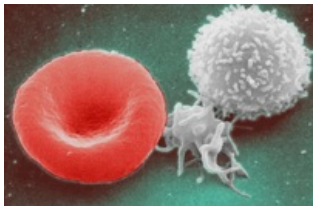
Red Blood Cells

Red blood cells (RBCs) or erythrocytes are the most abundant cells of blood. Their main function is to deliver oxygen to all tissues in the body. 1% of circulating RBCs are reticulocytes, which develop in the bone marrow and mature to RBCs after one day in blood circulation. It is important to note that RBCs do not have a nucleus.

Functions

1. Transport hemoglobin(Hb), the oxygen carrier, from lungs to tissues.
2. Consist of the enzyme carbonic anhydrase which catalyzes the reaction CO_2 + $H_2O \leftrightarrow H_2CO_3$. This catalytic effect is essential for the transport of CO_2 in the form of HCO_3^- (bicarbonate ion) in the blood, which is taken from tissues to lungs where it is reconverted by alveolar carbonic anhydrase to CO_2 that will be excreted.
3. Hemoglobin gives RBCs a strong acid-base buffer (they are responsible for most of buffering power in blood – HHb).
4. RBCs give blood its viscosity.



Erythrocyte, thrombocyte, leukocyte.

Structure, concentration, and amount

- Biconcave disks, lack cell organelles .
- Diameter: 7.8 µm
- Thickness 0.5 µm (in the middle), 2.5 µm (outer rim).
- Men (4.7–6.1) × 10^6/µL.
- Women (4.2–5.4) × 10^6/µL.
- *Note:* erythropoietin stimulates transcription for globin, the protein component of Hb.

Hemoglobin in RBCs

- There are 15 g of Hb per 100 ml of blood.
- 1 g of Hb combines with 1.34 ml of O_2, therefore 100 ml of blood contains 20 ml of O_2.
- The metabolic limit of RBCs forming Hb is 34 g/100 ml.

Factors affecting RBC count

1. Erythropoietin: this is a cytokine for erythrocyte precursors in bone marrow (remember that cytokines are signaling molecules used in cellular communication).
2. Hypoxia: this is the most important stimulus for increased RBC formation. Hypoxia results in increased secretion of erythropoietin from kidneys (from peritubular fibroblasts of the renal cortex). Erythropoietin stimulates production of proeythroblasts, which results in increased RBC numbers and thus hypoxia is relieved.
3. Vitamin B12 & Folic acid: required for the formation of thymidine triphosphate, an essential building block of DNA. Absence of thymidine triphosphate causes abnormally diminished DNA and failure of nuclear maturation + cell division. Therefore, fragile RBCs are formed with decreased life-spans.

Note: Vitamin B12 is absorbed by the gastrointestinal tract with the help of Intrinsic factor secreted by parietal cells. The Intrinsic factor binds to the vitamin in order to protect it from digestion by gastrointestinal secretions and mediates its absorption at the ileum. It is stored in the liver in such large quantities that are enough for about 4 years without any intake of dietary Vit B12 (1–3 µg/day required).

Life span and destruction

Erythrocytes have a lifespan of 120 days. Ageing erythrocytes undergo changes in plasma membrane making them susceptible to recognition by phagocytes and subsequent phagocytosis in the spleen, liver and bone marrow. Breakdown products are re-circulated in the body. Heme is broken down to Fe^{3+} and biliverdin. Then, the membrane become fragile and ruptures as it passes from tight spots; mostly this happen in the spleen as the RBC pass through red pulp.

Anemia

Anemia is caused either by decreased numbers of erythrocytes or decreased hemoglobin levels. It is defined as < 7.4 mmol/L of Hb in non-pregnant women, and < 8.1 mmol/L of Hb in men.

Types of anemia:

1. Aplastic anemia: bone marrow does not produce sufficient new cells to replenish blood cells, therefore there

are lower counts of all 3 types of blood cells.
2. Hemolytic anemia: for example Sickle cell anemia; when HbS is deoxygenated, as occurs in venous capillaries it polymerizes into long chains distorting the shape of the cell making it more fragile. Sickled cells are rigid and more fragile and thus have a decreased life-span.
3. Blood loss anemia: viscosity of blood decreases and the resistance to blood flow in peripheral blood vessels decreases, thus making the blood flow and the cardiac output to increase.

Note: polycythemia is the increase in RBC number; this occurs during hypoxic conditions and it may be physiologic in people living in high altitudes where pO_2 is low.

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