BLOOD & CIRCULATORY SYSTEM

CHAPTERS 10 & 11
BLOOD

- Sticky, opaque with metallic taste
- Alkaline – pH of 7.35 – 7.45
- Temperature 38°C
- 8% of body weight
- 5 -6 L in average male
A. COMPONENTS

- Fluid tissue
- Living cells called **formed elements** suspended in nonliving fluid matrix called **plasma**
1. Plasma

- 90% water; straw colored fluid
- Plasma proteins – most abundant – produced by the liver
  - Albumin – aids in osmotic pressure of blood keeping water in bloodstream
  - Fibrogen – clotting protein
  - Globulins – antibodies for defense
May also contain:

- Nutrients (glucose, a.a., fatty acids, vitamins)
- Salts
- Gases (O₂ & CO₂)
- Hormones
- Metabolic wastes (urea, uric acid)
Composition varies daily
Body works to maintain homeostasis
- Ex. Liver increase production of plasma proteins when low
- Respiratory systems & kidneys maintain pH – acidosis or alkalosis
2. Formed Elements

A. Erythrocytes

- red blood cells
- Anucleated & lack organelles
- Hemoglobin – iron containing protein that transports oxygen
- Number of rbc determines viscosity of blood
- Confined to bloodstream
B. Leukocytes
- White blood cells
- Located in the “buffy coat” between plasma & formed elements
- Nucleated & contain organelles
- Fight pathogens & can slip out of bv through process called diapedesis—circulatory system is just their means of transportation
Wbc number can indicate infection or tissue damage

- Leukocytosis – increased wbc; indicates infection
- Leukopenia – decreased wbc; can be caused by certain drugs, anticancer agents or corticosteroids
- Leukemia – abnormally high wbc; defective & immature; unable to carry out functions
Types of Leukocytes

- 1. Granulocytes – contain granules & lobed nuclei
  - A. Neutrophils – most abundant; phagocytes – fight infection
B. Eosinophils – response to allergies & parasitic infections
C. Basophils – rarest; response to inflammation
2. Agranulocytes – absence of granules & spherical nuclei
   A. Lymphocytes – produce antibodies; fight tumors & viruses
B. Monocytes – largest; initiate clotting; Chronic infections
NEUTROPHILS
LYMPHOCYTES
MONOCYTES
EOSINOPHILS
BASOPHILS

Never Let Monkeys Eat Bananas
HIGH WBC COUNT

- Neutrophils – bacterial infection, burns, stress, inflammation
- Lymphocytes – viral infections, some leukemias
- Monocytes – viral or fungal infections, tuberculosis, some leukokemia, chronic diseases
- Eosinophils – allergic reactions, parasitic infections, autoimmune diseases
- Basophils – allergic reactions, leukemias, cancers, hypothyroidism
LOW WBC COUNT

- Neutrophils – radiation, drug toxicity, vitamin B12 deficiency, lupus
- Lymphocytes – prolonged illness, immunosuppression, cortisol treatments
- Monocytes – bone marrow depression, cortisol
- Eosinophils – drug toxicity, stress
- Basophils – pregnancy, ovulation, stress, hyperthyroidism
- C. Thrombocytes
- Platelets
- Fragments of multinucleated cells
- Clot damaged by by clinging to the broken area
HEMATOPOIESIS
(Blood Cell Formation)

- Occurs in the red bone marrow of skull, pelvis, ribs, sternum & epiphyses of humerus & femur
- Hemocytoblast – stem cell in bone marrow that gives rise to a blood cell
- Hemocytoblast develops into either a lymphoid stem cell or myeloid stem cell
  - Lymphoid stem cells produce lymphocytes (developing white blood cells)
  - Myeloid stem cells produce all other types of blood cells
Red Blood Cell Formation

- Takes 3 – 5 days to produce new rbc’s
- Rbc’s circulate for 100 – 120 days then fall apart; remains are eliminated by the liver, spleen & other tissues
- Controlled by erythropoitoitin – hormone produced by the kidney
- Amount of oxygen in blood controls release of erythropoitoitin
Developing rbc divide & produce large amounts of hemoglobin

When enough hemoglobin is present the nucleus & organelles are ejected & cell collapses inward

Young rbc – reticulocyte (still has an ER) enter bloodstream & transport oxygen

Within 2 days ER is ejected & cell becomes a mature erythrocyte
HEMOCYTOBLAST

MYELOID STEM CELL

RETICULOCYTE

ERYTHROCYTE
HEMOSTASIS

(3 Phases – Vascular Spasms, Platelet Plug Formation, Coagulation)

☐ 1. Collagen fibers of the inner lining of broken bv are exposed

☐ 2. Platelets release serotonin which causes bv to spasm – narrows bv & lessens blood to area

☐ 3. Platelets stick to collagen fibers forming a plug – white thrombus

☐ 4. Injured cells produce thromboplastin to aid in clotting
5. PF3, a phospholipid that coats platelets interacts with thromboplastin, blood proteins & Ca+ to form an activator that begins the clotting process.

6. prothrombin in the plasma converts to active enzyme called thrombin.

7. thrombin joins soluble fibrinogen proteins into hair like strands called insoluble fibrin.
8. fibrin forms a mesh that traps rbc’s & forms a clot
9. within an hour the clot begins to retract squeezing serum (plasma minus proteins) from the mass pulling ruptured edges of bv together

http://www.mhhe.com/biosci/esp/2002_general/Esp/folder_structure/tr/m1/s7/trm1s7_3.htm
HUMAN BLOOD GROUPS

- Antigens (also called agglutinogens) recognize foreign substances in body & stimulate immune system to release antibodies

- Each person’s rbc contain their own genetically determined antigens on the plasma membrane
Blood Type Percentages

- O Positive: 38%
- A Positive: 34%
- B Positive: 9%
- AB Positive: 3%
- O Negative: 7%
- B Negative: 2%
- A Negative: 6%
- AB Negative: 1%
<table>
<thead>
<tr>
<th>Type</th>
<th>Antigens</th>
<th>Genes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type A</td>
<td>A Antigens</td>
<td>Genes: AA or AO</td>
</tr>
<tr>
<td>Type B</td>
<td>B Antigens</td>
<td>Genes: BB or BO</td>
</tr>
<tr>
<td>Type AB</td>
<td>A &amp; B Antigens</td>
<td>Genes: AB</td>
</tr>
<tr>
<td>Type O</td>
<td>Absence of Antigens</td>
<td>Genes: OO</td>
</tr>
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</table>
Figure 29.9  Blood typing of ABO blood types. When serum containing anti-A or anti-B agglutinins is added to a blood sample, agglutination will occur between the agglutinin and the corresponding agglutinogen (A or B). As illustrated, agglutination occurs with both sera in blood group AB, with anti-B serum in blood group B, with anti-A serum in blood group A, and with neither serum in blood group O.
- Universal recipient – type AB; can receive all 4 blood types
- Universal donor – type O
- Type A – receive type A or O
- Type B – receive type B or O
Rh factor – indicates the presence of a certain blood protein; same protein is found in the Rhesus Monkey

- Rh- means protein is absent
- Rh+ means protein is present
Situation: Rh- woman conceives an Rh+ child

Result: fetal Rh+ blood can mix with mother’s Rh- blood during delivery

The mother’s Rh- blood will build antibodies against & attack the Rh+ red blood cells

Future pregnancies will be affected because the mom now has antibodies to fight Rh+ blood cells

Rhogam
- http://nobelprize.org/medicine/educational/landsteiner/readmore.html
- http://nobelprize.org/medicine/educational/landsteiner/index.html
PHYSICAL CHARACTERISTICS OF THE HEART

- Relatively the size of a fist; 1 lb; hollow
- Positioned to the left of thoracic cavity
- Cone shaped
- Apex – pointed end; directed toward the left hip
- Base – posterosuperior; leads to major bv
HEART COVERINGS & WALLS

- Pericardium – sac containing heart
  - Epicardium / visceral peritoneum – hugs external surface; outermost layer of heart wall
  - Parietal peritoneum – dense c.t.; anchors heart to sternum & diaphragm
LAYERS OF HEART WALL

- Epicardium – outermost
- Myocardium – bundles of cardiac muscle; contraction
- Endocardium – innermost; line the heart chambers
HEART CHAMBERS

- **Right Atria** – receives deoxygenated blood from the body
- **Left Atria** – receives oxygenated blood from the lungs
- **Right Ventricle** – releases deoxygenated blood to the lungs
- **Left Ventricle** – releases oxygenated blood to the body
FETAL HEART

- Foramen Ovale & ductus arteriosus are fetal structures that close at birth
- Function is to bypass blood from the fetal lungs
MAJOR BLOOD VESSELS

- Oxygen poor blood from the veins of the body is received into the right atria of the heart through the superior & inferior vena cava.
- The oxygen poor blood enters the right ventricle and is pumped through the pulmonary trunk, which divides into two pulmonary arteries that carry blood to the lungs.
- Gas exchange occurs at the lungs and the oxygen rich blood returns to the left atria of the heart through four pulmonary veins. Oxygen rich blood travels through the left ventricle and is distributed throughout the body by the aorta.
- Pulmonary circulation – circulation of blood between the heart and lungs
- Systemic circulation – circulation of blood throughout the body
- Coronary arteries – vessels on the outer surface of heart that provide oxygen & nutrients to the heart muscle
http://www.smm.org/heart/heart/pumping.htm

http://health.howstuffworks.com/adam-200083.htm

http://www.guidant.com/condition/heart/heart_bloodflow.shtml
HEART VALVES

- Atrioventricular (AV) – between atria & ventricles
  - Bicuspid/ mitral valve – located between left atria & ventricle; 2 cusps or flaps
  - Tricuspid – located between right atria & ventricle; 3 cusps or flaps
Semilunar valves – guard large arteries leaving the ventricle

- Pulmonary semilunar – located between right ventricle & pulmonary trunk
- Aortic semilunar – located between left ventricle & aorta

http://www.guidant.com/condition/heart/heart_valves.shtml
- Chordae tendinae – “heart strings”
- Anchor flaps to walls of heart
<table>
<thead>
<tr>
<th>Anemia</th>
<th>Description</th>
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<tbody>
<tr>
<td>Hemorrhagic anemia</td>
<td>Decrease in rbc due to prolonged or excessive bleeding</td>
</tr>
<tr>
<td>Hemolytic anemia</td>
<td>Lysis of rbc due to bacterial infection</td>
</tr>
<tr>
<td>Pernicious anemia</td>
<td>Lack of Vitamin B12 which is needed for red blood cell formation</td>
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<tr>
<td>Aplastic anemia</td>
<td>Destruction of red bone marrow by cancer, radiation or medications</td>
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<tr>
<td>Iron deficiency anemia</td>
<td>Lack of Fe in diet; small rbc &amp; pale color due to lack of hemoglobin</td>
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<tr>
<td>Sickle cell anemia</td>
<td>Genetic disorder in which rbc shape is distorted (sickle shaped); easily rupture &amp; clog blood vessels</td>
</tr>
<tr>
<td>Polycythemia</td>
<td>Increase rbc; can result from bone marrow cancer or change in altitude</td>
</tr>
<tr>
<td>DISORDER / DISEASE</td>
<td>DESCRIPTION</td>
</tr>
<tr>
<td>--------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
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<tr>
<td>Leukemia</td>
<td>Excessive increase in wbc; bone marrow caner; immature &amp; defective wbc</td>
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<tr>
<td>Thrombus</td>
<td>Persistent clot in an unbroken bv; blocks blood flow</td>
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<tr>
<td>Embolus</td>
<td>Thrombus which is floating in the blood stream</td>
</tr>
<tr>
<td>Thrombocytopenia</td>
<td>Insufficient platelet number; spontaneous bleeding from vessels</td>
</tr>
<tr>
<td>Hemophilia</td>
<td>Genetic sex linked disorder; lack of clotting factors leads to bruising, joint bleeding &amp; inability to repair damaged bv</td>
</tr>
<tr>
<td>Hemolytic disease of newborns</td>
<td>Incompatible Rh between mom &amp; newborn; mom’s antibodies destroy newborn’s rbc causing anemia &amp; hypoxia</td>
</tr>
<tr>
<td>Physiological jaundice</td>
<td>Fetal blood cells rapidly broken down; liver cannot dispose of hemoglobin in bile fast enough; leads to yellowing of skin &amp; eyes</td>
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