

I. hematocrit = % of blood volume occupied by erythrocytes

average = 45% (average plasma volume = 55%)

II. erythrocytes

A. physical characteristics

- 6 - 8 mm diameter
- biconcave discs

- more surface area than spherical cells
- more flexible and less fragile
- no nuclei or organelles
- filled with hemoglobin

B. hemoglobin

- each molecule of Hb is made of 4 subunits
- each subunit contains 1 peptide and 1 heme

- normal adult Hb has 2 alpha (α) and 2 beta (β) peptides
- each heme contains one iron (Fe) atom that carries O₂
- the peptide carries CO₂

C. average lifespan of a RBC = 100 to 120 days

- old RBCs are removed from circulation by phagocytes
- some components (amino acids and Fe) are recycled
- the remainder of the heme group is waste—it is converted to bilirubin and excreted in bile

D. disorders involving erythrocytes

1. anemia

- defined as a reduced ability of the blood to carry oxygen (NOT always characterized by low red blood cell count or low hematocrit)
- primary effect is fatigue
- types and causes:
 - a. iron deficiency caused by lack of iron in diet
 - b. vitamin B12 deficiency / pernicious anemia caused by lack of intrinsic factor production in stomach
 - c. aplastic anemia due to destruction of stem cells in bone marrow by exposure to radiation, toxic chemicals, or chemotherapy
 - d. hemolytic anemia is caused by destruction of red blood cells during viral or parasitic infections
 - e. hemorrhagic anemia is caused by blood loss
 - f. genetic disorder causing abnormal hemoglobin, examples are sickle cell and thalassemia

2. polycythemia

- defined as an abnormally high RBC count
- primary effect is increased blood viscosity leading to decreased perfusion
- types and causes:
 - a. primary – caused by bone marrow cancer
 - b. secondary – caused by:
 - adaptation to increased activity or high altitude
 - dehydration (this one is temporary)
 - excess secretion of erythropoietin

III. leukocytes

A. classification

1. granulocytes (neutrophils, eosinophils, basophils) have these characteristics:
 - large cytoplasmic granules
 - distorted, inactive nuclei
 - ability to phagocytize
2. agranulocytes (lymphocytes, monocytes) have these characteristics:
 - lack obvious granules in cytoplasm

B. specific characteristics of leukocytes

1. neutrophils (40 - 70%)
 - nucleus has 2-6 lobes
 - cytoplasm stains light purple

- phagocytize bacteria
2. eosinophils (1 - 4%)
 - nucleus has 2 lobes
 - cytoplasm stains red, orange or dark pink
 - phagocytize antigen-antibody complexes and fight parasitic worms
 3. basophils (0 - 1%)
 - nucleus has 2 lobes (not visible)
 - cytoplasm stains dark blue/black
 - release histamine and other chemicals
 4. lymphocytes (20 - 45%)
 - nucleus round, dark, takes up most of cell
 - cytoplasm seen as thin rim of light blue
 - about same size as RBCs
 - functionally divided into 2 categories:
 - B cells make antibodies
 - T cells attack foreign, cancer and virus-infected cells
 5. monocytes (4 - 8%)
 - nucleus horseshoe or kidney shaped
 - cytoplasm pale blue
 - largest WBC
 - become macrophages after migrating to c.t.

C. disorders involving leukocytes

1. leukocytosis – elevated leukocyte count, usually during infections
2. leucopenia – low leukocyte count, may be caused by disease and certain drugs
3. leukemia – various kinds of cancer causing uncontrolled production of leukocytes

IV. thrombocytes

- called platelets
- not cells, but fragments of cytoplasm enclosed by plasma membrane
- produced from the edges of large bone marrow cells called megakaryocytes
- cytoplasm contains secretory granules that are released during hemostasis to enhance platelet plug formation and coagulation
- form platelet plugs during hemostasis to seal off small openings in blood vessel walls

V. hematopoiesis (blood cell formation) occurs in the bone marrow (myeloid tissue)

- bone marrow is located inside bones
- there are two categories:
 - red - active
 - yellow - inactive

A. adult red marrow location:

- proximal epiphyses of femur and humerus
- axial skeleton
- limb girdle bones

B. bone marrow histology

- reticular tissue stroma supports blood-forming cells
- sinusoids (large, leaky capillaries) run through tissue
- adipose tissue
- multipotent blood stem cells (hemocytoblasts)
- immature blood cells

C. stem cell divides by mitosis to form two daughter cells

- one daughter cell becomes the new stem cell and remains in the bone marrow
- one daughter cell differentiates into a type of blood cell, matures, and enters the blood stream through the wall of a sinusoid

D. lineages

hemocytoblast daughter cells become either a lymphoid stem cell OR a myeloid stem cell

- lymphoid stem cells produce only lymphocytes
- myeloid stem cells produce all other formed elements:
 - erythrocytes
 - granulocytes
 - monocytes
 - megakaryocytes => platelets