Republic of Iraq

Ministry of Higher Education and Scientific Research

Al-Furat Al-Awsat Technical University

Karbala Technical Institute

Department of Community Health

# General Human Physiology

**Theoretical Lectures**

**Class: 1st Year (First semester)**

**Time: 2 hours**

**Preparation by;**


Assist. Pro.

Dr. Zainab Abdmohsen Al-Habobi

Lecturer.

Dr. Shukrya H. Alwan


**2022 – 2023**

** وصف البرنامج الاكاديمي:-

يوفر برنامج الوصف الاكاديمي هذا ايجازاً مقتضياً لاهم خصائص البرنامج ومخرجات التعليم المتوقعة من الطالب تحقيقها مبرهناً عما اذا كان قد حقق الاستفادة القصوى من الفرص المتاحة. ويصاحبه وصف لكل مقرر ضمن البرنامج.

| | |
|---|---|
| 1. المؤسسة التعليمية | جامعة الفرات الأوسط التقنية |
| 2. القسم العلمي/ المركز | المعهد التقني كربلاء |
| 3. اسم البرنامج الاكاديمي او المهني | وظائف الأعضاء |
| 4. اسم الشهادة النهائية | دبلوم تقني |
| 5. النظام الدراسي: سنوي/مقررات/اخرى | فصلي |
| 6. برنامج الاعتماد المعتمد | القسم العلمي في طور الاعتراف الرسمي من قبل الاعتماد الاكاديمي للتخصصات الطبية لمنظمة الصحة العالمية |
| 7. المؤثرات الخارجية الأخرى | هناك علاقة وثيقة بسوق العمل الذي يستقبل خريجينا |
| 8. تاريخ اعداد الوصف | 2022/12/11 |

**9. اهداف البرنامج الاكاديمي**

1- المعرفة التقنية سيكون الطالب قادرا على أن يتمكن من أجراء بعض الفحوصات والتحليلات الخاصة بوظائف الأعضاء والأجهزة المختلفة للجسم.

2- مؤهلات الخريج /
- معرفة تركيب وظيفة كل عضو في الجسم .
- ب 2 معرفة الفحوصات السريرية وعلاقتها بوظيفته الاعضاء .
- ب 3 معرفة الامراض المعدية وطرق الوقاية .
- ب 4 معرفة الصحة المدرسية والريفية والمهنية

3- التحضير للمهنة /يكون التحضير من خلال العمل على أجراء التحليل التي لها علاقة مع وظائف الجسم .

4- المهارات العامة والتأهيلية المنقولة (المهارات الاخرى المتعلقة بقابلية التوظيف والتطور الشخصي)

1. خريج المعهد الطبي -
2. قدرتة العالية على التعاون وتصحيح الاخطاء -
3. مهارته في اداء العمل المطلوب -
4. قابلية على تطوير اي مهارة يتطلبها العمل الموجود فيه

طرائق التعليم والتعلم

1. المحاضرة واستخدام الوسائل العلمية الحديثة في عرض المحاضرات - (data show).
2. المختبرات .
3. اسئلة مباشرة .
4. نقل واقع المحاضرة من الجانب النظري الى العملي .
5. توزيع الطلبة بشكل مجاميع لمناقشة مواضيع معينة.

طرائق التقييم

1- الإمتحانات اليومية.
2- الامتحانات الفصلية
3- الامتحانات النهائية.
4- المشاريع العملية.
5- التقارير المختبرية .

10. بنية البرنامج

| المرحلة الدراسية | رمز المقرر او المساق | اسم المقرر او المساق | الساعات المعتمدة | |
|---|---|---|---|---|
| | | | نظري | عملي |
| المرحلة الاولى | T.C.H | وظائف الأعضاء | (15) فصل 1 | (15) فصل 1 |
| | | | (15)فصل 2 | (15) فصل 2 |
| | | | | |

11. التخطيط للتطور الشخصي

1- التعليم التطبيقي في المؤسسات الصحية .
2- العمل في المختبرات واجراء التجارب التي لها علاقة بقياس وظائف الجسم .

12. معيار القبول ( وضع الانظمة المتعلقة بالالتحاق بالكلية أو المعهد)

| |
|---|
| 1- المعدل لخريجي الدراسة الإعدادية /الفرع العلمي الاحيائي . |
| **13. أهم مصادر المعلومات عن البرنامج** |
| **1. Lecture Notes. Dr. Zainab A. Alhabobi& Dr. Shukrya H. Alwan, 2022.**<br>**2. Hall, J. E. 1. (2006). Guyton and Hall textbook of medical physiology (11th edition.). Philadelphia, PA: Elsevier.**<br>**3. Bipin Kumar. 2001.Human Physiology. Campus Books International, New Delhi.** |
| **14 . الاهداف الوجدانية والقيمية** |
| 1- مهارات البحث.<br>2- أجراء التجارب الخاصة بوظائف الأعضاءوكفية العمل على الاجهزة الأجهزة .<br>3- مهارات على تحديد الوظائف الحيوية للجسم المتعلقة بوظائف الجسم . |

15. بنية المنهج الفصل الأول

| Week | Topics details |
|---|---|
| 1&2 | Safety precautions from the hazards of the laboratory materials, chemicals and electricity.<br>Cells (Define – types – structure of the cell) , Tissues ( Define types ,structure of the tissue), Muscles( Define , types , structure of the muscles). |
| 3&4 | Blood –Functions – properties composition –blood plasma –blood serum- Erythrocyte(proprieties –shapes-number –functions) production and degradation of blood cells |
| 5 | Leukocyte ( Types –Shapes –number-functions ) |
| 6 | Hemoglobin-functions –normal value- composition<br><br>Platelets( number-functions) Coagulation of blood – anticoagulan |
| 7 | Cardiovascular system –heart- structure of heart – function – cardio valve- cardiac cycle – heart sounds |
| 8 | Blood vessels (arteries –veins-capillary blood vessels ) properties –blood cycle (pulmonary &systemic) |
| 9 | Blood pressure –normal value- factors effecting of blood pressure |
| 10 | Respiratory system –structure –expiration –inspiration – respiratory muscles – respiratory rate |
| 11 | Pulmonary volume – pulmonary ventilation – regulation of gas exchange in blood by respiration |
| 12 | Urinary system – structure – functions |

| | |
|---|---|
| **13** | Functions of kidneys- composition of urine – cast and stone in urine normal |
| **14** | Ear and eye ( structure & functions ) |
| **15** | Skin ( Define , structures and function) |

16. بنية المنهج الفصل الثاني

| Week | Topics details |
|---|---|
| **1** | Digestive system – part of it |
| **2** | Stage of digestion (oral, stomach, intestine) and digestives enzymes. |
| **3** | Intestinal functions and absorption |
| **4** | Digestion system glands (salivary glands , pancreas – liver ) structures and functions |
| **5** | Gallbladder – structure and functions |
| **6** | Stool formation |
| **7&8** | Nervous system –structure – functions<br>Central nervous system –peripheral nervous system |
| **9** | The brain and spinal cord |
| **10 &11** | Different area in brain which responsible for sense, movement, hearing, smell, taste, sight. |
| **12 &13** | Endocrine glands (types & functions ) |
| **14 &15** | Reproductive system (male and female) structure and functions |

# *Physiology:*

## الاسبوع الاول والثاني

**Cells (Define – types – structure of the cell), Tissues (Define types, structure of the tissue), Muscles (Define, types, structure of the muscles).**

-The cell is the fundamental organizational unit of life. All living things are composed of cells, which are then further subdivided based on the presence or absence of the nucleus, into two types: eukaryotic cells these cells are present in all humans, animals, and plants with a clear, distinct nucleus. Prokaryotic cells are some bacteria and blue-green algae which do not contain a clear and distinct nucleus, but the nuclear material is spread within the cytoplasm. The cells with a similar structure and function come together to form tissue.

-Although there are many types of cells in the human body, they are organized into four broad categories of tissues: epithelial, connective, muscle, and nervous. Each of these categories is characterized by specific functions that contribute to the overall health and maintenance of the body. A disruption of the structure is a sign of injury or disease. Such changes can be detected through histology, the microscopic study of tissue appearance, organization, and function

**-The Four Types of Tissues**

- Epithelial tissue also referred to as epithelium, refers to the sheets of cells that cover exterior surfaces of the body, line internal cavities and passageways, and form certain glands. Connective tissue, as its name implies, binds the cells and organs of the body together and functions in the protection, support, and integration of all body parts. Muscle tissue is excitable, responding to stimulation and contracting to provide movement, and occurs in three major types: skeletal (voluntary) muscle, smooth muscle, and cardiac muscle in the heart. Nervous tissue is also excitable, allowing the propagation of electrochemical signals in the form of nerve impulses that communicate between different regions of the body (Figure 1).

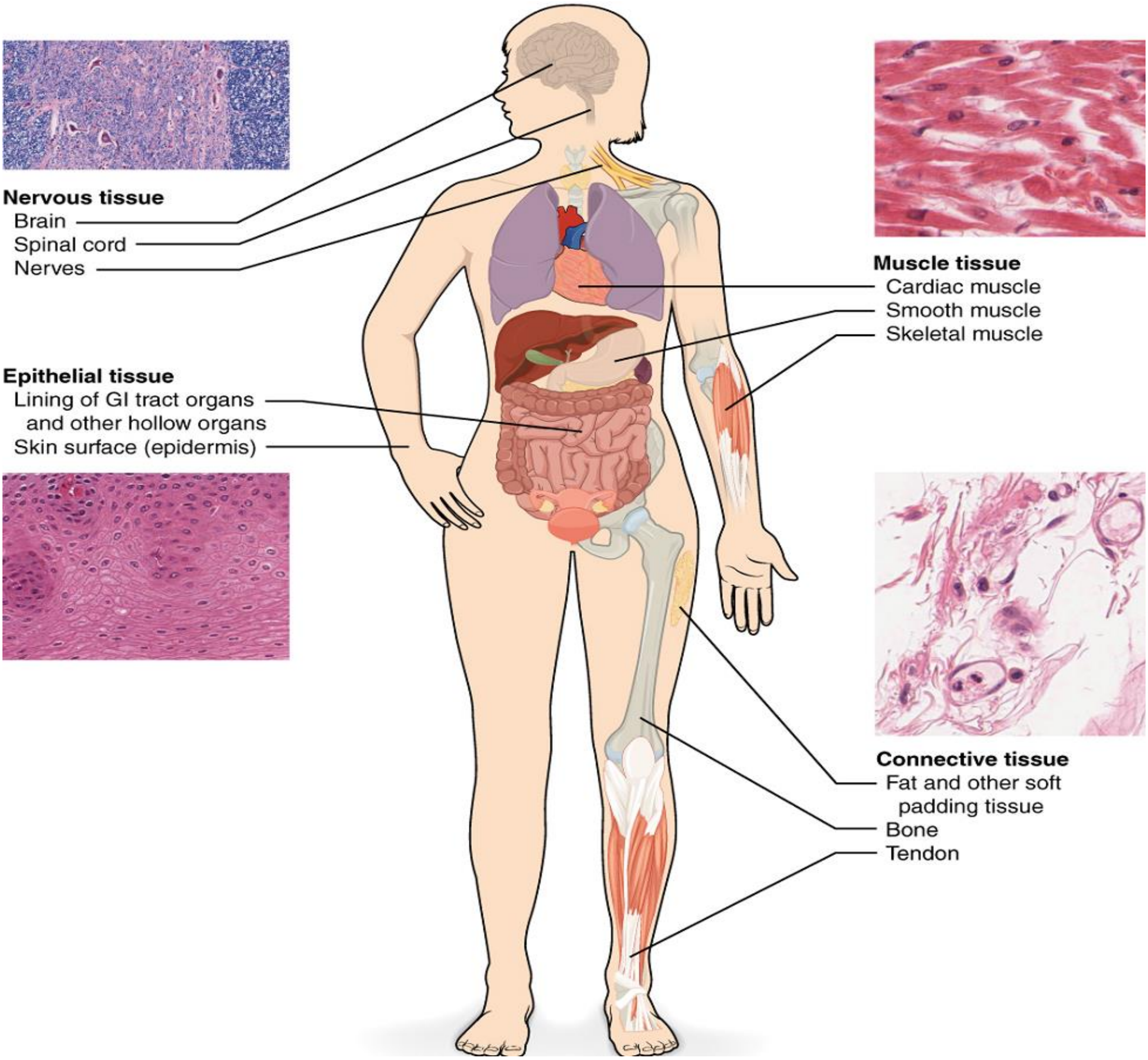


**Figure 1. Four Types of Tissue: Body.** The four types of tissues are exemplified in nervous tissue, stratified squamous epithelial tissue, cardiac muscle tissue, and connective tissue in small intestine.

-The next level of organization is the organ, where several types of tissues come together to form a working unit. Just as knowing the structure and function of cells helps you in your study of tissues, knowledge of tissues will help you understand how organs function. The epithelial and connective tissues are discussed in detail in this chapter. Muscle and nervous tissues will be discussed only briefly in this section.

-More than 600 muscles in your body. Some muscles help you move, lift or sit still. Others help you digest food, breathe or see. Your heart is a muscle that pumps blood through your body. Many injuries and diseases can affect how the muscles work. To keep your muscles strong, maintain a healthy weight, eat right and exercise regularly.

-Muscles play a role in nearly every system and function of the body. Different kinds of muscles help with:

- Breathing, speaking and swallowing.
- Digesting food and getting rid of waste.
- Moving, sitting still and standing up straight.
- Pumping blood through the heart and blood vessels.
- Pushing a baby through the birth canal as muscles in the uterus contract and relax.

All types of muscle tissue look similar. But there are slight differences in their appearance:

- **Skeletal muscles:** Many individual fibers make up skeletal muscles. Actin and myosin are proteins that make up the fibers. The bundles of fibers form a spindle shape (long and straight with tapered ends). A membrane surrounds each spindle. Providers describe skeletal muscles as striated (striped) because of the striped pattern the spindles create together.
- **Cardiac muscles:** These striated muscles look similar to skeletal muscles. Special cells called cardiomyocytes make up the fibers in cardiac muscles. Cardiomyocytes help your heart beat.
- **Smooth muscles:** The proteins actin and myosin also make up smooth muscle fibers. In skeletal muscles, these proteins come together to form a spindle shape. In smooth muscles, these proteins appear in sheets. The sheets give this muscle tissue a smooth appearance.

-All sizes of muscles in your body. The largest muscle is the gluteus maximus (the muscle that makes up your bottom). The smallest muscle is the stapedius, which is deep inside your ear. This tiny muscle helps you hear by controlling the vibration and movement of small bones in your ear.

**Physiology** is the study of normal function within living organism and its component parts, including all its chemical and physical processes. It is a sub-section of biology, covering a range of topics that include organs, anatomy, cells, biological compounds, and how they all interact to make life possible. The term physiology literally means "knowledge of nature." At the level of the organism, physiology is closely tied to anatomy.

## Levels of organization of the body

The body is a very complex organism that consists of many components. The body is organized in this way **(Figure 1.2)**:

- The atom – e.g. hydrogen, carbon
- The molecule – e.g. water, glucose
- The macromolecule (large molecule) – e.g. protein, DNA
- The organelle (found in the cell) – e.g. nucleus, mitochondrion
- The tissues – bone, muscle
- The organs – e.g. heart, kidney
- The organ system – e.g. skeletal, cardiovascular
- The organism – e.g. human, cat.

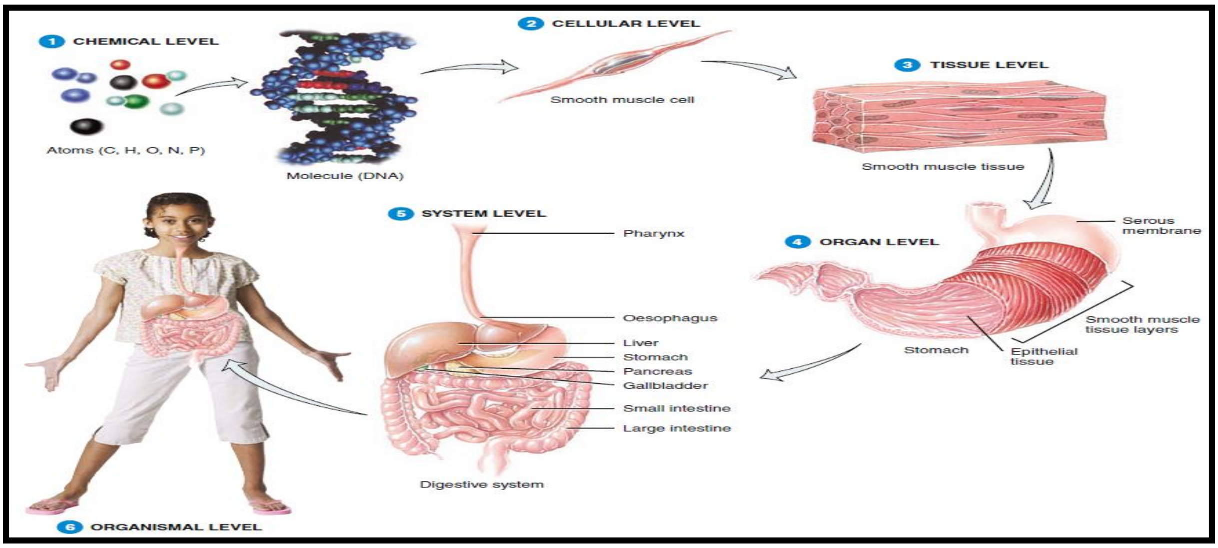


**Figure (1.2): Levels of organization of the body**

## Homeostasis

**Homeostasis** is the body's state to maintain stable internal physical, and chemical conditions maintained by living systems. The body is normally able to achieve a relatively stable internal environment even though the external environment is constantly changing – from cold to hot, or from dry to wet, etc. The body uses various homeostatic mechanisms to maintain a dynamic state of equilibrium within the body.

### The homeostatic mechanisms include

**1.Receptors** - these receptors sense external and internal environmental changes and provide information on the changes to the control center.

**2. Control center** - the controls center determines what a particular value (e.g. pH value or blood pressure) should be and sends out a message to the effectors.

**3. Effectors** - once they have received the information from the control center, the effectors cause responses to take place within the body's internal environment which hopefully will produce the changes that will return the internal environment to return to normal values.

### Homeostasis refers especially to the maintenance of proper conditions for

-Examples of organic, inorganic substances and some conditions that maintain homeostasis in the body: -

a. Oxygen (O2) and Carbon dioxide (CO2) levels (brain and respiratory - adjust breathing rate).

b. Levels of nutrients in blood (e.g. glucose (insulin/glucagon) - blood glucose levels

c. Electrolyte /salt balance and osmotic pressure (fluid levels).

d. Acid-base balance (pH).

e. Temperature.

f. Pressure of body cavities (especially lungs).

**The first week**

**-Subject: The concept of tissue - its objectives - its importance. The concept of the cell, its objectives and function, the concept of muscle, types and function.**

**-Lecture objectives: At the end of the first and second weeks, the student will be able to: the cell, tissue types, muscle types**

**-Several explanatory methods were used (an explanatory film and a PowerPoint presentation of the lecture with the use of drawing on the board).**

**https://www.youtube.com/watch?v=2ZL6j2N89Tc**

**https://www.youtube.com/watch?v=vtMIBHYRYEw**

**https://www.youtube.com/watch?v=z0R4t6jDFzo**

**https://www.youtube.com/watch?v=lsuK8QtVa98**

**-Pre-test Number of types of tissues in the human body, types of Muscles-Answer: Four, three**

**-Self-test & Post-test**

**Q: Define muscle tissue and the numerate of its types.**

# General Human Physiology

الاسبوع الثالث والرابع

## *Circulatory system: Blood Physiology(Hematology)*

**The Circulatory System consists of three components, which include:**

**1. Pumping organ** (heart),

**2. Containers** (blood vessels),

**3. Transport medium** (blood).

## Hematology

It is the study of the blood forming tissues and circulating blood components.

## The Blood

-It is the fluid that circulates in the cardiovascular system, has many kinds of chemicals dissolved in it, and has millions upon millions of cells floating in it.

-An adult has about 5 liters of blood in his body.

-The circulating blood accounts for 5–7% of total body weight.

## Functions of blood

**The functions of the blood are:**

1.Transportation.

2.Maintaining body temperature.

3.Maintaining the acid base balance.

4.Regulation of fluid balance.

5.Removal of waste products.

## Composition of the blood:

**Blood is composed of two major elements (Figure 2.1):**

A. Plasma (Fluid elements).

B. Cellular Elements such as red blood cells (erythrocytes), leucocytes (white blood cells) and platelets.

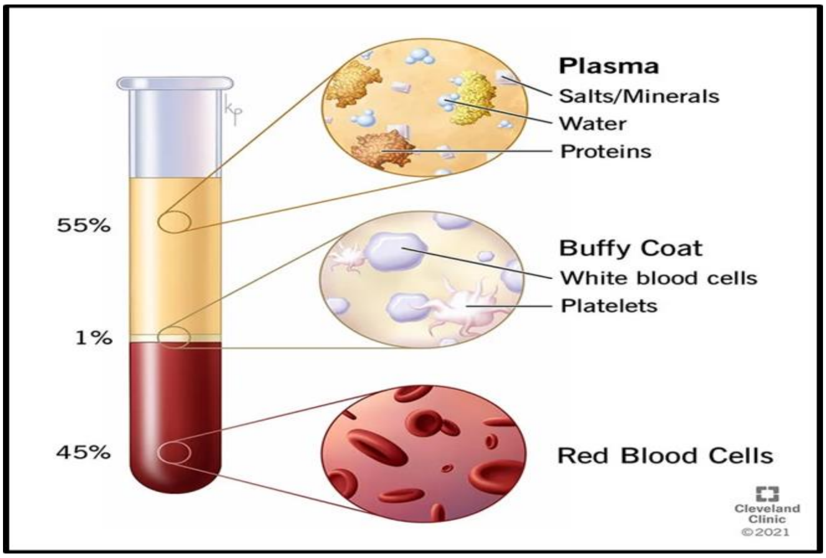


**Figure (2.1): Components of blood**

## A. Blood plasma (Fluid elements)

**Blood plasma** is a pale yellow - colored fluid and its constitutes approximately 55% of blood 's volume **(Figure 2.1)**. Blood plasma is approximately 91% water and 10% solutes, most of which are proteins.

## Plasma composition

**1.Water:** the water forms about 91% of total volume of the blood plasma, which form the intravascular component of the extracellular fluid.

**2. Plasma proteins:** The proteins form about 8% of total volume of blood plasma, such as albumin, globulin, prothrombin and fibrinogen. Plasma proteins form three major groups:

a) Albumin (54%): The most numerous plasma proteins are synthesised in the liver, and its main function is to maintain plasma osmotic pressure. It also acts as a carrier molecule for other substances such as hormones, drugs, lipids, and biologically active substances.
b) Globulins (38%): serve for immune functions and are synthesised in the liver. These proteins are divided into three groups based on their structure and function which include: alpha globulin, beta globulin and gamma globulin.
c) Fibrinogen (7%): is essential for blood clotting and is synthesised in the liver homeostasis.
d) Prothrombin (1%): is serves for blood clotting and hemostasis.

**3.Organic materials:** such as glucose, amino acids, and fat.

**4.Nonorganic materials** such as ions.

**5.others:** hormones, blood gases and others.

### Functions of Plasma

1.Transport of hormones, vitamins, minerals, and drugs. Examples: albumin is a universal transporter, while other plasma proteins are specific for transport of some substances like transferrin (transport of iron), transcobalamine (transport of Vitamin B12), Apolipoprotein B (transport of lipoproteins).

2.Control of capillary permeability.

3.Contribution to acid-base- balance: Plasma proteins contribute to about 15% of the buffer activity of blood.

4.Contribution to regulation of arterial blood pressure, as follows:

* Plasma proteins contribute to blood viscosity.

* Plasma proteins exert oncotic pressure, which tends to pull water into the blood (at capillary level), which maintains the blood volume.

5.Blood coagulation: Most of clotting factors are plasma proteins.

6.Immune functions.

7.Contribution to gas transport: Plasma proteins participate in $CO_2$ transport in blood.

## Blood plasma and serum

The difference between plasma and serum **(Figure 2.2)**: -

| Plasma | Serum |
|---|---|
| 1.Blood obtained when anti-coagulated blood has been centrifuged. | 1.Blood obtained when coagulated blood has been centrifuged. |
| 2.Anti-coagulated are needed for separation. | 2.Anti-coagulated are not needed for separation. |
| 3. Fibrinogen is present in Plasma. | 3. Fibrinogen is absent. |
| 4.Dose not (standing); it could be centrifuged as soon as it has been mixed thoroughly. | 4.Serum takes a longer time to prepare. |

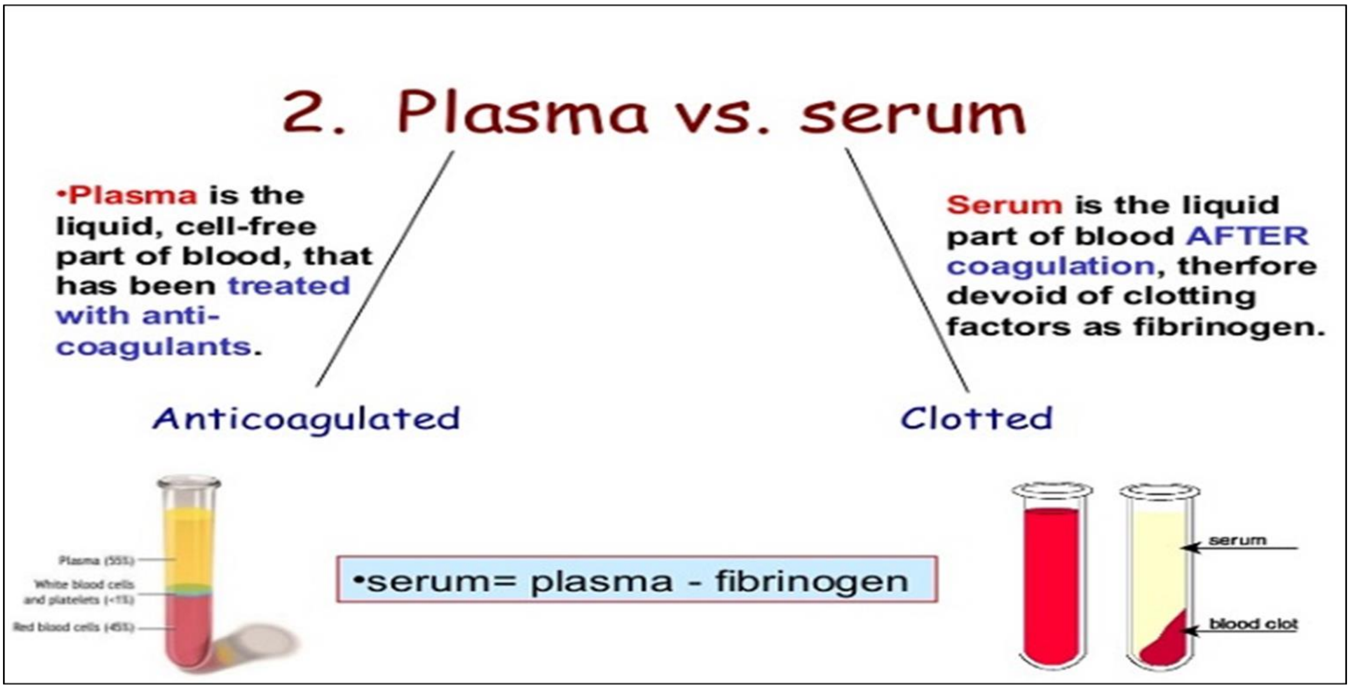


Figure (2.2): Plasma vs. serum

## Third and fourth week

**-Subject: - Blood –Functions – properties composition –blood plasma –blood Serum-Erythrocyte (proprieties –shapes-number –functions) production and degradation of blood cells.**

**-Lecture objectives: At the end of the week, the student will be able to:**

**The function and components of blood, plasma and serum**

**The structure and function of red blood cells**

## Pre -test

**Q: The functions of the blood are:**

1.Transportation. 2.Maintaining body temperature. 3.Maintaining the acid base balance. 4.Regulation of fluid balance. 5.Removal of waste products.

**-Several explanatory methods were used (an explanatory film and a PowerPoint presentation of the lecture with the use of drawing on the board)**

https://www.youtube.com/watch?v=wtEM4ukqlyM

## Post-test

**Q /What is the Plasma composition?**

**1.Water:** the water forms about 91% of total volume of the blood plasma, which form the intravascular component of the extracellular fluid.

**2. Plasma proteins:** The proteins form about 8% of total volume of blood plasma, such as albumin, globulin, prothrombin and fibrinogen. Plasma proteins form three major groups:

a) Albumin، (Fibrinogen (7%): is essential for blood clotting and is synthesised in the liver homeostasis.

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**3.Organic materials:** such as glucose, amino acids, and fat.

**4.Nonorganic materials** such as ions.

**5.others:** hormones, blood gases and others.



## General Human Physiology

## الاسبوع الخامس والسادس

-Leukocyte (Types –Shapes –number-functions)

-Hemoglobin-functions –normal value- composition

-Platelets(number-functions) Coagulation of blood – anticoagulan

## B. Cellular Elements

### 1. Red blood cells (erythrocytes)

-Red blood cells (RBCs) are the most abundant blood cells. The diameter of an RBC is 7.8 µm and a thickness is 2.5 µm at the thickest point and 1 µm in the center. Erythrocytes have a life span of 120 days after they get destructed by hemolysis in the spleen. They are biconcave discs **(Figures (2.3) & (2.4))** and contain oxygen - carrying protein called haemoglobin. Haemoglobin is composed of a protein called globin bound to the iron - containing pigments called haem.

-Young red blood cells contain a nucleus (reticulocyte), however, the nucleus is absent in a mature red blood cell and without any organelles such as mitochondria, thus increasing the oxygen - carrying capacity of the red blood cell. The average volume of the RBC is 90-95 $\mu m^3$. Males have higher numbers of RBCs compared to females. In men, the average number of RBCs per cubic millimeter is 5,200,000 (±300,000); in women, it is 4,700,000 (±300,000).

- An increase in the RBC count is known as **polycythemia**, while a decrease in the RBC count is known as **anemia**.

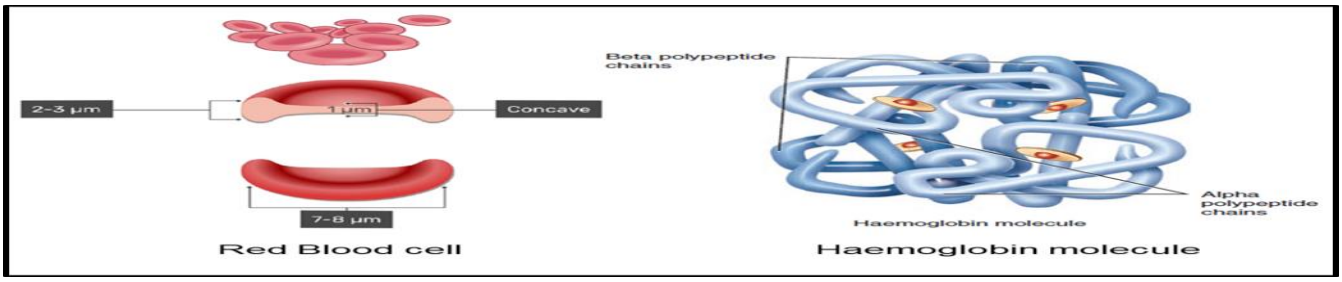



**Figure (2.3): Red Blood cells and Haemoglobin molecule**

## Functions of the RBCs

1.Contain hemoglobin which carries oxygen from the lungs to the tissues.

2. Contain carbonic anhydrase enzyme that catalyzes the reaction between carbon dioxide ($CO_2$) and water to form carbonic acid ($H2CO_3$). This reaction makes it possible for the blood to transport $CO_2$ in the form of bicarbonate ion ($HCO_3^-$) from the tissues to the lungs.

3. The hemoglobin in the RBCs is an excellent acid-base buffer, so the RBCs are responsible for most of the acid-base buffering power of whole blood.

## 2. White blood cells (Leukocyte)

-White blood cells (WBCs) are formed in bone marrow and lymph tissue and transported in the blood to areas of inflammation to fight infectious. There are approximately 5,000–10,000 WBCs in every cubic millimeter of blood. An increase in white blood cells is called **leukocytosis** and an abnormally low level of white blood cells is called **leucopenia**. There are two main types of leukocyte **(Figure 2.4)**:

**A. Granulocytes (contain granules in the cytoplasm):** Depending upon the staining property of granules, the granulocytes are classified into three types:

**I. Neutrophils:** The most abundant WBCs (60–65% of granulocytes) and play an important role in the immune system (fighting bacteria and fungi).

**II. Eosinophils:** These cells form approximately 2–4% of granulocytes and have B-shaped nuclei. They contain lysosomal enzymes and peroxidase in their granules (which fight parasites and modulate allergic responses).

**III. Basophils:** Basophils are least abundant (1% of granulocytes) and contain elongated lobed nuclei. In inflamed tissue they become mast cells and secrete granules containing heparin, histamine. Basophils play an important role in providing immunity against parasites and also in the allergic responses.

**B. Agranulocytes:** Which are type of WBCs and agranulocytes are classified into two types:

**I. Monocytes:** These cells form about 5% of agranulocytes. Monocytes that migrate into tissues (macrophages) engulf pathogens or foreign proteins. Macrophages play a vital role in immunity and inflammation by destroying specific antigens.

**II. Lymphocytes:** These cells form about 25% of the leucocytes and most are found in the lymphatic tissue such as the lymph nodes and the spleen. There are two types of lymphocytes: T and B lymphocytes. Lymphocytes play an important role in immunity.

### 3. Platelets (thrombocytes)

- Platelets are small blood cells consisting of some cytoplasm surrounded by a plasma membrane disk shape **(Figure 2.4)**. Their life span is 5 – 9 days. Platelets play a vital role hemostasis (stopping of bleeding).

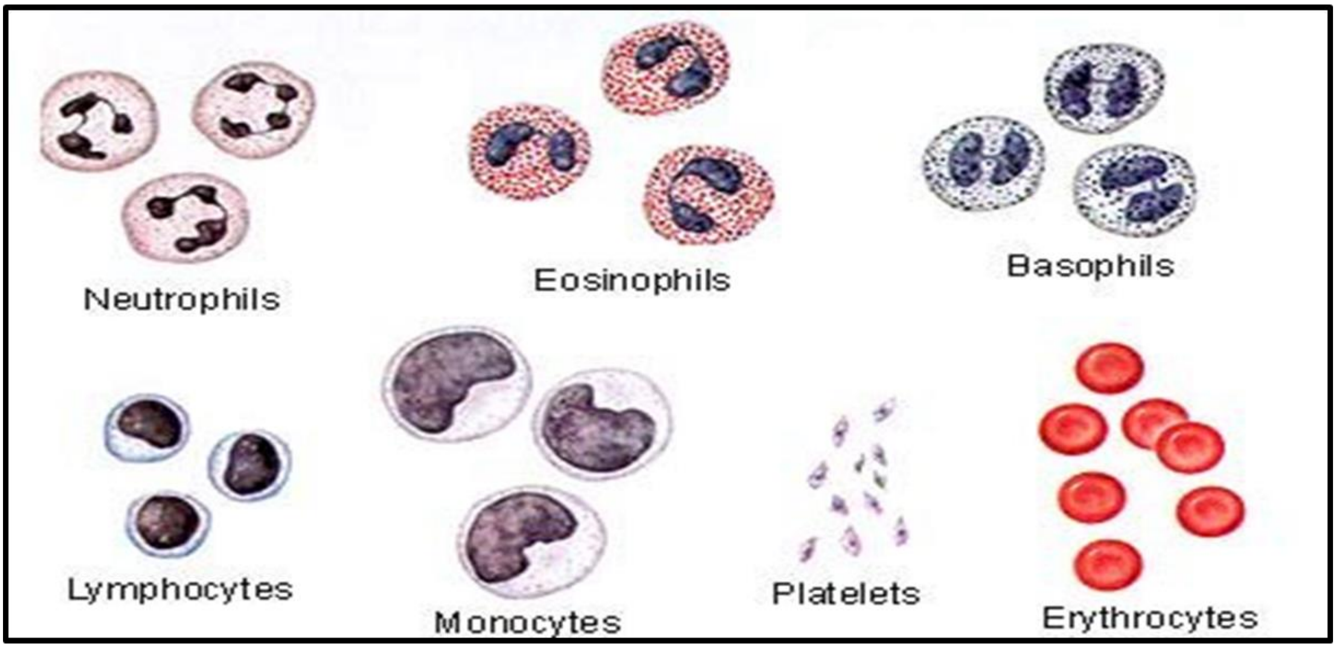



**Figure (2.4): Cellular elements of Blood**

**The anti- infection action of neutrophils and how reach the site of infection (Figure 2.5)**

1. **Margination**: sticking of neutrophils to capillary wall.

2. **Diapedesis:** neutrophils squeeze themselves through the capillaries to the tissue space.

3. **Amoeboid movement**.

4. **Chemotaxis:** Attraction of neutrophils by chemical substances, such as bacterial toxins, leukotriene, components of the immune compliment and breakdown products of the inflamed tissue.

5. **Phagocytosis:** Ingestion of bacteria by the neutrophil. It occurs as follows:

After being phagocytized, the bacteria can be killed either by lysosomal proteolytic enzymes of the neutrophils, or by bactericidal agents formed inside the neutrophils like free radicals and hypochlorite. After phagocyting bacteria, the neutrophil will be inactivated and die.

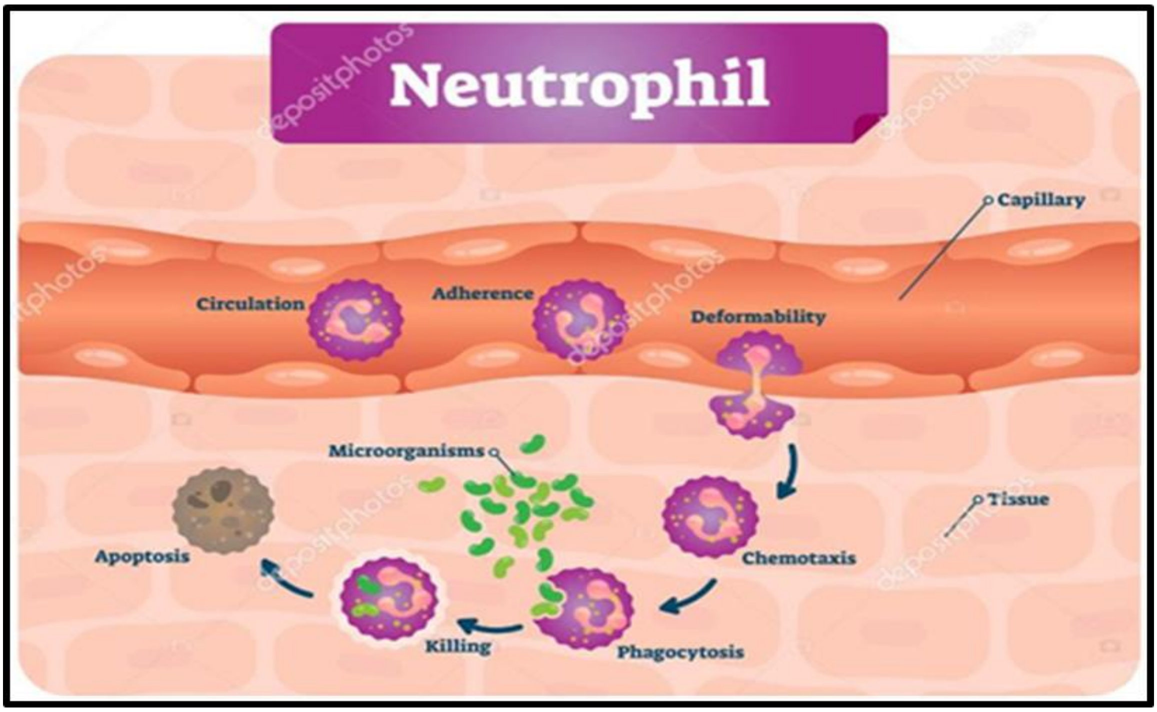



**Figure (2.5): Neutrophils defense agonist microorganism's infection**

## Blood cells formation (Hematopoiesis)

**Hematopoiesis** is the production of the formed elements of blood. The tissues that produce blood are called **hemopoietic tissues**.

- **Hematopoiesis occurs in different organs, depending on the stage of development:**

- In **developing embryo**, it occurs in the **yolk sac**.
- After the development progress it occurs in **liver, spleen and lymph nodes**.
- After birth and maturation of bone marrow, it occurs in the bone marrow of long bones (humerus, femur, tibia, and fibula for example), while in adults it occurs in bone marrow of flat and short bones (pelvis, sternum, vertebrates, and cranium for example. -After the hematopoiesis stops occurring in bone marrow of long bone, the hematopoietic tissue is replaced by fat tissue and is then called yellow bone marrow instead of red bone marrow.

-All Blood cells originate from a single type of type of unspecialized cell called pluripotent hematopoietic stem cells in bone marrow **(Figure 2.6)**.

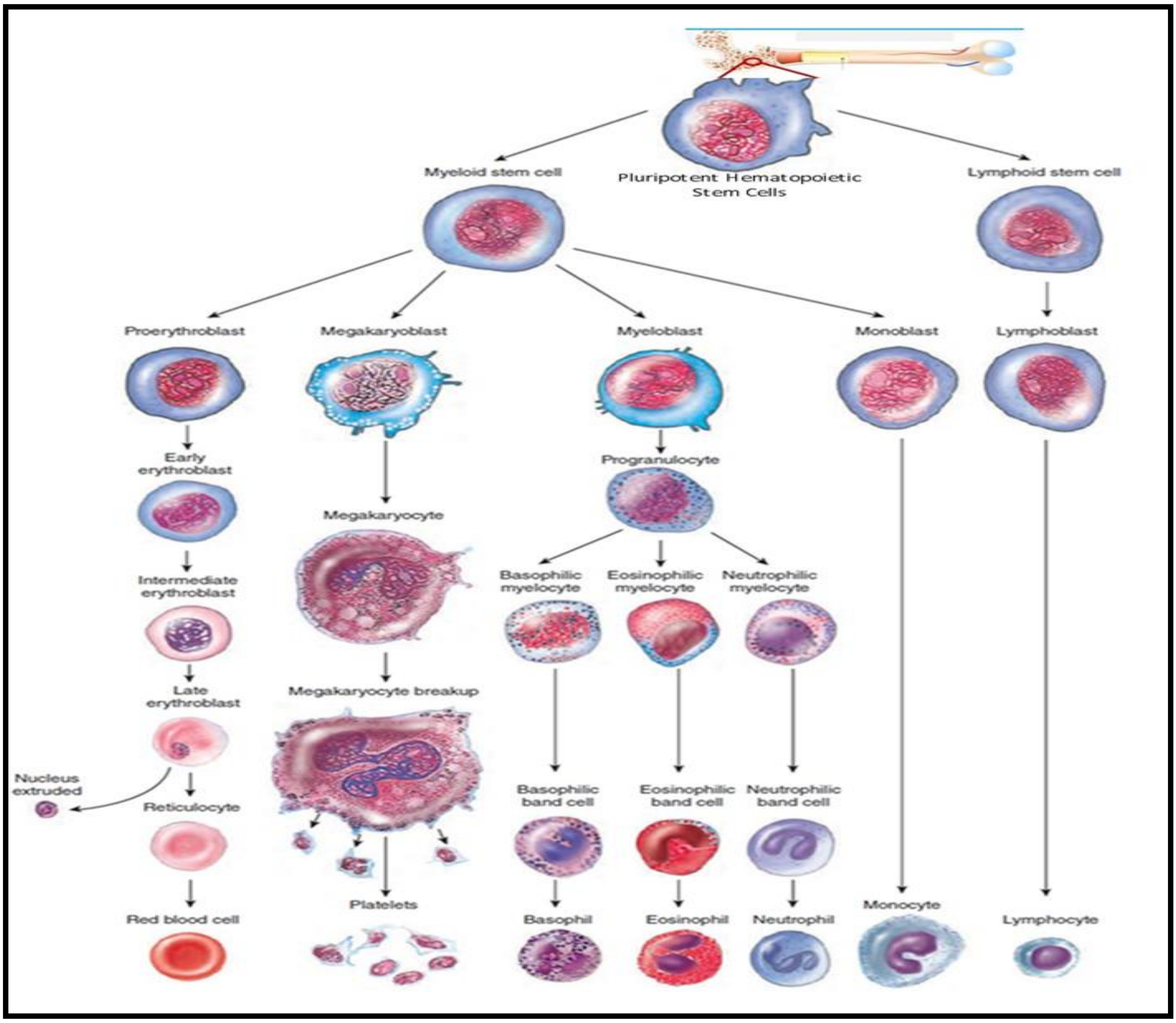



**Figure (2.6): Blood cells formation (Hematopoiesis)**

## Hemostasis and blood coagulation

**Hemostasis** means prevention of blood loss. It involves the following steps **(Figure 2.7)**:

1.Vascular constriction.

2. Formation of a platelet plug.

3. Formation of a blood clot.

4. Growth of fibrous tissue into the blood clot.

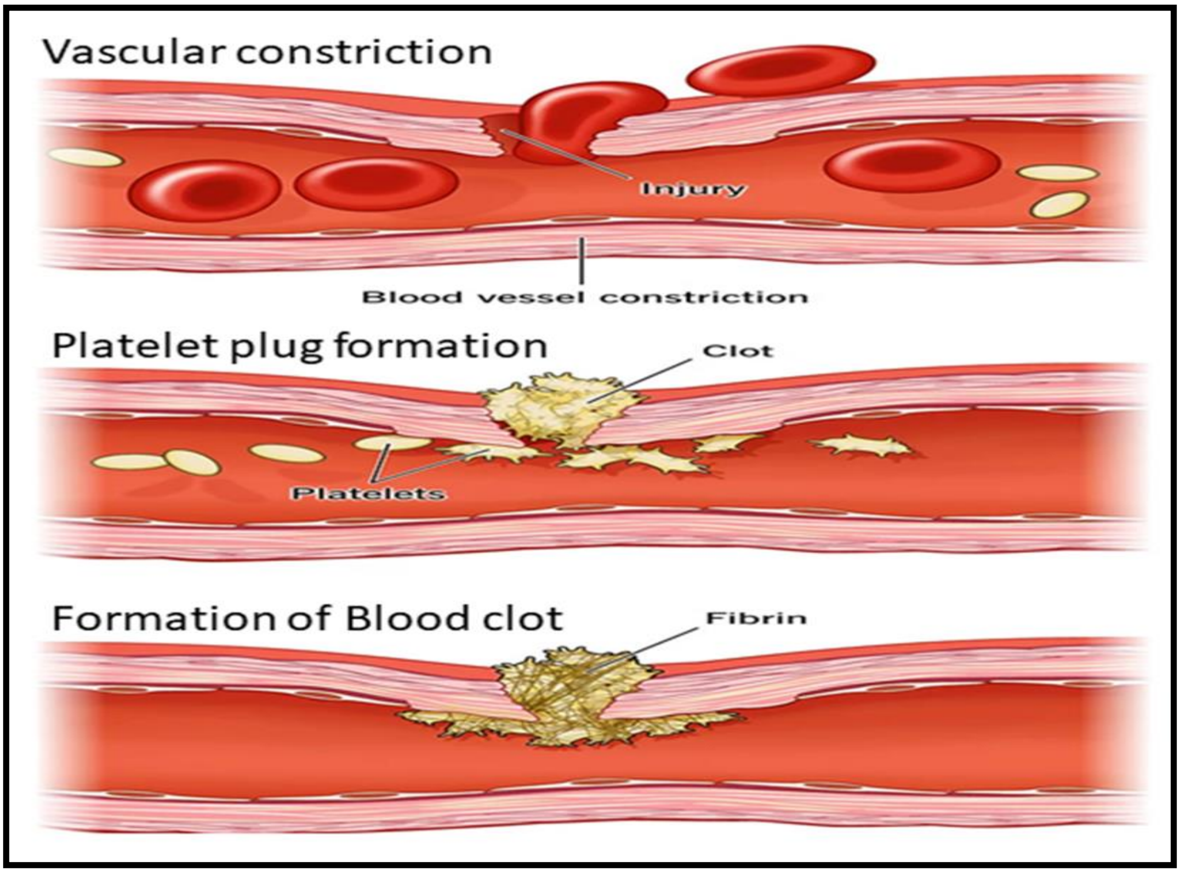



Figure (2.7): Hemostasis

## 1.Vascular constriction

- Immediately after a blood vessel injury, the smooth muscles of the vessel wall will contract to reduce the flow of blood from the injured vessel.

**-The causes of vascular muscle contraction include (Figure 2.8):**

1. Local myogenic spasm: a reflex initiated by direct damage to the vascular wall.

2. Local vasoconstrictor factors: these are released from the surrounding injured tissues, vascular endothelium, and blood platelets and include serotonin and thromboxane A2.

3. Nervous reflexes: These are reflexes induced by pain from the injury causing blood vessels to constrict.

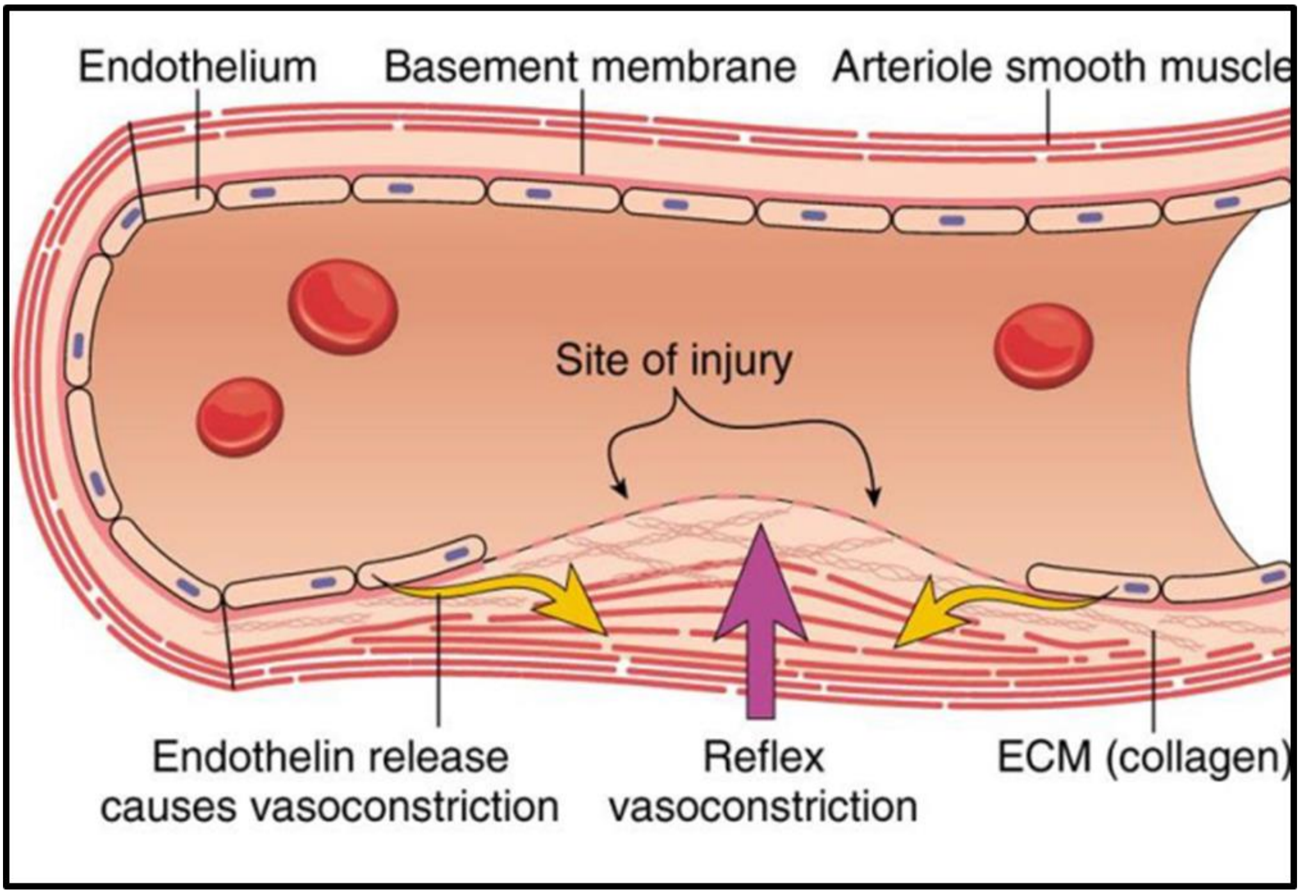



**Figure (2.8): Vascular constriction**

## 2. Formation of a platelet plug

-Platelet plug formation involves following steps **(Figure 2.9)**:

**a. Platelet adhesion:** Following injury, the platelets become sticky and adhere to the sub-endothelial collagen of damaged vessel wall through a protein, which leaks from the plasma into the traumatized tissue.

**b. Platelets activation:** The activated platelets secrete adenosine diphosphate (ADP) and thromboxane A2, which act on the nearby platelets to activate them. These additional platelets will adhere to originally activated platelets. In this way, positive feedback cycle is initiated leading to activation and adherence of large number of platelets.

**c. Platelets aggregation:** The activated platelets stick to each other forming platelets aggregation. Aggregation of platelets is increased by platelet activating factor (PAF), which is secreted by neutrophils, monocytes and platelet. The platelets adherence and aggregation finally leads to the formation of platelet plug. At first, this plug is weak but is enough for stopping blood loss if the vascular injury is small.

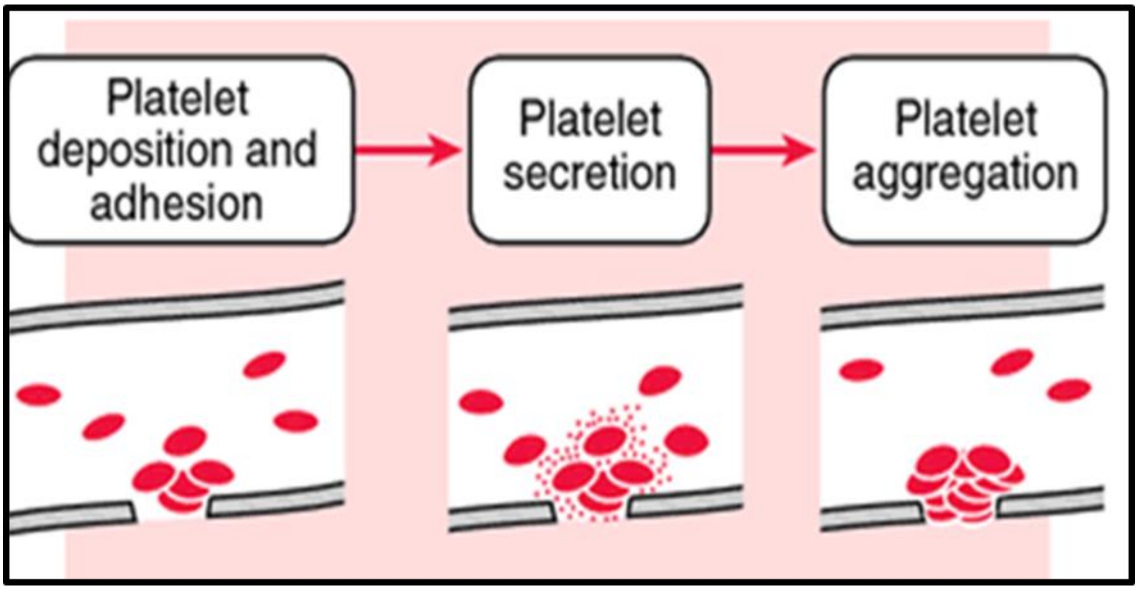



**Figure (2.8): Formation of a platelet plug**

### 3. Formation of a blood clot

-The temporary platelet plug is converted into the definitive hemostatic plug by the process of clot formation (blood coagulation).

**Blood coagulation** mean blood remains in fluid condition within the blood vessels. It loses its fluidity when it is shed from the vessels or collected in a tube, where it is converted into a clot.

**Clot formation is caused by the following:**

1. Trauma to the vessel wall or to tissues adjacent to the vessel.
2. Contact of blood with damaged endothelial cells, sub-endothelial tissue, or collagen.

### The coagulation cascade:

The process of coagulation involves a cascade of reactions in which activation of one factor leads to activation of next clotting factor. It can be divided into three main steps **(figure 2.9)**:

***A. Formation of prothrombin activator***

-Clotting starts with the formation of a substance called prothrombin activator which converts prothrombin into thrombin. There are two pathways for the formation of prothrombin activator, which are:

### 1. Extrinsic pathway (from the outside of the blood)

-In this pathway, the formation of prothrombin activator is initiated by the tissue thromboplastin (factor III), which is released from the injured tissues. This pathway begins with trauma to the vascular wall or to the tissues outside the vessel. It includes following three basic steps:

**Step (1): - Release of tissue thromboplastins:** The traumatized tissues release tissue thromboplastin (factor III). Since this factor is found outside the vessel.

**Step (2): - Activation of VII:** Tissue thromboplastin will activate factor VII to (VIIa). VIIa activates factor X to Xa.

**Step (3): - Activation of X and the formation of prothrombin activator:** Xa together with calcium, platelet phospholipid and activated factor 5 form a complex called *prothrombin activator*. This prothrombin activator will activate prothrombin to thrombin.

### 2. Intrinsic pathway (from the inside of the blood)

- In this pathway, the formation of prothrombin activator is initiated by platelets, which are within the blood itself. It is activated after exposure of blood to collagen in a traumatized vascular wall. It includes following three basic steps:

**Step (1): - Activation of factor XII:** After a trauma, the endothelium is damaged and the collagen beneath the endothelium is exposed. Factor XII comes in contact with collagen and is converted into activated factor XII (XIIa). The XIIa will initiate the intrinsic pathway. Platelets are also activated.

**Step (2): - Activation of factor XI:** The activated factor XII will activate factor XI.

**Step (3): - Activation of factor IX:** The activated factor IX will activate factor IX.

**Step (4): - Activation of factor VIII:** The activated factor XI will activate factor VIII.

**Step (4): - Activation of factor X:** The activated factor VIII in the presence of Ca2+ will activate factor X to form Xa.

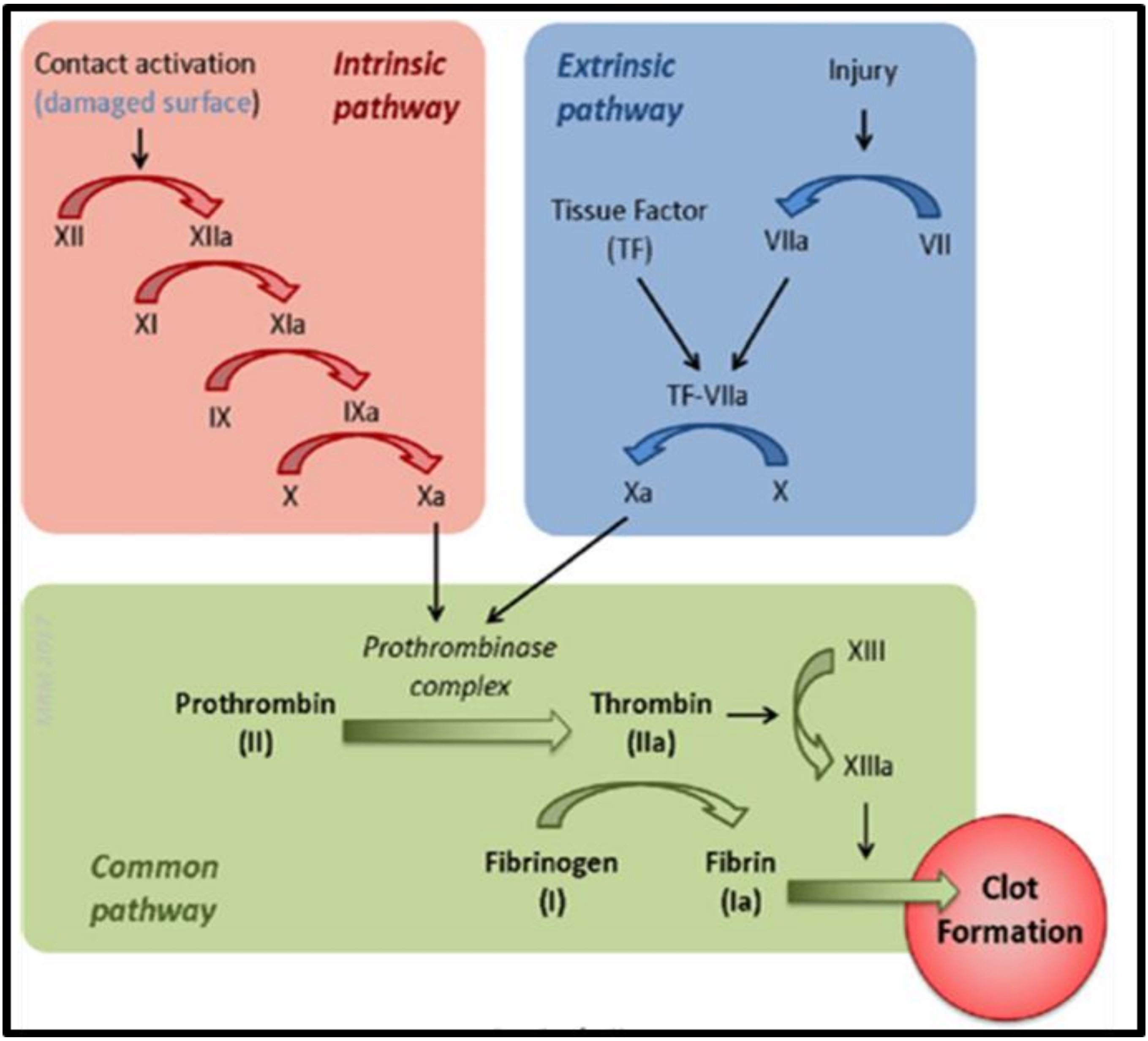



**Figure (2.9): Clot formation**

### *B. Conversion of prothrombin to thrombin*

-Conversion of prothrombin to thrombin is caused by the prothrombin activator in the presence of Ca2+. This occurs at the surface of platelets which form the platelet plug at the site of injury. It accelerates the rate of formation of prothrombin activator by the activating factors V, VIII, and XIII. In this way, thrombin itself can cause further conversion of prothrombin into thrombin (amplification effect).

### *C. Conversion of fibrinogen to fibrin*

**1. Proteolysis:** Thrombin hydrolyzes fibrinogen into fibrin monomer.

**2. Polymerization:** Fibrin monomer polymerize into weak fibrin threads.

**3. Stabilization of fibrin polymers:** Fibrin stabilizing factor (factor XIII) in the presence of Ca2+ causes cross-linkages between fibrin threads, thus strengthening the clot.

## ABO Blood types

### ABO blood groups (RBCs antigens = agglutinogens)

-The blood group is determined by the presence or absence of antigen (agglutinogens) on the surface of the RBCs. These agglutinogens cause blood transfusion reactions. There are 2 types of agglutinogens: A and B **(Figure 2.10)**.

- When neither A nor B is present, the blood group is **type O**.
- When only A is present, the blood group is **type A**.
- When only B is present, the blood group is **type B**.
- When both are present, the blood group is ***type AB***.

### The RBCs plasma antibodies (agglutinogens)

-Each blood group has an antibody in its plasma. The antibody is named after the

missing surface antigen **(Figure 2.10)**.

- When type A is missing, plasma antibodies are called anti-A.
- When type B missing, plasma antibodies are called anti-B.
- When both type A and B are missing, plasma antibodies are called anti-A &anti-B.
- When both type A and B are present, the plasma will have no antibodies.

| | Group A | Group B | Group AB | Group O |
|---|---|---|---|---|
| Red blood cell type | A | B | AB | O |
| Antibodies in plasma | Anti-B | Anti-A | None | Anti-A and Anti-B |
| Antigens in red blood cell | A antigen | B antigen | A and B antigens | None |

Figure (2.10): The Blood groups

## Rh blood types (the Rh factor)

-Rh factor is an antigen present on RBC surface **(Figure 2.11)**. It was first discovered in Rhesus monkey and hence the name ‘Rh factor’. There are many Rh antigens but only the D antigen is more antigenic in human. The persons having D antigen are called ***‘Rh positive’*** and those without D antigen are called ***‘Rh negative’***.

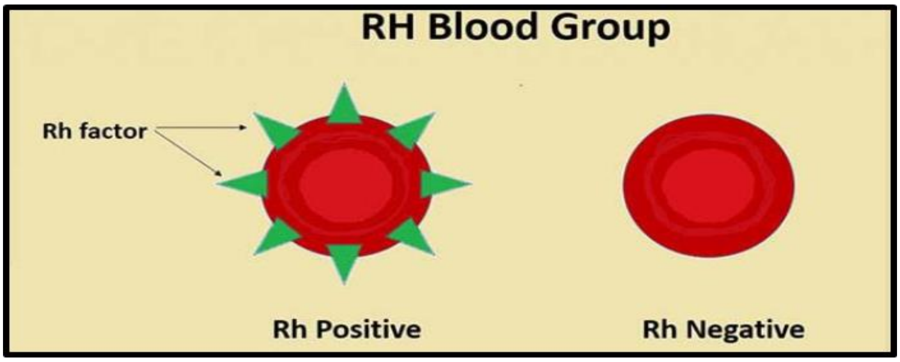



Figure (2.11): Rh Blood groups

الاسبوع الخامس و السادس

-Leukocyte (Types –Shapes –number-functions )

**-**Hemoglobin-functions –normal value- composition

-Platelets(number-functions) Coagulation of blood – anticoagulan

**Objectives of the topic:** To familiarize the student with the most important cellular components of blood, and to know their forms and functions. At the end of the sixth week, the student will have knowledge of how cells work and the mechanics of blood clotting.

**Pre-test**

Q: What are the cellular components of blood

-Answer: red blood cells, white blood cells, platelets

**Post- test**

**Q: Give the role of Extrinsic pathway (from the outside of the blood)**

**-**(Answer)-In this pathway, the formation of prothrombin activator is initiated by the tissue thromboplastin (factor III), which is released from the injured tissues. This pathway begins with trauma to the vascular wall or to the tissues outside the vessel. It includes following three basic steps:

**Step (1): - Release of tissue thromboplastins:** The traumatized tissues release tissue thromboplastin (factor III). Since this factor is found outside the vessel.

**Step (2): - Activation of VII:** Tissue thromboplastin will activate factor VII to (VIIa). VIIa activates factor X to Xa.

**Step (3): - Activation of X and the formation of prothrombin activator:** Xa together with calcium, platelet phospholipid and activated factor 5 form a complex called *prothrombin activator*. This prothrombin activator will activate prothrombin to thrombin.

https://www.youtube.com/watch?v=Lo30GnQsIxs

https://www.youtube.com/watch?v=bJwOTopWM7E

https://www.youtube.com/watch?v=0kwHBSeBilQ

# General Human Physiology

## الاسبوع السابع

-Cardiovascular system –heart- structure of heart – function – cardio valve- cardiac cycle – heart sounds

# *Cardiovascular system (CVS) Physiology*

---

## Functions of cardiovascular system (CVS)

1. Carry nutrients and O2 to cells and take wastes and CO2 from them to kidney and lung for excretion.

2. Regulate body temperature.

3. Carry hormones to target tissues

4. Carry antibodies, platelets and leucocytes to aid body defense mechanism.

## The cardiovascular system is composed of the following (Figure 3.1)

**A. Heart:** muscular organ pumps the blood.

**B. Blood vessels:** which is classification in to five types:

**1. Arteries**: carry blood (rich in oxygen) away from heart to the arterioles.

**2. Arterioles**: carry blood from arteries to capillaries.

**3. Capillaries**: the site of exchange between cells and blood.

**4. Venules**: receive blood from capillaries and deliver it to veins.

**5. Veins**: carry blood (non-oxygenated blood) from venules toward the heart.

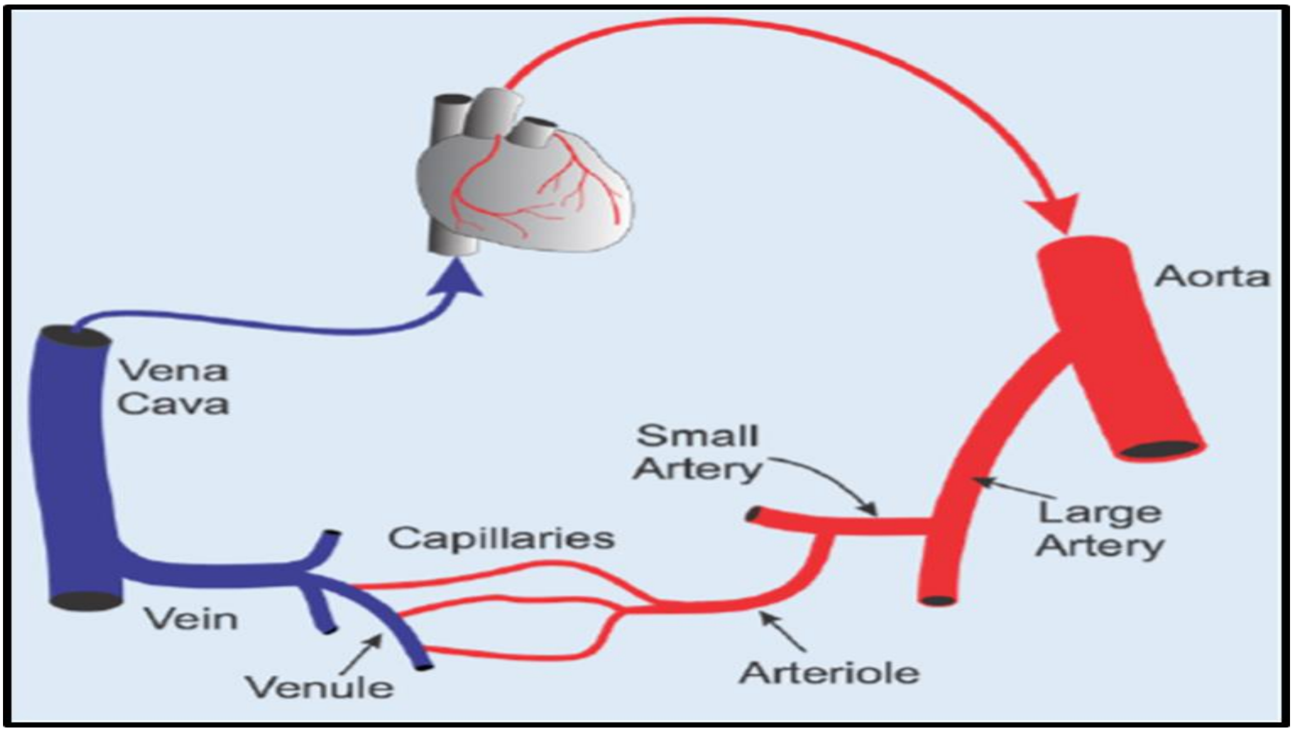



**Figure (3.1): Heart and blood vessels**

## Anatomy and Physiology of the Heart

**Heart** is a funnel -shaped, hollow and muscular organ containing four chambers **(Figure 3.2)**. Its main function is to pump blood around the circulatory system of the lungs and the systemic circulation.

- It is made of 2 pumps (right and left) each pump is made of an atrium (that receives blood) and a ventricle (that pumps blood).

- ***Right atrium:*** receives blood from the body (except lungs) and pumps it to right ventricle.
- ***Right ventricle:*** receives blood from right atrium and pumps it to lungs (pulmonary circulation)
- ***Left atrium:*** receives blood from lungs and pumps it to left ventricle.
- ***Left ventricle:*** receives blood from left atrium and pumps it to body (systemic

circulation)

## The heart wall composed of three layers:

**I. Epicardium:** Outer layer made of mesothelial cells.

**II. Myocardium (thick muscle layer):** middle layer made of cardiac muscle cells.

**III. Endocardium:** Inner layer made of endothelial cells.

## Cardiac muscle cells (Cardiomyocytes):

-The cardiac muscle is an involuntary, striated muscle with fiber. Connected together by intercalated discs so they work as a single unit.

## Valves of the heart

**-The heart has four valves (Figure 3.2):**

A. Two valves located between atria and ventricles (called ***atrio-ventricular valves*** *"AV valves"*): -

i. **Mitral valve:** between left atrium and left ventricle.

ii. **Tricuspid valve**: between right atrium and right ventricle.

B. Two values located between the ventricles and arteries (called ***semilunar valves***): -

i. **Aortic valve**: between left ventricle and aorta.

ii. **Pulmonary valve**: between right ventricle and pulmonary artery.

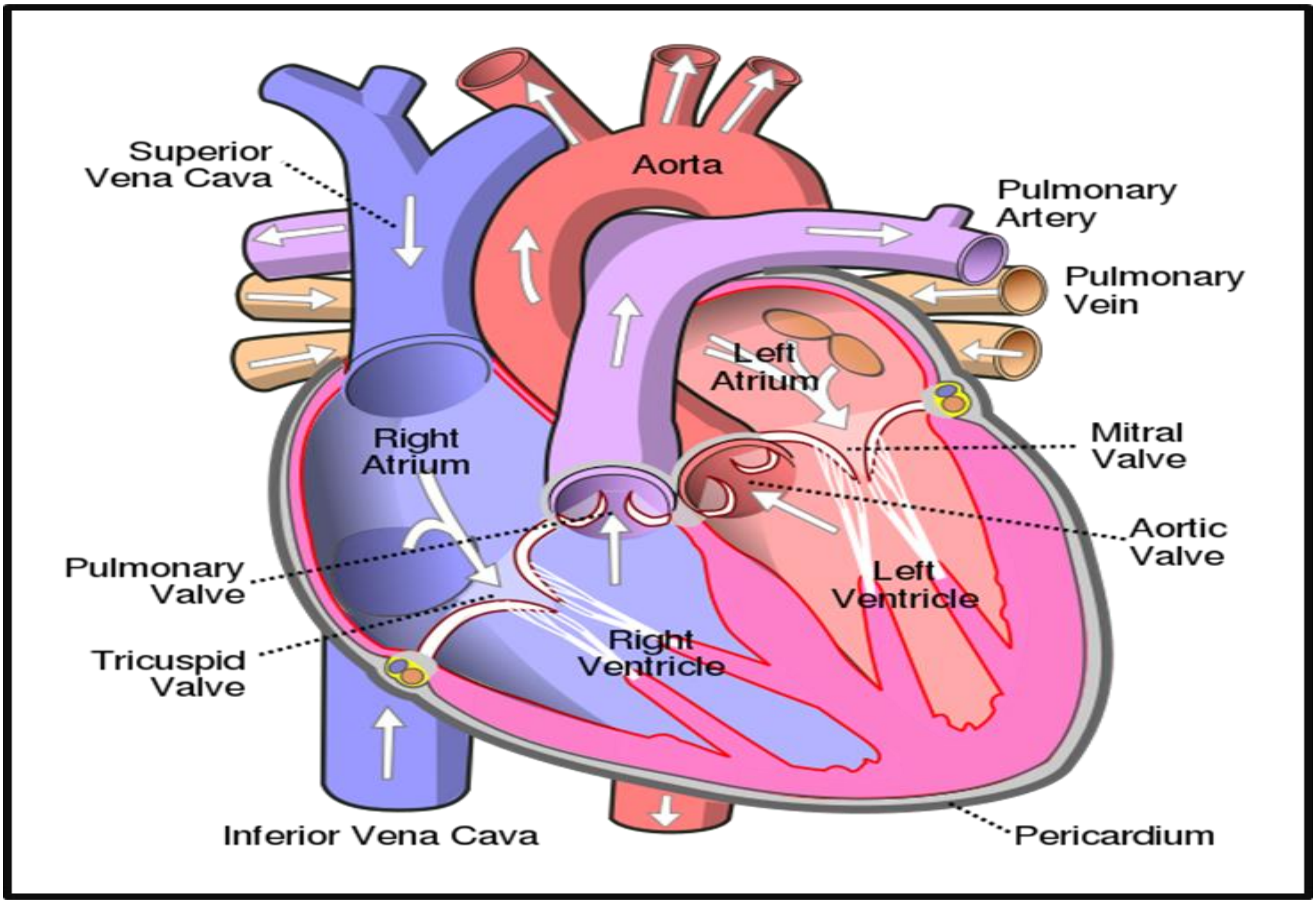



**Figure (3.2): Heart (chamber and valves)**

## Properties of cardiac muscle:

**1.Automaticity**: the ability to generate action potentials by itself (without the need of the brain). It is a function of the SA-node.

***2.* Conductivity:** the ability to conduct impulses "like nerves". It is a function of the AV-node.

**3. Contractility***:* the ability to contract in response to action potential. It is a function of the atrial and ventricular muscles.

# Cardiac action potentials

## There are 2 types of action potentials in the heart:

### 1. Pacemaker potentials (SA node):

This action potential is generated by the SA-node and spread to the rest of the heart and starts the stimuli for cardiac contraction. It occurs spontaneously without the need for an external stimulus (without brain stimulation). **This action has three phases (Figure 3.3)**:

**a. Slow depolarization phase:** Sodium leaky channels cause slow sodium influx and slow depolarization pushing the membrane potential towards the threshold of (– 40 mV).

**b. Rapid depolarization phase:** At threshold, calcium channels open causing influx of calcium ions and rapid depolarization.

**c. Repolarization phase:** Calcium stops entering. Potassium channels open causing potassium efflux and repolarization. Then, the cycle repeats itself over and over.

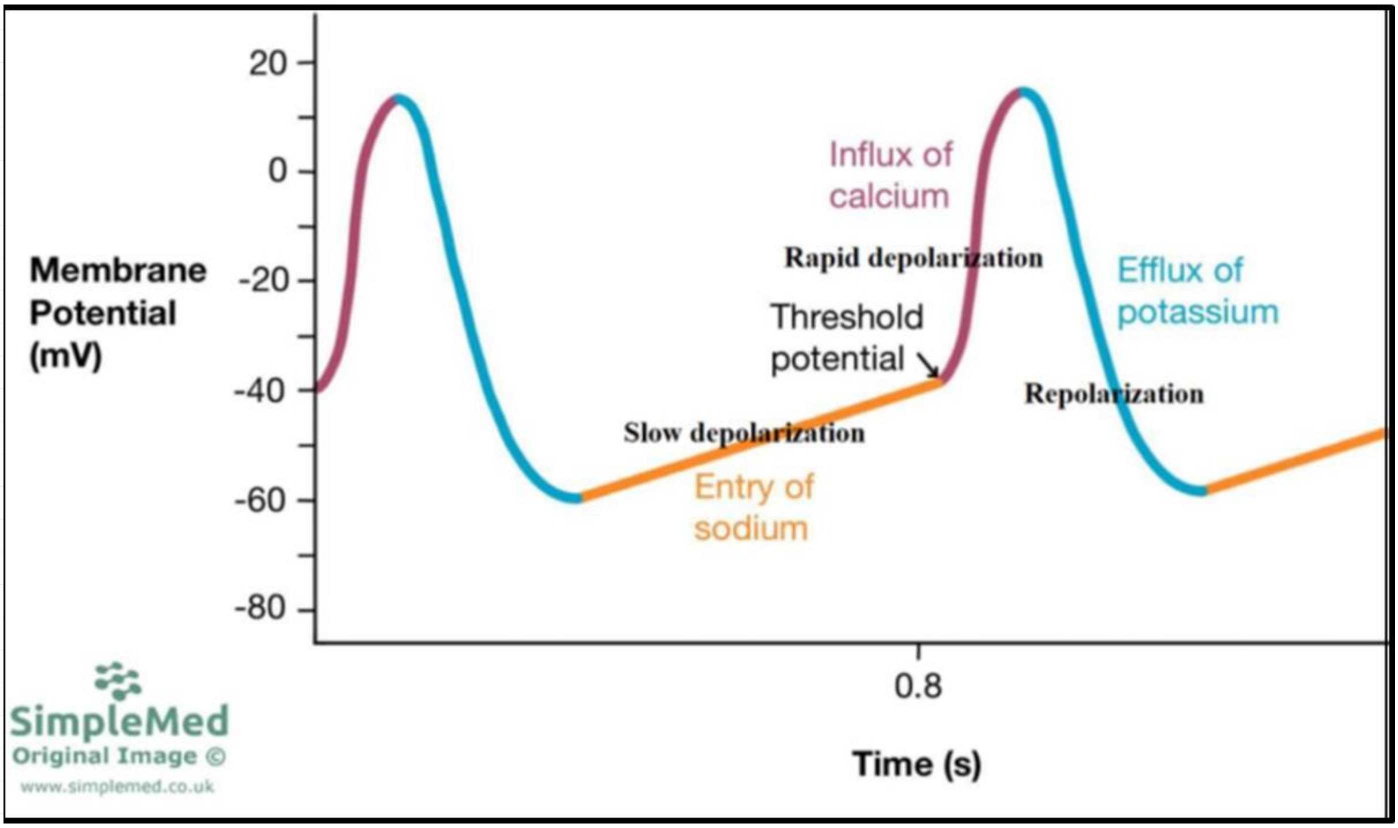



**Figure (3.3): Pacemaker action potentials**

## 2. Non-pacemaker potentials (atria and ventricles):

This action potential causes the cardiac muscle to contract and pump the blood. It occurs in response to the stimuli formed by the SA-node. **This action has five phases (Figure 3.4):**

***a*. Depolarization:** Na+ enters raising the RMP form (−90 mV) to (+20 mV).

***b*. Initial repolarization*:*** Sodium influx stops and potassium starts to efflux causing repolarization.

**c. Plateau:** Calcium influx starts causing contraction. Potassium efflux equals calcium influx (so membrane potential become flat “plateau”).

**d. Final repolarization:** Ca2+ channels close and potassium keeps moving out restoring the RMP to (– 90 mV) but ions now had changed their positions.

**e. Restoration of RMP*:*** All sodium and calcium ions, which had entered the cell will move out, potassium ions which have left, will move in by the action of:

- *3 sodium-2 potassium pump* (needs ATP) moves 3 sodium out and 2 potassium in.
- *3 Sodium-calcium pump* (needs ATP) moves 3 sodium in and 1 calcium out.
- *Calcium pump* (needs ATP) moves 1 calcium out.

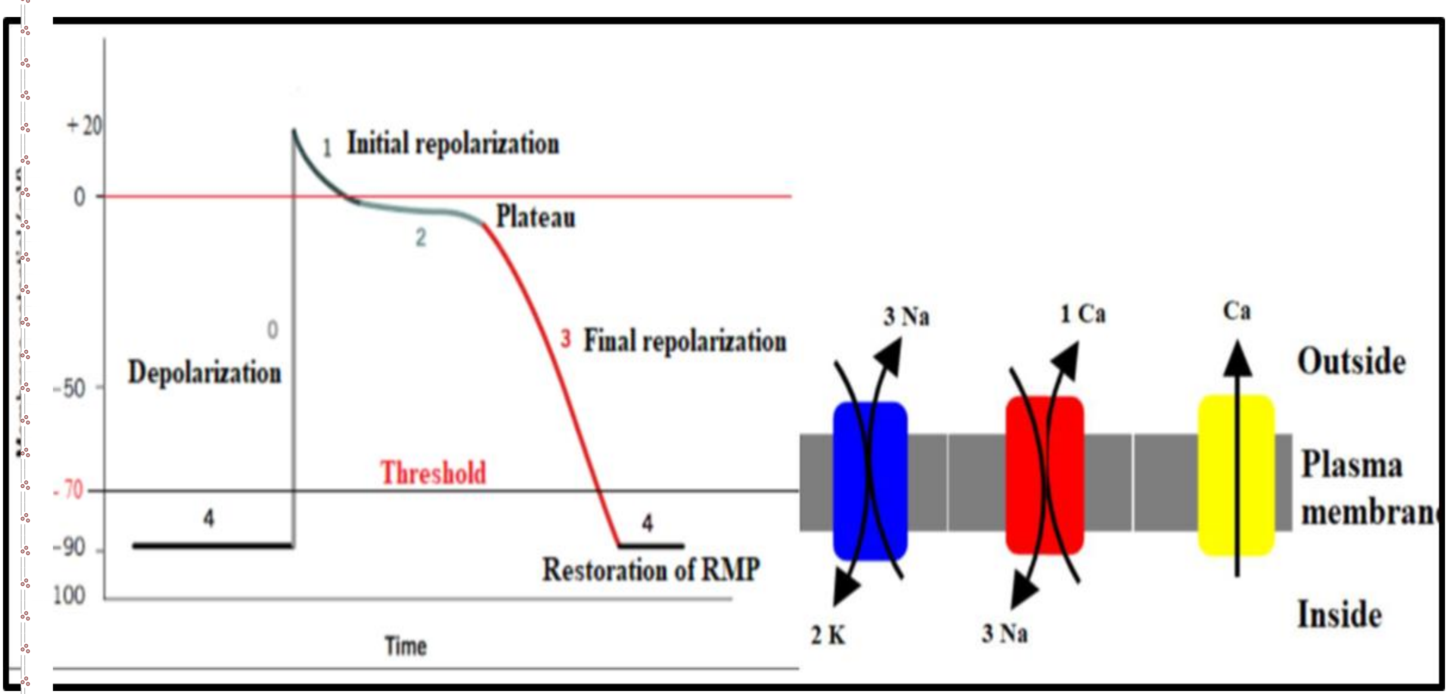



**Figure (3.4): Non-pacemaker action potentials**

## Conductive system in the heart

-The conductive system conducts impulses from SA node to the rest of the heart and consist of several components as following **(Figure 3.5)**:

**1.Sino-atrial node (SA) node:** generates signals and send them to AV node. It is located in right atrial wall, just inferior to the superior vena cava.

**2. Atrioventricular (AV) node:** delay the signal to allow atria to contract before ventricles. It is located just above tricuspid valve (between right atrium & ventricle).

**3. Bundle of His:** conducts the impulse to ventricles (in the inter atrial septum).

**4. Bundle branches:** The left bundle branch supplies the left ventricle and the right bundle branch supplies the right ventricle.

**5. Purkinje fibers:** Spread signals to ventricles (within the lateral walls of both the L and R ventricles).

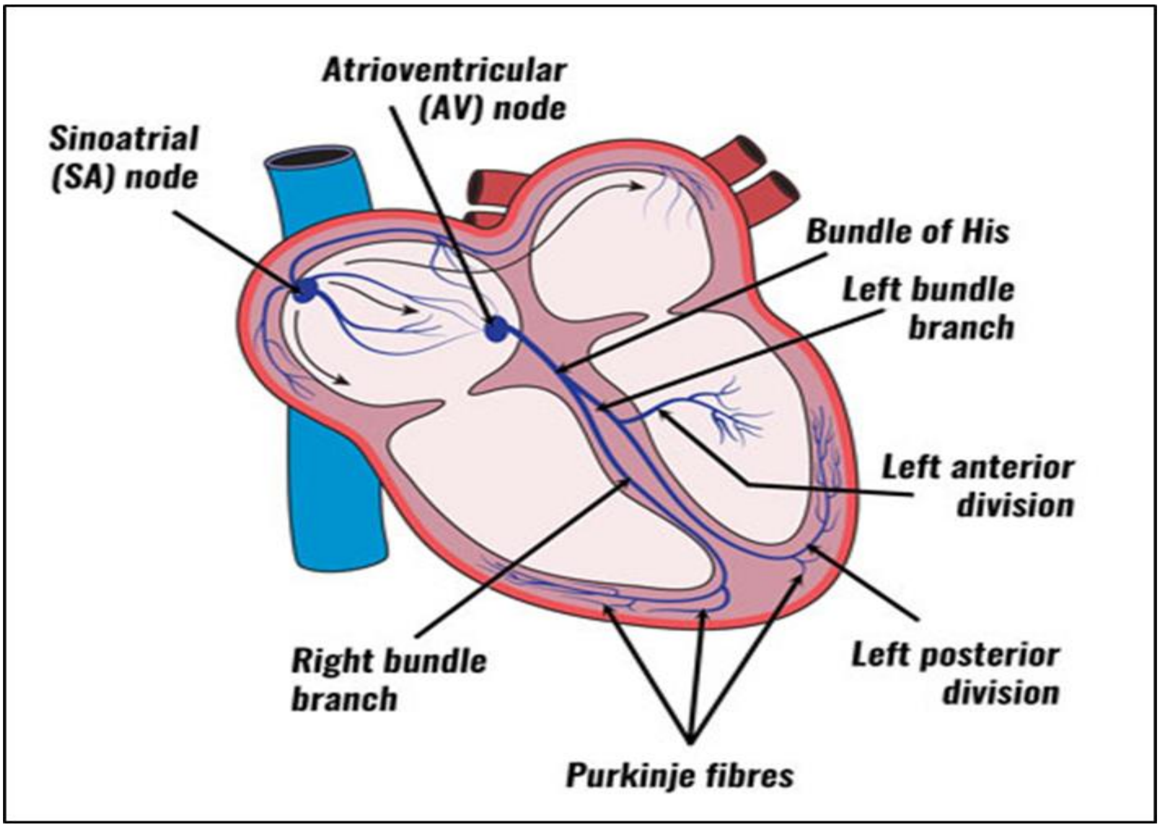



**Figure (3.5): Conductive system in the heart**

## Electrical Activity of the Heart (Electrocardiography (ECG))

**1. P -wave - initial wave**, demonstrates the depolarization from SA Node through both atria; the atria contract about 0.1 s.

**2. QRS complex** - next series of deflections, demonstrates the depolarization of AV node through both ventricles; the ventricles contract throughout the period of the QRS complex, with a short delay after the end of atrial contraction; repolarization of atria also obscured.

**3. T Wave** - repolarization of the ventricles (0.16 s)

**4. PR (PQ) Interval** - time period from beginning of atrial contraction to beginning of ventricular contraction (0.16 s)

**5. QT Interval** the time of ventricular contraction (about 0.36 s); from beginning of ventricular depolarization to end of repolarization **(Figure 3.6).**

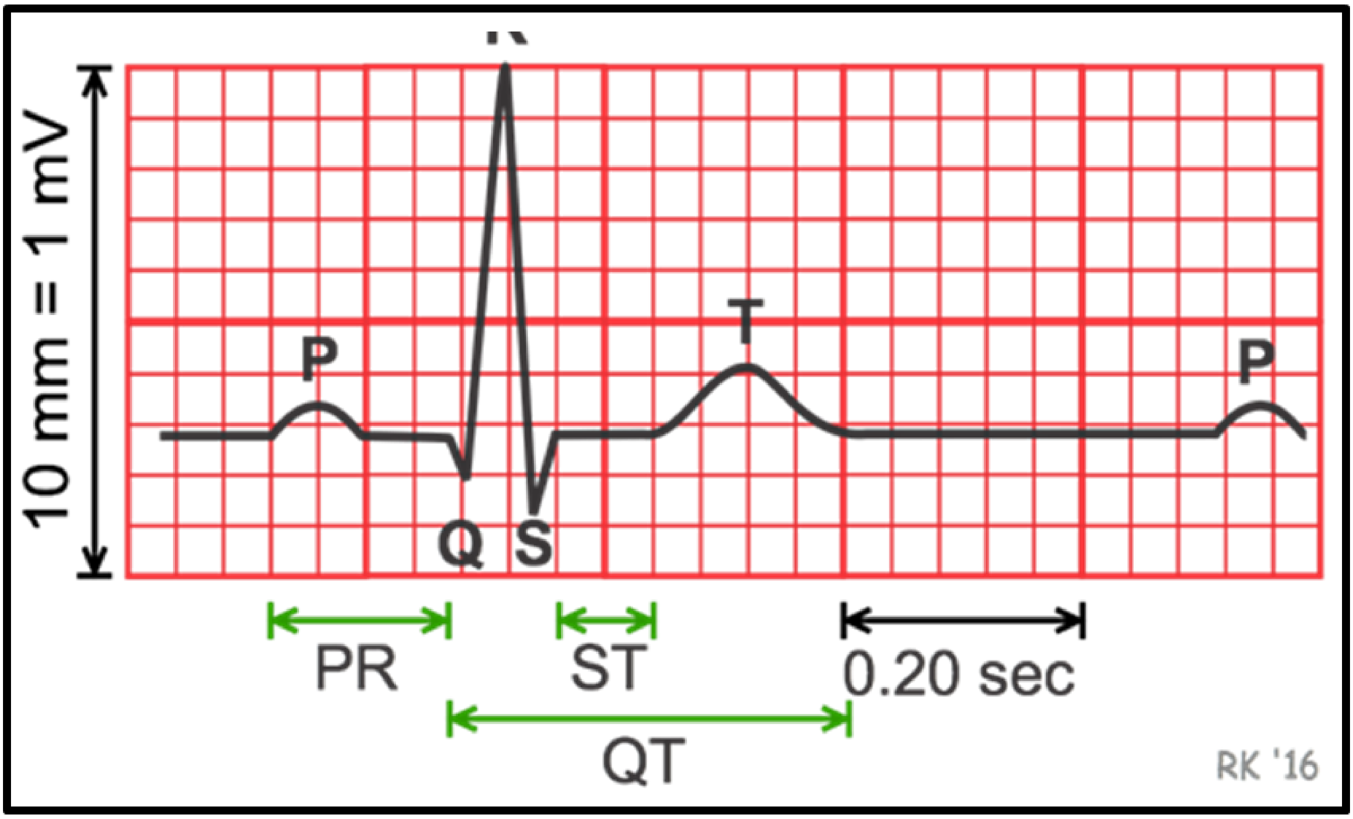



**Figure (3.6): Electrocardiography (ECG)**

## The blood Circulation

**-The heart pumps blood into two circulations (Figure 3.7):**

**A. Pulmonary circulation:** The blood pumped by the ***right ventricle*** enters the pulmonary artery, the deoxygenated blood pumped into the pulmonary artery is passed on to the lungs (where gases exchange occurs) from where the oxygenated blood is carried by the pulmonary veins into the ***left atrium***.

**B. Systemic circulation:** The ***left ventricle*** pumps blood into the aorta. The oxygenated blood entering the aorta is carried by a network of arteries, arterioles and capillaries to the tissues (where gases, nutrients and wastes material exchange) from where the deoxygenated blood is collected by a system of venules, veins and vena cava (superior and inferior) which emptied into the ***right atrium***.

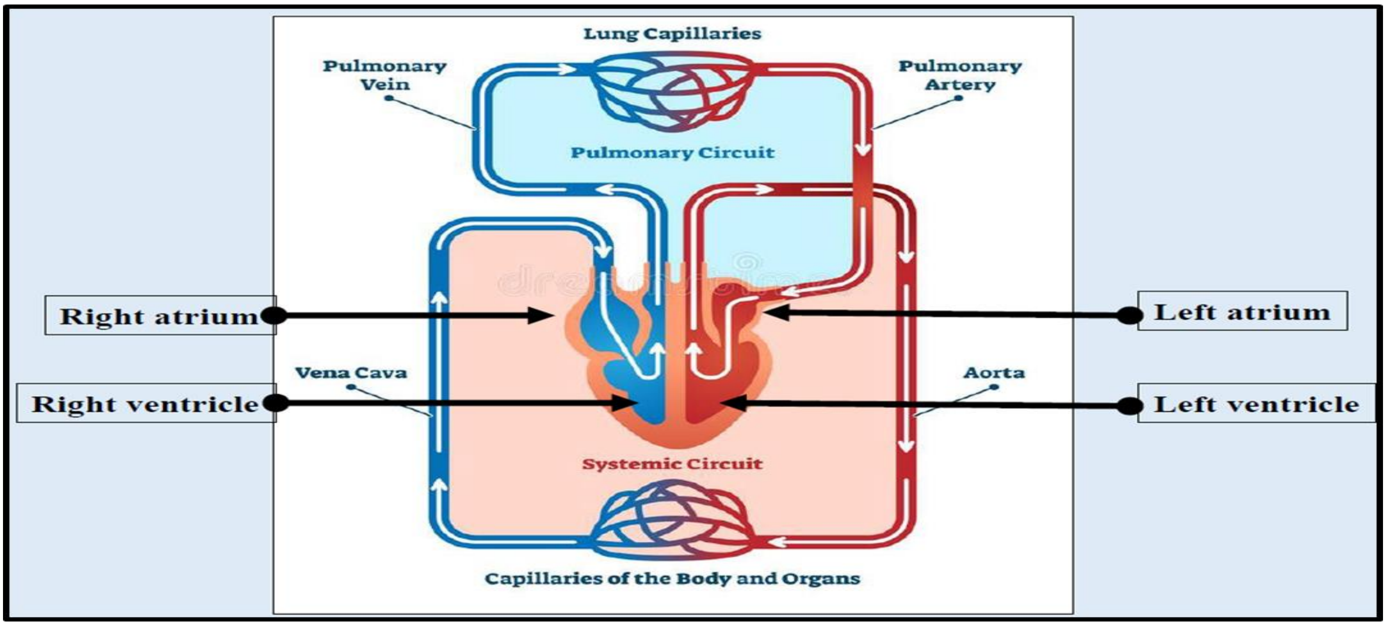



Figure (3.7): The blood Circulation

## Capillary exchange

-**Capillary exchange** is the exchange of material between blood and tissues. It results from the interaction of two opposing forces **(Figure (3.8)**:

- Hydrostatic pressure: moves fluid out. It`s value is (35 mmHg) at the arterial and (15 mmHg) at the venous ends of the capillary.
- Osmotic pressure: moves fluid in. It`s value is (20 mmHg) at both ends of the capillary.

**- At the arterial end:** the hydrostatic pressure is higher than the osmotic pressure thus water will move out (carrying O2 and nutrients with it from blood to cells).

**- At the venous end:** the osmotic pressure is higher than the hydrostatic pressure thus water will move in (carrying $CO_2$ and wastes with it from cells to blood).

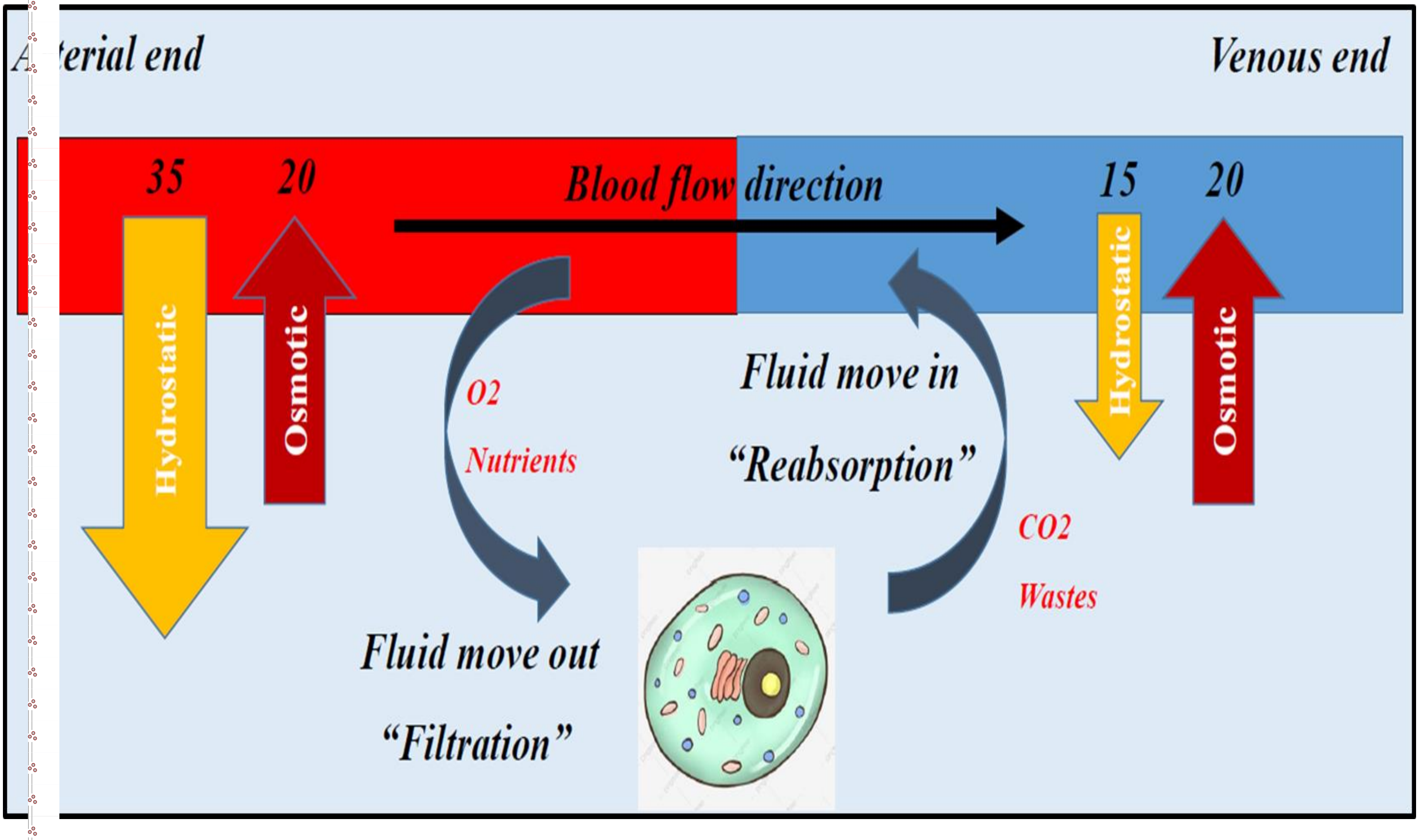



Figure (3.8): Capillary exchange

## The Normal Cardiac Cycle

### A. General Concepts:

**i. Systole** - period of chamber contraction

ii. **Diastole** - period of chamber relaxation

**iii. Cardiac cycle -** all events of systole and diastole during one heart flow cycle

### B. Events of Cardiac Cycle:

**1. Diastole:**

a. AV valves are open

b. Pressure: **low** in chambers; **high** in aorta/pulmonary trunk

c. Aortic/pulmonary semilunar valves **closed**

d. Blood flows from vena cava/pulmonary vein into atria

e. Blood flows through AV valves into ventricles (70%)

**2. Systole: blood ejected from heart**

a. Filled ventricles begin to contract, AV valves **close**

b. Semilunar valves **open**

c. ventricles **closed**

d. Contraction of closed ventricles increases pressure

e. Ventricular ejection phase - blood forced out (into aorta & pulmonary trunk).

## Heart Sounds: Stethoscope Listening

1. lub-dub, - , lub, dub.
2. Lub - closure of AV valves, onset of ventricular systole
3. Dub - closure of semilunar valves, onset of diastole
4. Pause - quiescent period of cardiac cycle
5. Tricuspid valve (lub) - right 5th intercostal, medial
6. Mitral valve (lub) - left 5th intercostal, lateral
7. Aortic semilunar valve (dub) – right 2nd intercostal
8. Pulmonary semilunar valve (dub) - left 2nd intercostal

## Heart Murmurs

Murmur sounds of the heart other than the typical "lub-dub"; typically caused by disruptions in flow:

**I. Incompetent valve** - swishing sound just AFTER the normal "lub" or "dub"; valve does not completely close, some regurgitation of blood

**II. Stenotic valve** - high pitched swishing sound when blood should be flowing through valve; narrowing of outlet in the open state.

## Cardiac output

**-Cardiac output** which is the amount of blood ejected by each ventricle per minute.

- ❖ **Cardiac output (CO) = Stroke volume (SV) * Heart rate (HR)**

**-Stroke volume (SV)** is the volume of blood pumped from the ventricle per beat. Usually it equals (70 ml/beat)

**-Heart rate (HR)** is the number of heart beats per minute. Usually it equals (70 beat/minute)

- ❖ **Cardiac output = 70 ml/beat * 70 beat/min = 4900 ml/min (approximately 5 L/min)**

- Cardiac output decides the rate of blood flow to the different parts of the body.

- ❖ Decrease in cardiac output = Decrease in blood flow
- ❖ Increase in cardiac output = Increase in blood flow

## Factors affecting cardiac output

- ❖ Cardiac output (CO) = Stroke volume (SV) * Heart rate (HR)
- ❖ So, any factor that affect either (HR) or the (SV) will affect the (CO)

**A. Factors affecting the stroke volume:** which is depend on

*i. Venous return (direct relationship): this is the blood entering the heart from the veins, factors increasing the venous return:*

1. Gravity: lying flat will increases the venous return.

2. Increases in blood volume: as in giving intravenous fluid.
3. Skeletal muscle contraction: when a skeletal muscle contracts it will pumps the venous blood towards the heart.
4. Inspiration: inspiration increases venous return whereas expiration reduces it.
5. Venoconstriction: sympathetic stimulation constricts veins squeezing the blood toward the heart.

*ii. Resistance to flow (inverse relationship): this is the resistance to flow offered by the arterioles, factors affecting resistance to blood flow including:*

1. Viscosity of blood (direct): The greater the viscosity, the greater the resistance. Blood viscosity depends on RBC, it is increased in polycythemia and decreased in anemia.
2. Vessel length (direct): Greater the length of a vessel, more will be the resistance.
3. Radius of the vessel (inverse): It is the most important factor to determine the resistance to flow. Slight change in radius of a vessel brings great change to flow because. Resistance is inversely proportional to the fourth power of the radius (multiplying the radius by itself four times

**B. Factors affecting heart rate:** which include the following

i. Nervous factors

- ❖ Sympathetic stimulation: increases heart rate
- ❖ Parasympathetic stimulation: decreases heart rate

ii. Hormonal factors: thyroxine and catecholamine increase HR.

- Normal heart rate = (60-100) beat/min.

- ❖ Tachycardia - higher than normal resting heart rate (over 100); may lead to fibrillation
- ❖ Bradycardia - lower than normal resting heart rate (below 60).

## Blood pressure

**-Blood pressure** is the force applied by blood on the wall of blood vessels.

-blood pressure is important in maintaining the cardiac output. For example, when the resistance increases, the CO will decrease (and tissues will receive less blood and oxygen) but this is prevented by increasing the blood pressure **(Figure 3.9)**.

**1.Systolic blood pressure (SBP):** the highest recorded value. Normally = 100-140 mmHg. It occurs during ventricular systole.

**2.Diastolic blood pressure (DBP):** the lowest recorded value. Normally = 60-90 mmHg. It occurs during ventricular diastole.

-**Hypotension (below normal blood pressure, < 100/60)**

1. Factors - age, physical conditioning, illness

2. Chronic hypotension - ongoing low blood pressure

a. low blood protein levels (nutrition). b. hypothyroidism

d. sign of various types of cancer c. Addison's disease (adrenal cortex malfunction).

**-Hypertension (above normal blood pressure at rest, > 140/90)**

1.Factors - weight, exercise, emotions, stress

2. Chronic hypertension - ongoing high blood pressure:

a. prevalent in obese and elderly b. heart disease, renal failure, stroke

c. arteriosclerosis.

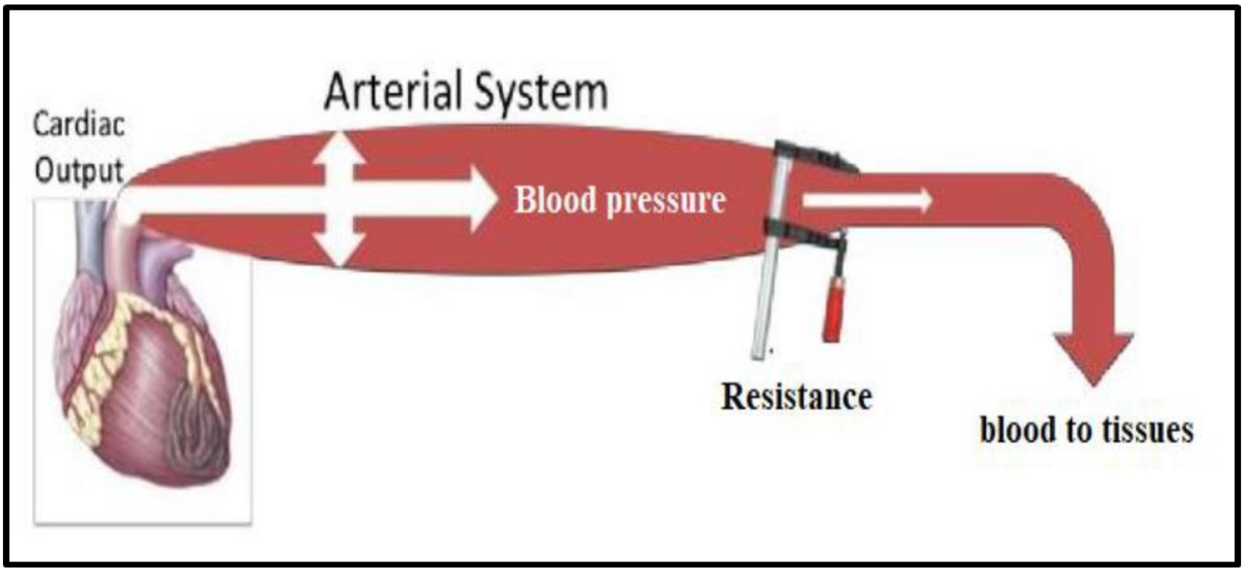



**Figure (3.8): Mechanism of Blood pressure**

# *Physiology of Respiratory System*

## Functions of respiratory system:

1.Supplies oxygen and removes carbon dioxide.

2. Helps in acid base regulation.

3.Helps in blood and lymph flow.

4.Filters inspired air.

5.Produces sound.

6.Contains receptors for smell.

7.Eliminates excess water and heat.

## Anatomical divisions of the respiratory system

-The respiratory system is divided anatomically into **(Figure 5.1)**: -

A. Upper respiratory tract which include: nose (nasal cavity), pharynx and Larynx.

B. Lower respiratory tract which include: trachea, bronchi, bronchioles and lungs.

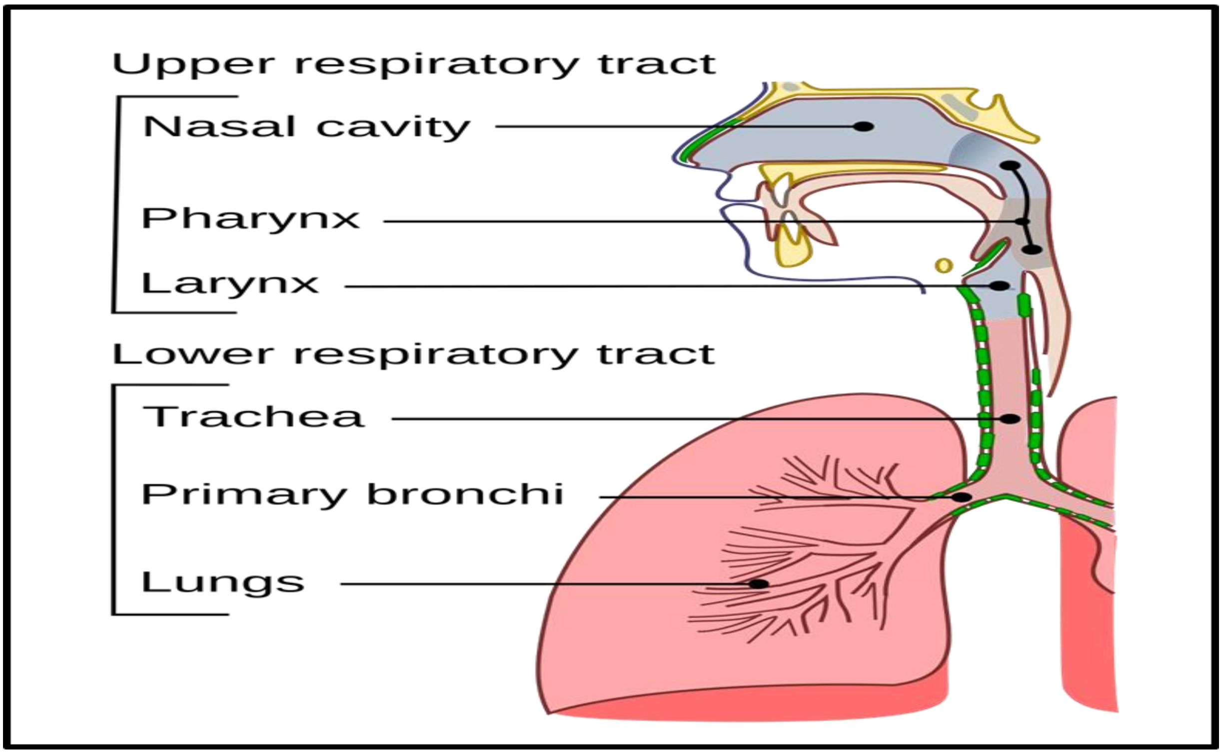



**Figure (5.1): Divisions of Respiratory system**

## Lungs

-The lungs are the organs of respiration. The function of the lungs is to oxygenate blood. They achieve this by bringing inspired air into close contact with oxygen poor blood in the pulmonary capillaries **(Figure 5.2)**.

### The alveolus

-These are the basic functional units of the respiratory system. Both lungs contain about 300 million alveoli. Alveoli are essential for gas exchange. Each alveolus has 2 types of cells:

1. Alveolar type I these form the wall of the alveolus.

2. Alveolar type II these secrete surfactant.

### Intrapleural space (pleural cavity)

-The Intrapleural space is a fluid filled space that separates the lungs from the thoracic cage. It contains a small amount of fluid that allows the lungs to move freely during breathing (keep the lung stuck to chest wall).

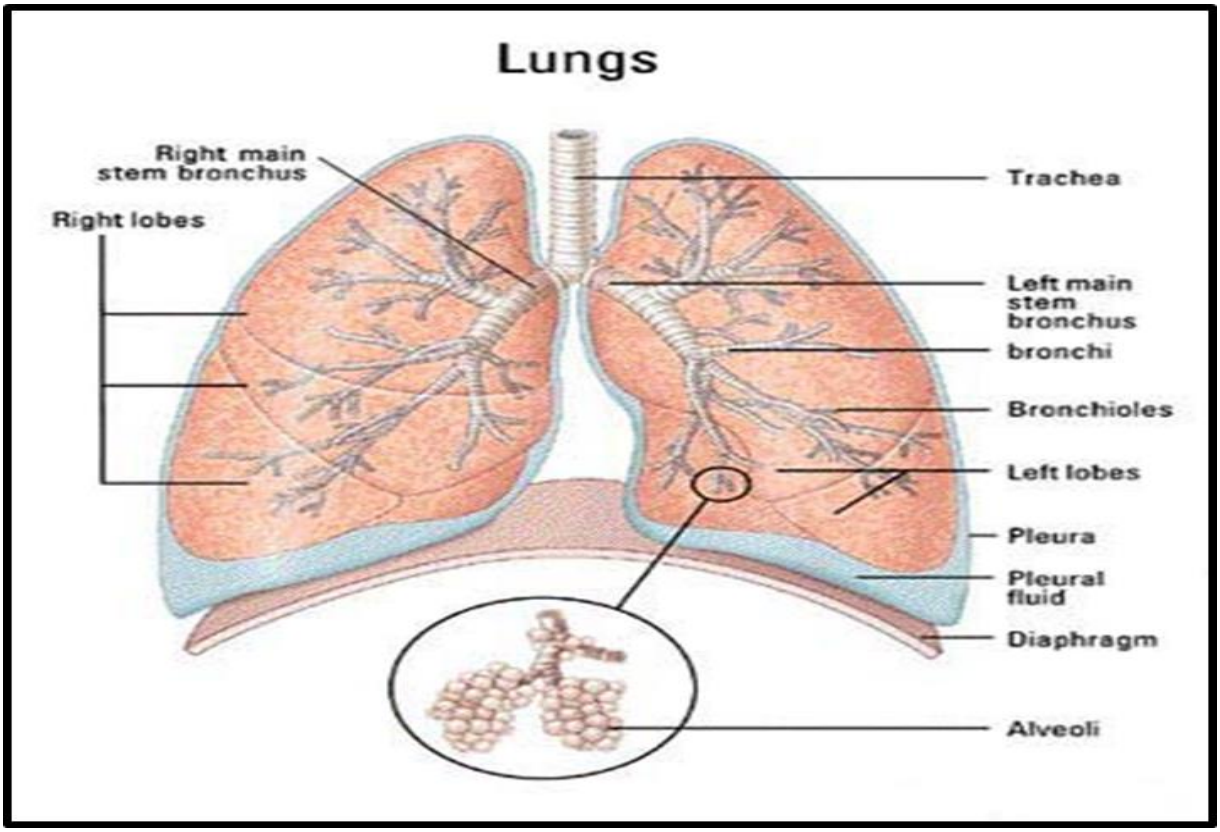



**Figure (5.2): Lungs and Alveoli**

## Respiratory volumes and capacities

### A. Respiratory volumes (Figure 5.3)

**I. Tidal volume (TV)**: Volume of air with each inspiration and expiration about 500 mL.

**II. Inspiratory reserve volume(IRV)**: Additional air inspired above tidal volume about 3 L).

**III. Expiratory reserve volume(ERV):** Additional air expired below tidal volume about 15L.

**IV. Residual volume (RV):** Air remaining in lungs after maximal expiration about 1 L.

### B. Lung capacities (Figure 5.3)

**I. Vital capacity (VC):** the maximal amount of air that can be expired after maximal inspiration. **VC= IRV +TV +ERV**

**II. Inspiratory capacity (IC):** amount of air that can be inhaled after the end of a normal expiration. **IC= TV +IRV**

**III. Functional residual capacity (FRC):** volume remaining in the lung after a normal expiration.

**FRC= ERV + RV**

**IV. Total lung capacity (TLC):** the total amount of air that the can be hold by lung

**TLC= IRV+ TV+ ERV+ RV**

## Dead space

- Dead space is the space of airways which does not participate in the gas exchange. It is of Three types:

**1. Anatomical dead space**: it is all the volume of air in conductive zone from nose to terminal bronchioles It doesn't participate in gas exchange since it has no alveoli. Its normal value is 150 ml.

**2. Alveolar dead space:** is the volume of air which enters alveoli with no or little blood supply (the non-perfused alveoli).

**3. Physiologic dead space**: is all the volume of air that does not participate in the gas exchange It equals the sum of both, anatomical and alveolar dead spaces.

**Physiological dead space = anatomical dead space + alveolar dead space**

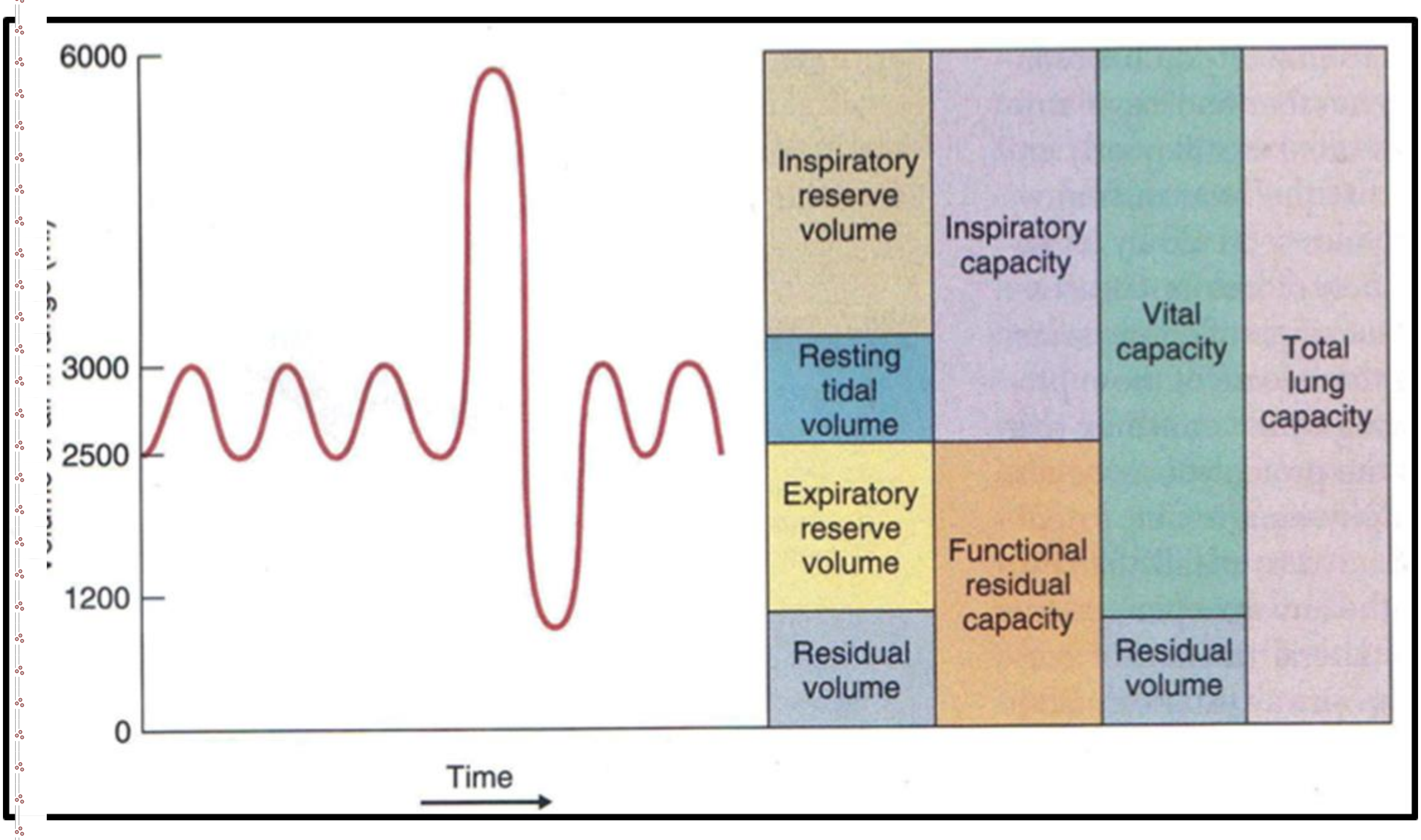



**Figure (5.3): Lungs and Alveoli**

## Respiration

**Respiration** is the supply of O2 from atmosphere to body tissues and removal of CO2 from the body to atmosphere. It involves five major steps:

**A. Pulmonary ventilation:** is the movement of air into and out of lungs. It

is accomplished by inspiration and expiration **(Figure 5.4)**.

***i. Inspiration***: inflow of air into the lungs. This occurs when the pressure inside the lung falls below the atmospheric air pressure. Muscles of inspiration include diaphragm, external intercostal muscles, external intercostal muscles and accessory muscles of inspiration.

***ii. Expiration***: outflow of air out of the lungs. This occurs when the pressure inside the

lung rises above the atmospheric air pressure.

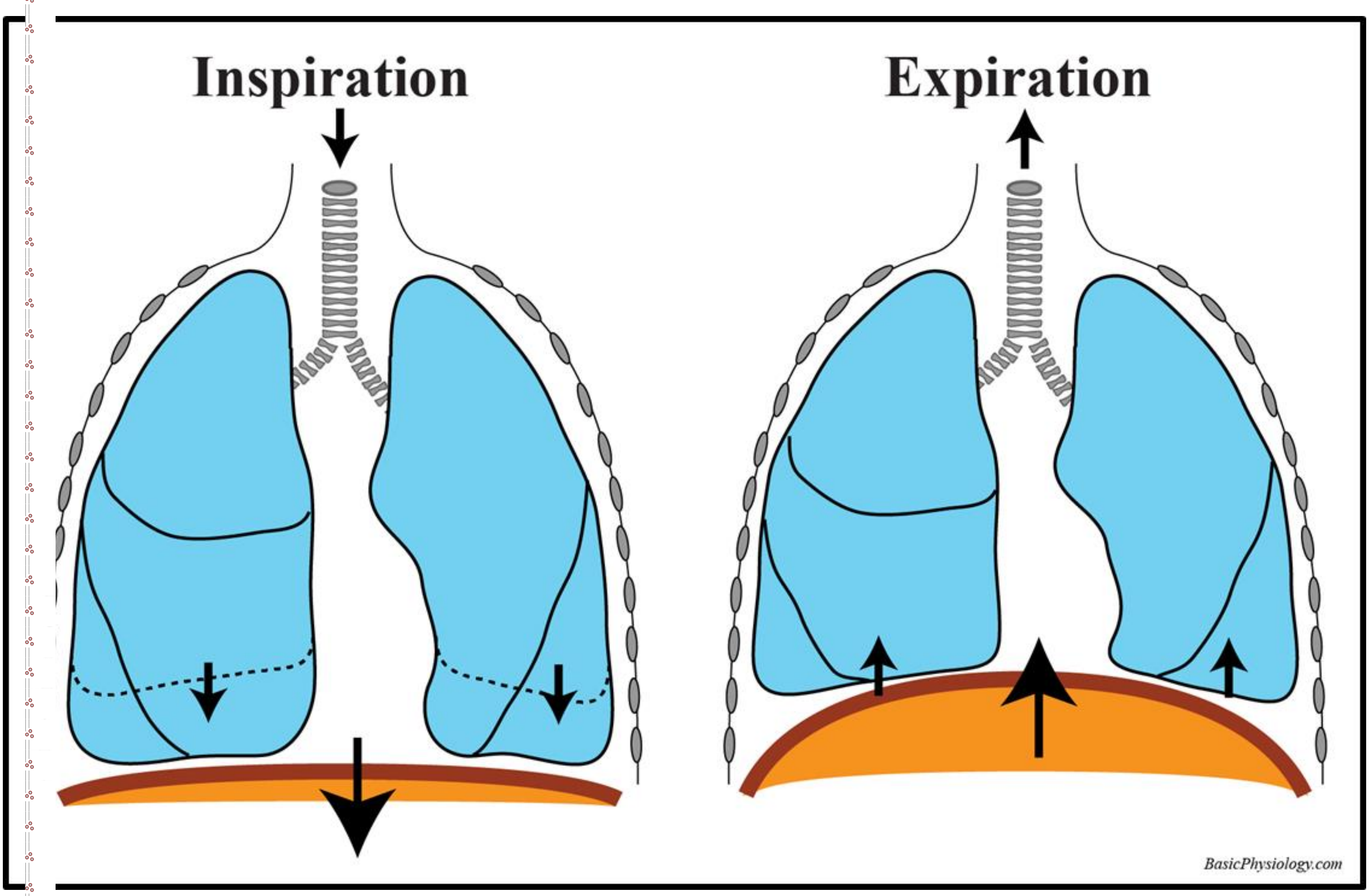



**Figure (5.4): Inspiration and Expiration**

## Factors that affect pulmonary ventilation

1.Resistance to airflow

2.Physical properties of the lungs, which include: compliance of lung and Elasticity of lung.

## Surface tension

**Surface tension** is the force exerted by fluid in alveoli that causes elastic recoil of the lung at expiration and causes the alveoli to collapse

-**The surfactant** is a phospholipid produced by alveolar type II cells and it reduces the surface tension.

**B. External respiration (Pulmonary gas diffusion):** Gas exchange between air and capillaries in the lungs. It is the movement of $O_2$ from the alveoli into blood and $CO_2$from the blood into the alveoli. Gas diffusion occurs through the respiratory membrane which is made by alveolar and capillary walls.

**- Diffusion of Oxygen**

-Diffusion of oxygen is achieved by simple diffusion where there is a pressure gradient that permits the flow of $O_2$ from a region of higher $O_2$ pressure (to area of lower $O_2$ pressure (pulmonary capillary)

- ❖ From atmosphere ($PO_2$ 160 mmHg) to alveoli ($PO_2$ 100 mmHg).
- ❖ From alveoli ($PO_2$100 mmHg) to capillaries ($PO_2$ 40 mmHg).

**-Diffusion of carbon dioxide**

-Diffusion of $CO_2$ is done by simple diffusion where there is a pressure gradient that permits the flow of $CO_2$from a region of higher pressure to area of lower pressure

- ❖ -From alveolar capillaries ($PCO_2$ 45 mmHg) to alveoli $PCO_2$ 40 mmHg.
- ❖ From alveoli $PCO_2$ 405 mmHg) to atmosphere $PCO_2$ 0.3 mmHg).

**C. Gas transport:** the transport of gases by blood between lungs and tissues.

**- Transport of $O_2$**

-The oxygen is transported from lungs to the peripheral tissues to be used in

cellular respiration. Oxygen is transported in two forms*:*

- ❖ 3% dissolved in plasma This value is low because of poor solubility of oxygen in plasma
- ❖ 97% combined with hemoglobin

-**Transport of carbon dioxide**

- Carbon dioxide ($CO_2$) is transported in three forms:

- As bicarbonate (60%).
- Bound to hemoglobin (30%)
- Dissolved in plasma (10%)

**D. Internal respiration:** Gas exchange between systemic capillaries and tissues.

**E. Cellular respiration:** using $O_2$ and giving $CO_2$ by the cells.

## Control of Respiration

Like the heartbeat, breathing must occur in a continuous, cyclic pattern to sustain life processes. inspiratory muscles must rhythmically contract and relax to alternately fill the lungs with air and empty them. Both these activities are accomplished automatically, without conscious effort.

1. **The respiratory centers:** Involuntary respiration is controlled by the respiratory centers of the upper brainstem which contain chemoreceptors that detect pH levels in the blood and send signals to the respiratory centers of the brain to adjust the ventilation rate.

2. **The medulla oblongata:** is the primary respiratory control center. Its main function is to send signals to the muscles that control respiration to cause breathing to occur.

**The pons:** is the other respiratory center and is located underneath the medulla. Its main function is to control the rate or speed

# *Physiology of Urinary system*

## Functions of the urinary system

1.Excrete wastes and foreign substances such as nitrogenous wastes (creatinine, and uric acid), toxins and drugs.

2.Maintain blood osmolality and water balance.

3.Regulates blood electrolyte levels (potassium) and blood glucose level.

4. Regulate blood volume and regulate blood pressure.

5. Regulates blood pH by maintaining proper balance between acids bases.

6. Produces hormone erythropoietin which stimulates erythrocyte production.

7. Activation of vitamin D which allows calcium uptake from GIT to blood

## Anatomy of urinary system

A. Two Kidneys clean and filter blood

B. Two Ureters tubes that take urine to bladder

C. Urinary bladder stores urine until eliminated

D. Urethra removes urine from body.

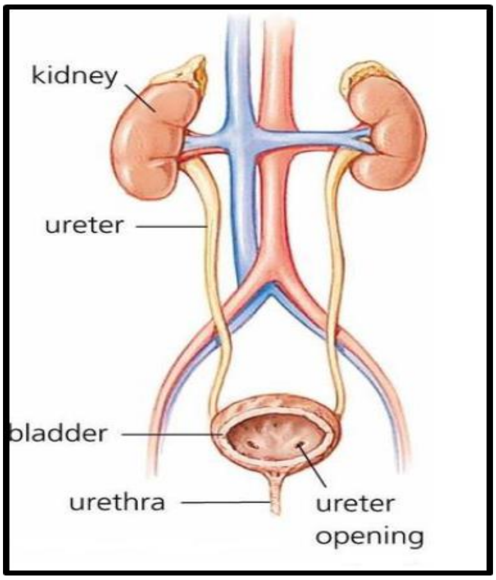



**Figure (7.1): urinary system**

## The nephron

Is the basic functional unit of the kidney. Number 1 million nephrons/ kidney. They filter the blood and form urine.  Each nephron consists of **(Figure 7.2)**:

**1. Bowman's capsule:** Cup-shaped capsule containing capillaries (The glomerulus).

**2. The glomerulus:** The glomerulus is a capillary tuft that receives its blood supply from an afferent arteriole of the renal circulation. It mechanically filters blood.

**3. Long renal tube** which divided into:

**a) Proximal convoluted tubule (PCT):** reabsorbs 75% of the water, salts, glucose, and amino acids.

b) Loop of Henle.

c) Distal convoluted tubule(DCT): tubular secretion of H ions, potassium, and certain drugs.

-Nephrons filter 125 ml of body fluid per minute; filtering the entire body fluid component 16 time each day.

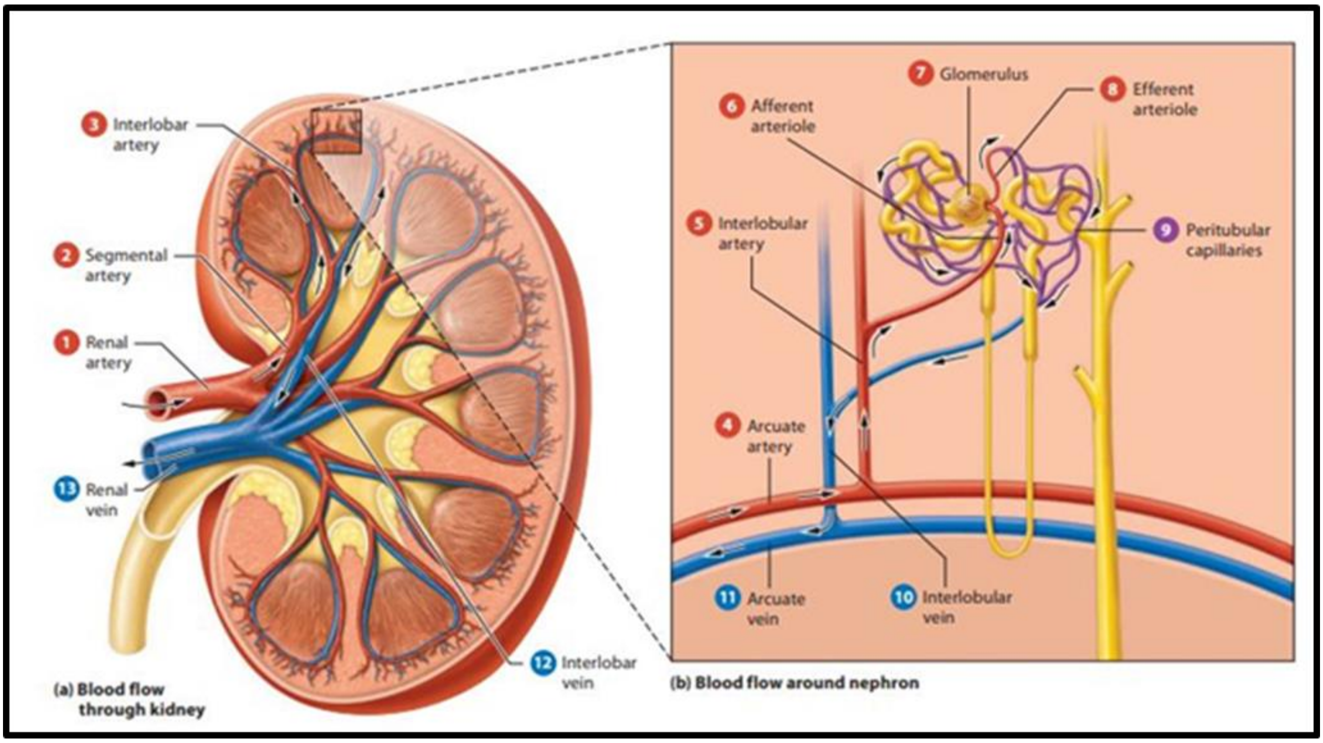



**Figure (7.2): Nephron**

## Urine Formation

-urine formation involves 4 processes **(Figure 7.3)**:

1. **Filtration**: small molecules are filtered from glomerulus's to bowman's capsule.
2. **Reabsorption**: nutrient molecules are transported from PCT and DCT to per tubular capillaries.
3. **Concentration**: water is reabsorbed from descending limb of loop of handle and from collecting duct into peritubular capillaries.
4. **Secretion**: waste or harmful substances are transported from peritubular capillaries to PCT and DCT.

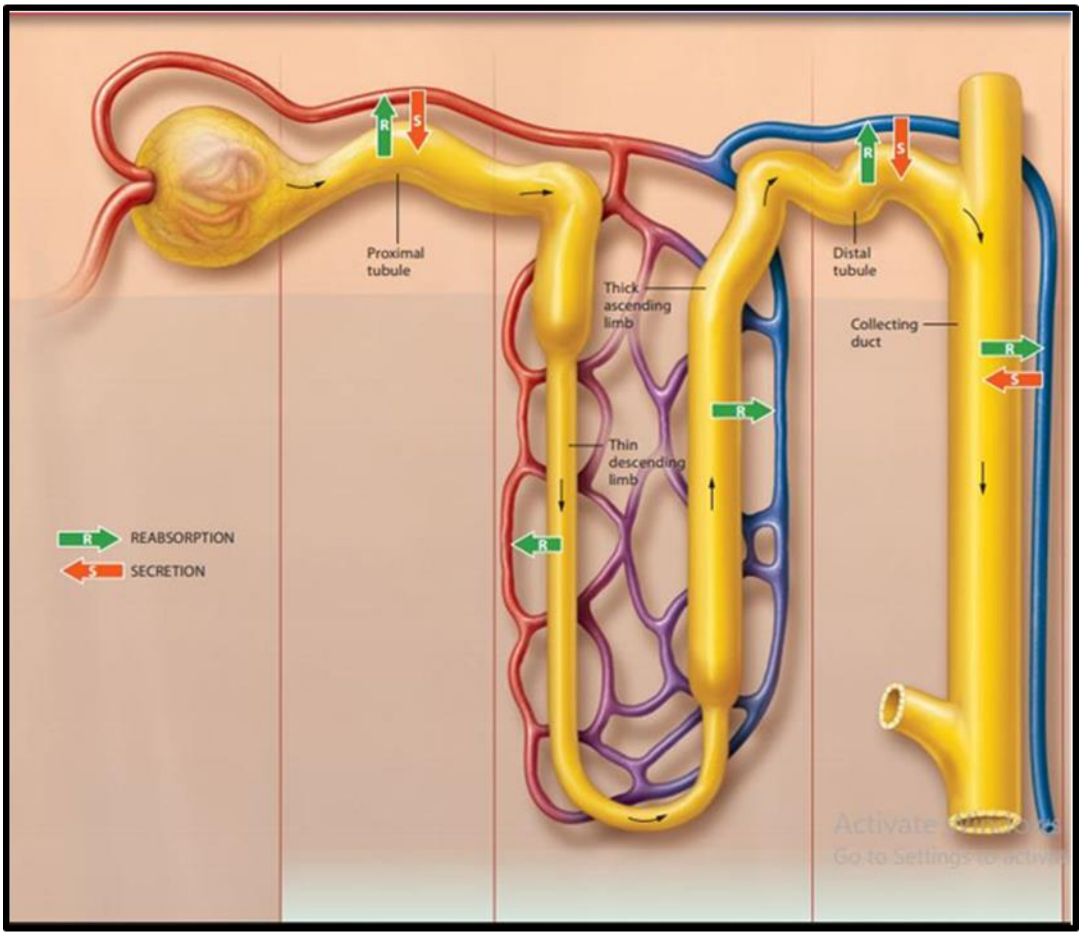



**Figure (7.3): Urine formation**

## Glomerular filtration rate (GFR)

-Is the volume of plasma filtered by the glomeruli of both kidneys per minute. Normal value of GFR 125 ml/min 7 5 L/h 180 L/day). GFR is auto regulated by the following mechanisms:

### 1. Extrinsic mechanisms (outside of the kidney)

**A. Hormonal mechanisms**

**-Renin Angiotensin II system** cause vasoconstriction of efferent arteriole If blood pressure decreases, angiotensin II increases and causes efferent vasoconstriction to:

- Increase the glomerular capillary hydrostatic pressure and maintains the GFR so that the kidney keeps functioning.
- Decrease the peritubular capillary hydrostatic pressure to facilitate more water absorption in these capillaries

**-Natriuretic peptides** these are made by the heart in case of increased blood volume and blood pressure They cause vasodilation of afferent arteriole to increase the GFR and water excretion

**B. Neural mechanism**

Sympathetic stimulation cause vasoconstriction of afferent arteriole→ Decrease RBF

(important in shock to reduce blood flow to the kidney to maintain blood flow to other organs).

**2. Intrinsic mechanisms (inside of the kidney)**

**A. Myogenic mechanism via increasing afferent resistance**

- Increase RBF → stretching of afferent arteriole →afferent arteriole smooth muscles contract → RBF decreased.

**B. Tubulo- glomerular feedback mechanism**

**-**Mediated through the **juxtaglomerular apparatus (Figure 7.4).**

-The **juxtaglomerular apparatus** lies between afferent arteriole, efferent arteriole, and distal convoluted tubule of the same nephron. And it consists of the following:

- **Macula densa** these are modified cells in the distal convoluted tubule They act as chemoreceptors sensitive to changes in Na+ content of the fluid in the distal convoluted tubule.

- **Juxtaglomerular cells** these are modified cells in the afferent arterioles as they enter the glomeruli They acts as baroreceptors and respond to decrease in blood pressure or hypovolemia and respond by secreting renin.

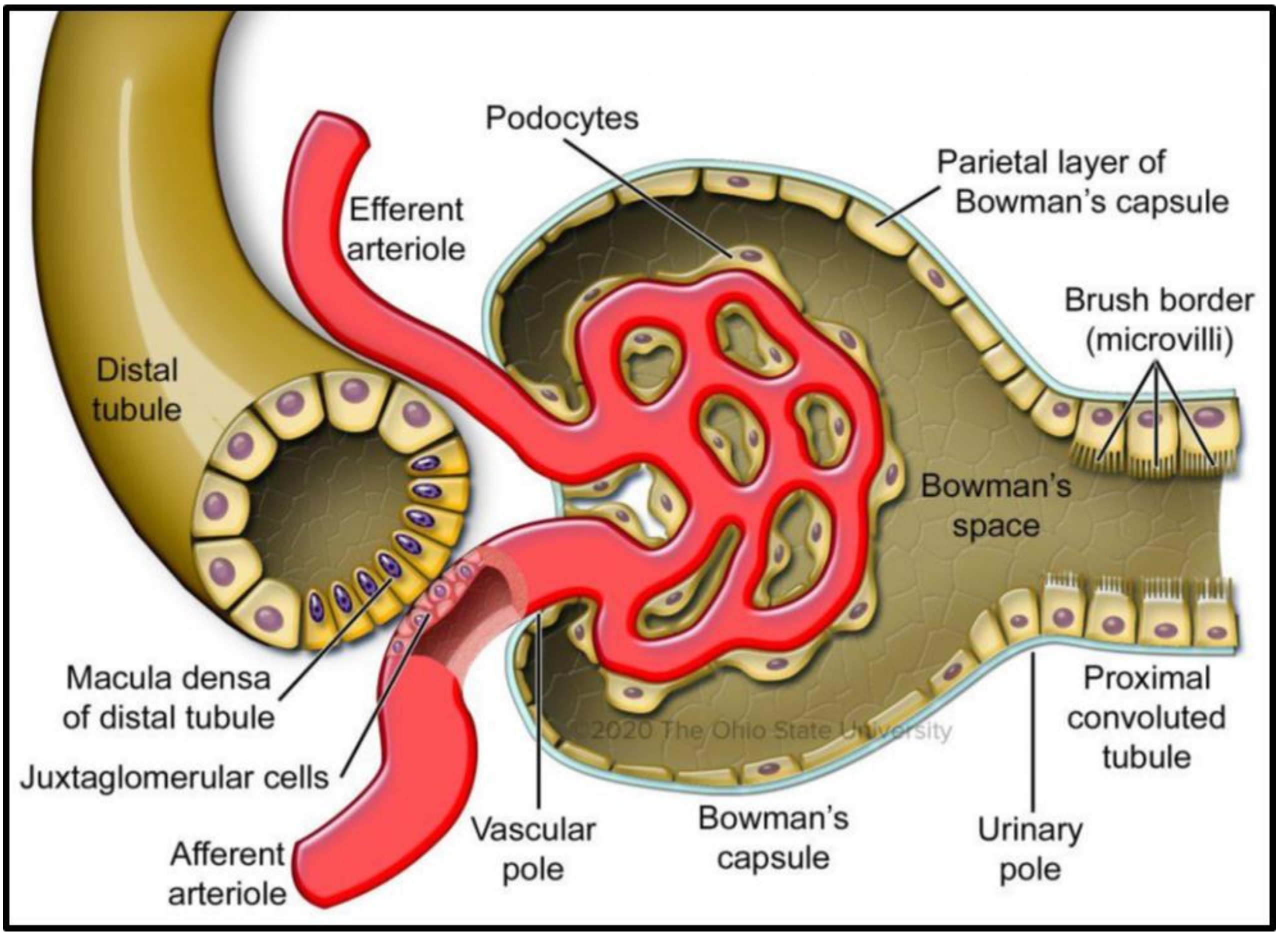



**Figure (7.4): Juxtaglomerular apparatus**

**The tubulo glomerular feedback mechanism**

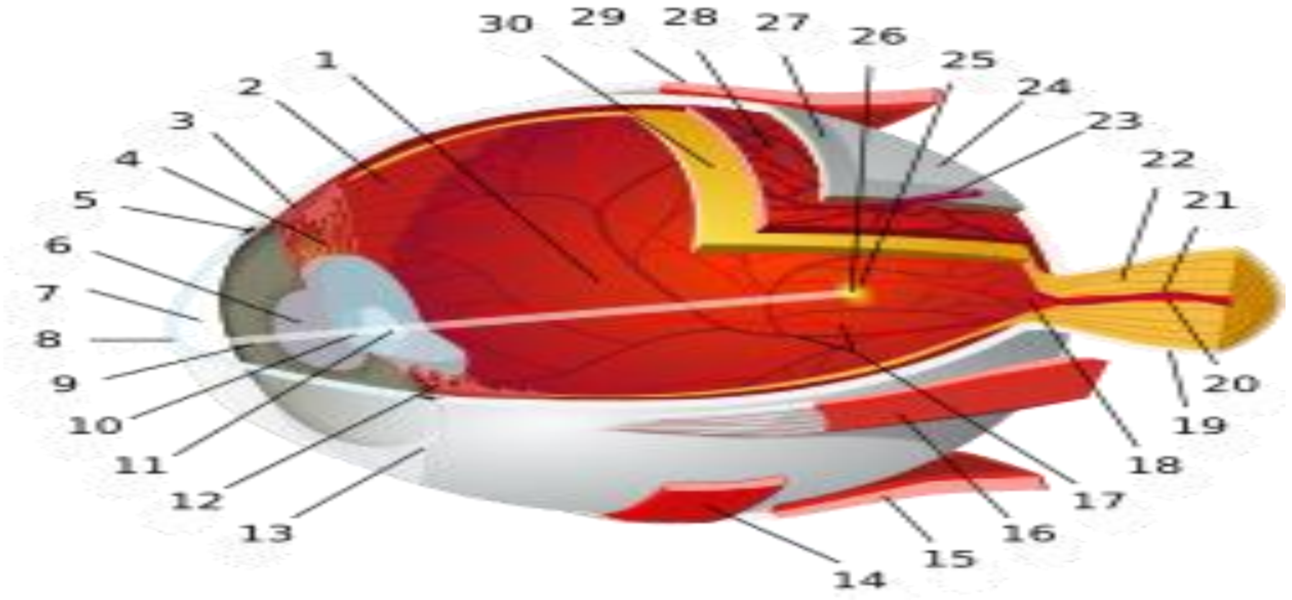
-In case of increased pressure: (the GFR is high now and must be decreased)

Increase glomerular hydrostatic pressure → increase GFR → increased Na+ delivery to macula densa → macula densa secretes adenosine (a vasoconstrictor) → adenosine causes vasoconstriction of afferent arteriole → decreases glomerular hydrostatic pressure →decreases GFR.

**-In case of decreased pressure: (the GFR is low now and must be increased)** Decreased glomerular hydrostatic pressure → decreased GFR → decreased Na+ delivery to macula densa →macula densa secrete nitric oxide prostaglandin (both are vasodilators) → vasodilation of afferent arteriole → increased glomerular hydrostatic pressure →increased GFR.

**Eye physiology**

The human eye is a sensory organ, part of the sensory nervous system, that interacts with visible light and allows humans to use visual information for various purposes including seeing objects, maintaining balance, maintaining a circadian rhythm.




1. vitreous body 2. ora serrata 3. ciliary muscle 4. ciliary zonules 5. Schlemm's canal 6. pupil 7. anterior chamber 8. cornea 9. iris 10. lens cortex 11. lens nucleus 12. ciliary process 13. conjunctiva 14. inferior oblique muscle 15. inferior rectus muscle 16. medial rectus muscle 17. retinal arteries and veins 18. optic disc 19. dura mater 20. central retinal artery 21. central retinal vein 22. optic nerve 23. vorticose vein 24. bulbar sheath 25. macula 26. fovea 27. sclera 28. choroid 29. superior rectus muscle 30. retina

## Vision:-

We see things in moderation. But in fact, the lens forms an inverted miniature image on the sensitive spot of the retina. And that image is translated in its colors in the retina into electrochemical signals that are transmitted through the eye nerve to the brain for treatment. Each of the eyes sees an image of the object, and the brain merges the two images, so we see a stereoscopic image of the object. Colors are seen by a certain type of cell that is sensitive to the colors of light, and that is a cone cell: a type of those cone cells sees red, a type sees blue, and a third type sees green. This is enough for the eye to distinguish all the colors that we see for things.

## Central fovea

In the center of the retinal macula, there is a smaller area called the central foveaThus, the eye moves continuously while reading from word to word, so that the beam falling from the lens on the retinal spot is always located on the central fovea.

## The human eye consists of three main layers:

Sclera, located on the outside, consisting of connective tissue; It protects the eye, which is rich in blood vessels. The front part of this transparent layer is the cornea, and the cornea does not contain blood vessels, so it takes what it needs of food and oxygen from the aqueous humor that is secreted from the ciliary body.

**The Choroid,** and it is laying between the retina and the sclera. contain blood vessels; It delivers oxygenated blood to the retina. It is rich in melanin pigment, which absorbs excess light rays that pass the retina, preventing them from being reflected, and causing clarity of vision.The choroid forms in the anterior part of it:

**A- The iris**: It is a colored disk (responsible for the color of the eye) in the middle of which is a hole whose diameter changes according to the amount of light entering the eye called the pupil.

**B- The ciliary body**: It forms behind the iris and is surrounded by ciliary appendages that secrete the aqueous humor. The iris and the ciliary body contain smooth muscle fibers, some of which are radial and some of which are circular. They are subject to the supervision of the peristaltic nervous system, and their work is involuntary.

**The retina**: It is the inner layer of the eye, and it is characterized by being thin, the thickness of which does not exceed the thickness of a book paper, and it contains ten layers composed of nerve cells, nerve fibers, photoreceptor cells, and supporting tissue. • The retina, which lines the choroid from the back and sides, but does not reach the front.

## The retina consists of two leaves:

1. External pigmentary leaflet

2. Inner nerve leaf

**External pigmented leaflet**

It sticks to the inner surface of the placenta, and its cells contain a black pigment that performs two functions:

1. It makes the hollow of the eye ball dark, thus achieving clarity of vision.

2. It stores large amounts of vitamin A.

## The inner nerve leaflet

It consists of three neuronal layers, separated by two layers of synapses, in order from the outside to the inside:

**1. The layer of visual cells**: they are bipolar neurons, of which there are two types: rods and cones.

**2. The middle layer**: It contains many cell types, especially bipolar neurons.

**3. Inner clips layer**

**4. Nodal layer** and contains multipolar neurons whose fibers form the optic nerve.

**The retina**, including its photoreceptors (protuberance cells and cone cells), converts light rays into (electrochemical) nerve impulses that are transmitted through the optic nerve to the higher brain centers to process them and form an image of the visual objects.

Photoreceptors are of two types: a plant (or rod) cell that helps with night vision and does not distinguish colors; The other type is cone cells that are also sensitive to light and distinguish colors. These two types of cells cover the thin, inner layer of the eye called the retina, and are able to form an image.

The number of cone cells is dense in a spot of the retina called the macula retina. That spot is opposite the lens of the eye, and the rays gather in it at a point called the “fovea” (in English: Fovea); The cone cells in that fovea have the highest sensitivity to form an image of the visual object. And through it, sharp vision takes place.

## Transparent circles of the eye

Light entering the eye passes through four transparent media, which are, in order from front to back:

1. The transparent cornea: It is derived from the sclera layer and is devoid of blood vessels.

2. Aqueous humor: It is a liquid that occupies the anterior chamber of the eye and nourishes the transparent cornea (because it is devoid of blood vessels).

3. The crystal body: It is a biconvex flexible lens.

4. Vitreous humor: It occupies the inner chamber of the eye.

# Ear physiology

The ear in the human body is divided into three main parts, which are the outer ear, the middle ear, and the inner ear, and the combined function of these parts lies in hearing and maintaining body balance. The outer ear is on both sides of the head, while the inner and middle ears are in cavities inside the temporal bones in the skull is on both sides of the head

## Inner ear

The inner ear is located behind the middle ear and is the innermost part of the ear. The inner ear comprises tiny, fluid-filled bony structures that help with hearing and maintaining balance. The function is to process sound. It comes from the inner ear, in addition to any other functions related to vision and memory. It is worth noting that any problems in the inner ear may affect hearing and balance.

Parts of the inner ear / Anatomy of the inner ear

The inner ear consists of three main parts:

**The cochlea**: (in English: Cochlea), is the part responsible for hearing, which contains the hearing nerves. The width of the cochlea is about 9 millimeters at its widest point, and its length is about 5 millimeters. Two parts are filled with fluid, and this membrane is lined with small hairs, and when sound waves reach the ear, the fluids in the inner ear vibrate, and this in turn causes the vibration of small hairs that line the membrane, which leads to sending electrical signals to the brain, which are translated into different sounds

**Semicircular canals:** (in English: Semicircular canals), which is the part responsible for balance, and the semicircular canals consist of three channels, arranged at an angle of 90 degrees from each other, and these channels are filled with fluids and contained in their lining small calcium crystals, in addition to Some small hairs that sense the movement of the fluids in them, and the function of these channels is to help the brain know the direction in which the head is moving.

**The vestibule**: (in English: Vestibule), is the central part that contains balanced receptors and is connected from the front to the cochlea and from the back to the semicircular canals. The vestibule is separated from the middle ear by what is known as the oval window.

## Functions of the inner ear

As mentioned previously, the functions of the inner ear in the human body are summarized in two main functions: hearing and balance, and the following is a description of each:

1- Hearing 2-Balance 3- small hairs covered with a membrane that contains particles of calcium carbonate, which are called otoliths. When a person moves his head, this leads to moving the ear stones on the small hairs, which leads to To stimulates the vestibular nerve, which works to show the position of the head in relation to the rest of the body.

## The skin (anatomy and physiology)

The skin is the natural covering of the human body that envelops and covers it from the top of the head to the toes of the feet, protecting it from the harm of the external factors surrounding it, and protecting it from heat and cold.

It is the largest and widest organ in the human body. Its area, ranges between 1.5 - 2 square meters, and its weight is 15% of the general body weight (i.e. approximately 11 kg).

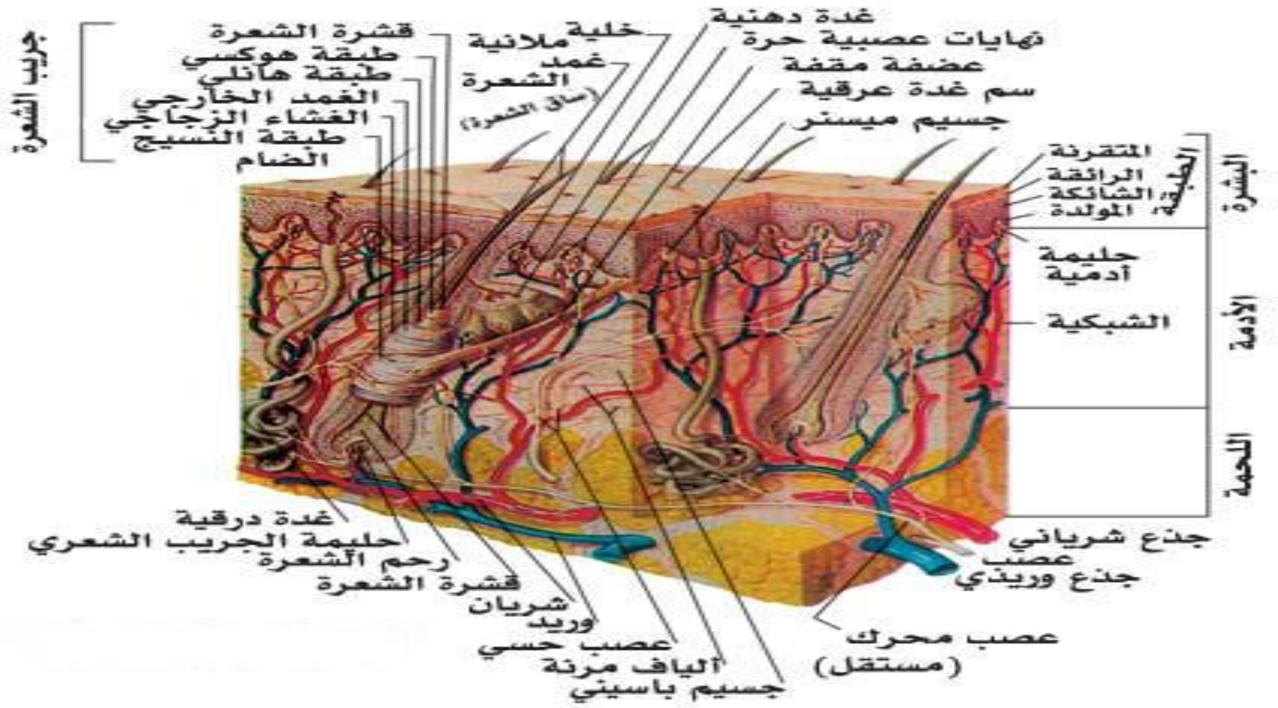
The thickness of the skin varies according to the areas of the body. It is thicker in the skin of the soles of the feet, and thinner in the skin of the eyelids and glans.

As for its color, it varies according to race and region, just as the same color differs, for the same person, according to the areas of the body and the extent of their exposure to the sun and light.

### Skin anatomy

The skin consists of cells and fibers that are interconnected to form a strong, flexible and resistant tissue. It is rich in blood and lymphatic vessels, nerve fibers, sensory and tactile corpuscles, hairs, sebaceous glands, sweat glands, and arrector muscles.

Each group of similar skin cells, stacked next to each other regularly, forms a homogeneous




layer, or forms several layers stacked on top of each other.

The histological section of the skin, from top to bottom, consists of three distinct layers:

The epidermis is the visible surface layer، The dermis is the dermis that is closely connected to the epidermis.، The hypodermis is the deep layer following the dermis and mixing with it.

**1- The epidermis:** It is known as the epithelial layer, and it is very thin, with a thickness of approximately 0.25 mm, and it consists of cells lined up and identical to each other in the form of groups. Each group of these identical and homogeneous cells forms a distinct layer. They are from bottom to top:

**A - The basal layer. B - The prickle layer. C - Stratum granulosum.**

These three layers are known as the living epidermis or Malbecian layer.

**d - stratum Str. Lucidum e - stratum corneum Str. corneum**

These two layers are known as dead or scaly epidermis.

And spread between the cells of the basal layer cells called melanocytes or pigment cells, which are responsible for the formation of melanin, which gives the skin its natural color.

**2- The dermis:** It is known as the true skin. It is approximately 2 mm thick, lies just below the epidermis, and adheres closely to it. It is divided into two distinct parts: the superficial dermis or papillary layer, and the deep dermis or reticular layer.

**3- The hypodermis or (hypodermis**): It is the layer of tissue under the skin, and it consists of the elements of the dermis itself, and of fat cells that form the lining of the skin.

**The mesenchyme** is connected to the dermis so closely that the two layers cannot be separated from each other.

The hypodermis contains blood and lymphatic vessels that reach the dermis and provide nourishment to the skin. It also contains cutaneous nerves and touch particles.

**The cutaneous nerves** are sensory, motor, excretory and feeding nerves, or blood vessel nerves, and are distributed in the parenchyma and dermis.

As for the sensory nerves, they end in the dermis or epidermis, either in the form of free nerve endings, or in the form of endings that carry various sensory organs (touch, pressure, heat, cold, pain, and itching).

## Skin physiology

The skin is the mirror that clearly reflects the healthy state of the body, and it is the published page on which you read the events and changes that occur in the whole organism, what is visible and what is hidden.

Looking at the skin, it is possible to extrapolate by open observation the condition of the various organs and what happens to them, such as heart lesions, liver injuries, biliary tracts, gland lesions, and central and peripheral nerve injuries, whose manifestations are reflected on the skin, by changing its color or the appearance of skin lesions on it.

The skin has major functions that are specific to it and not other organs, namely:

Sensation, touch, protection, prevention, thermoregulation, external secretion, internal secretion, absorption, and fluid retention.

**1- Sense and touch:** The skin is the sense organ, and it is the mediator between the external environment and the central nervous system, as the nerve endings and sensory bodies emanating from the layers of the skin transmit various sensations of cold, heat, pain, itching and pressure to the cerebral cortex.

**2- Protection and prevention**: The skin is the natural covering of the human body, so it protects the body and protects it from harmful external influences, whether mechanical, physical, chemical or bacterial.

It is a poor conductor of heat, so it protects the human body from extreme heat and cold and maintains a constant temperature. The stratum corneum is an mpenetrable shield against the entry of harmful germs.

3- **Heat regulation:** The skin plays an important role in regulating body temperature, either through increased sweating in the case of extreme heat and fever, or through decreased sweating in the case of low internal body temperature.

4- **Exocrine secretion of the skin**: It includes the secretion of sweat and fat and the excretion of keratinized cells.

**A- Sweat secretion:** This secretion is carried out by the sweat glands that are abundantly spread on the surface of the skin. Through sweat, a person excretes a lot of toxic waste, water and salts, which helps regulate electrolytes and body heat.

**B- Sebum secretion:** this secretion is mediated by the sebaceous glands of the skin. It is of great importance in the safety of the skin, as it gives it softness, and prevents the growth of many pathogenic germs due to its acidic reaction (the pH of the skin is between 5 and 3 pH).

**C- Excretion of keratinized cells:** The dead keratinized superficial epidermal cells are shed either spontaneously by their desquamation, or by means of water and detergents.

**5- Internal secretion of the skin:** It includes:

**A- Melanocytes** in the skin and hair form melanin, which is the natural pigment of human skin and hair.

**B- Keratinocytes** form keratin, which is the main constituent of the epidermis.

**C- The mast cells** present in the dermis have a significant role in regulating blood clotting and the secretion of histamine.

**D- Finally,** the skin synthesizes vitamin D, with the effect of ultraviolet radiation.

**6- Absorption capacity of the skin**: Some volatile medicinal substances, such as chloroform and ether, are easily absorbed by the skin. Therefore, this characteristic is used to introduce medicinal substances into the body through the skin.The skin also absorbs gases such as oxygen and carbon dioxide, which helps the lungs to breathe.

7- Preserving fluids: This function is performed by the stratum corneum, which is semi-permeable, preventing the loss of fluids contained in the layers of the skin.