BLOOD PHYSIOLOGY

TEXTBOOK OF MEDICAL PHYSIOLOGY
GUYTON & HALL 13TH EDITION
UNIT VI CHAPTERS 32-36

L1 Topic: Red Blood Cells RBCs)

1. Composition of the Blood
2. Functions of the Blood
3. Morphological Features of RBCs.
4. Production of RBCs
5. Regulation of production of RBCs

BLOOD COMPOSITION

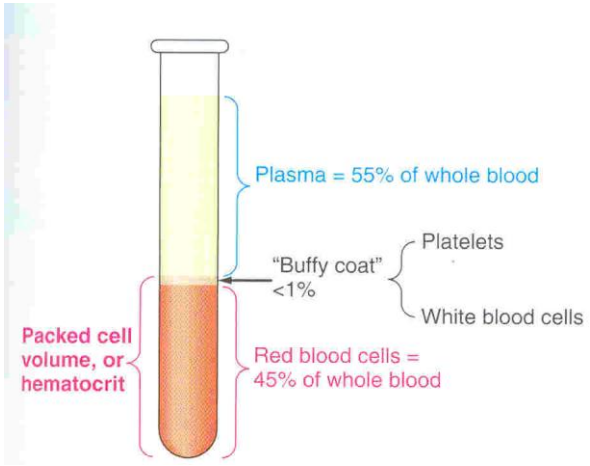
1. Cellular components
   - Red Blood Cells (Erythrocytes)
   - White Blood Cells (Leucocytes)
   - Platelets (Thrombocytes)
2. Plasma
   - 98% water, ions, plasma proteins (Albumin, globulin, Fibrinogen)
   - Same ionic composition as interstitial fluid

FUNCTIONS OF BLOOD

1. Transport
    - O2, CO2, nutrient, hormones, waste product
2. Homoeostasis
    - Regulation of body temperature, ECF pH
3. Protecting against infections
    - White Blood Cells, Antibodies
4. Blood clotting prevent blood loss

Blood Volume

1. 5 liter in adult
   - 45% is packed cells volume (PCV)
   - 55% is plasma volume



Blood Cells Formation

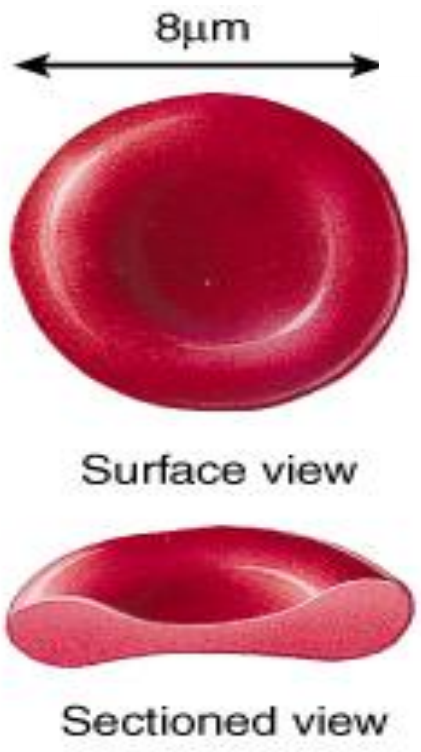
- **Erythropoiesis: Formation of RBC (erythrocytes)**
- **Leucopoiesis: Formation of WBC (leucocytes)**
- **Thrombopoiesis: Formation of platelets (thrombocytes)**

Red Blood Cells

- **Function of RBC**
  - **O_2 transport**
  - **CO_2 transport**
  - **Buffer**

Red Blood Cells

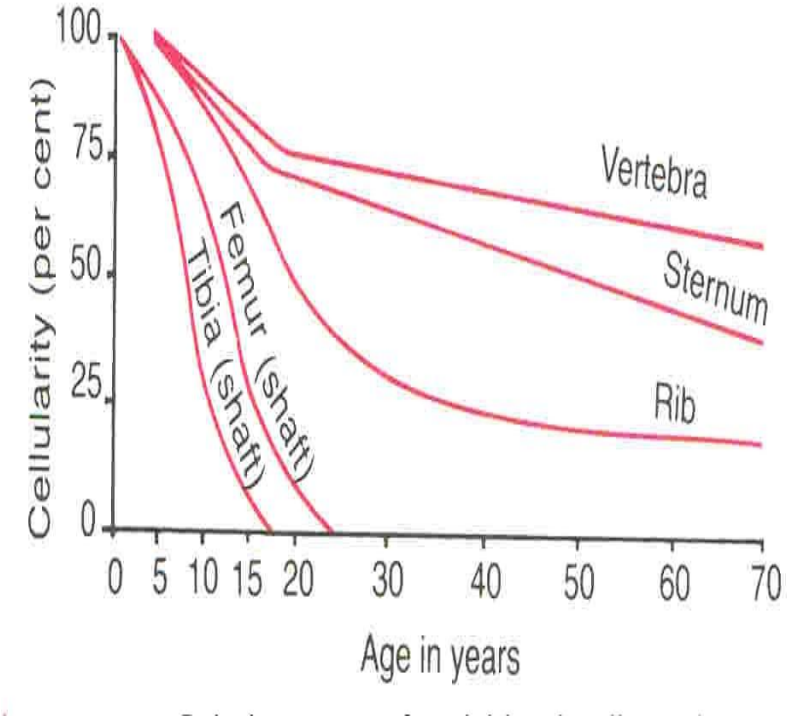
- **Shape & size**
  - **Flat Biconcave Disc**
  - **Non-nucleated**
  - **Diameter 7-8 mm x 2.5 mm , 1 mm**
  - **Average volume 90-95 mm^3**
  - **Flexible**
  - **Number =4.7-5 $x10^6$**
  - **Hb =34g/dl of cells**
  - **Hb= 14-16 g/dl in the blood**



Sites of RBC Production

- **Early few weeks of embryo nucleated RBCs are formed in yolk sac.**
- **Middle trimester mainly in liver & spleen & lymph nodes.**
- **Last months RBCs are formed in bone marrow of all bones**
- **Bone marrow of flat bone continue to produce RBC into adult life**
- **Shaft of long bone stop forming RBC at puberty while the epiphysis continued to produce RBC**

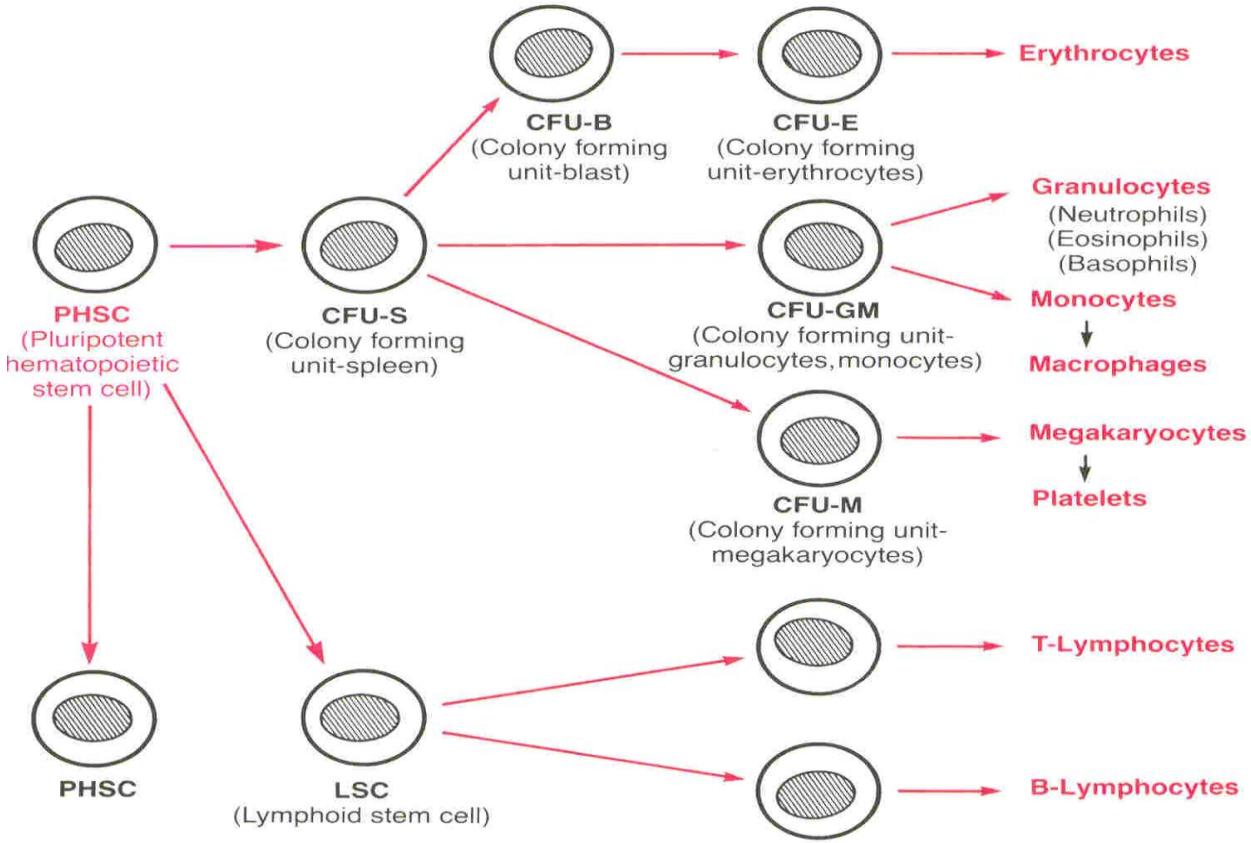
Production of RBC



Genesis of RBC

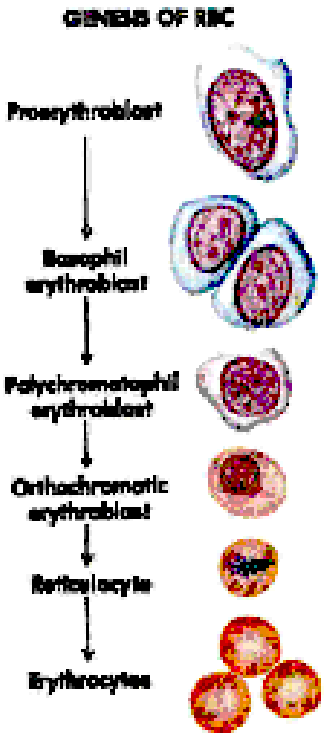
- **All blood cell are formed from Pluripotential hematopoietic stem cells ⇒ committed cells to form RBC, WBC**
- **Committed stem cells for RBC**
- **Committed stem cells for WBC**
- **Growth of different stems cells are controlled by different growth factors**

Genesis of RBC



Stages of differentiation of RBC

- **Stages of RBC development**
  - **Committed stem cell**
    - **Proerthroblast**
    - **basophil erythroblast**
    - **polychromatophil erythroblast**
    - **orthochromatic erythroblast**
    - **Reticulocytes**
    - **Mature erythrocytes**
  - **Rapid RBC production → ↑ reticulocytes in the circulation**



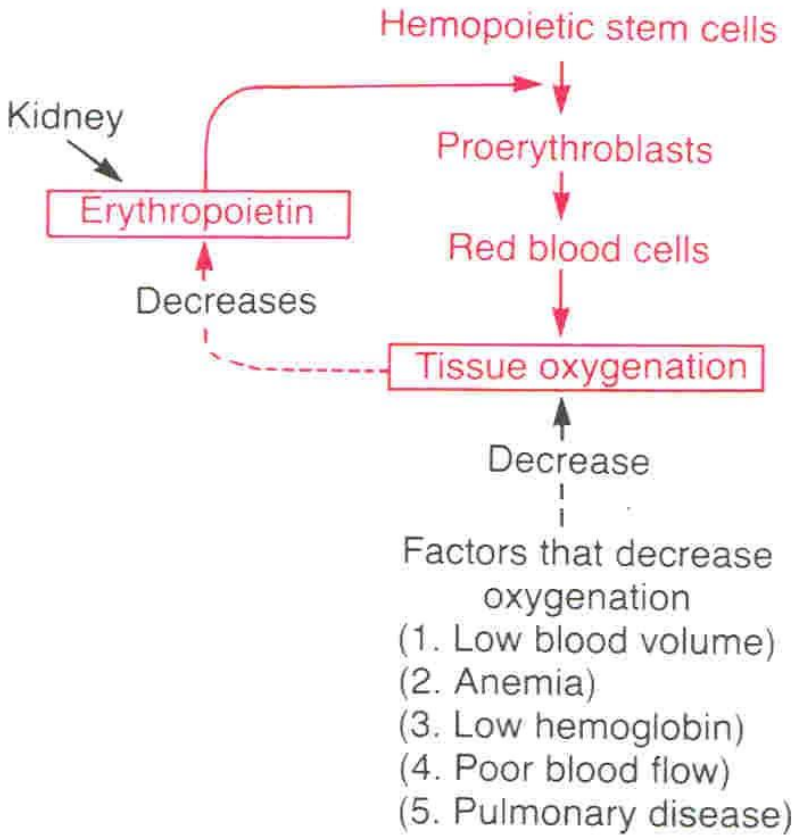
Signs of erythrocytes maturation

- RBC development is characterize by:
  - decrease in cell size
  - disappearance of nucleus
  - appearance of haemoglobin

Regulation of RBC production

- **Erythropoiesis is stimulated by erythropoietin hormone produced by the kidney in response to hypoxia (low oxygen in the blood)**
- **Hypoxia caused by:**
  - **Low RBC count (Anaemia)**
  - **Hemorrhage**
  - **High altitude**
  - **Prolong heart failure**
  - **Lung disease**

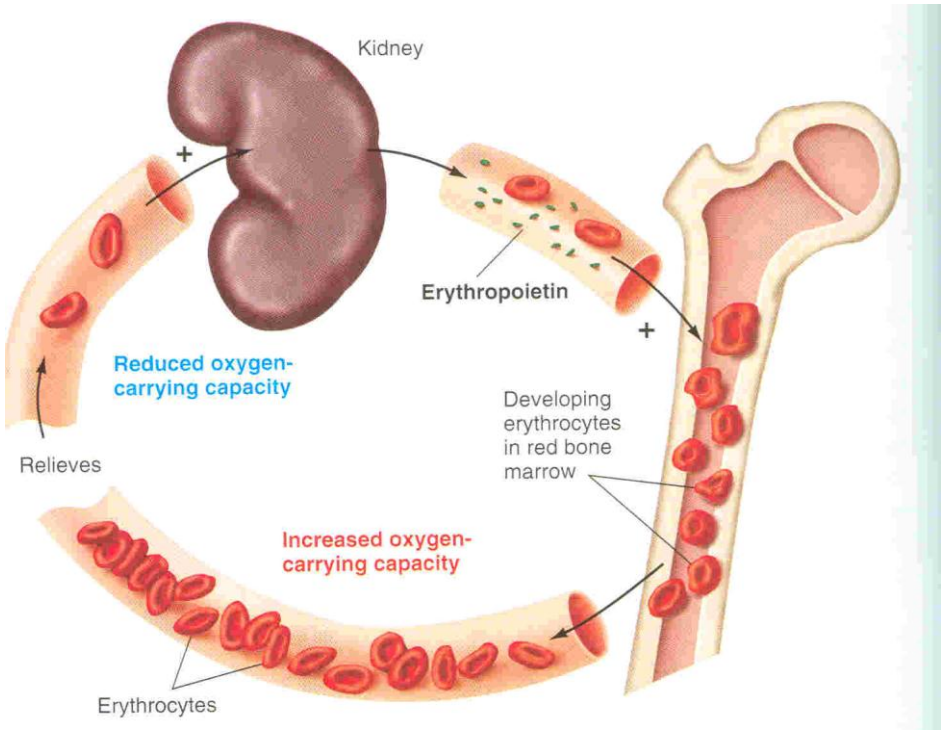
Tissue oxygenation and RBC formation



Erythropoietin

- Glycoprotein
- 90% from renal cortex 10% liver
- Stimulate the growth of early stem cells
- Does not affect maturation process
- Can be measured in plasma & urine
- High level of erythropoietin
  - anemia
  - High altitude
  - Heart failure

Role of the kidneys in RBC formation



Objectives

At the end of this lecture student should be able to:

1. **Describe Cellular and non-cellular components of blood**
2. **Recognise functions of blood**
3. **Define Erythropoiesis; leucopoiesis, thrombopoiesis.**
4. **Recognize sites of RBC formation at different developmental age**

Objectives

At the end of this lecture student should be able to:

5. **Describe different stages of RBC differenation.**
6. **Describe features of RBC maturation.**
7. **Describe regulation of RBC production and erythropoietin hormone secretion in response to hypoxia.**
8. **Recognize clinical conditions associated with high level of erythropoitein in the blood**