the **interstitial** located **beneath the skin** and in the **cavities** in the body (**extravascular**), and **become evident** when **interstitial fluid increase by 2.5 – 3L.**

Edema happens most often in the **feet, ankles,** and **legs**, but can affect other parts such as the **face, hands**, and **abdomen.** It can also involve the **entire body**.





4 - Types of Edema ccording to Injured body organ

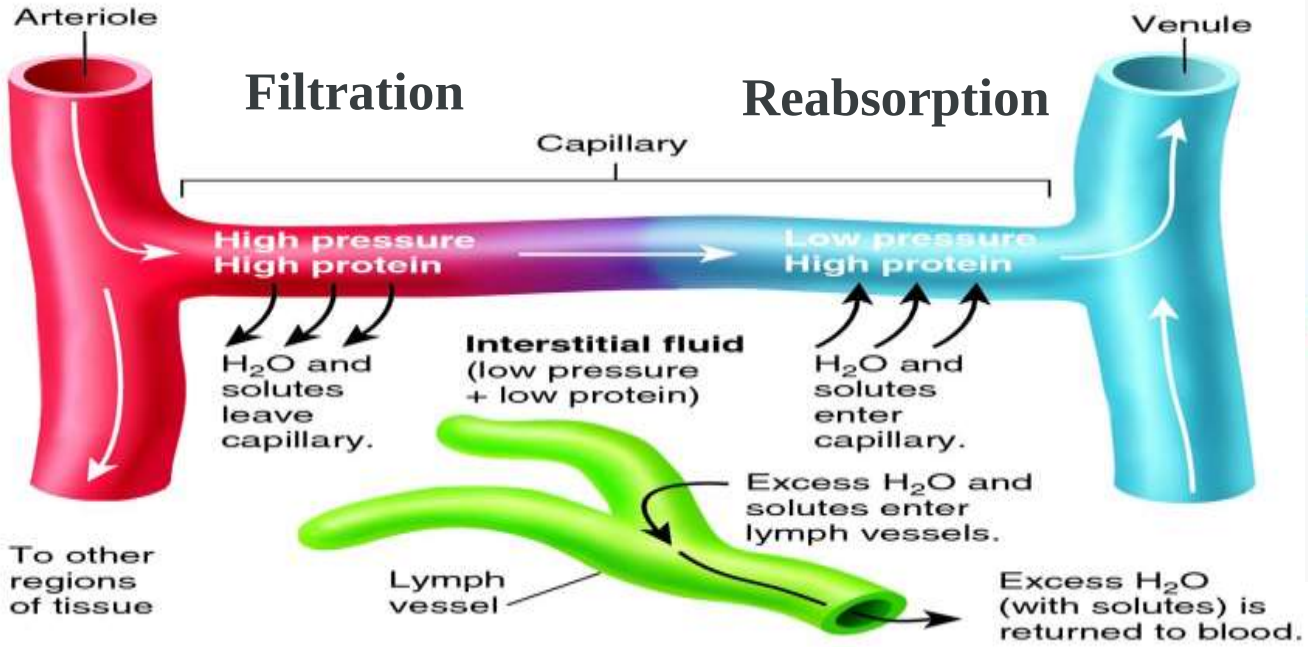
- **Pedal edema**- affects **lower legs, ankles,** and **feet**. Possible causes: **pregnancy, being older**.
- **Peripheral edema/Lymphedema**- affects the **arms, legs,** and **feet.** ...
- **Pulmonary edema**- affects **lung**s, makes it **hard to breathe**, especially **when lying down**.
- **Cerebral edema**- affects the **brain**

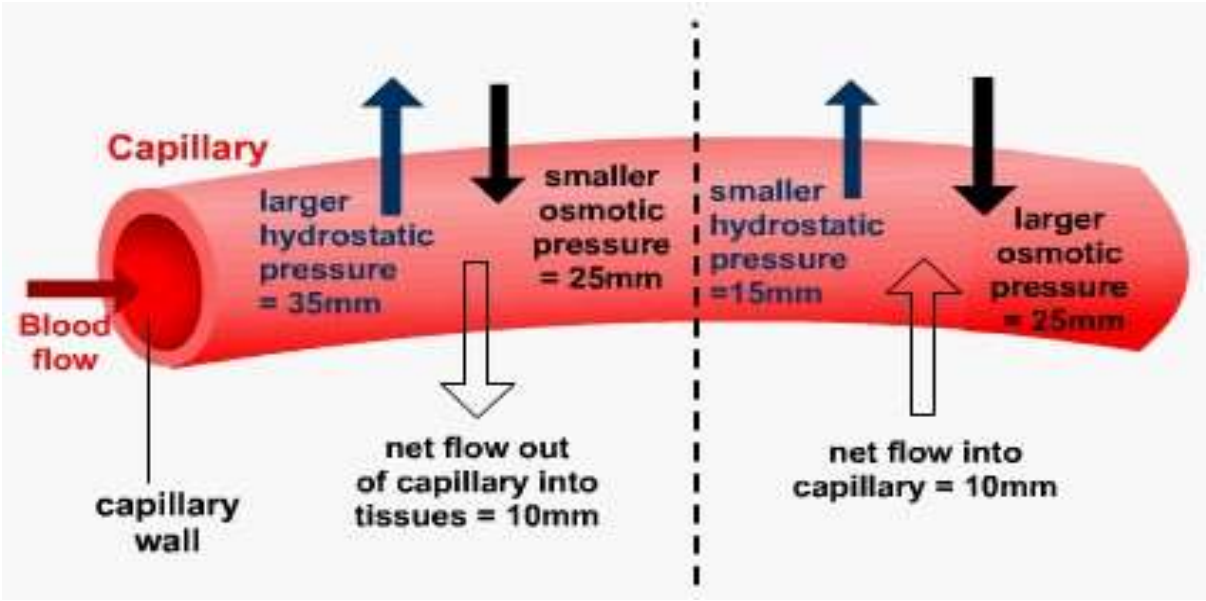
Capillary Exchange Mechanisms

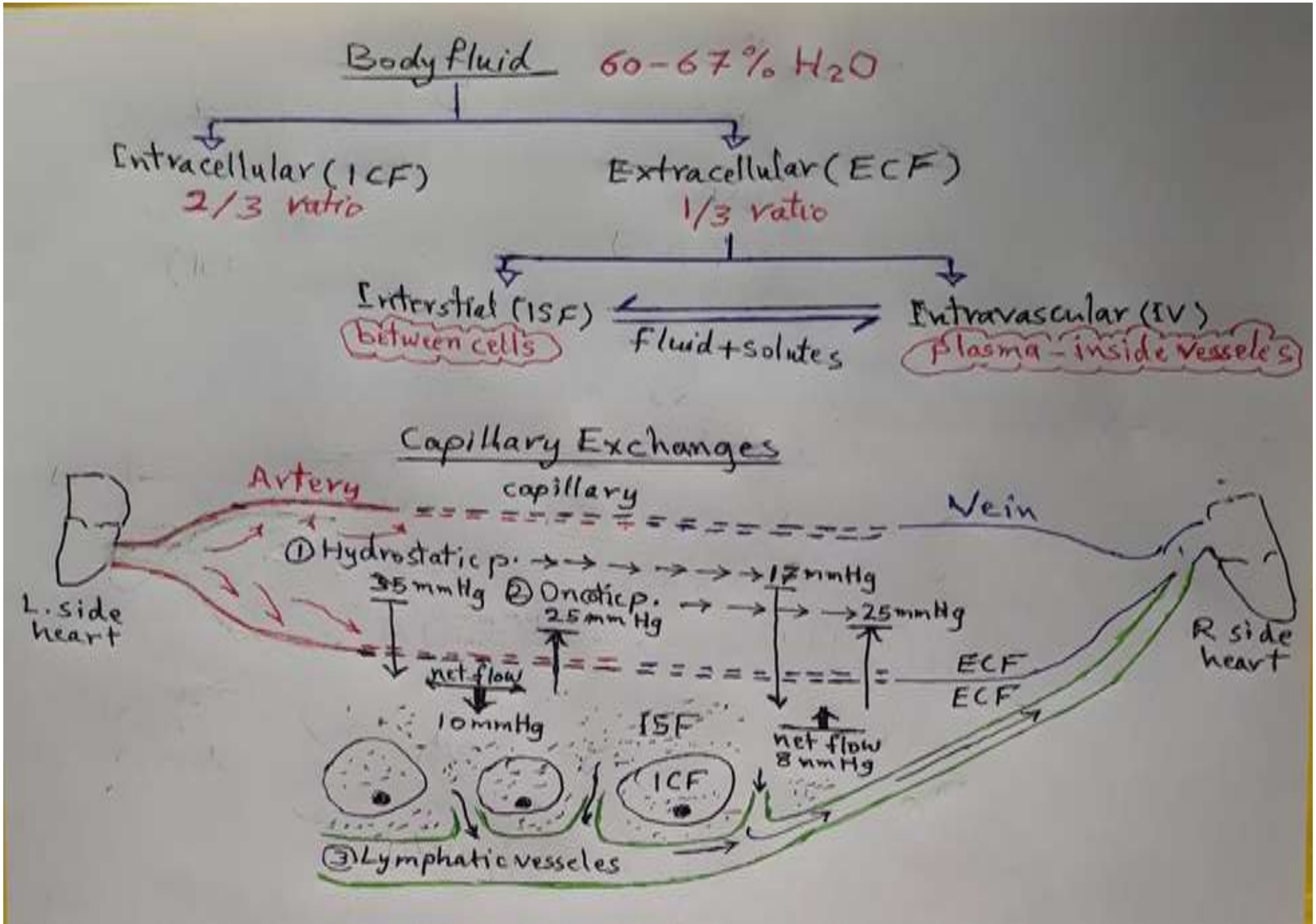
- **Capillary exchange** - the **exchange of material** from the blood in the capillary into the tissues.
- **Three mechanisms** - facilitate capillary exchange: **diffusion, transcytosis** and **bulk flow.**
- **Mechanisms done by:**

1 - Hydrostatic pressure - is a **force generated** by the **pressure of fluid** on the capillary walls either by the blood plasma or interstitial fluid.

2 - Oncotic pressure -form of **osmotic pressure exerted by proteins** either in the blood plasma or interstitial fluid.





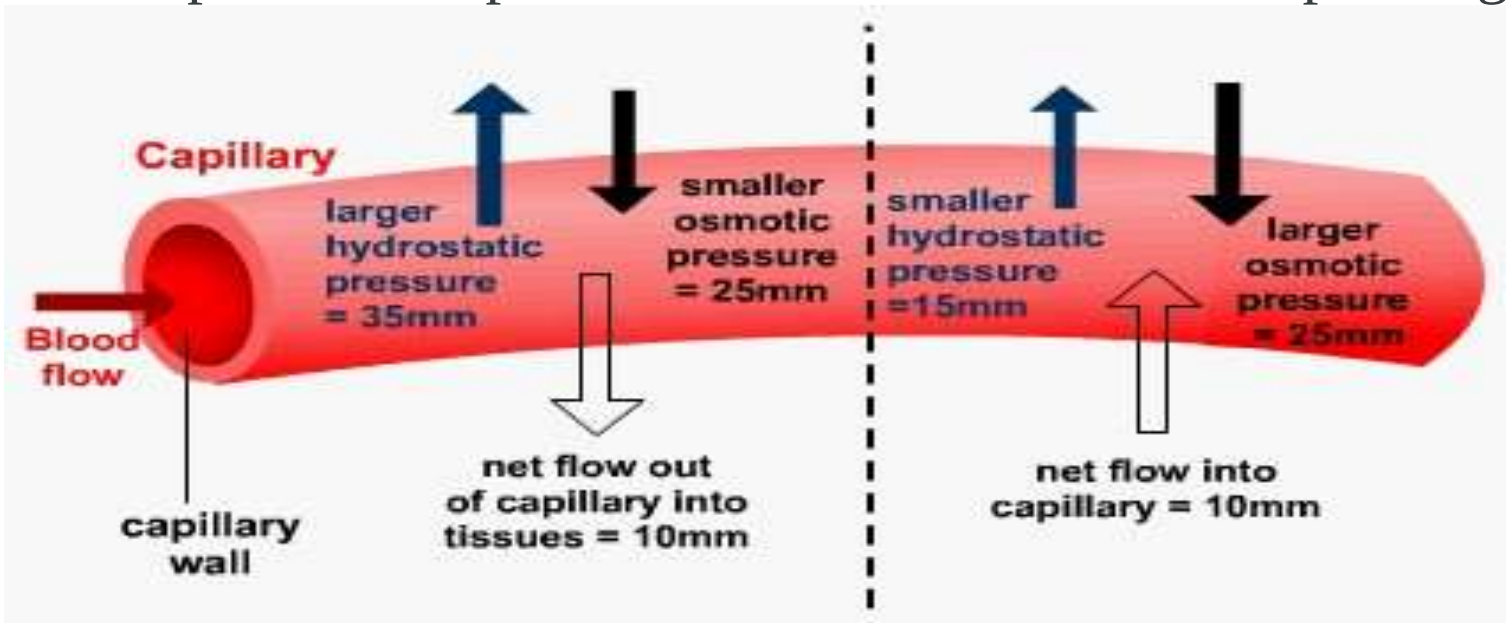

Body fluid
60-67% H_2O
Intracellular (ICF)
2/3 ratio
Extracellular (ECF)
1/3 ratio
Interstitial (ISF)
between cells
Fluid + solutes
Intravascular (IV)
plasma - inside vessels
Capillary Exchanges
Artery
capillary
Vein
① Hydrostatic p.
35 mmHg
17 mmHg
② Oncotic p.
25 mmHg
25 mmHg
L. side heart
R side heart
net flow
10 mmHg
ISF
ECF
ECF
net flow
8 mmHg
ICF
③ Lymphatic vesseles

Capillary Exchange Mechanisms

Diffusion, it is the flow of **small molecules across capillaries** such as **glucose** and **oxygen** from the blood into the tissues and **carbon dioxide** from the tissue into the blood. The process depends on the **difference of gradients** between the interstitial fluid and blood, with molecules moving to low-concentrated spaces from high-concentrated ones.

Transcytosis is the mechanism whereby **large, lipid-insoluble substances** cross the capillary membranes. The substance to be transported **endocytosisly** by the endothelial cell into a lipid vesicle which moves through the cell and is then **exocytosed** to the other side.

Bulk flow is used by **small, lipid-insoluble solutes in water** to cross the capillary wall. The movement of materials across the wall is dependent on pressure and is bi-directional depending on the net **filtration pressure**.



Mechanisms of Edema

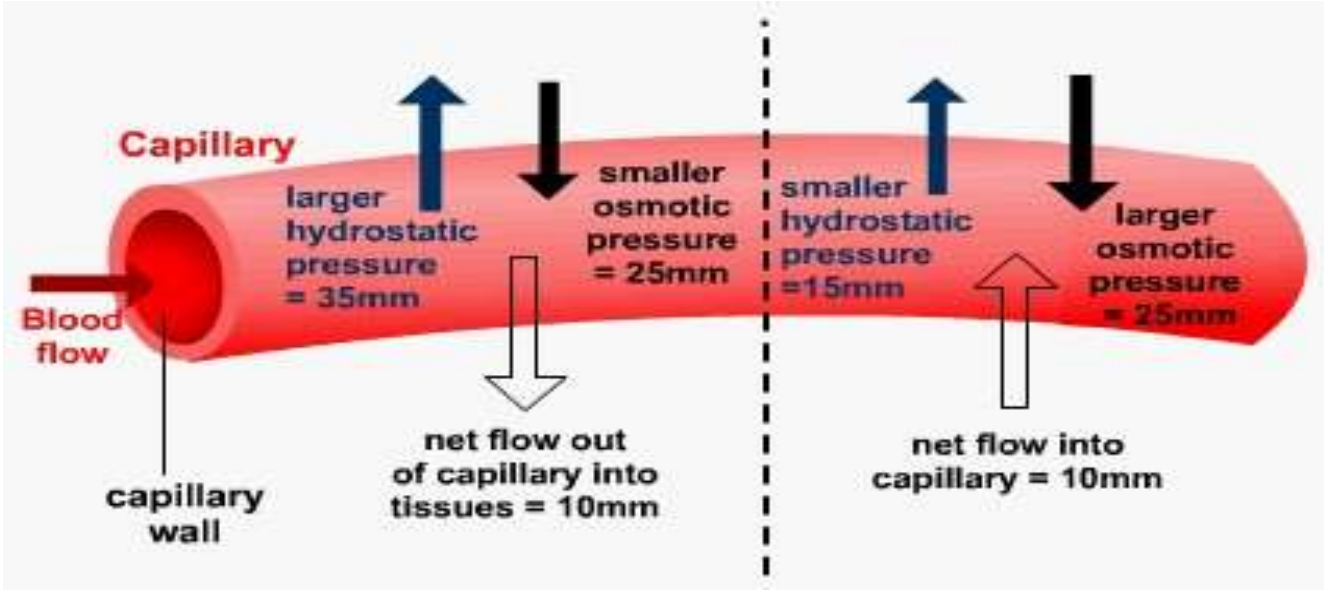
Mechanisms of Edema

Interstitial fluid is **regulated** by the forces of the **Starling equation.**

Starling's equation states that the **rate of leakage of fluid** is **determined by** the **difference** between the **two forces (hydrostatic and oncotic pressure difference between capillaries and interstitial fluid) and** also by the **permeability of the vessel wall** to water, which determines the rate of flow for a given force imbalance.

(1) Hydrostatic pressure within blood vessels tends to **cause water to filter out (into the tissue)**. This **leads to a difference in protein concentration** between blood plasma and tissue.

(2) As a result, the colloidal **or** oncotic pressure of the **higher level of protein** in the plasma tends to **draw water back into the blood vessels** from the tissue.



(3) Lymphatic system acts like an "over flow" and can **return much excess fluid to the** bloodstream**.**

If the lymphatic system is congested, then the **fluid will remain in the tissues**, **causing swellings** in legs, ankles, feet, abdomen or any other part of the body.

(4) Capillary permeability - inflammations cause increase permeability

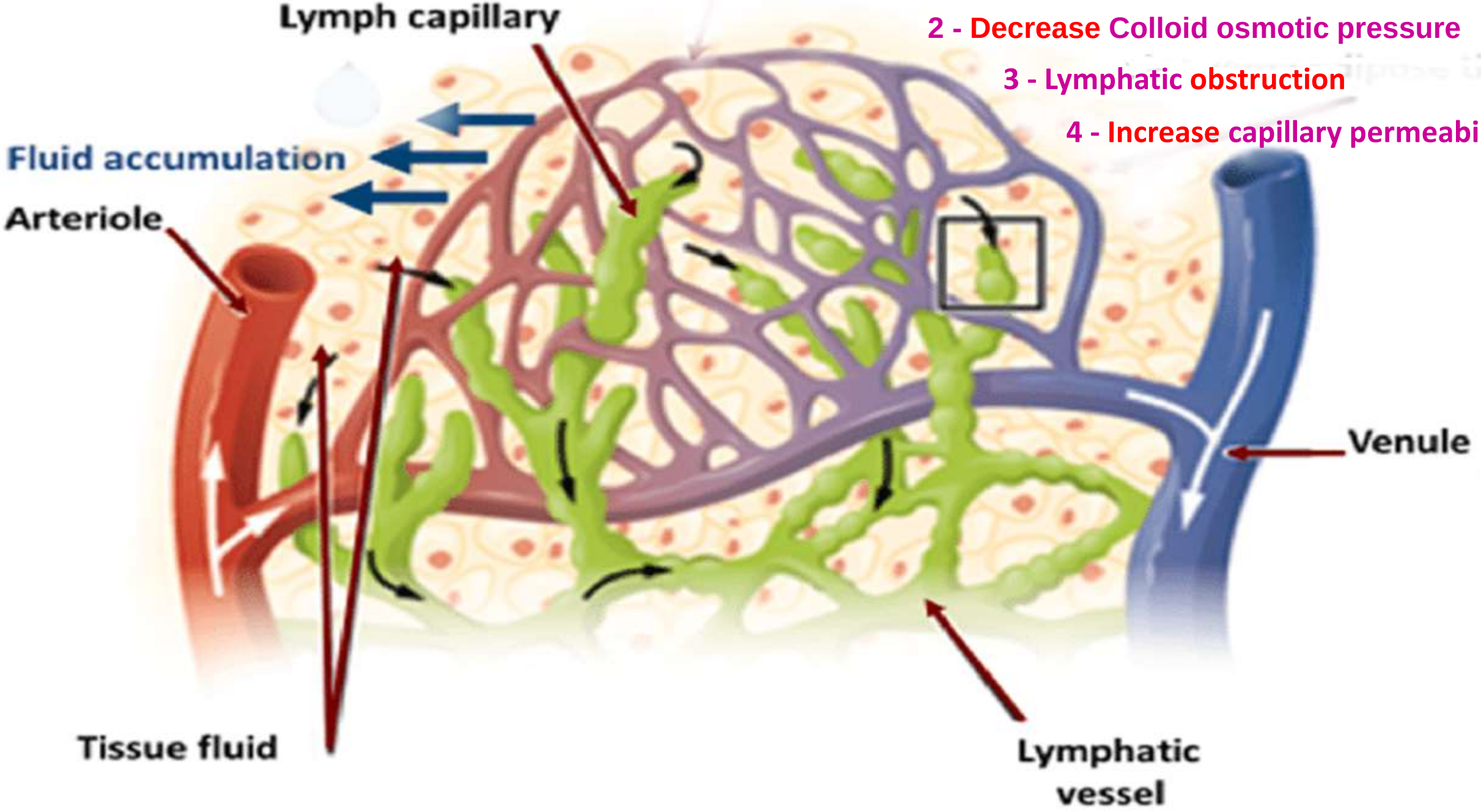
Mechanisms of Edema

1 - Increase in capillary hydrostatic pressure

2 - Decrease Colloid osmotic pressure

3 - Lymphatic obstruction

4 - Increase capillary permeability



The mechanism of edema involves one or more of the following and causes:

Physiological and pathological causes

1 - Increased capillary hydrostatic pressure. (Filtration)

Causes: 1 – Heart failure (right -**generalized edema**), Left ventricles (**pulmonary** edema)
2 – Venous obstruction

2 - Decreased plasma oncotic pressure. (Absorption – Albumin**)**

Causes: 1 – Malnutrition
2 – Malabsorption
3 – Liver diseases (cirrhosis)
4 – Renal diseases

3 - Lymphatic obstruction

Causes: 1 – Tumor
2 - Lymphedema

4 - Increase capillary permeability

Causes: 1 – Inflammation
2 – Burns (blisters)
3 – Allergy – (hypersensitivity reaction – release **histamine** from basophil and mast cell)

Some of the most common causes of edema are:

- **Standing** or **sitting.** Sitting or standing for too **long period** can cause extra **fluid to build up** in your **feet, ankles,** and **lower legs, because of gravity** pull down water into legs and feet.
- **Venous insufficiency.** A **weakening in the valves** of the **veins** in the legs makes it **hard for the veins to push blood back up to the heart,** and leads to **varicose veins** and a buildup of fluid in the legs.
- **Underlying medical conditions**. such as **congestive heart failure** and **Chronic lung, liver, kidney,** and **thyroid diseases** — can cause edema or make it worse.
- **Side effects from medication,**. **Some medications** may cause or worsen edema.
- **Compromised immune system (An allergic reaction), severe inflammation, burns, trauma, clot(s),**
- **Too much salt** from your diet can make edema worse.
- **Pregnancy.** Being pregnant can cause **edema in the legs as the uterus puts pressure on the blood vessels** in the lower trunk of the body.
- **Low levels of protein** or **poor nutrition**. can also cause edema.

The symptoms of edema

Signs of edema include the following:

- The affected area is **swollen.**
- The **skin** over the **swollen area** might **look stretched and shiny.**
- **Pushing** in gently on the **swollen area** with your finger for at least 5 seconds and then removing your finger will **leave a dimple in the skin.**
- You may have **trouble walking** if your legs are swollen.
- You may be **coughing** or have **trouble breathing** if you have edema in the lungs.

Dehydration

A **condition** occurs when the **body loses more fluid** than **it takes in** with an accompanying **disruption** of **metabolic processes**. **This condition can result from:**

1 - illness
2 - a hot, dry climate (Excessive sweating).
3 – Vomiting and diarrhea, or hemorrhage
4 - not drinking enough water
5 - overuse of diuretics or other medications that increase urination.

Dehydration can cause **hypernatremia** (high levels of sodium ions in the blood) and is distinct from **hypovolemia** (loss of blood volume, particularly blood plasma).

Body **water is lost** through the skin, lungs, kidneys, and GIT.
The loss of body water without sodium causes dehydration.

Age (years)	Amount Fluid Needed Per Day (8 oz cups)
Infants	3 cups
1 to 3	4 cups
4 to 8	5 cups
9 to 13	8 cups
Males ≥ 14	11–13 cups
Females ≥ 14	8–9 cups

There are three main types of dehydration:

1 - hypotonic (primarily a loss of electrolytes)
2 - hypertonic (primarily loss of water)
3 - isotonic (equal loss of water and electrolytes).

Forms of dehydration:

1.**Isotonic water loss** occurs when **water and sodium are lost together**. **Causes** of isotonic water loss are **vomiting, diarrhea, sweating, burns, intrinsic kidney disease, hyperglycemia, (and hyperaldosteronism X).**

2.**Hypertonic dehydration** occurs when **water losses exceed sodium losses**. Serum sodium and osmolality will always be elevated in hypertonic dehydration. Excess pure water **loss occurs through** the skin, lungs, and kidneys. **Etiologies المسببات** are **fever**, **increased respiration**, and **diabetes insipidus**.

3.**Hypotonic dehydration** is mostly **caused by** **diuretics**, which cause more sodium loss than water loss. Hypotonic dehydration is characterized by low sodium and osmolality.

Symptoms:

- **Thirst.**
- **Dry or sticky mouth.**
- **Not peeing very much.**
- **Dark yellow pee.**
- **Dry, cool skin.**
- **Headache.**
- **Muscle cramps.**
- **A 2% decrease in brain hydration can result in short term memory loss and have trouble with math computations.**

Prolonged dehydration causes brain cells to shrink in size and mass, a condition common in many elderly who have been dehydrated for years. **Lead to lack of mental clarity**, sometimes referred to as “brain fog.”

Many diseases -- such as **diabetes, cystic fibrosis, and kidney disease -- increase dehydration risk** and the need for fluids. For example, people with uncontrolled diabetes urinate frequently. Some medications can also cause a person to urinate or sweat more than normal.

Signs of moderate to severe dehydration include:

Dizziness or light-headedness.

Irritability

delirium هذيان

confusion

Homeostasis and Transport across cell membrane

Lecture 3

Homeostasis , Definition

- Homeostasis is **any self-regulating process** by which an **organism tends to maintain stability of internal environment** out of changing in **external** or **internal conditions** , and must be at **optimum condition for survival.**

Ability to maintain internal stability

at optimum condition for body function

- Homeostasis is mainly **involved in managing various internal variables** of the living system like **body temperature, pH** of various fluids, the **concentration** of different **ions,** and the **body sugar level.**
- **Control: Nervous, Hormonals**

Hemostasis

It is the **mechanism** that **leads to cessation of bleeding from a injured blood vessel**.
It is a **process** that involves **multiple interlinked steps**. That cause **formation of a "plug"** that closes up the damaged site of the blood vessel and controlling the bleeding.

Homeostasis component and mechanisms

Homeostasis is **maintained by a complex system** that consists of **individual units working** in a particular sequence **to balance a given variable. (Feedback Loops mechanism)**

1. Stimulus

- The stimulus is **something that results in changes** within the system involving the **variable**. (**Any thing make moving away any bodily value or case from its normal range**)
- **Example** of this is the **increased temperature** of the body **above 37°C** due to various causes.

2. Sensor/ Receptor

- The sensor or receptor **is the sensing unit** of homeostasis, where it **monitors and responds** to the changes in the body., then **sends** the information to the control unit **by afferent nerve.**
- like **thermoreceptors, baroreceptors and mechanoreceptors**

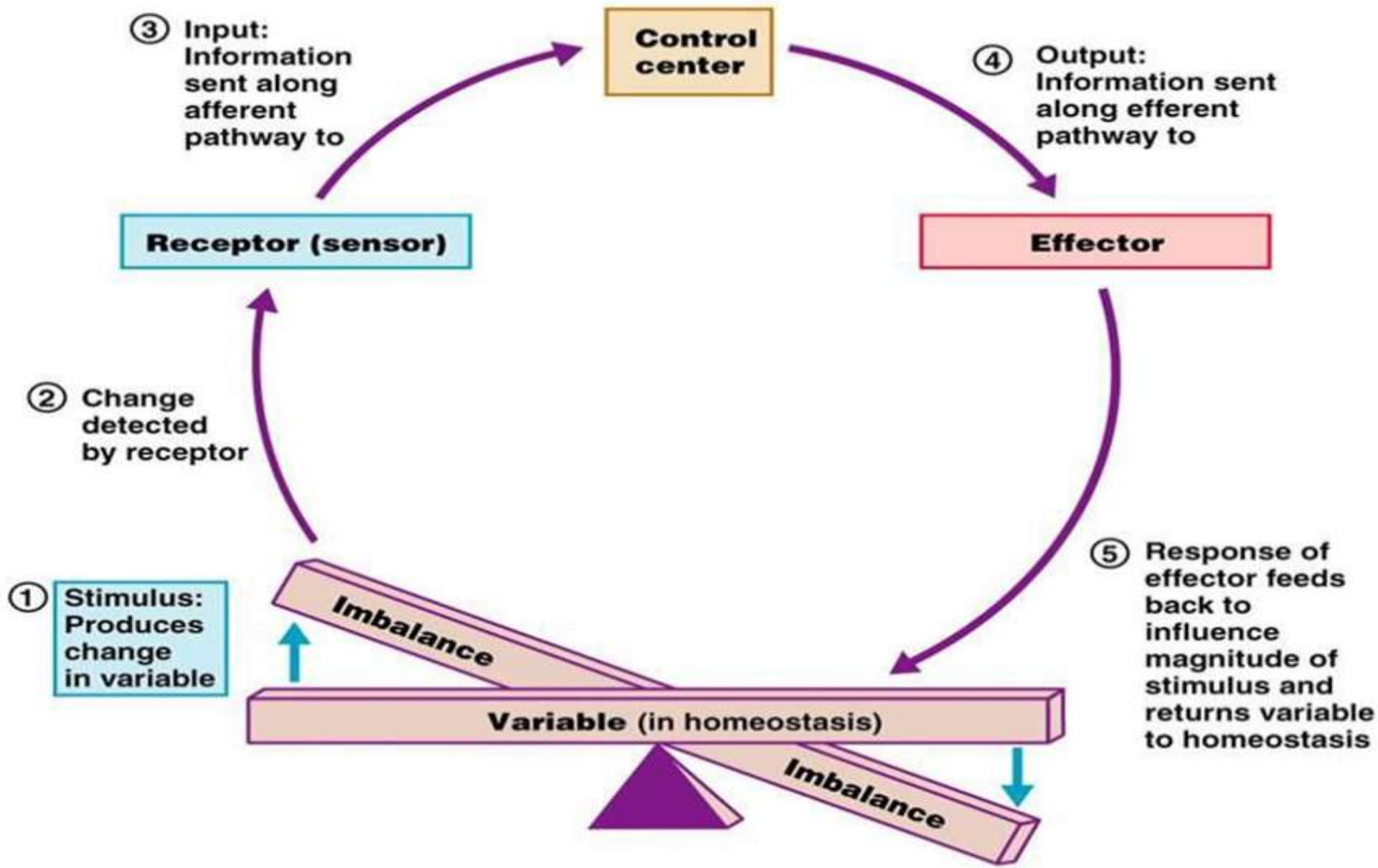
3. Control unit

- Once the information is send to the control unit (**brain, spinal cord**),it **send order to changed value to its normal value**, by **activates the effectors against the stimulus**. **by efferent nerve**

4. Effector

- Effectors can be **muscles, organs, glands,** or other similar structures that are **activate** by a signal from the control unit, **to bring the value of variable back to normal.**

This homeostasis manifest by a mechanism called feedback mechanism



Feedback Loops mechanism: It is a **biological system that helps to maintain homeostasis** where the result of the system **either enhances the system** (positive feedback) or **inhibits the system** (negative feedback).This **require cooperation of the body organs together**.

There are two types of feedback loop that assist the process of homeostasis:

1. Negative feedback loop

- Negative feedback loops result in an **output that tends to minimize the effect of the stimulus** in order to stabilize the system.(**counteract the stimulus**)
- **An example** of a negative feedback loop is the **production of RBCs** when the **decreased level of oxygen** is sensed in the body. Where **kidneys produce erythropoietin** facilitate the bone marrow to **increase production of RBCs**

2. Positive feedback loop

- Some biological and natural systems might utilize positive feedback loops where the **output tends to increase the effect of the stimulus.** .(**enhance the stimulus**)
- **An example** of a positive feedback ,is the **process of childbirth.** In this case, as the **baby's head pushes the cervix due to contraction of uterus,** the neurons in that region are activated. This **causes the brain to send signals to produce oxytocin** which **further increases** the uterine **contractions** putting more pressure on the cervix, **facilitating childbirth.**

Types of regulation to achieve homeostatic in the body

1. Thermoregulation

- Thermoregulation works by the **negative feedback loop** where once the body temperature is **either increased or decreased beyond its normal** temperature, it is **bring back to normal.**
- Different homeostatic **processes** like **sweating, dilation of blood vessels counteract the increased body temperature**, whereas **processes** like **contraction of blood vessels, and breakdown of adipose tissue** to produce heat **prevent the decreased body temperature.**
- **Control unit: Hypothalamus** of the **brain.**

2. Osmoregulation

- During this process, **excess water** or **ions** or other molecules like **urea** are **removed** from the body **to maintain the osmotic balance.**
- One classic **example** of this process is the **removal of excess water** and **ions** out of the blood in the form of **urine** to **maintain the osmotic pressure** of the blood.

The **renin-angiotensin system** and other hormones like **antidiuretic hormones act** as a messenger for the **electrolytic regulation system** of the body.

3. Chemical regulation

- During this process, the **concentration of hormones** like **insulin** **increases** when the **blood sugar level increases** in order to **bring the level back to normal.**
- A similar process is observe in the **respiratory system**, where the **rate of breathing increases** as the concentration of **carbon dioxide increases.**

Examples: **Acid-Base Homeostasis**

Glucose Homeostasis

Calcium homeostasis

Fluid Homeostasis

Blood pressure homeostasis

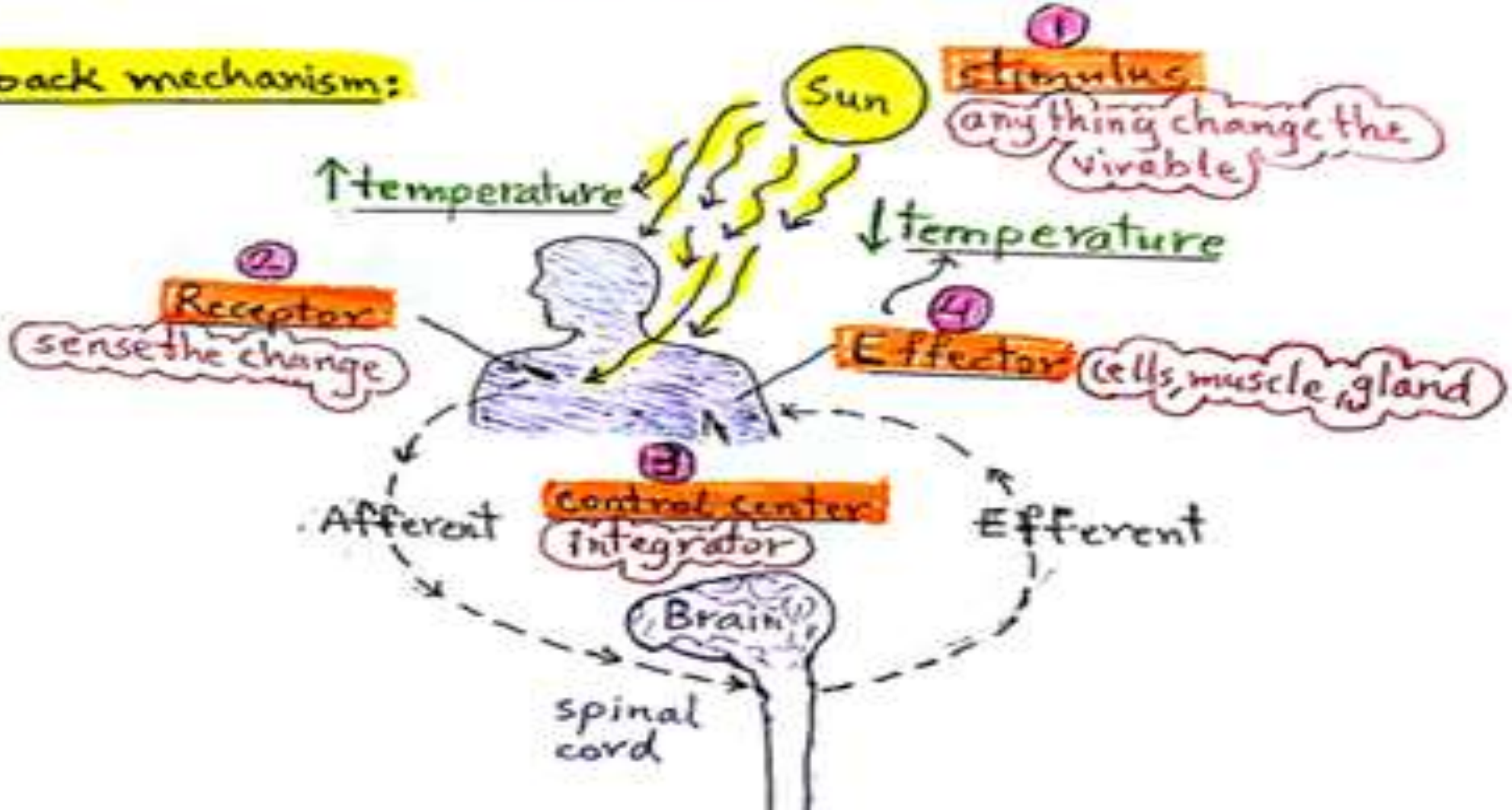
Advantage of homeostasis:

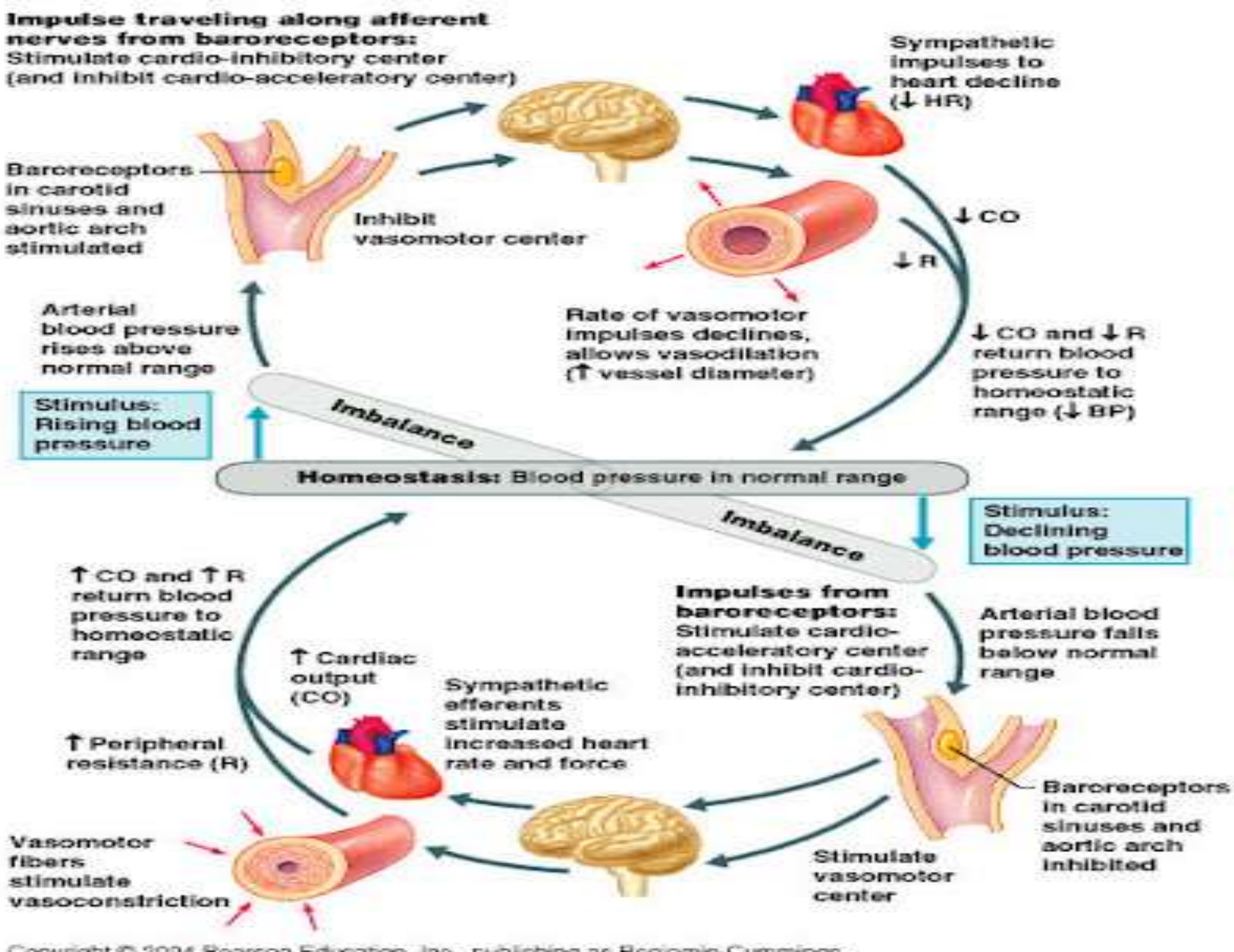
1- Increases the chance of survival

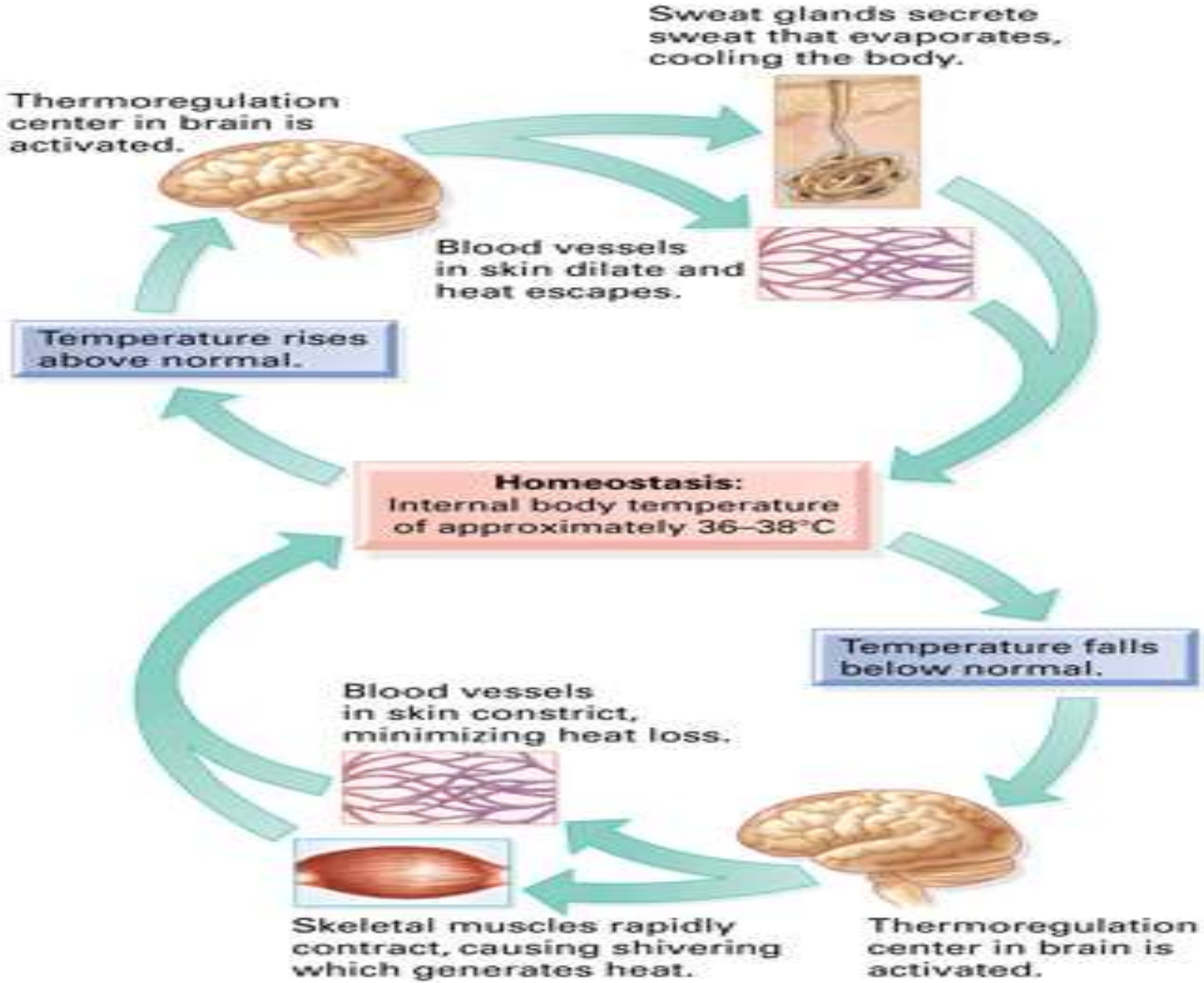
2- Allows freedom to live and work under a great variety of external environmental conditions.

Homeostasis – Not unlimited (limited in range and time)

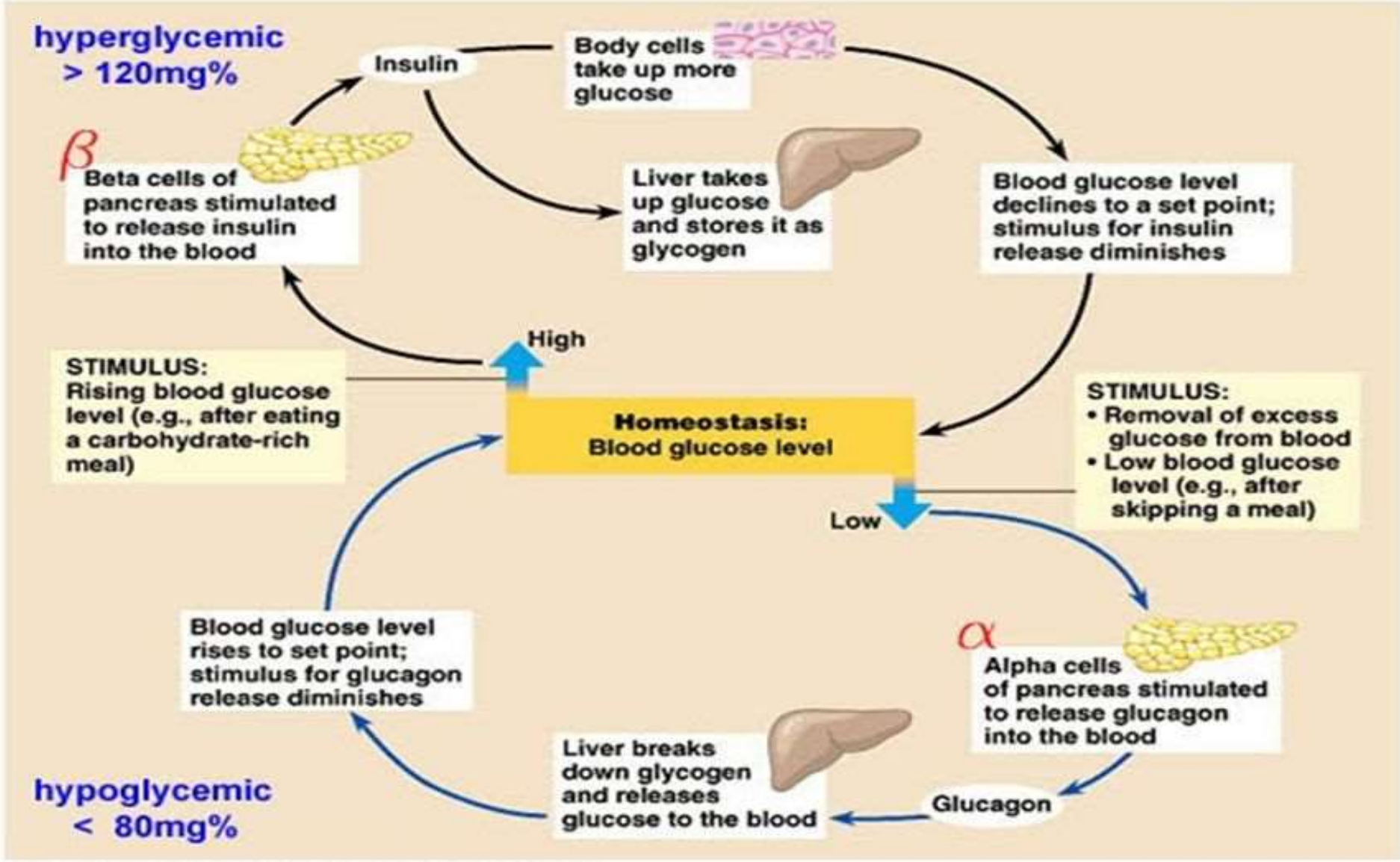
Feed back mechanism:



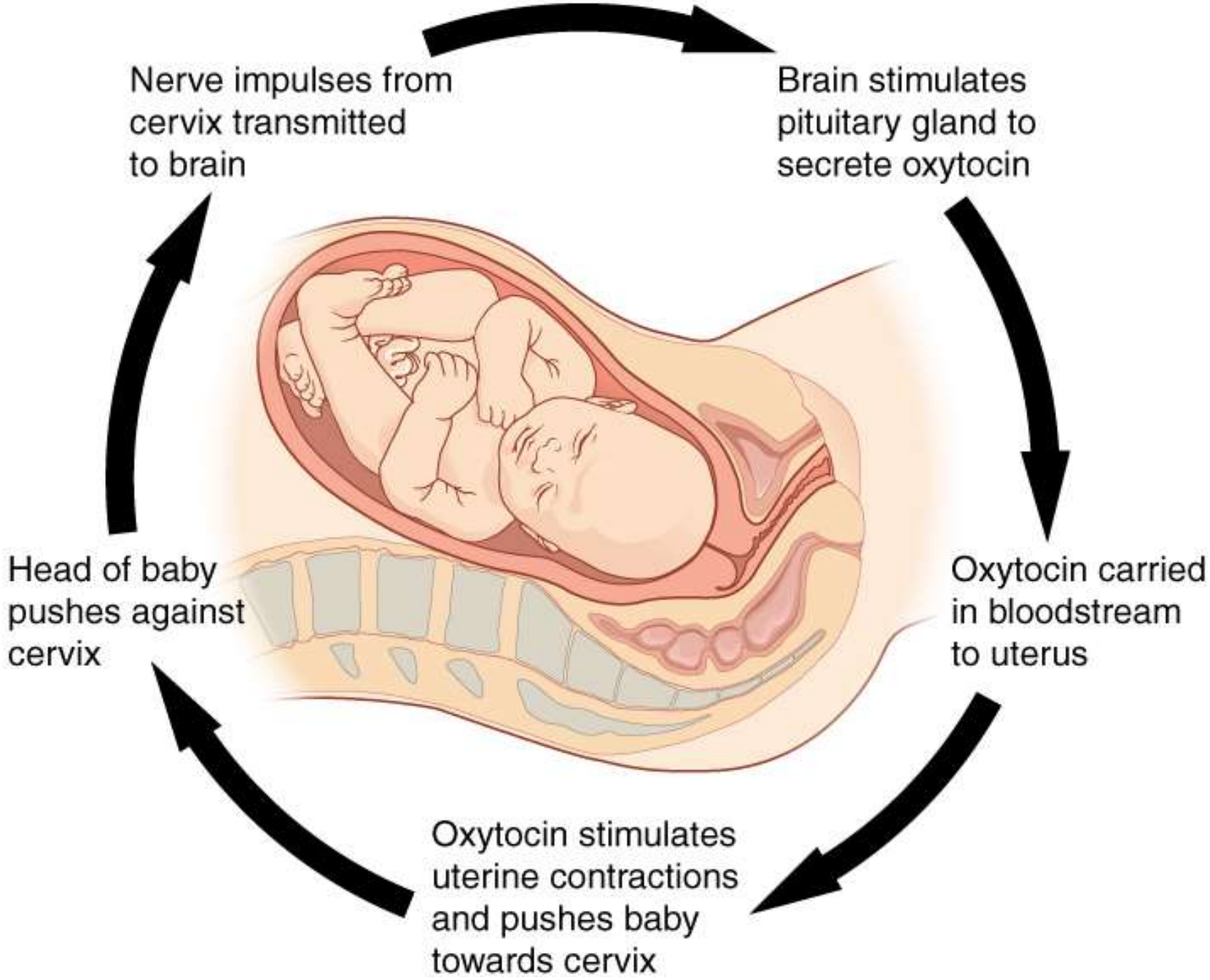

Impulse traveling along afferent nerves from baroreceptors: Stimulate cardio-inhibitory center (and inhibit cardio-acceleratory center)
Sympathetic impulses to heart decline (↓ HR)
Baroreceptors in carotid sinuses and aortic arch stimulated
Inhibit vasomotor center
↓ CO
↓ R
Rate of vasomotor impulses declines, allows vasodilation (↑ vessel diameter)
↓ CO and ↓ R return blood pressure to homeostatic range (↓ BP)
Arterial blood pressure rises above normal range
Stimulus: Rising blood pressure
Imbalance
Homeostasis: Blood pressure in normal range
Imbalance
Stimulus: Declining blood pressure
↑ CO and ↑ R return blood pressure to homeostatic range
Impulses from baroreceptors: Stimulate cardio-acceleratory center (and inhibit cardio-inhibitory center)
Arterial blood pressure falls below normal range
↑ Cardiac output (CO)
Sympathetic efferents stimulate increased heart rate and force
↑ Peripheral resistance (R)
Baroreceptors in carotid sinuses and aortic arch inhibited
Vasomotor fibers stimulate vasoconstriction
Stimulate vasomotor center


Sweat glands secrete sweat that evaporates, cooling the body.
Thermoregulation center in brain is activated.
Blood vessels in skin dilate and heat escapes.
Temperature rises above normal.
Homeostasis: Internal body temperature of approximately 36–38°C
Temperature falls below normal.
Blood vessels in skin constrict, minimizing heat loss.
Skeletal muscles rapidly contract, causing shivering which generates heat.
Thermoregulation center in brain is activated.

Regulation of Blood Glucose



Positive feedback loop



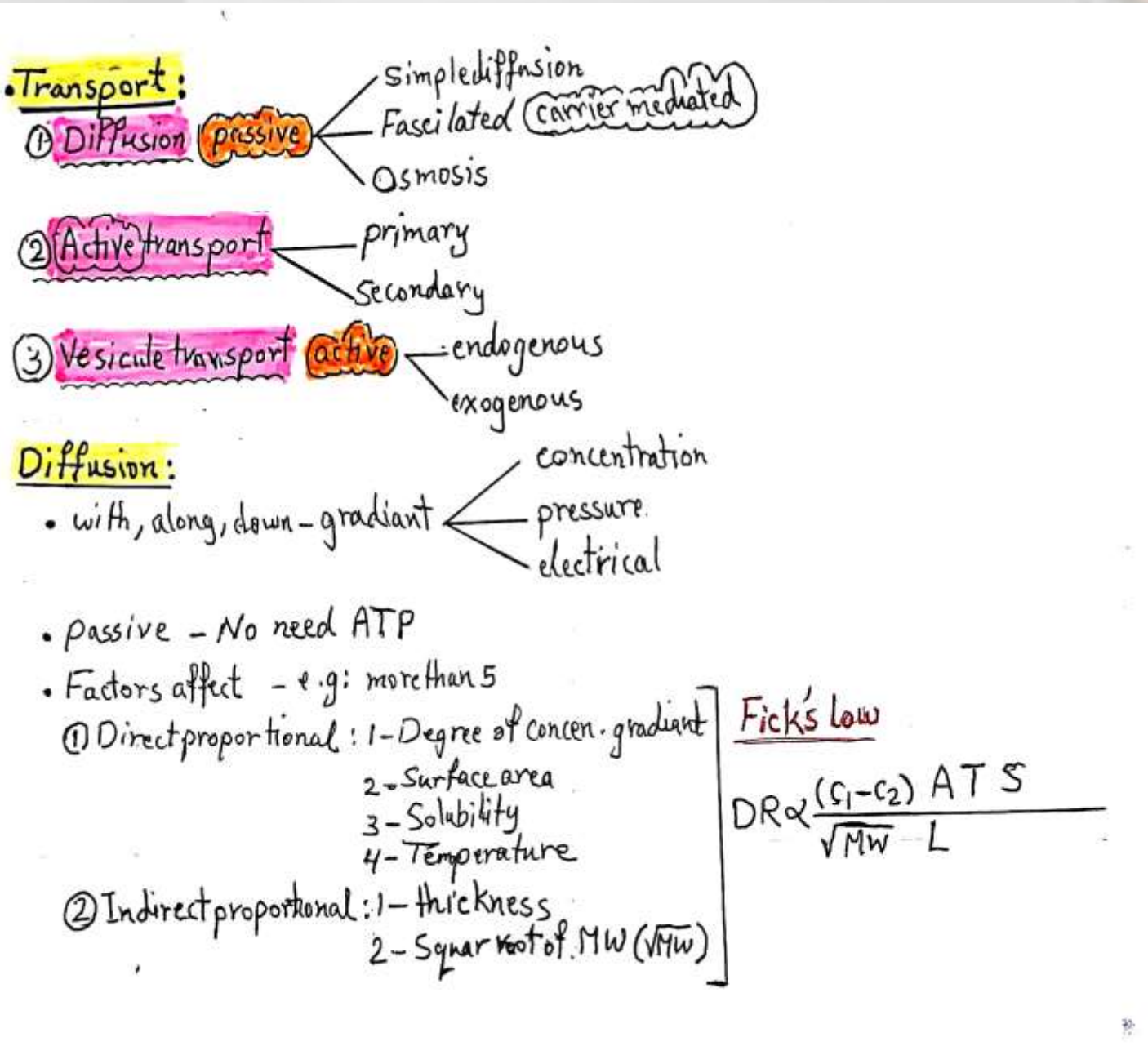
Cell membrane transport

Mechanisms - regulate the passage of solutes (ions, small molecules) through biological membranes.
This membrane is **a selective permeability** – (permeable to certain substances but not to others).
All substances that **transport based on whether or not energy is required.**

Types of transportation

1 - Diffusion: no need energy (passive)
2 – Active transport: using energy (ATP)
3 - Vesicle-mediated transport (active)

.



Diffusion : Transportation based on: **concentration gradients** , where substances move from higher concentration to lower concentration - requires not energy. .

A ***concentration gradient*** is the difference in concentration of a substance across a space.

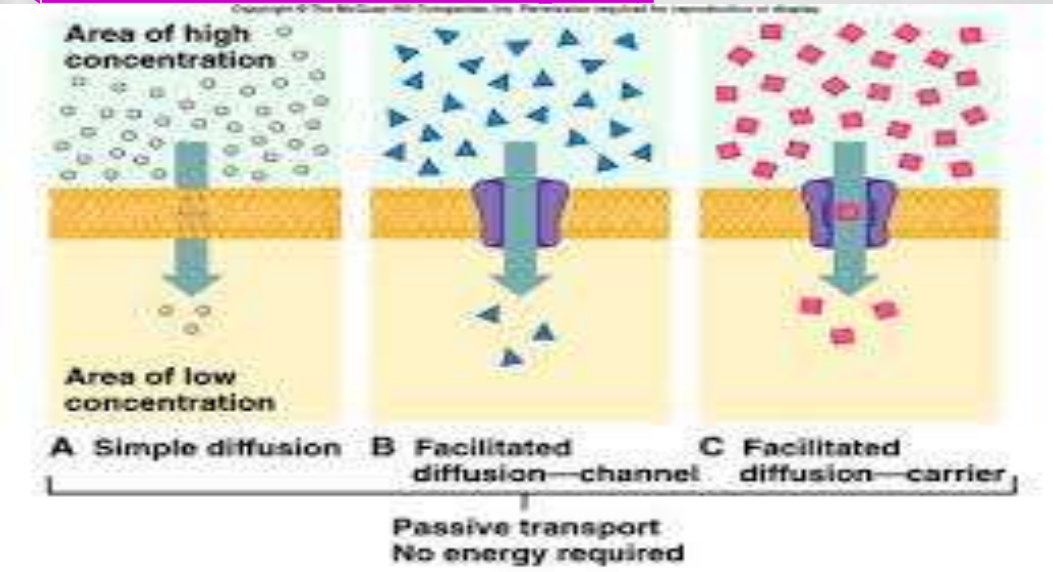
Its **types** include:

1 – Simple diffusion - oxygen and CO_2

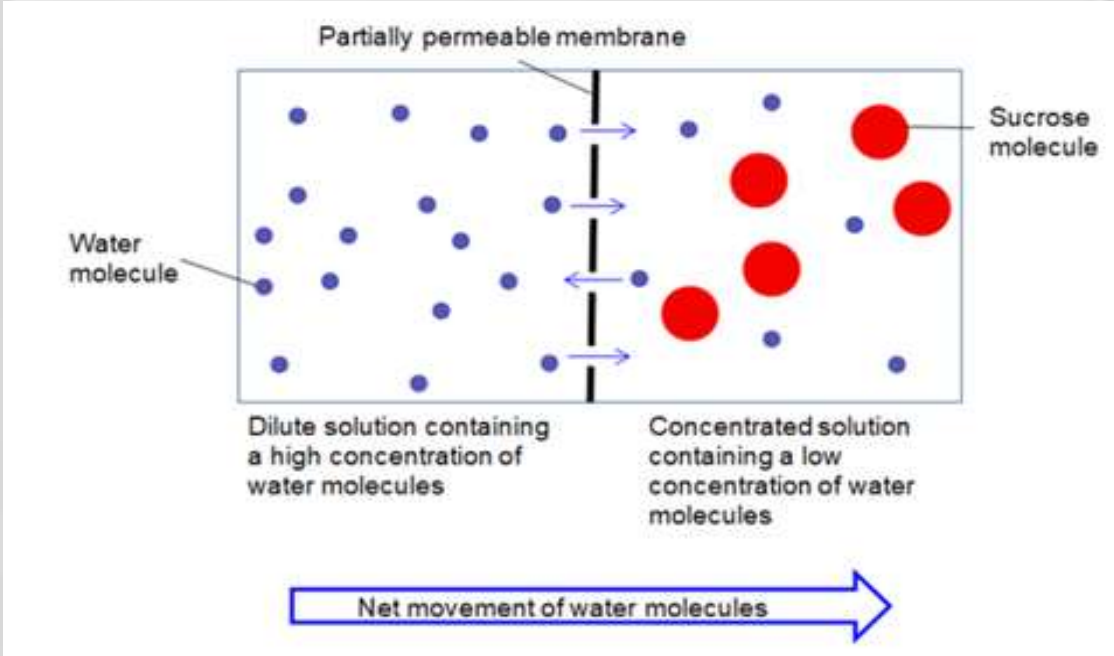
2 - Osmosis - water,

3 - Facilitated diffusion of large molecules**.**

(Carrier-assisted transport)



1-Simple diffusion It is the net movement of molecules or atoms from a region of high concentration with high chemical potential to a region of low concentration with low chemical potential. A gradient is the change in the value of a quantity e.g. concentration, pressure, or temperature with the change in another variable, usually distance.



- **Simple diffusion:**

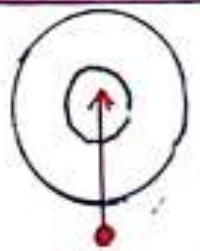
① **Lipid substance**

Lipid soluble molecules

DR α solubility

e.g. O_2, N_2, alcohol

② **protein channels**



1- Lipid insoluble

2- Small MW

3- water soluble

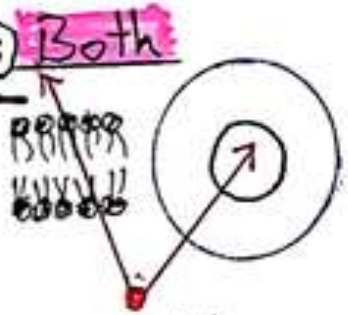
e.g. Ions

- Selective permeability

diameter, shape, charge

- Gating: 1- Non gated
  - 2- Gated
    - leakage gated ← Na^+ channel, K^+ channel
    - Voltage gated
    - Ligand gated
      - ① External ligand – Hormone
      - ② Internal ligand – Ca^{++}, CAMP

③ **Both**



1- Small MW

2- uncharged .. as a bullet

e.g. H_2O

3- water soluble. e.g. CO_2

3 - Carrier-assisted Transport (facilitated diffusion)

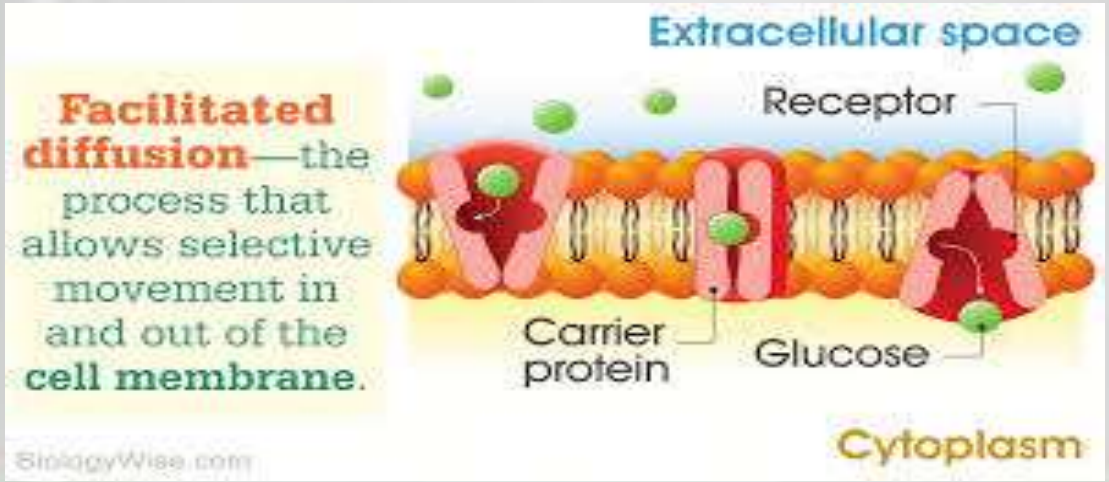
It is the **diffusion** of those **substances that cannot cross the lipid bilayer** due to their **size** and/or **polarity** unless help by **protein carrier**.

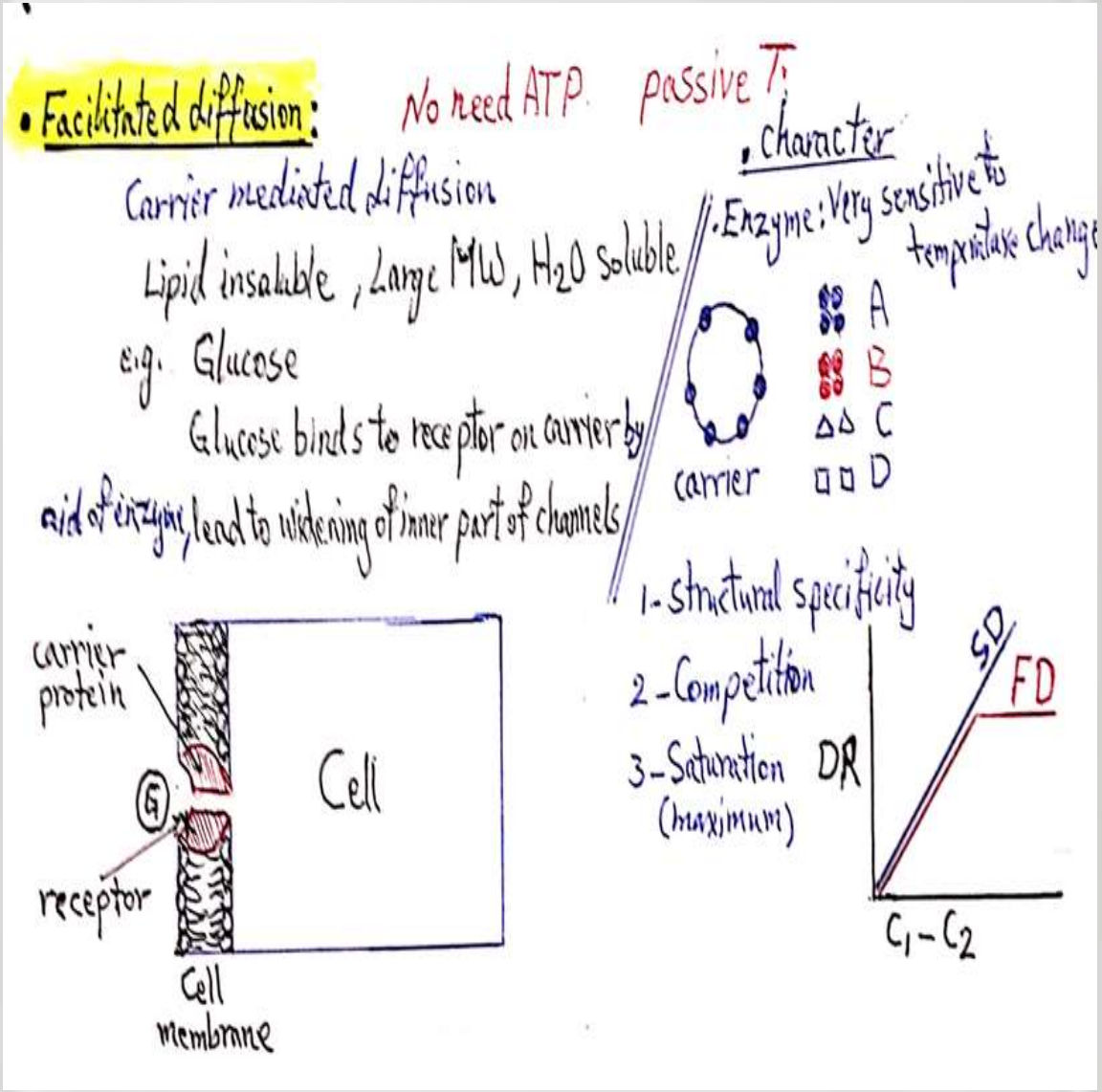
Example: the **movement of glucose** into the cell.

Facilitated diffusion of substances crossing the cell (plasma) membrane takes place with the:

(a) Channel proteins are less selective than carrier proteins, and their cargo based on size and charge.

(b) Carrier proteins are more selective, often only allowing one particular type of molecule to cross.





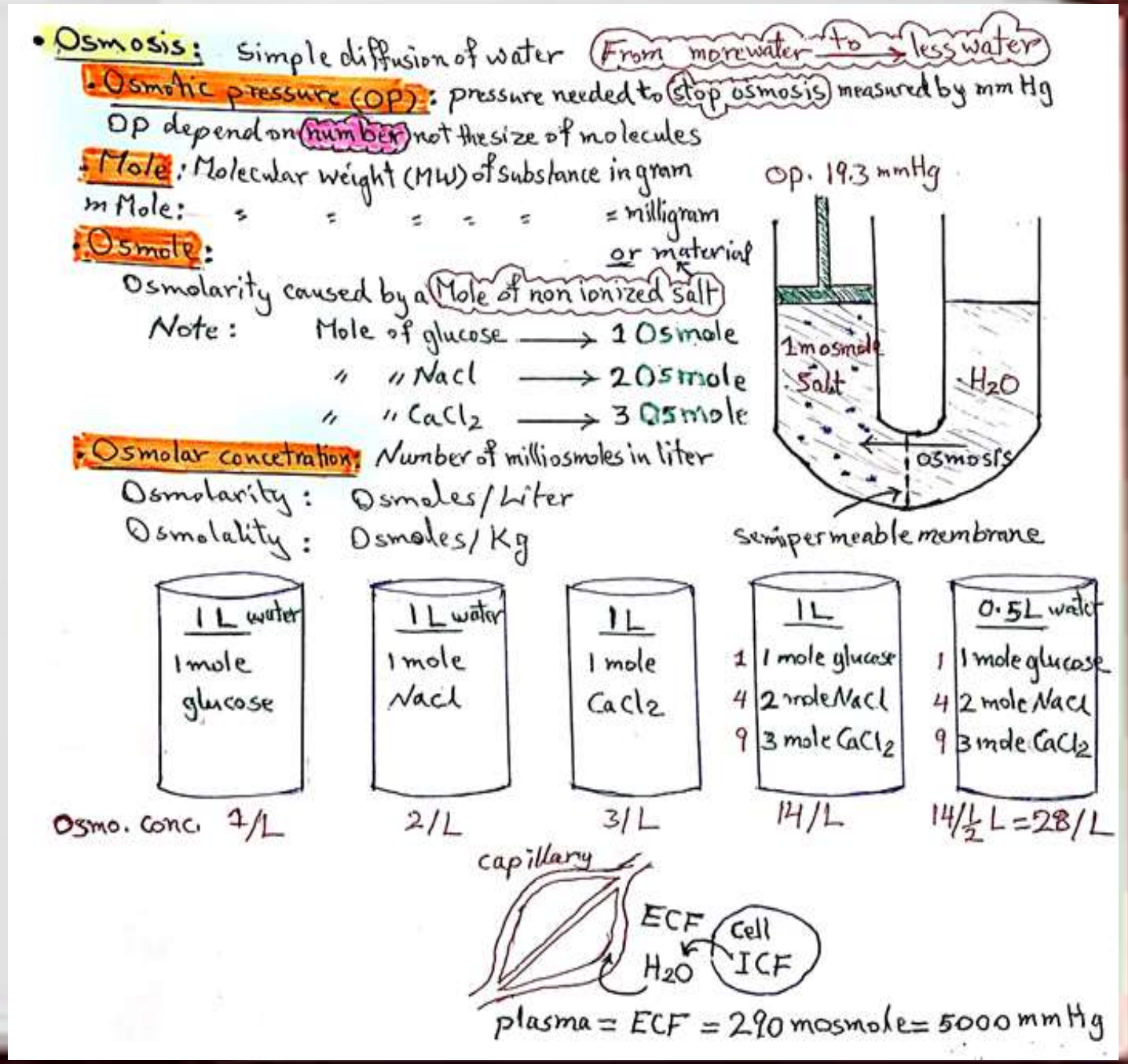
2 - Osmosis – It is the **diffusion of water** across a membrane. (Water will move **in the direction** where there is a **high concentration of solute.)**

In other ward, **water move** from **its high concentration to low concentration**

Osmolarity, is **the number of osmoles of solute per liter solution**

*The term **Osmolarity** refers to the **number of particles** or the **concentration of a particular solute** or **solutes per liter of solvent**. Osmolarity is defined in terms of osmoles.*

Osmolality, which is the osmoles of solute **per kilogram** of solution.



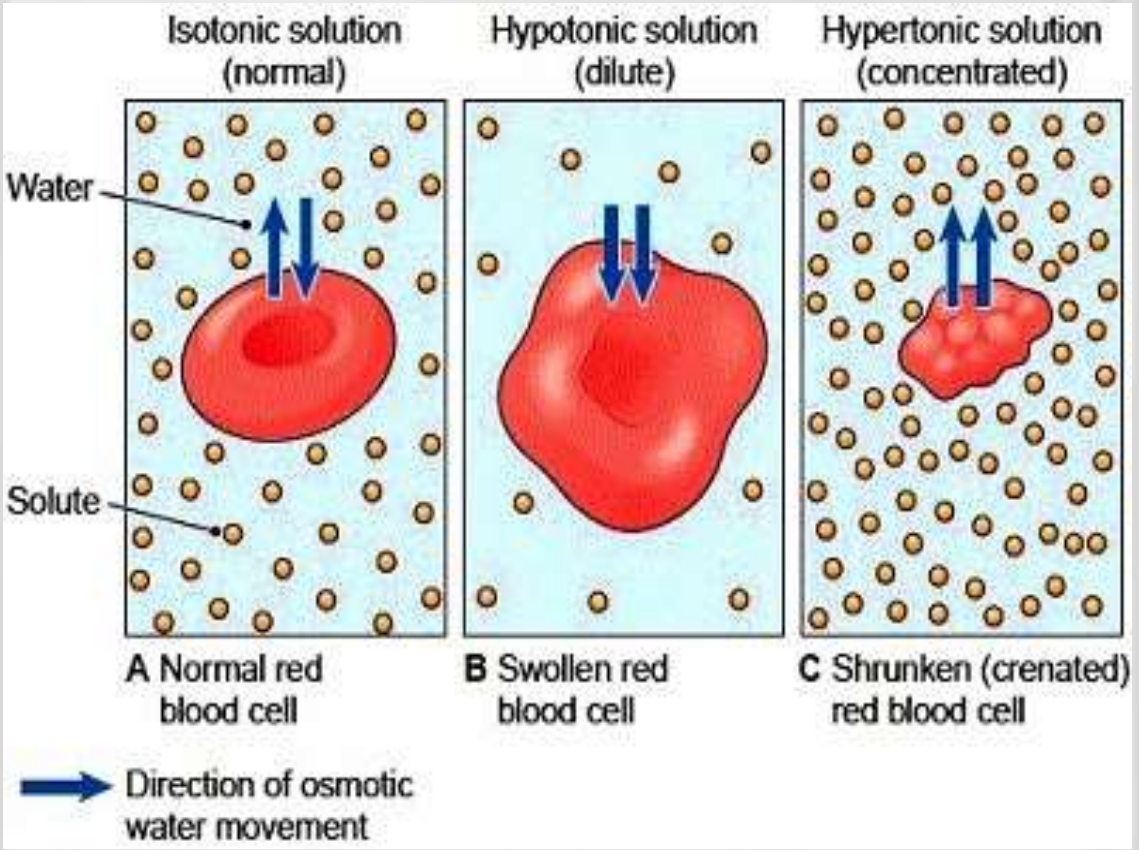
Type of Solutions :

what happen to cell in each.

Isotonic Solutions : the concentration of solute inside and outside of the cell are same, then water will move back and forth.

Hypotonic Solutions: In this case there are less solute (salt) molecules outside the cell, since salt sucks, water will move into the cell.

Hypertonic Solutions: In this case there are more solute (salt) molecules outside the cell, which causes the water to be sucked in that direction(out of the cell).



Three types of osmolarity

hyperosmotic, hypoosmotic, and **isosmotic** —are used to describe relative osmolarities between solutions.

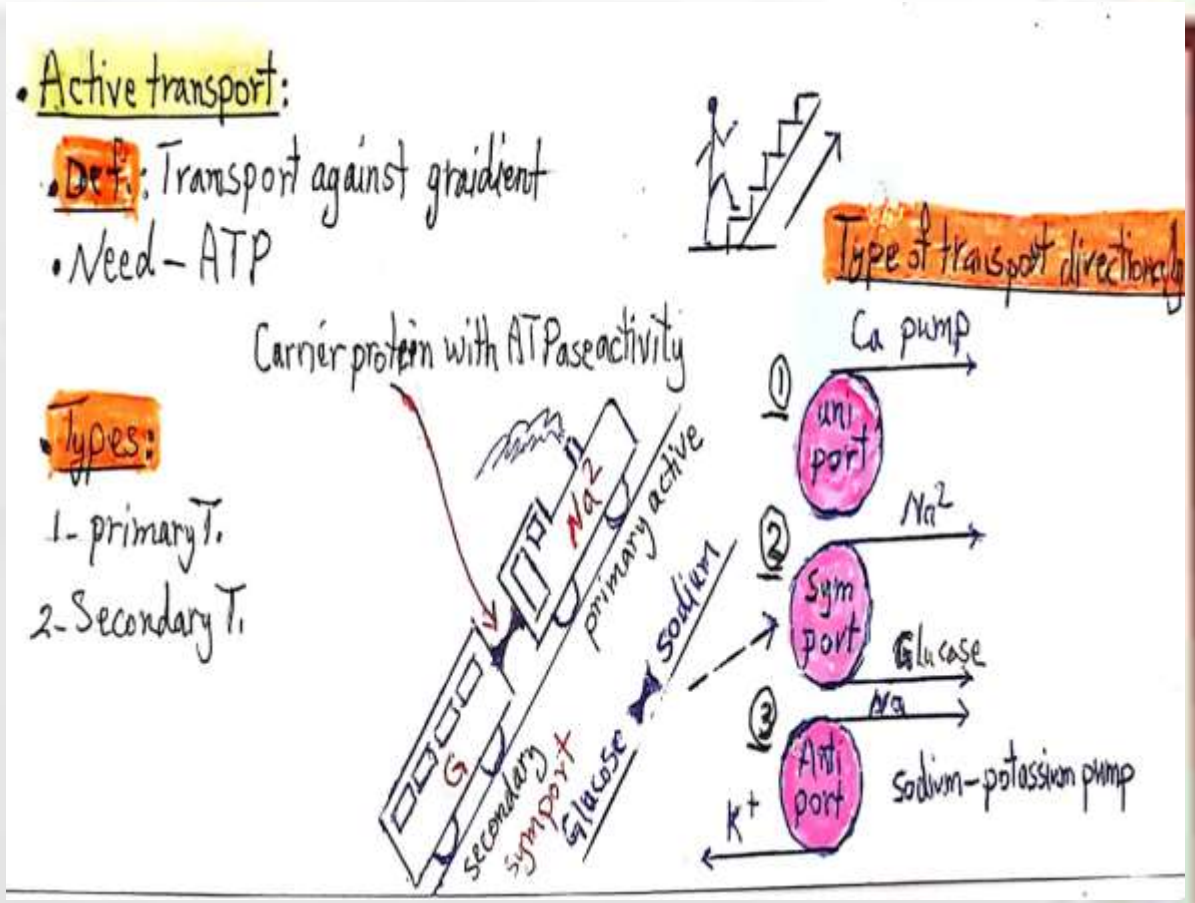
Active Transport It is the **movement** of molecules across a membrane from a **region of their lower concentration** to a region of **their higher concentration** . - requires cellular energy (**ATP**) to achieve this movement

There are two types of active transport:

1 - primary active transport that uses own energy **adenosine triphosphate (ATP)**. **Ex:** Na++ pump

2 - secondary active transport, the transport of a solute in the direction of its increasing electrochemical potential coupled to the facilitated diffusion of a second solute (usually an ion) in the direction of its decreasing electrochemical potential.

Ex:Na++drive glucose or Na++_ K++ pump



Type of primary active transport according to direction

Uniport, the molecules move in in one direction

Types of secondary active transport accord. To direction

Symport, the molecules move in the same direction across the transport membrane.

Antiport, the molecules are travelling in the opposite direction to each other,

An ex: of secondary active transport is the movement of glucose in the proximal convoluted tubule.

Vesicle-mediated transport

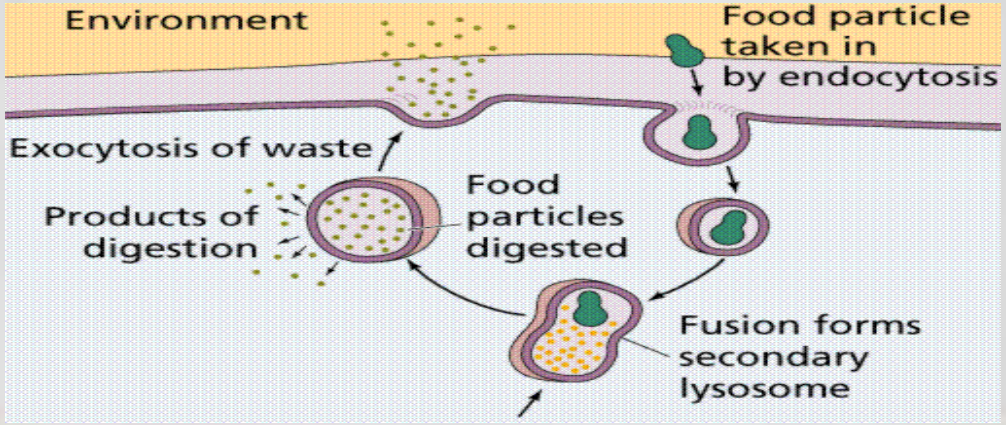
Vesicles and vacuoles that create from cell membrane and separate from the cell membrane to allow them to enter a cell or to release waste chemicals out of the cell.

Which are two types:

A-Exocytosis

It is a **form of active transport** and bulk transport in which a cell transports molecules (e.g., neurotransmitters and proteins) out of the cell by secreting them through an energy-dependent process.

B-Endocytosis : It is the case when a molecule causes the **cell membrane to bulge inward, forming a vesicle.**



Three type of endocytosis :

1- **Phagocytosis,** where an entire cell is engulfed.

means **"cellular eating"**

2- **Pinocytosis** ,It is when the external fluid is engulfed.

means **"cellular drinking"**

3 - Receptor-mediated endocytosis occurs when the material to be transported to **binds certain specific molecules in the membrane**.

Examples : the transport of insulin and cholesterol into animal cells.

All requires energy (ATP) for the uptake of materials