RBCs (characters and function)

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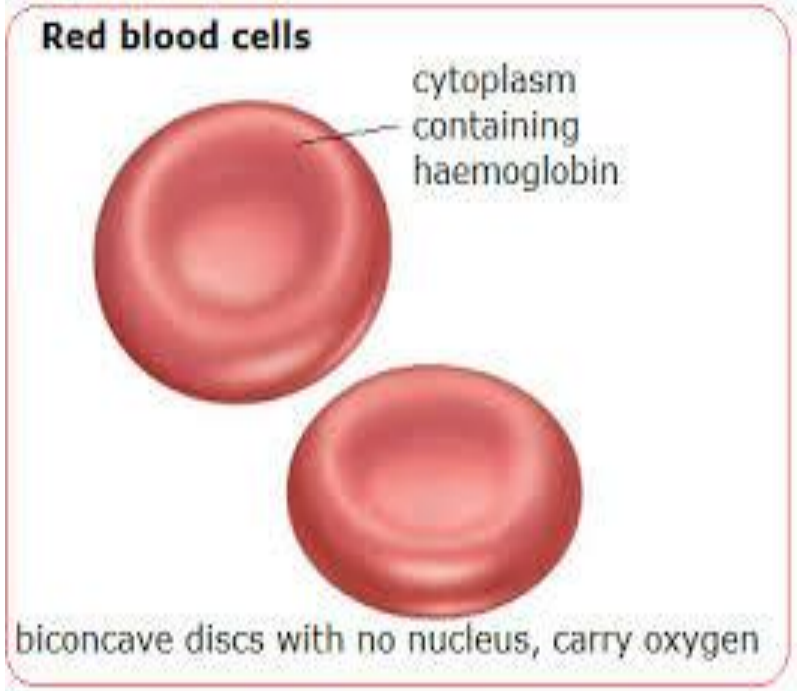
Red Blood Corpuscles (Erythrocytes)

- These are non-nucleated circular biconcave discs containing the red respiratory pigment (hemoglobin) and have an average life span of 120 days..
- The concentration of hemoglobin in R.B.Cs is 34%. The chief ion inside R.B.Cs is potassium (K+) also it contains carbonic anhydrase enzyme

and glucose-6-phosphate dehydrogenase (G-6-PD).Erythrocytes have **no** mitochondria. Therefore, they obtain their energy requirements from anaerobic glycolysis.

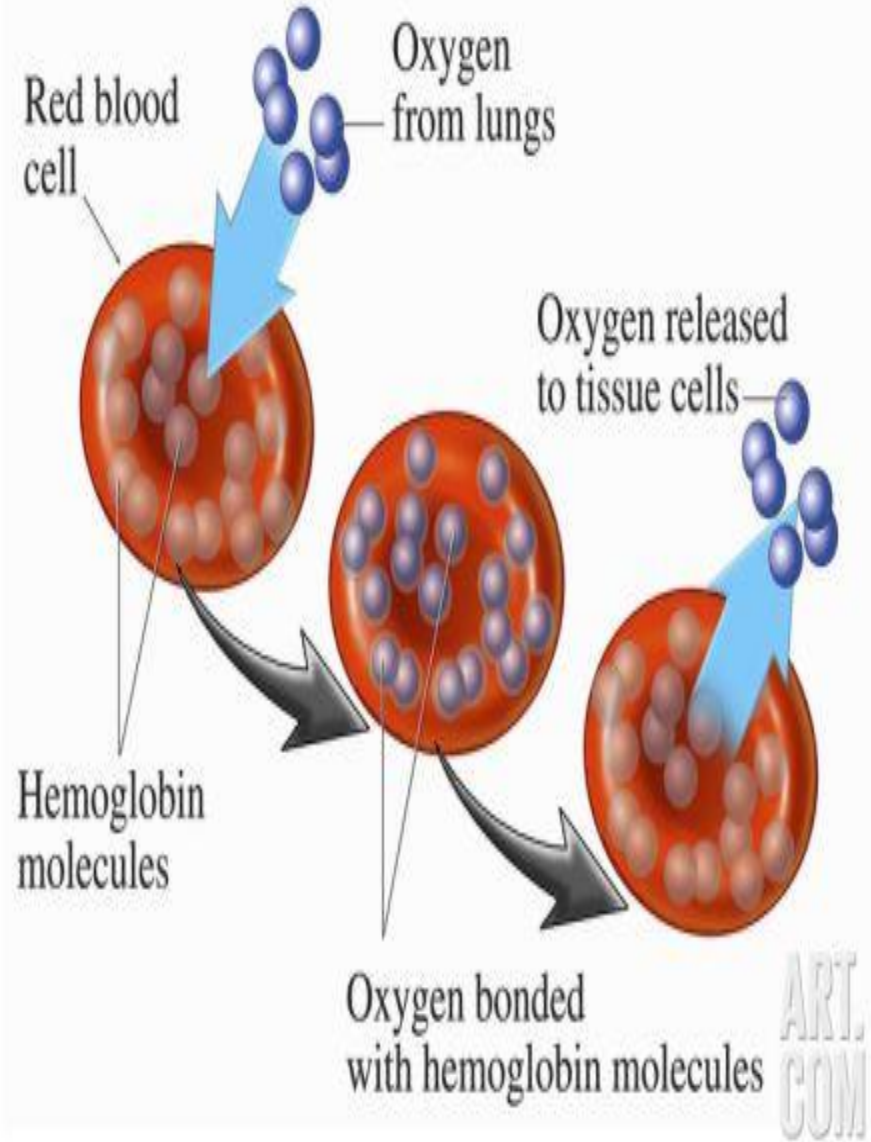


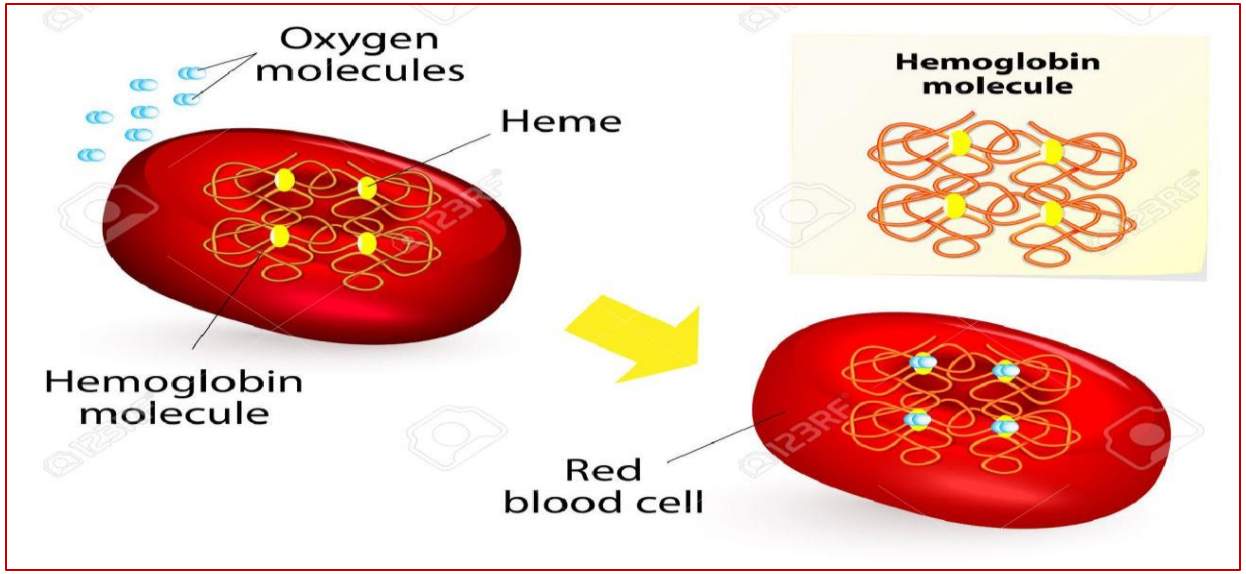
➢R.B.Cs Count:

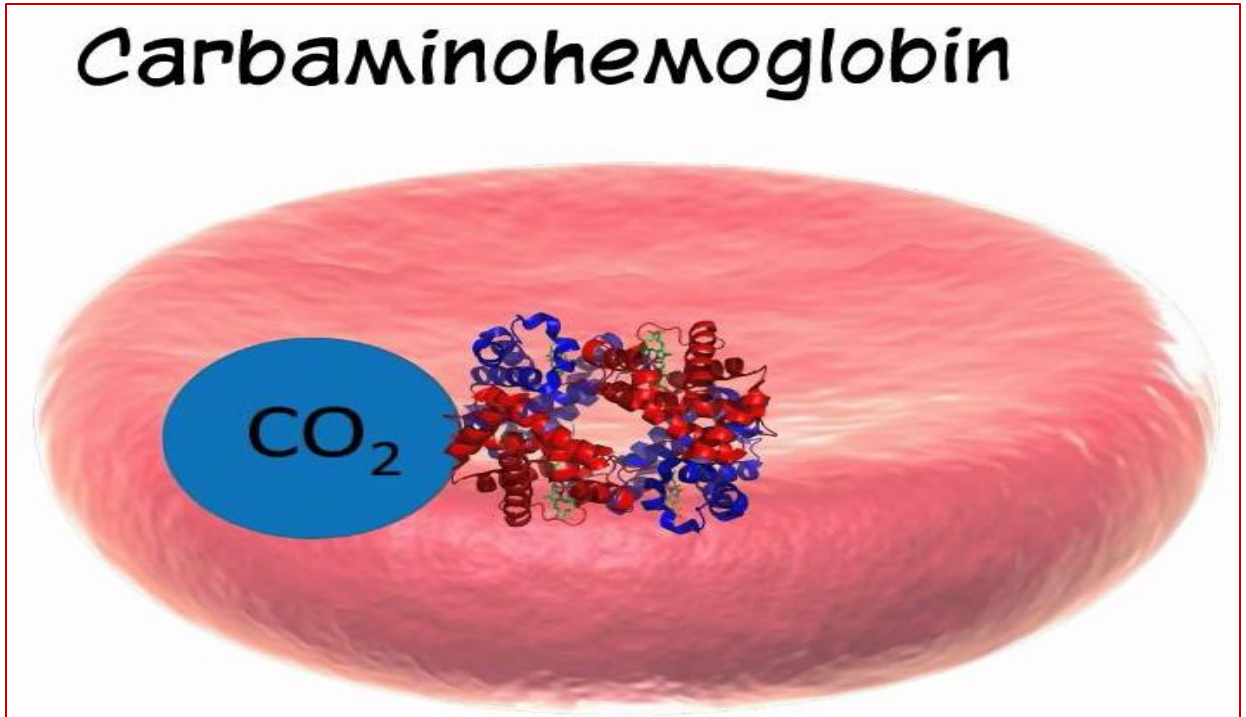
- **In adult males 5-6 million per cubic mm** (due to androgen hormone that stimulate its formation & increase male musculature which need more oxygen).
- **In adult females 4-5 million per cubic mm** (due to menstruation).
- **In newly born: 7 million per cubic mm** (due to intra-uterine oxygen lack & to increase the iron coming from the damaged RBCs that can be used for recycling and reformation of new RBCs due to poor iron in the milk).

➢Functions of R.B.Cs:

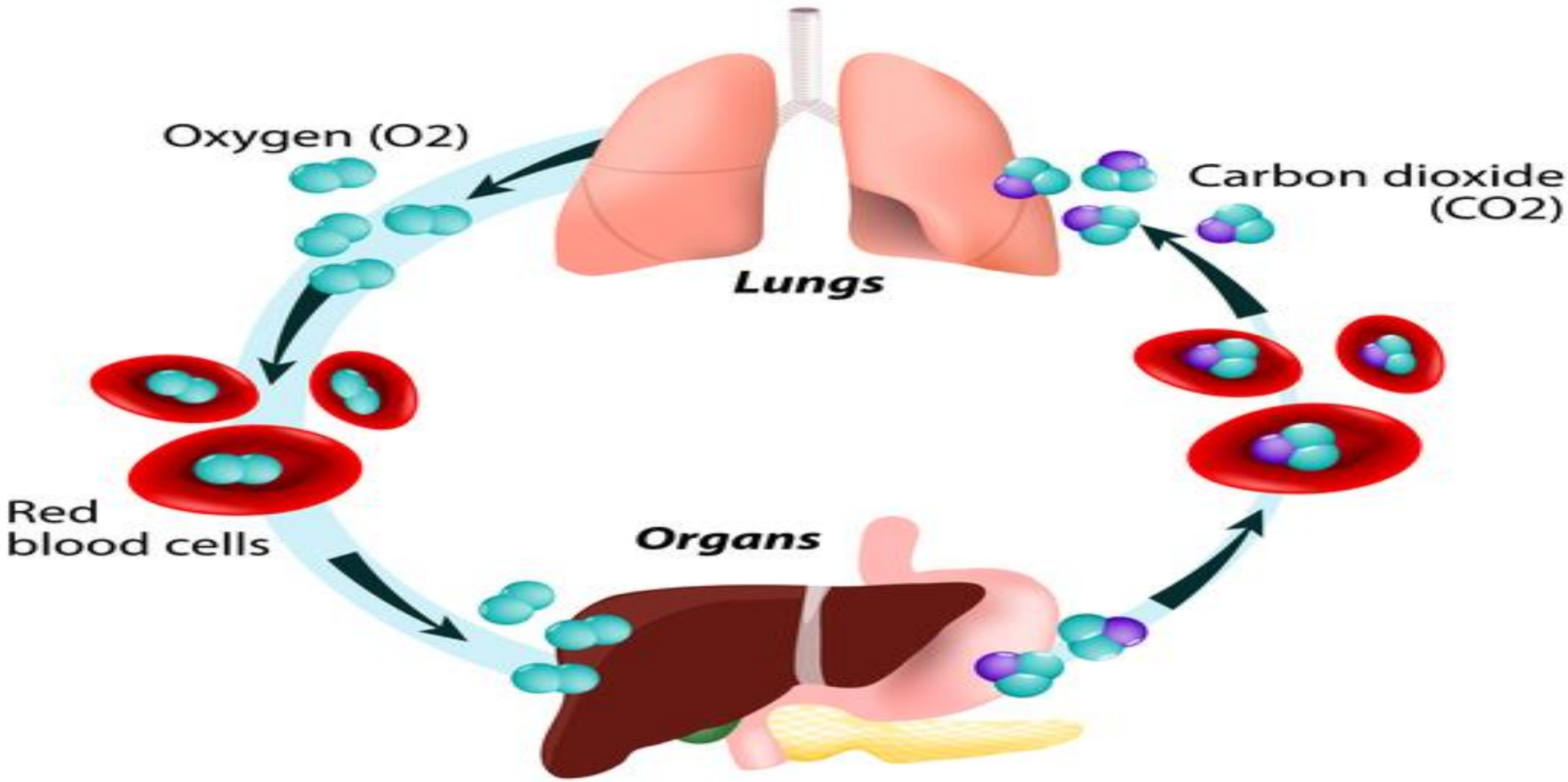
1. Hemoglobin carry O_2 to and take CO_2 from tissues.
2. Hemoglobin has buffering action (85% of blood buffering action).
3. R.B.Cs contain carbonic anhydrase enzyme which is important for CO_2 carriage.
4. The biconcave shape of R.B.Cs increases the surface area and helps the exchange of gases between R.B.Cs and tissues.
5. R.B.Cs membrane contains the specific agglutinogens that determine blood group.


Red blood cell
Oxygen from lungs
Oxygen released to tissue cells
Hemoglobin molecules
Oxygen bonded with hemoglobin molecules
ART.COM


Oxygen molecules
Heme
Hemoglobin molecule
Hemoglobin molecule
Red blood cell


Carbaminohemoglobin
CO_2

GAS EXCHANGE IN HUMANS



6. R.B.Cs membrane keeps hemoglobin inside them that prevents:

a- the increase in the load on the heart which can lead to heart failure; since free hemoglobin increase blood viscosity, and increase in blood volume due to increase plasma colloidal osmotic pressure.

b- obstruction of the renal tubules by the free hemoglobin which can lead to renal failure.

7- The plastic nature of R.B.Cs membrane giving it a high degree of flexibility that allows RBCs to compress passing in the narrow capillaries and then resume their normal shape on leaving these capillaries without rupture.

Formation of R.B.Cs (Erythropoiesis)

❑ Sites of R.B.Cs formation;

- In the fetus, they are formed in liver and spleen.
- In the last three months of fetal life and after birth, they are formed in bone marrow of all bone until adolescent.
- By the age of 20, they are formed by the bone marrow of upper parts of humerus and femur and of membranous bones.
- After the age of 20 years, they are formed in bone marrow of membranous bone as skull, vertebra, sternum and ribs.

- Rate of erythropoiesis must be equal to the rate of RBCs destruction to maintain normal RBCs count. After 120 days (life span) due to loss of flexibility, RBCs are engulfed and hemolysed by reticulo-endothelial cells mainly spleen.

❑Factors affecting erythropoiesis:

1. Oxygen supply to tissues:

Hypoxia occurs in hemorrhage (due to RBCs loss), high altitude (due to decrease O2 tension around) and heart failure (blood don't reach tissue properly).

- O_2 lack (hypoxia) → releases erythropoietin hormone from the kidney mainly → stimulates bone marrow → increase production of R.B.Cs (↑ erythropoiesis rate).

2. Diet:

Erythropoiesis requires:

- **Protein;** of high biological value containing essential amino acids that essential for formation of globin of hemoglobin.
- **Iron;**

Average daily intake of iron is 20 mg.

Most of the diet iron is in ferric state. However ferric iron poorly absorbed & ferrous iron is better absorbed than it.

- So, ferric iron is reduced to ferrous in the stomach by HCl and vitamin C.

Ferric iron (Fe 3+) $\xrightarrow{\text{HCl \& Vitamin C}}$ Ferrous iron (Fe 2+)

- The intestinal epithelial cells contain Apoferritin protein that combines with the ferrous iron to form ferritin. Iron is absorbed in this form from the upper part of small intestine (duodenum).

Ferrous iron(Fe^{2+}) + Apoferritin ⟶ Ferritin (the form in which the iron absorbed)

- The blood containing transferrin protein which carries iron to bone marrow to form a part of R.B.Cs hemoglobin or to the liver to be stored.

- Excessive oxalates, phytic acids and phosphates in diet precipitate iron and decrease its absorption.

- **Vitamins;**

➢ **Vitamin B_{12}:**

- It is called extrinsic factor and is important for RBC nuclear maturation and cell division. In addition, it is responsible for myelination of the nerves and integrity of digestive system mucosa.

- It unites with intrinsic factor, secreted by mucous membrane of the stomach forming intrinsic factor-Vit B_{12} complex. (intrinsic factor + Vit B 12 → intrinsic factor-Vit B_{12} complex)

- Intrinsic factor protects vitamin B_{12} from digestion by gastric enzymes and facilitates its absorption in lower part of ileum.

- Vitamin B_{12} is stored in large amount in liver and released slowly from liver as needed by bone marrow for formation of new red cells.

- **Folic acid:** the same importance as vitamin $B_{12,}$ important for RBC nuclear maturation and cell division..
- **Vitamin C:** stimulates tissue growth and metabolism in general including the bone marrow.

- **Trace elements:** copper and cobalt act as cofactors for hemoglobin formation.

3. **Hormones:**
   - Specific: Erythropoietin hormone.
   - Non-specific: thyroid hormones (↑ metabolism in general)
   - male sex hormones (Androgen), increase erythropoietin hormone and hence stimulate erythropoiesis.
4. **Healthy organs:**

. Bone marrow: A healthy bone marrow is essential for normal erythropoiesis (site for formation).

- **Liver:** is important for erythropoiesis as:

- Formation of globin of hemoglobin.
- Secretes 15% of erythropoietin hormone
- Site of storage of Iron & Vit B12.

- **Kidney:** It secretes 85% of erythropoietin hormone in response to hypoxia, anemia and androgen hormone.
- *N.B.* Patients with renal diseases or failure develop severe anemia because erythropoietin production by liver cannot compensate for the inability of the kidney to produce the hormone.
- **Stomach:**

- Gastric HCl is needed to convert ferric iron to ferrous.

- Intrinsic factor secreted by gastric mucosa is essential for vitamin B_{12} absorption.

- **Small intestine:** It is the site of iron and vitamin B_{12} absorption.


THANK YOU