Chapter 13

I. Erythrocites
   a. RBCs circulate for 120 days (at which point the body wants new ones)
   b. No organelles
   c. Functions
      i. Transports Oxygen to tissues
      ii. Removes carbon dioxide from tissues, which is a toxic waste product
      iii. Buffer blood pH
         1. Stabilize/neutralize pH = 7.35-7.45
   d. Hemoglobin → 4 globins, 4 hemes
      i. Oxygen carrying protein
      ii. Comprises 90% of RBC dry weight
      iii. Composed of 2 pairs of polypeptide chains called globins
      iv. Each globin contains a heme molecule
      v. Heme = iron+protoporphyrin
         1. Orange = iron
   e. Production
      i. Hematopoiesis
         1. Development of mature myeloid cells (RBCs, WBCs, platelets → fragments of cells) rom pluripotent stem cells
      ii. Erythropoiesis
         1. Development of mature erythrocytes only (only RBCs)
            a. Stem cell to erythroblast to reticulocyte to erythrocyte
            b. Reticulocytes will increase when erythrocytes are low to make more RBCs
      iii. Stimulation
         1. Decrease hemoglobin stimulates erythropoietin secretion from kidneys
      iv. Regulation
         1. Concentration of Hb in blood
   f. Destruction
      i. Hemolytic Anemia
      ii. RBCs → Hemelysis → senescent RBCs → Hemoglobin (Hb) → Heme → Bilirubin (use to form bile, the rest is thrown away)
      iii. Methemoglobin → Oxidized iron
         1. We don't want this in the body

II. Oxygen Transport
   a. 1 Hb binds 4 atoms of oxygen
      i. Oxyhemoglobin → oxygen binds to heme
      ii. When 1 globin binds to Oxygen the other oxygen's affinity increases
   b. Average Hb: 15g/100mL

i. (12-16 g/cL range)

c. Oxygen partial pressure
   i. Pressure/tension that oxygen creates when it is dissolved in blood
   ii. Normal range = 75-100mmHg
   iii. <60mmHg = hypoxcemia
   iv. 35-45 mmHg

III. Carbon Dioxide Transport
   a. Carbaminohemoglobin
      i. Hemoglobin binds to CO2
   b. Most commonly transported as bicarbonate
      i. Carbonic acid formed via carbonic anhydrase in RBC
         1. H2CO3, very volatile, through carbonic anhydrase will disassociate hydrogen acid to H and bicarbonate which is transported out in exchange for Cl
      ii. 90% CO2 in arterial blood, 60% CO2 in venous blood
   c. Other forms
      i. As dissolved gas
      ii. Bound to Hb
   d. CO2 partial pressure
   e. Hb has a higher affinity for carbon monoxide than oxygen
      i. Carbonmonoxide exhaust → cars, tires
      ii. Poisoning = drowsy, sleepy → coma → death. Moves very quickly.

IV. Acid-Base Regulation by Lungs
   a. Creation of bicarbonate and hyperventilate to breathe it out

V. Erythrocyte Disorders
   a. Polycythemia
      i. Presents as flushed/red with an increased clotting risk
      ii. Excess erythrocytes
      iii. Results in increased blood viscosity and volume
      iv. Leeches
   b. Anemia
      i. RBC deficit
         1. Lower O2 carrying capacity leading to tissue hypoxia
      ii. Classification
         1. Relative → normal total RBC mass, disturbances in plasma volume regulation
            a. Pregnancy → increased volume, dilutional anemia
            b. False anemia = too much plasma for a normal amount of RBCs
      iii. Compensatory Mechanism
         1. Increased oxygenated blood flow, increased heart rate/cardiac output and preferential increase in flow to vital organs (heart, brain, lung, kidneys)

iv. Mild Anemia (Hb > 8g/dL) → 8-10 g/dL
    1. Usually no symptoms in healthy
    2. Symptoms can appear in elderly with cardiovascular/pulmonary disease, more at risk for hypoxemia
v. Moderate (Hb <8g/dL)
    1. Low BP
    2. Orthostatic/nonorthstatic hypotension, weakness
    3. Vasoconstriction → low O2
    4. Tachypnea → rapid breathing
    5. Nocturnal Leg Cramps
    6. Tinnitus → ringing in ears

c. Aplastic Anemia
    i. Reduced RBC synthesis
        1. Stem Cell Disorder
            a. Reduced hematopoietic tissue in the bone marrow, replacement of normal bone marrow with fatty marrow
        2. Pancytopenia → reductions of RBCs, WBCs, and platelets
    ii. Etiological Factors
        1. Toxins
        2. Radiation
        3. Immunological Injury
    iii. Clinical Manifestations
        1. Insidious onset
        2. Palpitations, transient murmurs, tachycardia
        3. Pancytopenia, granulocytopenia
    iv. Management
        1. Avoid/treat etiological factors
        2. HLA/ABO typing to identify blood donors
        3. Maintain minimal hemoglobin and platelet levels
        4. Prevent/Manage infections
        5. Determine efficacy of bone marrow transplant
        6. Immunosuppressants
        7. Stimulate hematoiesis and bone marrow regeneration
d. Chronic Disease
    i. Usually due to chronic renal failure
        1. Impaired renal endocrine function results in reduced erythropoietin production
    ii. Diagnosis
        1. Low RBC, hematocrit and Hb levels
    iii. Treatment
        1. Dialysis
        2. Erythropoietin
e. Pernicious Anemia