

Haematology



Blood

- The blood consists of a suspension of special cells in a liquid called **plasma**.

- In an adult man, the blood is about **1/12th** of the body weight and this corresponds to **5-6 litres**.

- Blood consists of 55 % plasma, and 45 % by cells called formed elements.

Function Of Blood

❑ **Respiratory Function:** By means of the **Hb** contained in the R.B.Cs, it carries **O₂** to the tissues and collects the carbon dioxide (**CO₂**).

❑ **Nutritive & Excretory Functions:** It also conveys nutritive substances (e.g. amino acids, sugars, mineral salts) and gathers the excreted material which will be eliminated through the **renal filter**

❑ Regulator Function: the blood also carries hormones, enzymes and vitamins.

❑ **Defensive Function:** It performs the defense of the organism by mean of the **phagocytic activity** of the **leukocytes**, the **bactericidal power** of the serum and the immune response by **lymphocytes**.

BLOOD CONSTITUENTS

(A) 45 % Hematic Cells

(B) 55 % Plasma

Blood Constituents

- **55% Plasma.**

- **45% Hematic Cells.**

The Plasma

- **Liquid (90%)**
- **Solid materials (10%)**

Solid Materials are:

- 9 parts of organic materials.

e.g. protein, amino acids, carbohydrate, lipid, hormones & Vitamins.

- 1 part of non organic materials.

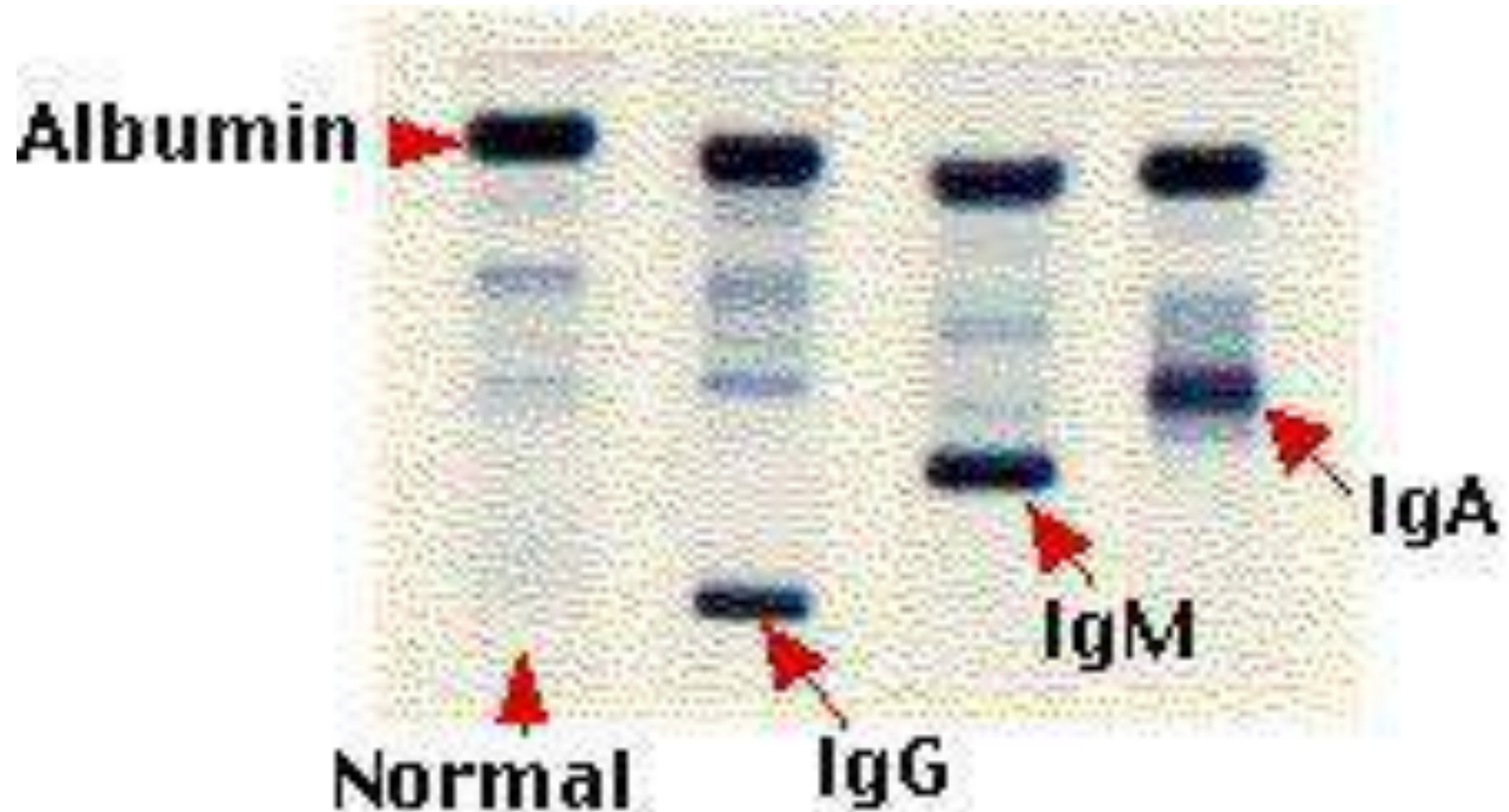
e.g anions and cations.

Serum Proteins

- Serum is blood plasma **without fibrinogen** and **other clotting factors**. Proteins make up 6–8% of the blood.

- They are about equally divided between **serum albumin** and a great variety of **serum globulins**.
- The serum proteins can be separated by **electrophoresis**.

Serum protein separated by electrophoresis.



Serum Lipids

- Serum lipids are related to cardiovascular disease, the analysis of serum lipids has become an important health measure.

Total cholesterol is the sum of

- HDL cholesterol
- LDL cholesterol and
- 20% of the triglyceride value

The following table shows the range of typical values of serum lipids

LIPID	Typical values (mg/dl)	Desirable (mg/dl)
Cholesterol (total)	170–210	<200
LDL cholesterol (bad)	60–140	<100
HDL cholesterol (good)	35–85	>40
Triglycerides	40–160	<160

- From the various values, we can calculate a cardiac risk ratio.

-

Cardiac risk ratio = Total cholesterol

divided by

HDL cholesterol

- A cardiac risk ratio greater than **7** is considered a warning.

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Serum differs from blood as it lacks

- (a) antibodies
- (b) clotting factors.
- (c) albumins
- (d) globulins

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This plasma protein is responsible for blood coagulation

- (a) Fibrinogen.
- (b) Globulin
- (c) Serum amylase
- (d) Albumin

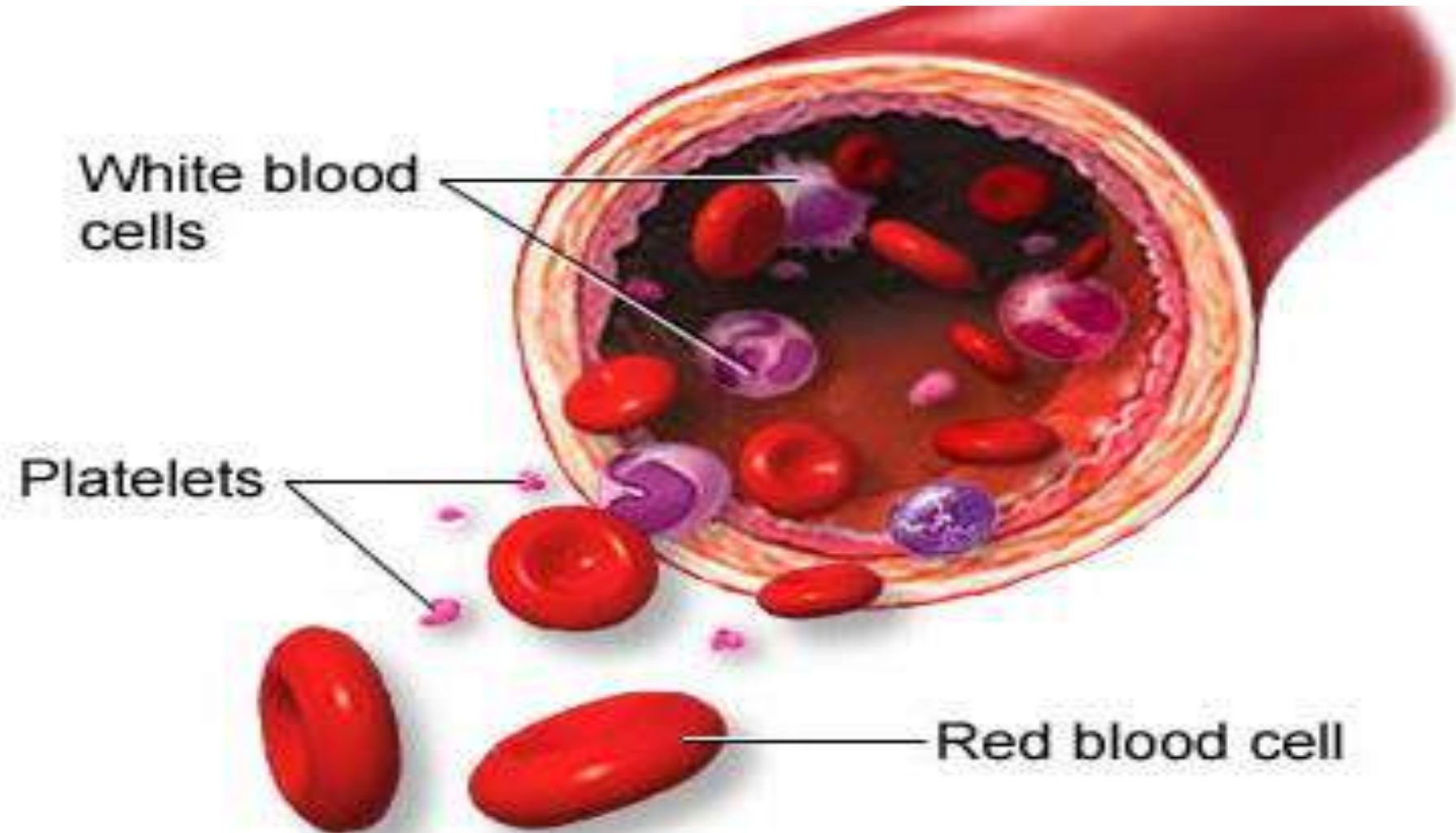
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DNA is present in following except:

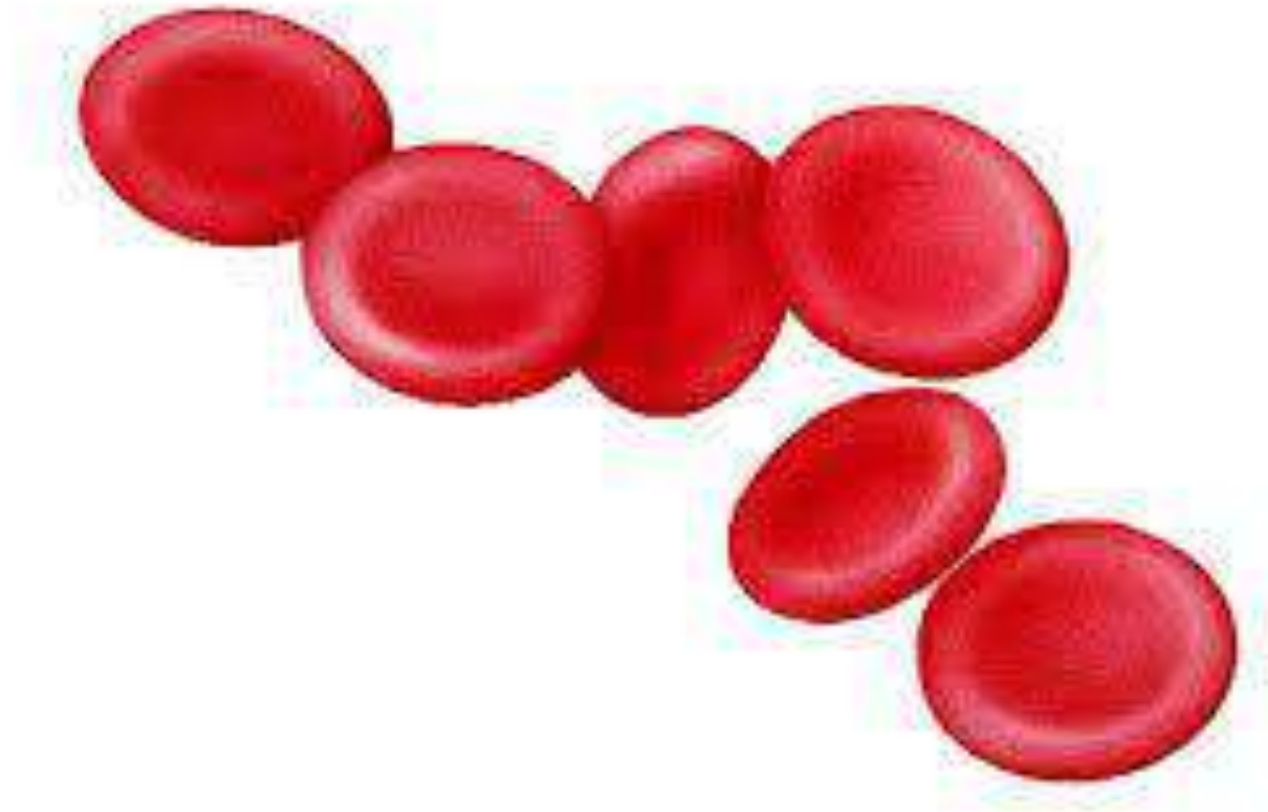
- (a) an enucleated ovum
- (b) hair root
- (c) a mature spermatozoa
- (d) mature RBCs.

The Hematic Cells

Haematic Cells Of Blood



Erythrocytes



- The **erythrocytes** are the most numerous blood cells i.e. about **4-6 millions/mm³**.
- Normal RBCs have a **diameter** of **6 - 8 μm** .

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In the dried form, the red blood cells exhibit a diameter of

- 1-4 μm ,
- 6-8 μm .
- 7-9 μm ,
- 3-8 μm ,

Globulins of the blood plasma are responsible for:

- (a) defence mechanisms.
- (b) blood clotting
- (c) oxygen transport
- (d) osmotic balance

- In all mammals, **erythrocytes** are **devoid** of a **nucleus** and have the shape of a **biconcave** lens.



- The lack of **nucleus** allows more room for **Hb** and the biconcave shape of these cells raises the surface and cytoplasmic volume ratio for more efficient the diffusion of **O₂**.

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Immature RBCs of mammals have:

- No nucleus.
- Single beaded nucleus,
- Many nuclei,
- Single nucleus,

N.B.: Like mature red blood cells, in mammals, reticulocytes do not have a cell nucleus.

- The mean life of **erythrocytes** is about 120 days.
- When they come to the end of their life, they are retained by the **spleen** where they are phagocytosed by **macrophages**.

Erythropoiesis

- The body must have a way to maintain the concentration of erythrocytes in the blood.
- The mechanism of erythropoiesis occurs in the following way:

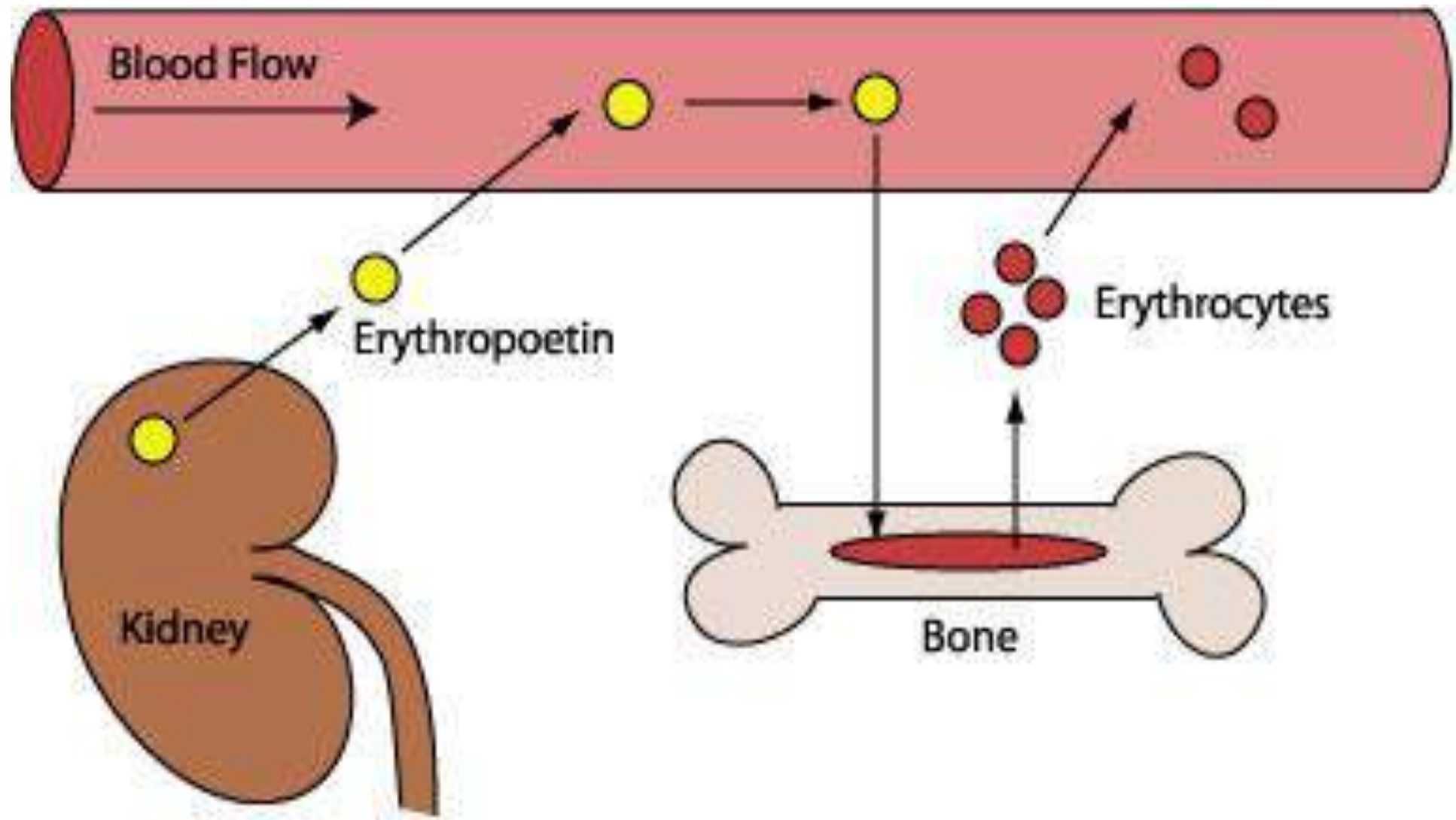
- **If oxygen** levels are **low** then the kidney secretes **erythropoetin** hormone.
- The **red bone marrow cells** have **erythropoetin receptors** which respond to the erythropoetin.

- Erythropoetin stimulates the production of erythrocytes in the bone marrow.
- These erythrocytes leave the bone marrow and move into the blood stream.

❑ As the erythrocyte population increases, the oxygen carrying capacity of the blood increases.

❑ When the kidney senses that oxygen levels are adequate, it responds by slowing the secretion of erythropoetin.

Role of erythropoietin in erythrocytes production



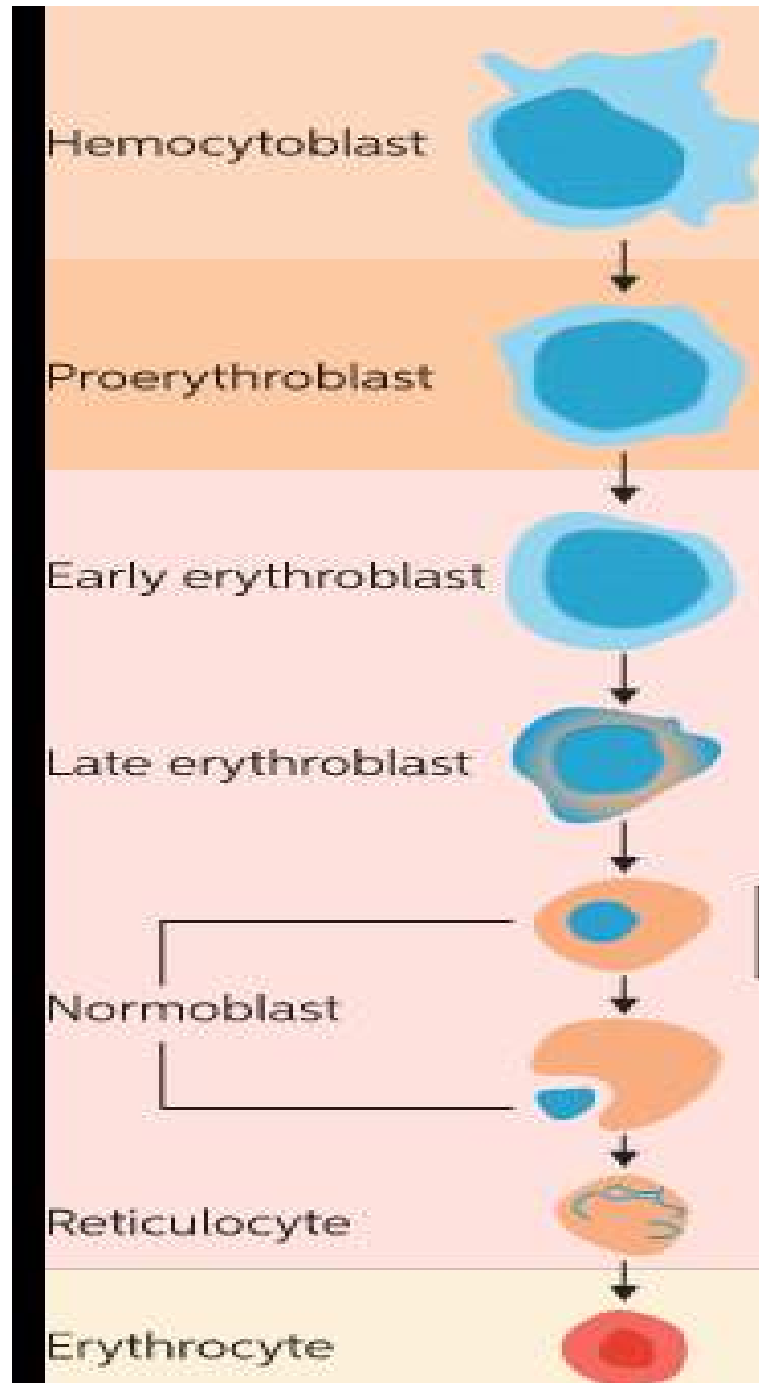
Production Of Erythrocyte

Production of new erythrocyte takes 4 days.

- **Hemocytoblasts:** Stem cells in the bone marrow from which all blood cells form.
- **Proerythroblasts:** They are produced by the division and differentiation of stem cells.
- **Early erythroblasts:** During this stage in erythropoiesis hemoglobin synthesis begins.

- **Intermediate erythroblasts:** At this time, the accumulation of hemoglobin due to its continued synthesis.
- **Late erythroblasts:** During this stage the **nucleus** is **extruded** from the cell.
- **Reticulocyte:** These cells exhibit a net-like appearance or reticulum in their cytoplasm when stained.
- **Mature erythrocytes:** At the final stage of maturation there is a **loss** of **ribosomes**. These cells enter the circulation.

- **Hemocytoblasts:**
- **Proerythroblasts:**
- **Early erythroblasts:**
- **Intermediate erythroblasts:**
- **Late erythroblasts:**
- **Reticulocyte:**
- **Mature erythrocytes:**



Factors Stimulating RBC Production

- Hemorrhage.
- Damage to bone marrow.
- Exposure to high altitude.
- Exercise.
- Hemolytic disease.
- Low hemoglobin levels.

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Red cell count is carried out by:

- Electrocardiogram,
- Haemocytometer.
- Haemoglobinometer,
- Sphygmomanometer,

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Formation of red blood cells is called:

- Haemocytosis
- Haemolysis
- Haemopoiesis.
- Haemocytosis

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Number of RBCs in man increase on living at high altitude, because:

- There is more oxygen,
- There is less oxygen.
- There is no germs in the air,
- More heat is needed,

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The hormone erythropoietin stimulates red blood cell production in the red bone marrow. Where in the body is erythropoietin produced?

- Spleen
- Kidney.
- Liver
- Thyroid

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Which of the following statements about erythrocytes is correct?

- **a)** They fight infection
- **b)** They clot blood
- **c)** They lack a nucleus.
- **d)** They are produced in the spleen

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Where does haematopoiesis take place?

- **a)** Lungs
- **b)** Pancreas
- **c)** Liver
- **d)** Bone marrow.

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Haemopoiesis is a process of the production of

- (a) Blood plasma
- (b) Erythrocytes.
- (c) Bone marrow
- (d) Haemoglobin

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What does erythropoietin control?

- a. Rate of erythrocyte production.
- b. Rate of leukocyte production
- c. Rate of myloid production
- d. Rate of stem cell production

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What part of blood is responsible for carrying oxygen and carbon dioxide to body cells?

- a. Red Blood Cells.
- b. White Blood Cells
- c. Platelets
- d. Plasma

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The red blood cells are of Shape.

- a) Biconcave
- b) Monoconvex
- c) Triconcave
- d) Squarence

Aging of Erythrocyte

- **A typical mature erythrocyte lives for about 120 days in the circulation.**
- **They cannot divide or synthesize new cellular components (lack a nucleus).**

- As a result, the cells degenerate due to aging and damage.
- In many chronic diseases, the lifespan of the red blood cells is reduced.

Breakdown Of Erythrocytes

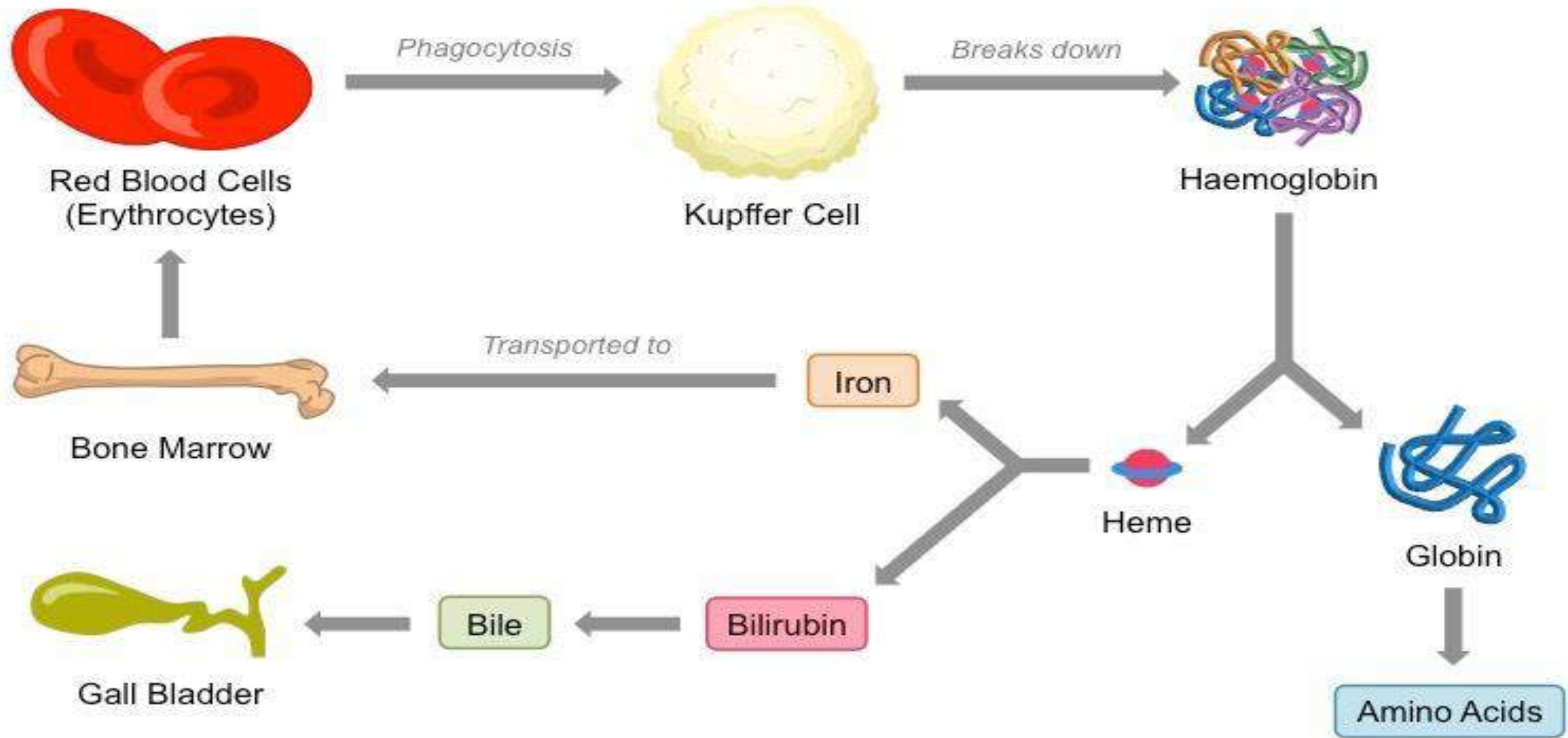
Old damaged cells are removed from the circulation in the following ways:

- About 90% of cells are removed from the circulation by the **phagocytic activities** of **macrophages** in the **liver, spleen** and **lymph** nodes and due to the action of lysosomal enzymes of macrophage.

- **The Hb of these cells is degraded into:**
- **Globin** utilized as amino acids and released into blood.
- **Heme** molecules go through a series of changes into **biliverdin** then bilirubin.
- Bilirubin forms a **complex** with blood albumin (**bound bilirubin**) & released into blood.

- In the liver cells the bound bilirubin reacts with **glucuronic acid** to form **conjugated bilirubin**.
- Iron is removed from heme molecules & it binds to the protein **transferrin** and is carried to the **bone marrow** to synthesize **new Hb**

Erythrocyte Recycling



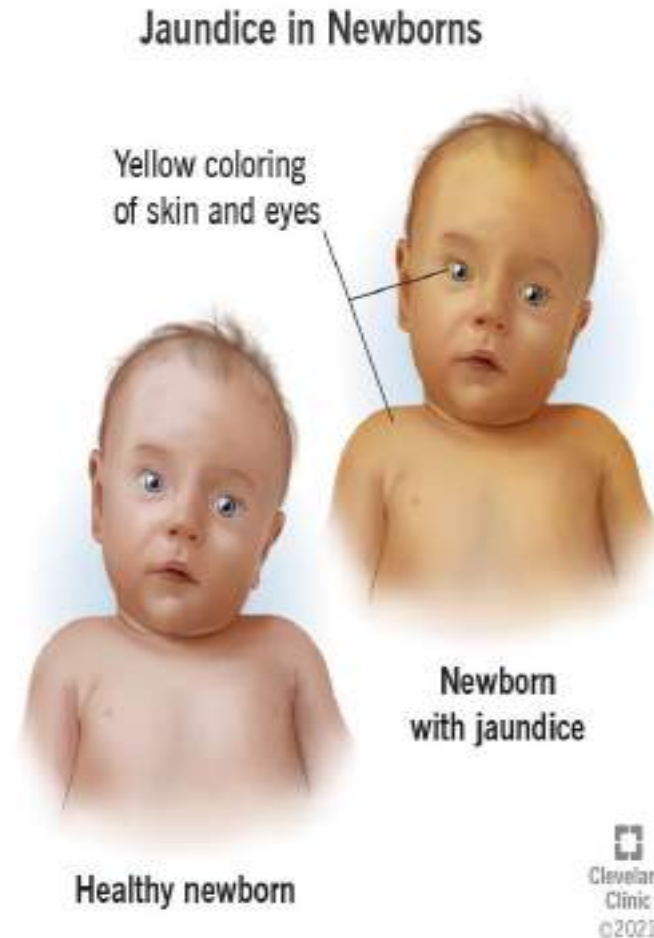
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What happens to the iron (Fe) that is released during the breakdown of damaged RBCs?

- (a)** It is used to synthesize proteins
- (b)** It is transported to the liver where it becomes part of the bile
- (c)** It is converted into urobilin and excreted in urine
- (d)** It attaches to transferrin and is transported to bone marrow.

Jaundice

It is a yellowish staining of the integument and sclera of the eyeball due to an accumulation of bile pigments. The chief causes of jaundice are:



- An increased rate of **erythrocyte breakdown** e.g., sickle cell anemia or **erythroblastosis fetalis**.
- **Obstruction in the biliary system** as blockage of the bile ducts (as **gall stones**).
- **Liver damage** as in **hepatitis**, **cirrhosis** and **liver cancer** .



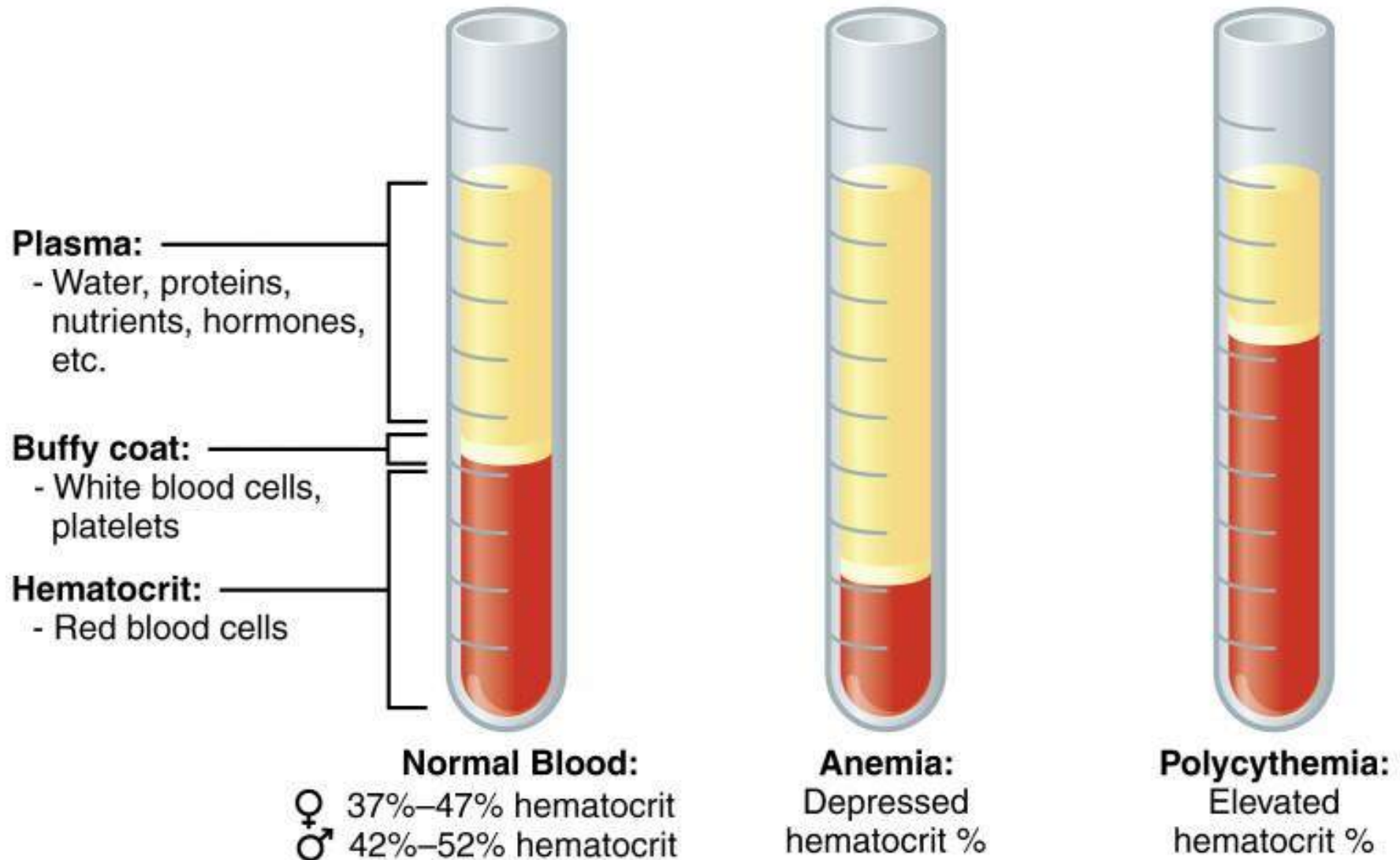
Hematocrit

- If whole blood is placed into a graded tube and centrifuged, the cells and the plasma will separate.

- Normally it is approximately 45%.
- Values much lower than this are a sign of [anemia](#)

- The **erythrocytes**, which are heavy, will pack into the bottom of the tube, the plasma will be at the top of the tube, and the **leukocytes** and **platelets** will form a thin layer (buffy coat) between the **erythrocytes** and the **plasma**.

Detrmination of Hematocrit



Platelets

- Platelets appears roundish in shape, they are not real cells.
- Their diameter is **2-3 μm** about.
- They are much smaller than erythrocytes. Their density in the blood is **200000-300000 /mm³**.
- The main function of platelets, or thrombocytes, is to stop the loss of blood from wounds (hematostasis).

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What is not considered a leucocyte?

- a. Lymphocyte
- b. Monocyte
- c. Neutrophil
- d. Thrombocyte.

- Platelets aggregate and release factors which promote the blood coagulation.



- Among them, there are the **serotonin** which **reduces** the **diameter** of **lesioned vessels** and **slows down the hematic flux**, the fibrin which trap cells and forms the clotting.

Blood Clotting & Haemostasis

- The process of blood clotting and then the subsequent dissolution of the clot, following repair of the injured tissue, is termed **hemostasis**.
- **Hemostasis**, composed of 4 major events:

- The initial phase of the process is vascular constriction (limits the flow of blood) .
- Next, platelets become activated by thrombin and aggregate at the site of injury, forming a temporary, platelet plug.

- **Upon activation, platelets release TXA2 , serotonin, phospholipids, lipoproteins, for the coagulation.**

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Which of the following will not coagulate when placed separately on four slides?

- a) Blood serum.
- b) Blood plasma
- c) Blood from pulmonary vein
- d) Blood from lymphatic tissue

N.B.: Blood serum does not contain **fibrinogen**.

مِنْهُ لَاحِقٌ لِّلْكَافِرِينَ لَئِيْلَ مَا كَانُوا يَفْعَلُونَ

لَا يَخْلُقُ أَشْيَاءَ مُّشَابِهَةً لِّمَا يَخْلُقُ أَفَلَا يَرْجِعُونَ

Respiration and

Respiratory System

Respiratory System

1- Upper Respiratory Tract

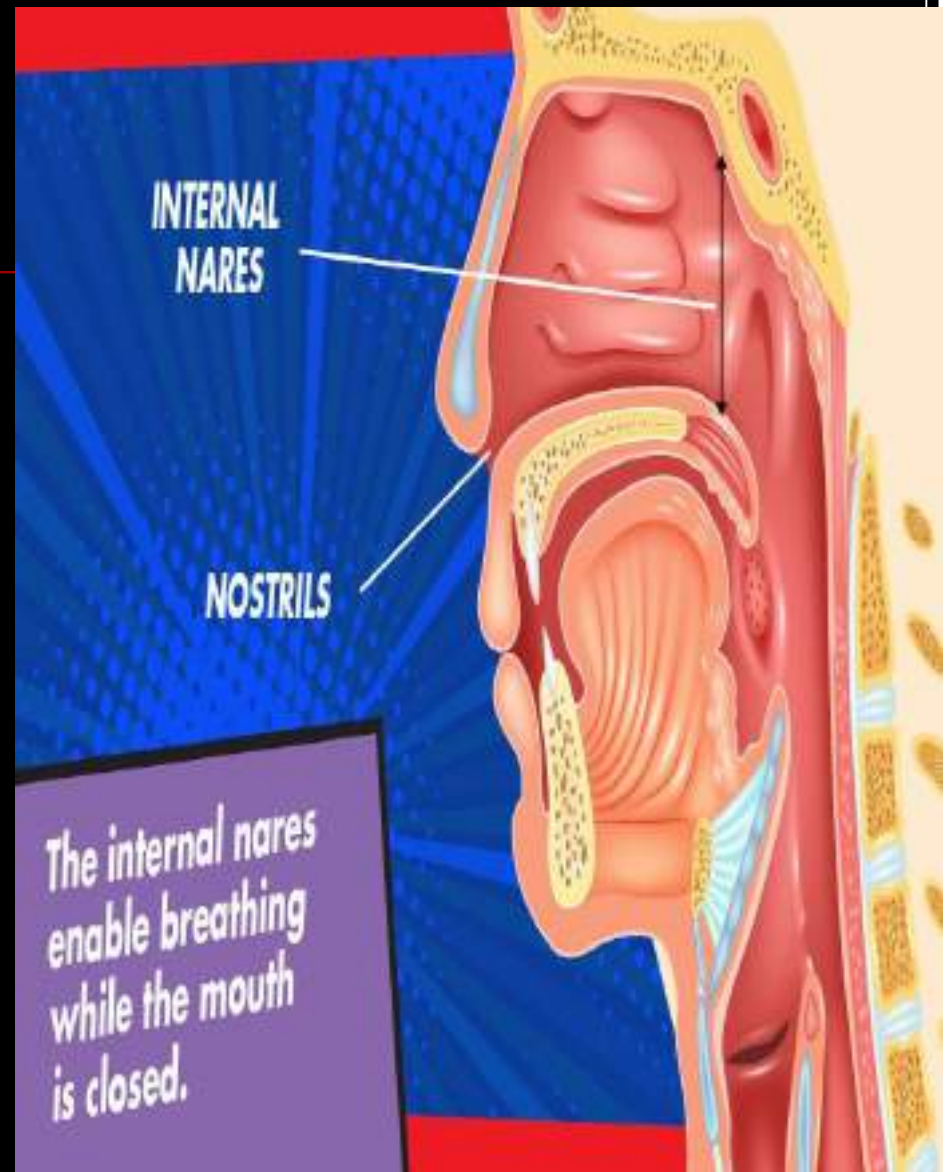
2- Lower Respiratory Tract

1- Upper Respiratory Tract

- Nares .
- Nasal Cavities .
- Pharynx.
- Glottis.
- Larynx .

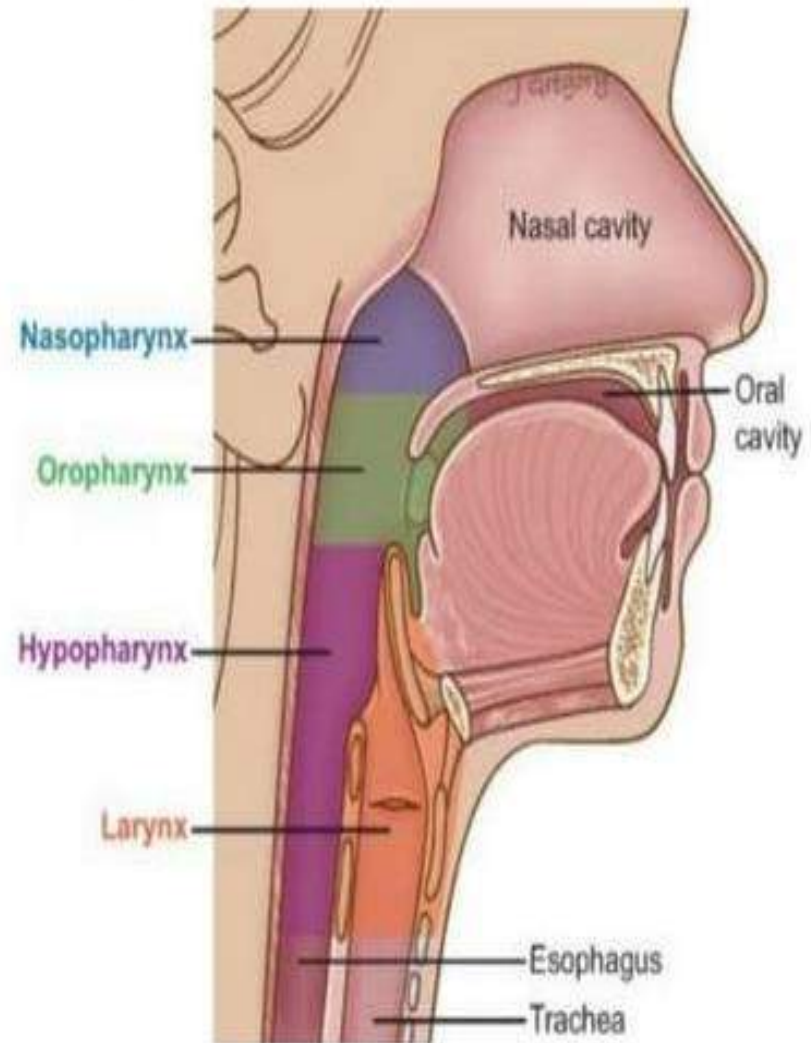
Nares

- They enable the entry and exit of air and other gasses through the **nasal cavities**.



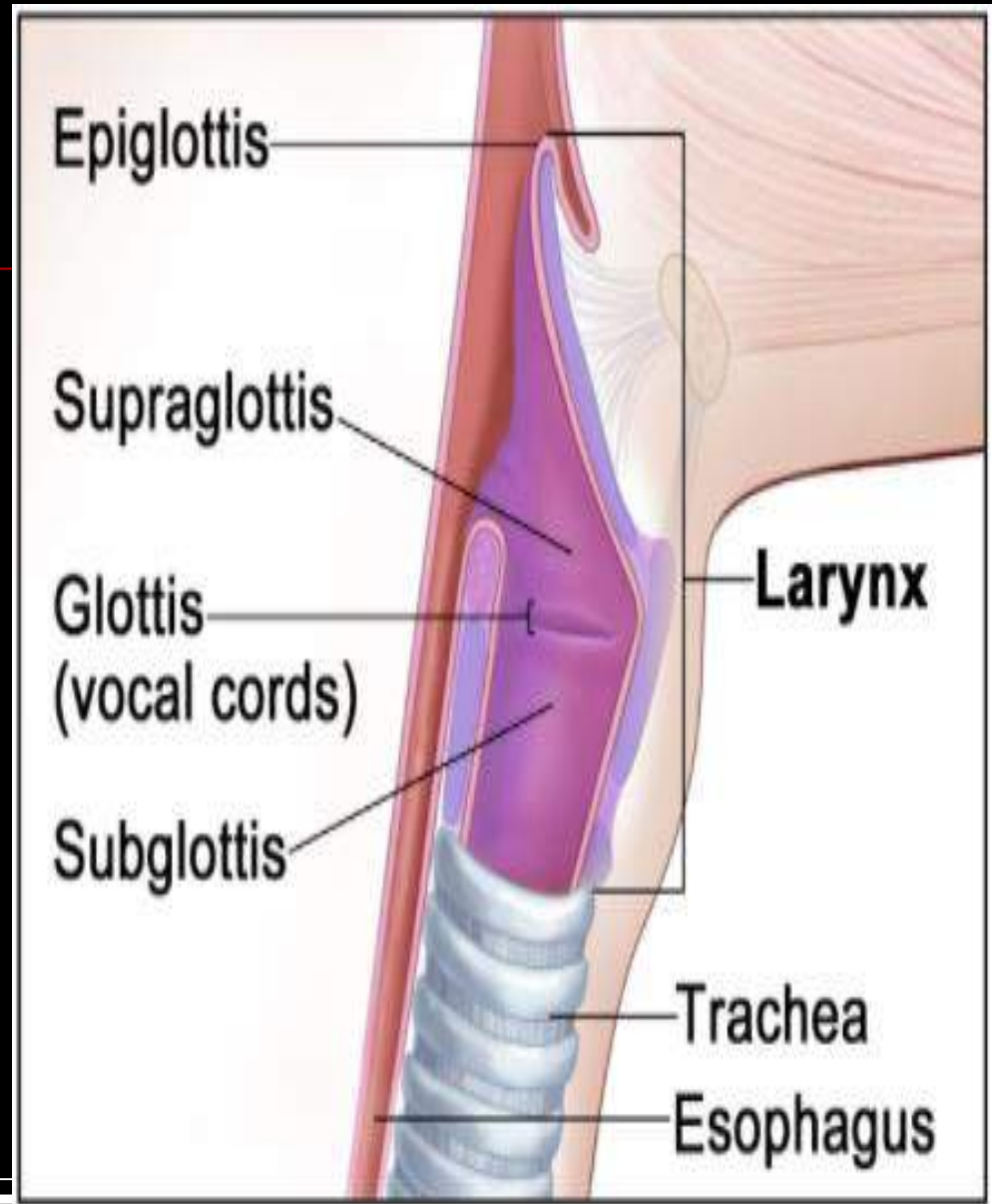
Pharynx

- The **pharynx** is the part of the **throat** behind the **mouth** and **nasal cavity**, and above the **esophagus** and **trachea**.



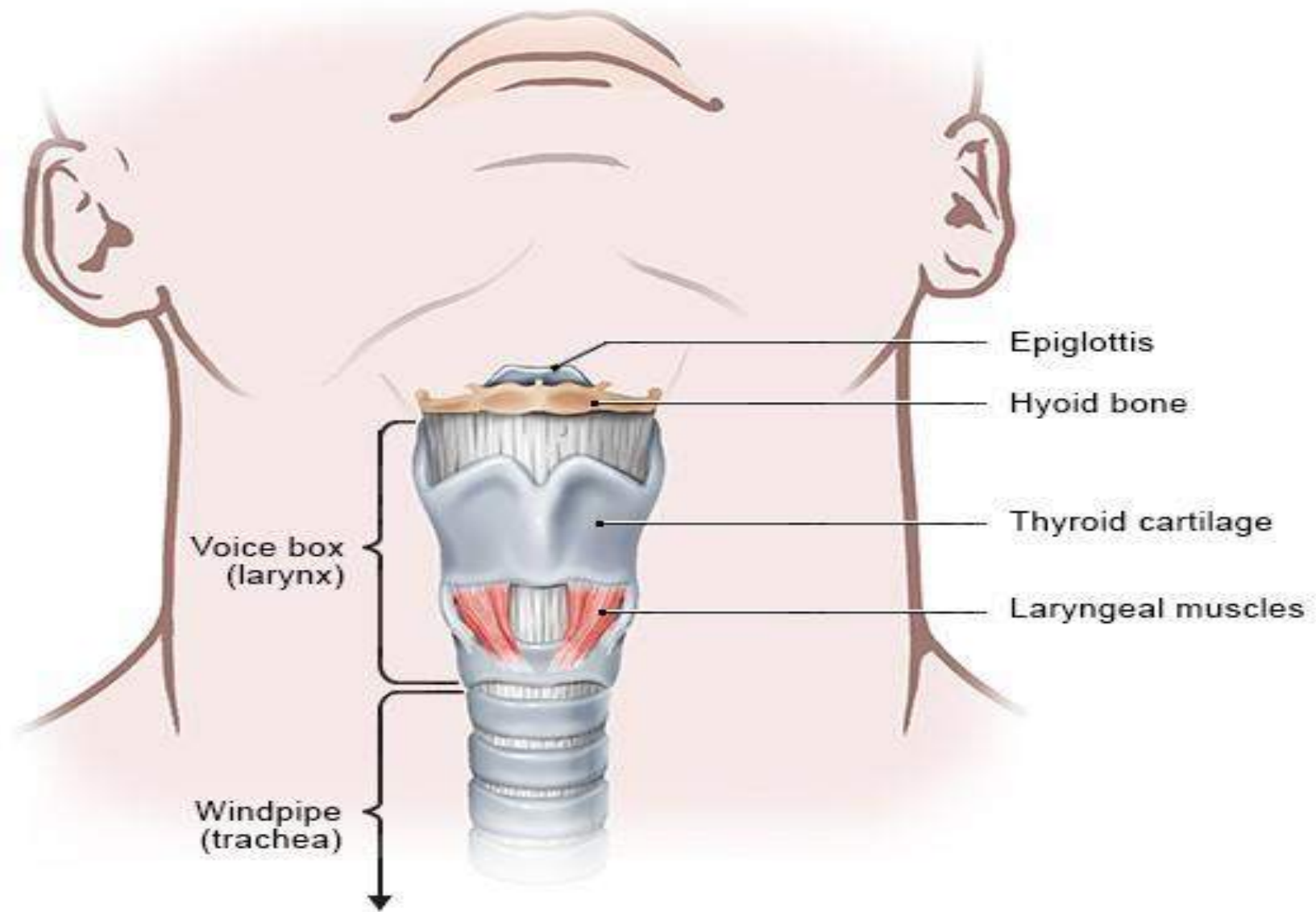
Glottis

- The **glottis** is the area between the vocal cords, which connect the airways in your throat to your lungs.



Larynx

- The **larynx** commonly called the **voice box**, is an **organ** in the top of the **neck** involved in breathing, producing sound and protecting the **trachea** against food aspiration.



2- Lower Respiratory Tract

- **Trachea.**
- **Bronchi.**
- **Bronchioles.**
- **Lungs .**

Upper & Lower Respiratory System

Upper Respiratory Tract

Nasal Cavity

Pharynx

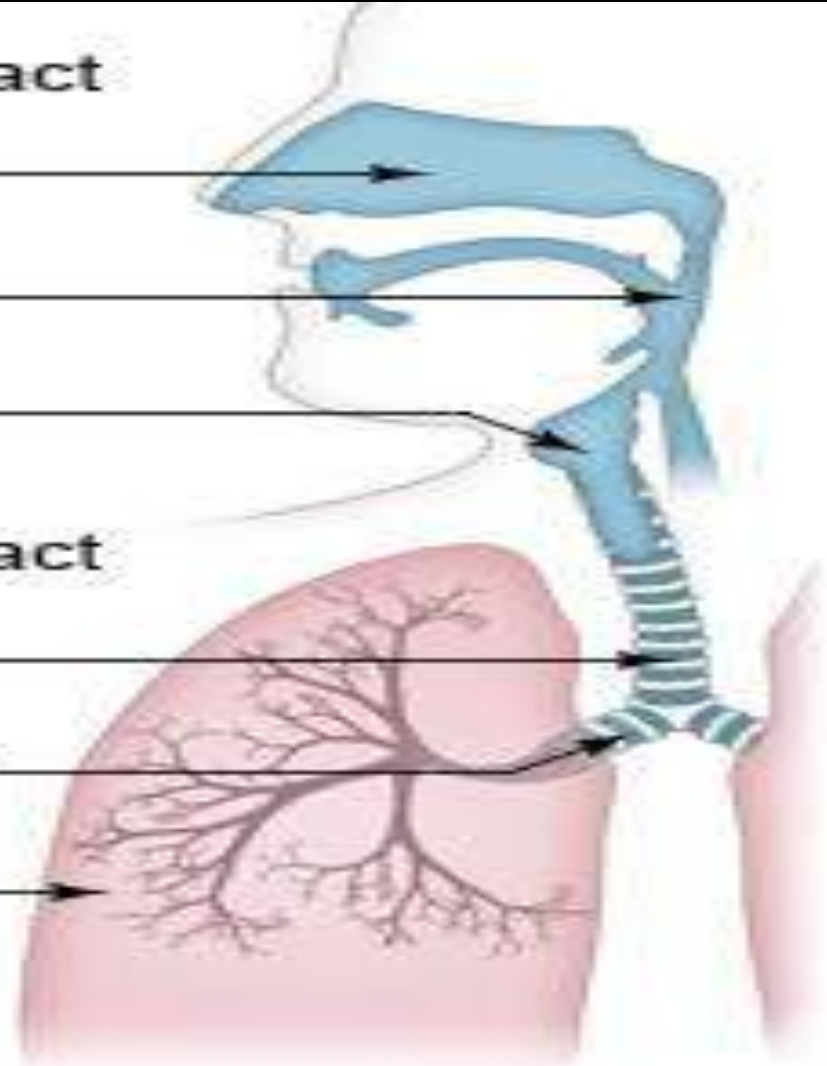
Larynx

Lower Respiratory Tract

Trachea

Primary Bronchi

Lungs



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**Function of larenx are the followings
Except:**

- A- Breathing
- B- Prevent food of entering trachea
- C- Creating vocal sounds
- D- **Secreating enzymes for digestion.**

MCQ

Which of the following are parts of the human respiratory system?

- (a) Trachea
- (b) Diaphragm
- (c) The lungs
- (d) **All of the above.**

Meaning Of Respiration

- Respiration means “repeated breathe”.

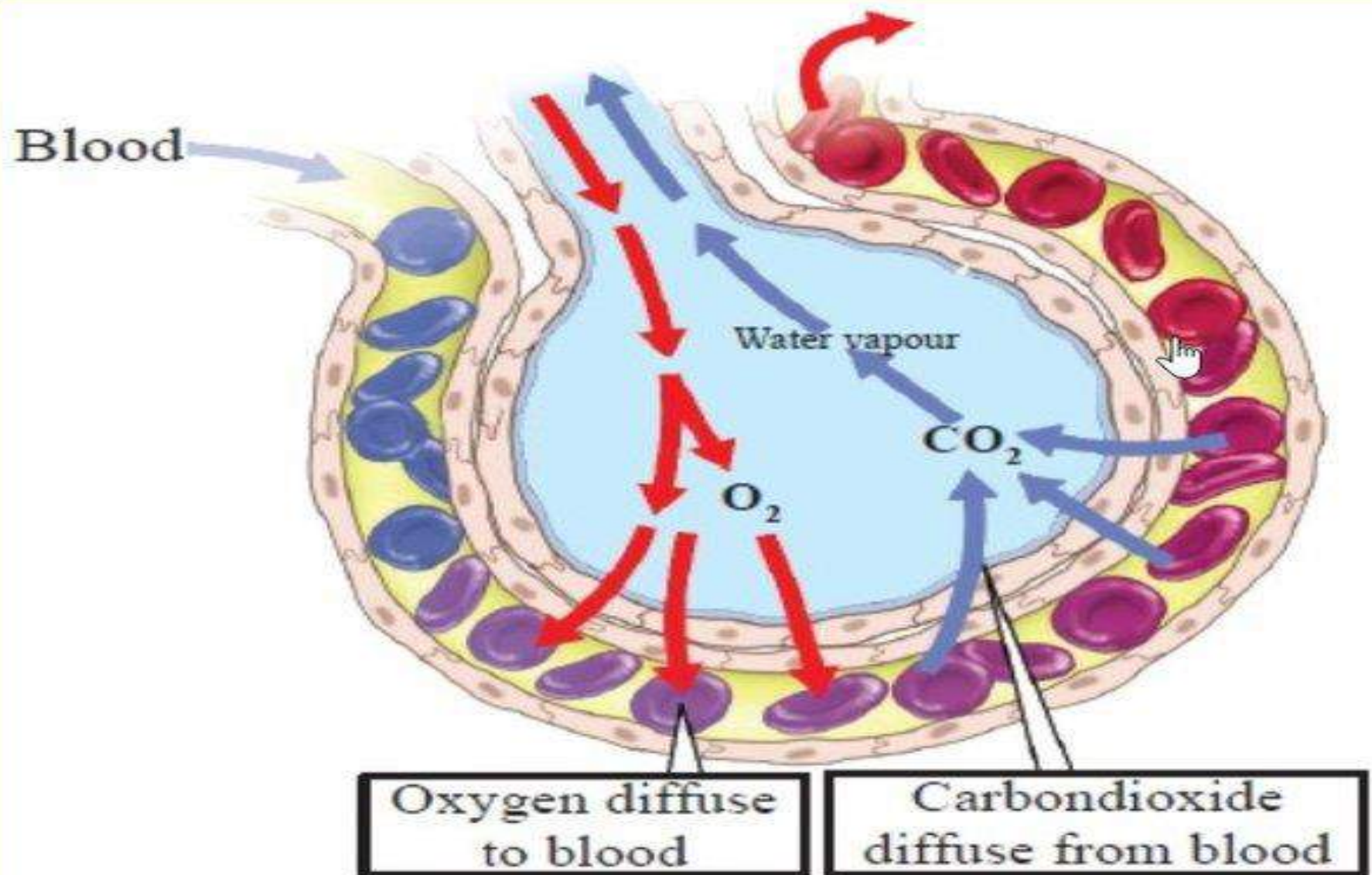
-
- Respiration is necessary to supply all parts of the body with O_2 and to get rid of the produced CO_2 .

-
- Insufficient of O₂ supply, cells are unable to produce enough energy for normal functions.

■ Accumulation of CO₂
leads to acidosis.

In respiration process

- The O₂ is derived from the atmosphere (21% O₂).
- The O₂ is exchanged in the body by the respiratory surface (alveoli).
- The alveoli in the lungs serve as the surface for gas exchange.



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Which of the following gas is released out during the process of respiration?

- (a) Oxygen
- (b) Hydrogen
- (c) **Carbon dioxide.**
- (d) None of the above

Gas exchange in humans can be divided into five steps:

- Breathing
- External Respiration
- Internal Respiration
- Cellular Respiration

a- Breathing

- Breathing consists of two phases:

1- Inspiration
and
2- Expiration

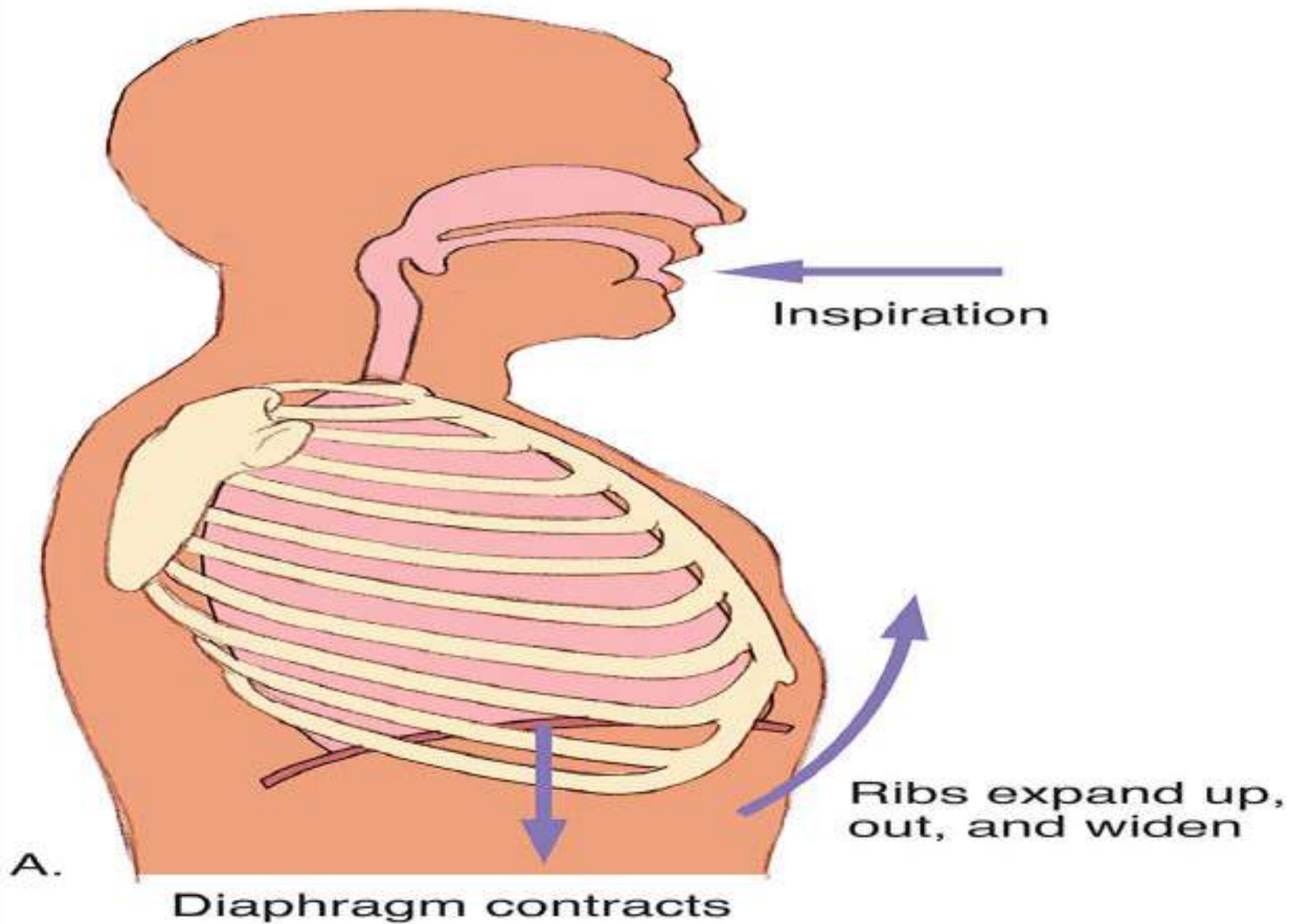
1- During Inspiration

- The diaphragm and the intercostal muscles contract.

- The diaphragm moves downwards increasing the volume of the thoracic cavity,
-

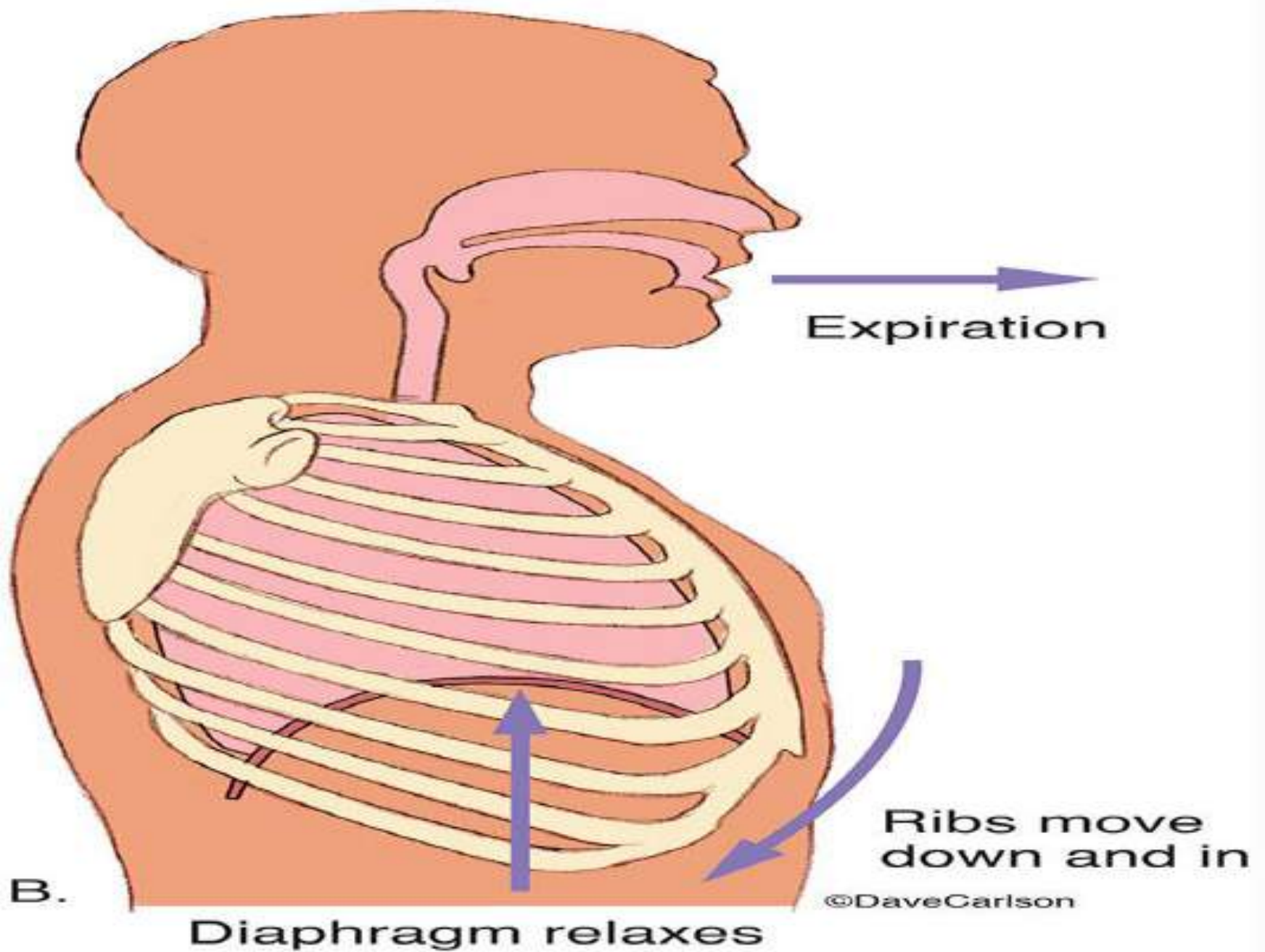
■ **And**

- The intercostal muscles
-
- pull the ribs up
expanding the rib cage
and further increasing
this volume.



2- During Expiration

- The diaphragm and intercostal muscles relax. This returns the thoracic cavity to its original volume, increasing the air pressure in the lungs, and forcing the air out.



b- External Respiration

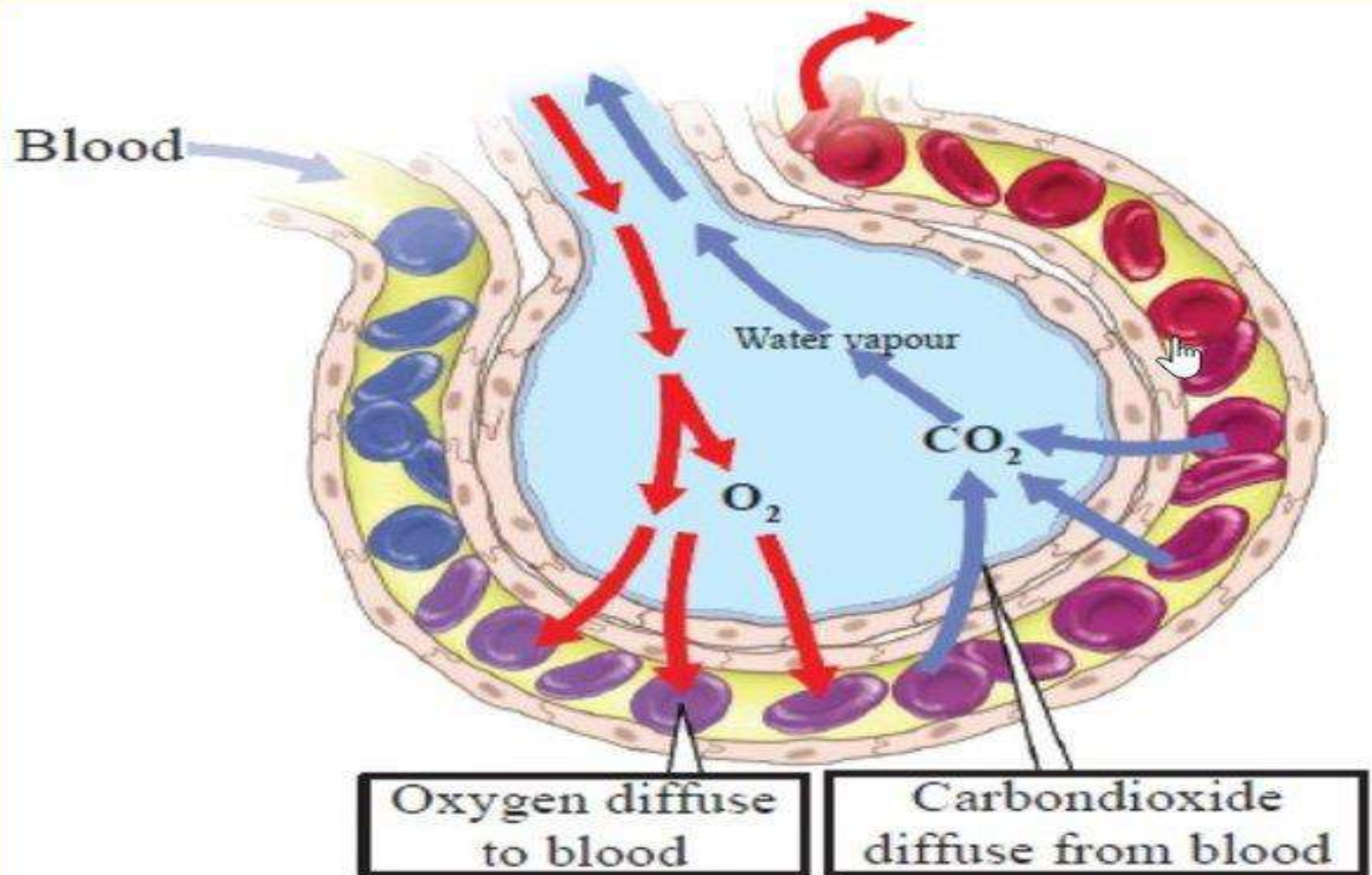
- It is the exchange of gases between the air in the alveoli and the blood within the pulmonary capillaries.
- A normal rate of respiration is 10-20 breaths per minute.

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A normal rate of respiration is:

- A- 40-50 breaths/ min
- B- 5-15 breaths/ min
- C- 10-20 breaths/ min.**
- D- Not of the above

- In external respiration, gases diffuse in either direction across the walls of the alveoli.
- Oxygen diffuses from the air into the blood and carbon dioxide diffuses out of the blood into the air.



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The exchange of gases between the external environment and the lungs_____.

- (a) Respiration
- (b) **External respiration.**
- (c) Cellular respiration
- (d) None of the above

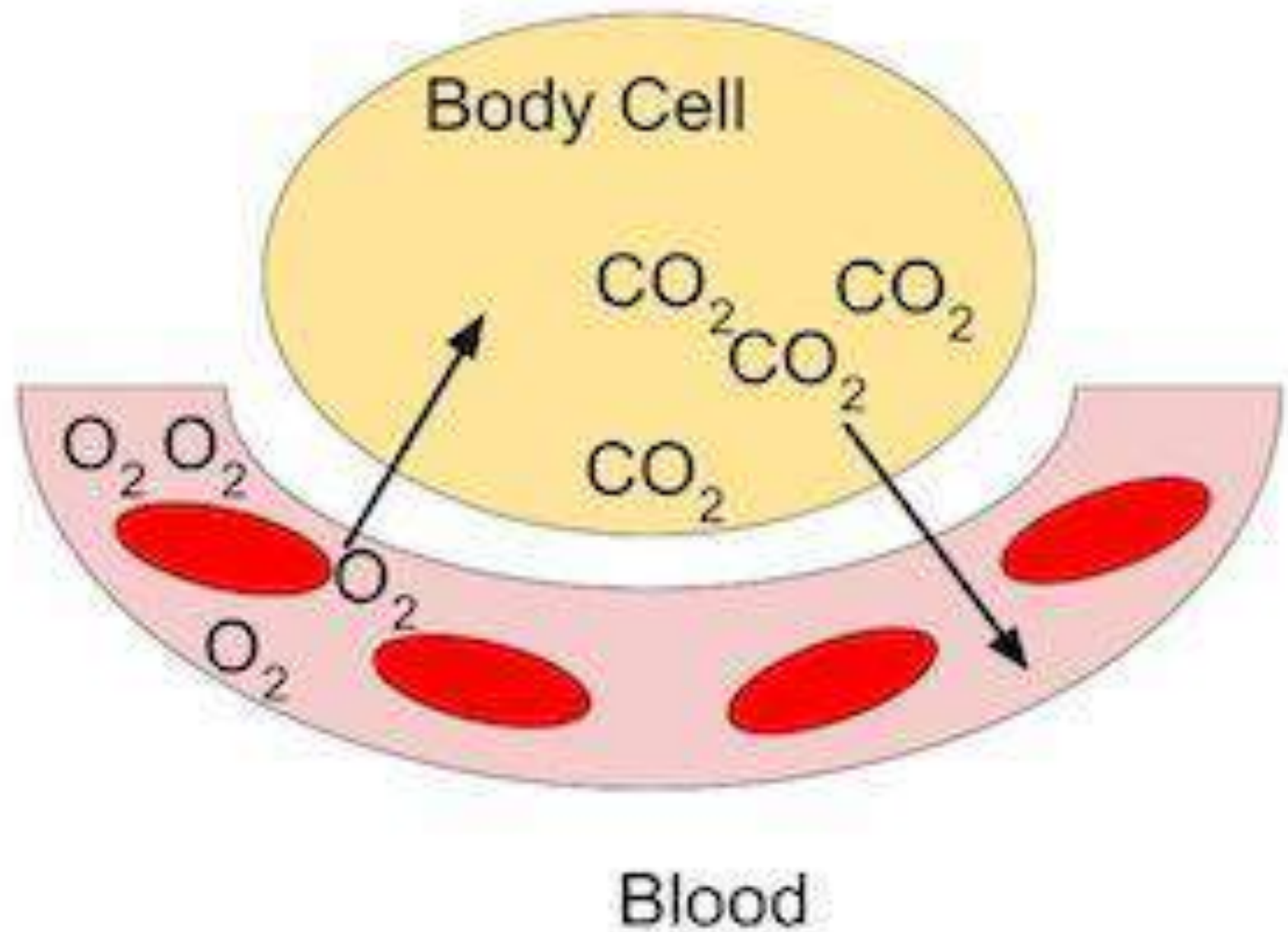
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Which of the following organs functions as an air conditioner?

- (a) Larynx
- (b) Pharynx
- (c) Nasal chambers.
- (d) All of the above

c- Internal Respiration

- Internal respiration is basically the exchange of gasses between the blood in the capillaries and the body's cells by **simple diffusion**.



d- Cellular Respiration

- The red blood cells contain hemoglobin that carries oxygen. The hemoglobin will give up the oxygen to the cell where it will be used for cell metabolism (fig.).

The release of energy during cellular respiration



energy released

glucose + oxygen  carbon dioxide + water



Control Of Respiration

- Respiration is regulated by **CO₂, hydrogen and O₂.**

■ High CO₂ or hydrogen causes bronchodilation

whereas low CO₂ causes bronchoconstriction.

■ This mechanism regulates the diameter of the bronchioles and thus airflow.

- Also, O₂ stimulate chemoreceptors located in the **carotid** and **aortic bodies**, these in turn transmitt nervous signal to the respiratory center.

MCQ

Which of the following is correct for the partial pressure of oxygen in alveoli?

- (a) Less than carbon dioxide
- (b) Less than the blood
- (c) **More than the blood.**
- (d) Equal to that of the blood

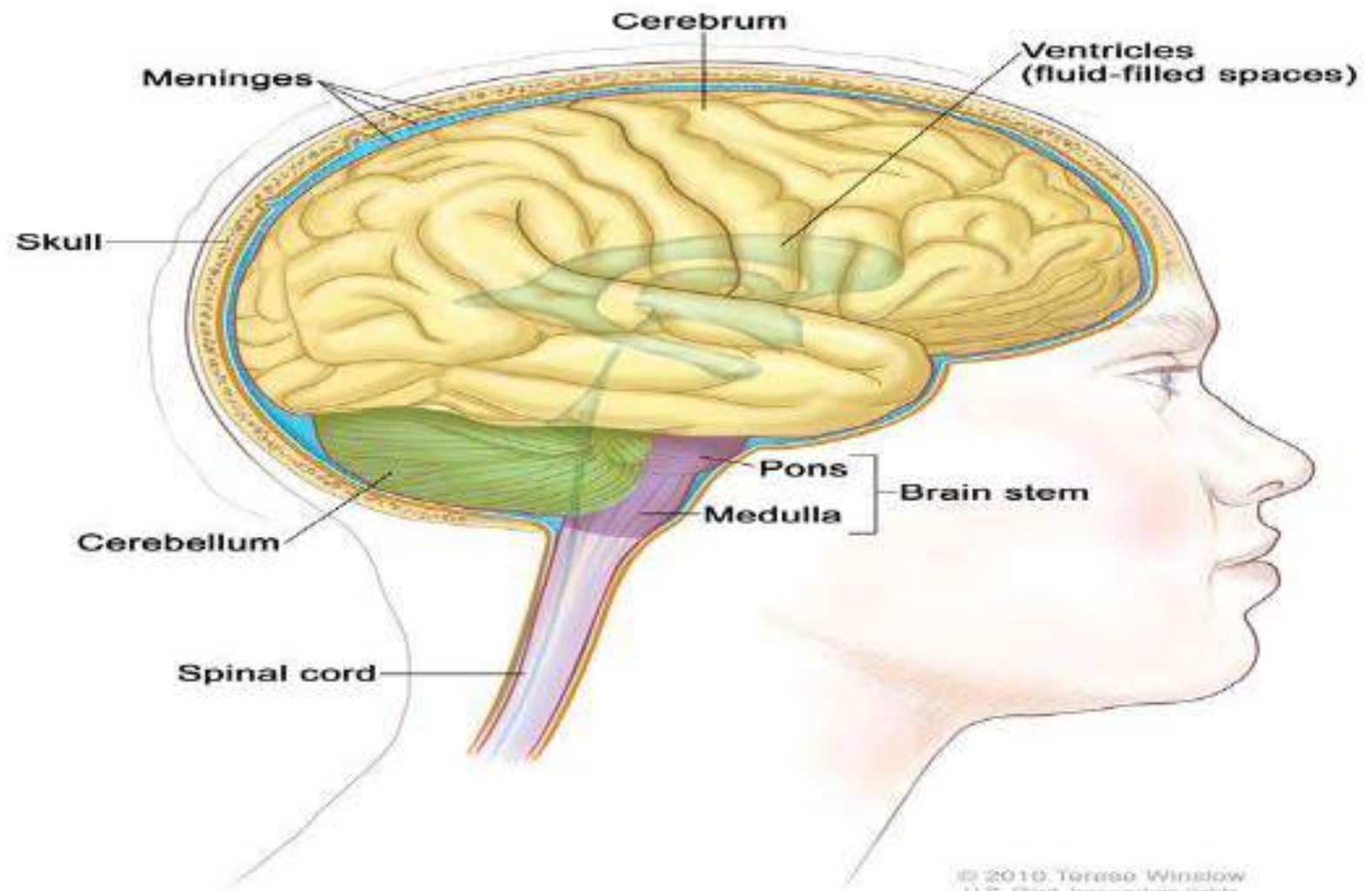
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Most of the carbon dioxide produced in the tissues is transported to the lungs as

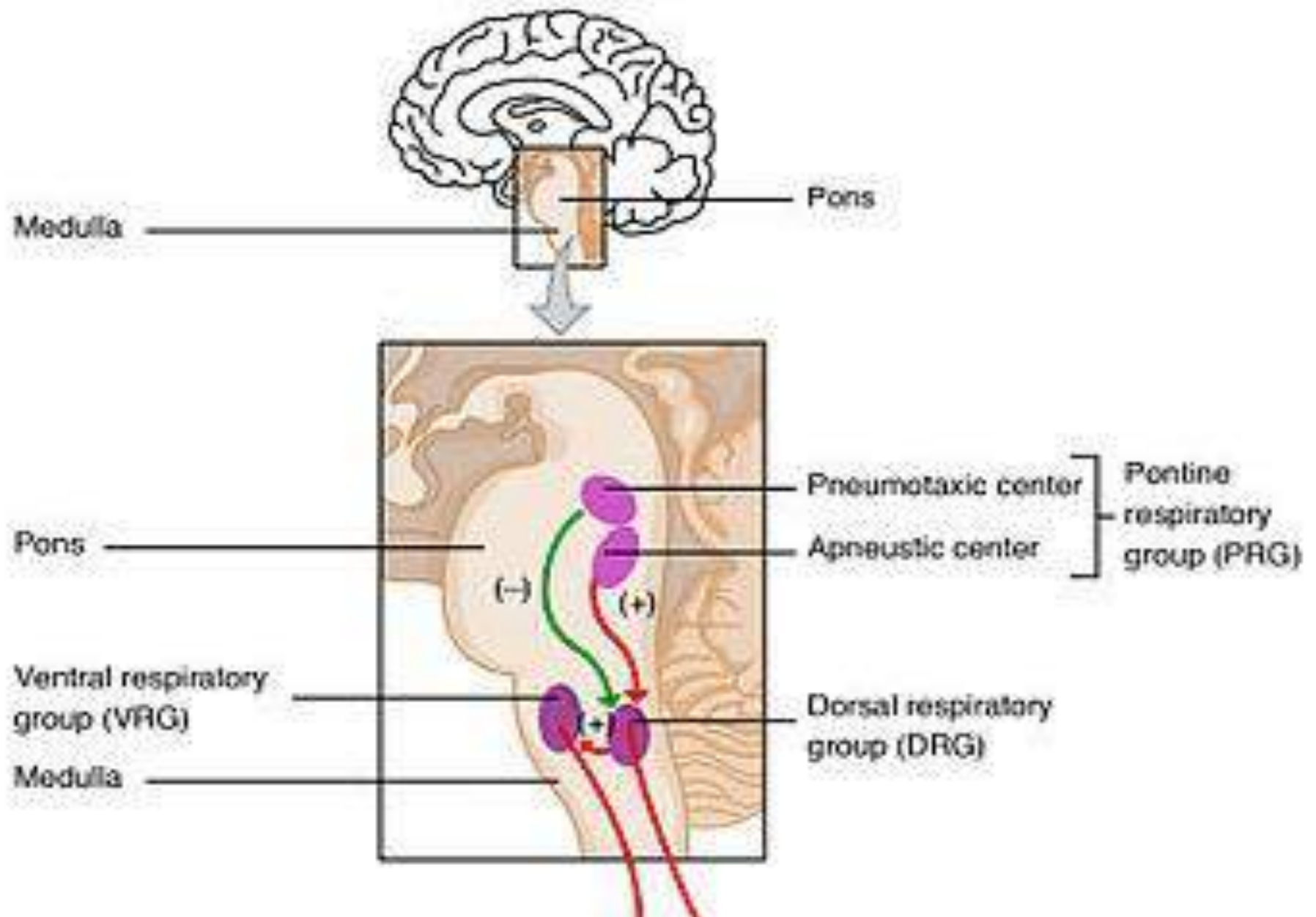
- (a) Carbonates
- (b) **Bicarbonates.**
- (c) Dissolved in the blood
- (d) Attached to haemoglobin

Respiratory Centers Of The Brain

- The involuntary control of respiration is mediated by the brain's respiratory centers located in the brainstem in the medulla oblongata and pons .



- **A dorsal respiratory center, located in the dorsal portion of medulla which causes inspiration.**
- **A ventral respiratory center located in the ventral portion of medulla causing inspiration or expiration**



- Also, the pneumotaxic and apneustic areas located in superior portion of the pons.
- These centers regulate the alternative rhythmic cycles of inspiration and expiration

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The normal breathing process is controlled by _____.

- (a) Lungs
- (b) Ventral respiratory group
- (c) Dorsal respiratory group
- **(d) Both (b) and (c).**

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Which of the following parts of the brain regulates the respiratory process?

- (a) The vagus nerve
- (b) Cerebral peduncle
- (c) **Medulla oblongata.**
- (d) Cerebellum

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The gaseous exchange in alveoli is a type of

- (a) simple diffusion.
- (b) osmosis
- (c) active transport
- (d) passive transport