

Overview of CARDIOVASCULAR SYSTEM

Functions of blood

1. transport of gases: oxygen & carbon dioxide
2. transport of nutrients (digested food)
3. transport of hormones to target organs
4. removal of wastes to kidney/lungs
5. regulate blood pH and electrolyte composition
6. defend against pathogens (white blood cells)
7. restrict blood loss through injury sites (sealant)
8. stabilization of body temperature

Blood composition

1. **Plasma** (~55% by vol.): non-cellular fluid matrix of blood
 - a. water, electrolytes
 - b. nutrients, metabolic wastes

2. **Plasma proteins:**
 - a. albumins: responsible for osmotic composition
 - b. globulins: transport hormones, lipids
 - c. fibrinogen: forms fibrin > basic framework for clots

3. **Formed elements** (~45% by vol.):
 - a. erythrocytes (Red Blood Cells - RBC's):
 - most abundant cell type (99.9%)
 - O₂ transport, removal of CO₂
 - b. leukocytes (White Blood Cells - WBC's):
 - immunological defense mechanisms
 - c. platelets: cell-fragments that aid blood clotting

Red Blood Cells - Erythrocytes

RBC formation & structure

1. RBC's produced by bone marrow: erythropoiesis
 - vertebrae, ribs/sternum, skull, pelvis, long bones

2. Enucleate biconcave discs (7.7 micrometers in dia.)
 - shape allows for a large surface area, flexibility
 - RBC's can stack-up (*rouleaux*)

3. Iron based pigment = hemoglobin (Hb)
 - a. O₂ transport to tissues / CO₂ removal from tissues
 - b. complex 4-part molecule (ea. heme @ Iron ion)
 - c. oxygen + iron pigment = red coloration
 - d. 280 million Hb molecules in each RBC
 - e. 25 trillion RBC's in each human

4. RBC lifetime: ~120 days (~700 miles of BV's)

Blood (RBC) Types - 4 primary 'flavors': A, B, AB, and O

1. Types are differentiated by their:

- a. surface antigens: 'recognition' proteins on cells
- b. antibodies (in plasma) - destroy 'unrecognized' cells

Type A: has surface antigen 'A' + type-B antibodies

Type B: has surface antigen 'B' + type-A antibodies

Type AB: has both A/B surface antigens + no antibodies

Type O: no surface antigens + both A/B antibodies

2. Cross Reaction: (e.g., blood transfusions)

- a. surface antigen 'A' meets with type-A antibodies
- b. surface antigen 'B' meets with type-B antibodies
- c. AB blood meets with either type-A or type-B antibodies

Result: *agglutination and hemolysis*

d. **Type AB** - universal recipients (poor donors)

e. **Type O** - universal donors (poor recipients)

3. Rh factor = additional surface antigens

- a. positive/negative (A- blood, AB+ blood etc.)

White Blood Cells

Some WBC generalities:

1. Few WBC's circulate, most are embedded in tissues
2. WBC functions are highly variable
 - a. participate in immune responses
 - b. remove toxins, wastes, parasites, damaged cells
3. WBC morphology is highly variable
 - a. obvious differences in shape of the nucleus
 - b. obvious differences in color/volume of the cytoplasm
4. Two main types of WBC...
 - a. granular (*granulocytes*)
 - cytoplasm appears granular
 - granules stain specific colors (histology)
 - b. agranular (*agranulocytes*)
 - cytoplasm is agranular
 - cytoplasm usually stains a pale 'clear' blue

Granular WBC's

Each of the following = Granulocytes

Neutrophils

1. most common (50-70%)
2. first to arrive at an injury - engulf pathogens
3. cytoplasm stains a neutral (light pink) color
5. nucleus has 2-5 lobes (segmented nucleus)
aka - polymorphonucleocytes (PMNs)

Eosinophils

1. relatively uncommon (2-4%)
2. elevated numbers during parasitic infections/allergies
3. granules stain a red color
4. nuclei has 2 relatively large lobes

Basophils

1. relatively uncommon (<1%)
2. cells enter damaged tissues and
 - a. granules release histamine (causes inflammation)
 - b. granules release heparin (prevents clotting)
3. cytoplasmic granules stain a dark blue/purple
4. nuclei have 2-5 lobes

Agranular WBC's

Monocytes

1. relatively common (2-8%)
2. enters damaged tissue > macrophage (phagocytosis)
3. cytoplasm is irregular in shape
4. nucleus is large, kidney-bean shaped

Lymphocytes

1. common (20-30%)
2. immunological function:
3. very small amount of blue cytoplasm
4. have a large, circular, dark purple/blue nucleus

Platelets

1. aka: thrombocytes: cytoplasmic fragments (anucleate)
2. produced in the bone marrow by megakaryocytes
3. platelets aid in hemostasis - blood clots/wound healing

Clinical Terminology concerning blood:

Hematopoiesis: production of formed elements

Erythropoiesis: Production of RBC's

Leucopoiesis: Production of WBC's

Hematocrit: % of whole blood = formed elements (37-54%)

Anemia: decreased oxygen carrying ability of the blood

a. decreased hematocrit (decrease in RBC's)

b. decreased hemoglobin content (small RBC's)

**either way: interference with oxygen delivery*

c. patients become weak, confused, pale in color

Sickle cell anemia: abnormal Hb proteins

- altered RBC shape...interferes with O₂ delivery

Leukemia: Abnormal WBC's (or #'s) in the blood

Leukopenia: low numbers of WBC's

Thrombocytopenia: low numbers of platelets

Erythrocytosis: excessive numbers of RBC's

Leukocytosis: excessive number of WBC's

Thrombocytosis: excessive number of platelets

Hemophilia: inherited blood disorder

- clotting factors are absent = inability to stop bleeding

Embolus: a drifting blood clot in the circulation

Embolism: arterial blockage due to a blood clot