Hematology—2022

- Study of Blood and Blood-forming Tissue
- Includes
    - Bone marrow, Blood, Spleen, Lymph system

Hematopoiesis
- Blood cell production
- Occurs within bone marrow

Bone Marrow
- Soft material in core of bone
- The red marrow produces blood cells
- Marrow is able to respond to meet the body's demands
- Produces hematopoietic stem cells that mature/differentiate to become:
    - Erythrocytes
    - Leukocytes
    - Platelets

Major Components of Blood
- Plasma- 55%
    - Composed of water, proteins, electrolytes, gases, nutrients, waste
    - Serum = plasma without clotting factors
    - Plasma proteins: albumin, globulin, clotting factors (mostly fibrinogen)
- Blood cells- 45%
    - Erythrocytes: O2 transport
    - Leukocytes: Protection from infection
    - Thrombocytes: Promote coagulation

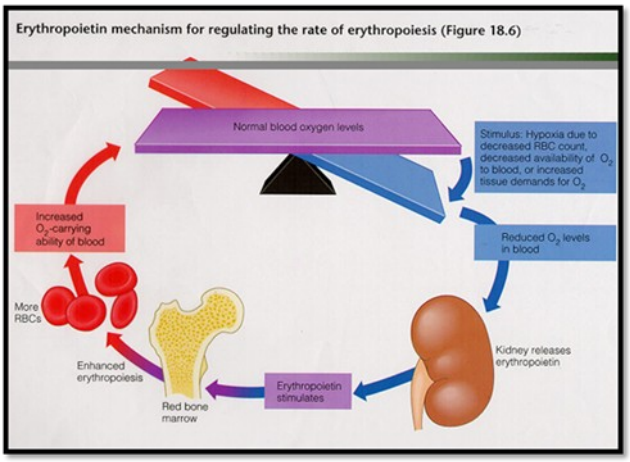
Important Roles of Blood: Transportation, Protection, Coagulation!

Erythrocytes
- RBC Lifespan 120 days
- RBC Function
    - Transport O2 and CO2
    - Assist in acid-base balance

- Reticulocyte
    - Immature RBC
    - Mature into erythrocyte within 48h of release
    - Reticulocyte count measures rate at which RBC's appear in circulation
- Hemoglobin
    - Major component of RBC
    - Made of
        - Heme (iron compound)
        - Globin (protein)

Erythropoiesis (Making Erythrocytes)
- Stimulated by oxygen requirements (hypoxia)
    - Erythropoietin released by kidney
    - Stimulates bone marrow to increase RBC production

- Essential nutrients needed to produce healthy RBC's
    - Iron, Cobalamin (Vit B12) and Folic Acid
- Hemolysis: Erythrocyte Destruction
    - Macrophages remove abnormal, defective, and damaged RBC's from circulation
    - Occurs in bone marrow, liver, spleen
        - Heme to bilirubin
        - Iron (recycled)
        - Globin breaks down into amino acids to build proteins (recycled)



Leukocytes

- Granulocytes
    - Neutrophils
        - First to arrive at site of infection
        - Primary phagocytic cells in acute inflammatory response
        - Mature neutrophils = segmented neutrophils
        - Immature neutrophils = bands
            - Increased % of bands called "shift to the left"
                - Indicates worsening infection
    - Eosinophils
        - Formed during allergic response to allergen- Antigen/Antibody response
        - Defend against parasitic infections
    - Basophils
        - Allergic and inflammatory reactions
        - Release heparin, serotonin, and histamines
        - Mast cells are basophils but they reside in connective tissue and play a key role in inflammation, permeability of blood vessels, and smooth muscle contraction.
- Agranulocytes
    - Lymphocytes
        - Immune response
            - B cells & T cells
        - Some circulate, others live in lymphoid tissue
    - Monocytes
        - Potent phagocytic cells
        - Engulf bacteria, dead cells, tissue debris, defective RBC's
        - Second type of WBC to arrive at injury
        - Migrate into tissues and become macrophages

Thrombocytes

- Initiate clotting process by producing platelet plug at site of injury
- Immature platelet = megakaryocyte which
- Live 8-10 days

Additional Components of the Hematologic System

Spleen

- Hematopoietic:
  - Produces RBC's during fetal development
- Filtration:
  - Removes old and damaged RBC's from circulation
  - Removes Hgb from RBCs and returns iron back to bone marrow for reuse
  - Filters out bacteria
- Immunologic
  - Rich supply of lymphocytes and monocytes
- Storage:
  - RBCs
  - 30% of total platelets stored here

Lymph System

- Consists of: lymph fluid, lymphatic capillaries/vessels, ducts, and nodes
- Carries fluid and nutrients from interstitial space back into circulatory system
  - Prevents edema
- Lymph fluid
  - Similar to blood plasma
  - Usually pale yellow
- Lymph capillaries
  - Larger than blood capillaries
  - Unidirectional flow
  - Lymphangitis = Inflammation of one or more lymphatic vessels
- Lymph nodes
  - Filter pathogens and foreign particles carried by lymph fluid
  - Swollen from inflammatory conditions, abscess, cancer, or infection
  - Lymphadenopathy = Disease of lymph nodes
    - Also used to indicate enlarged lymph nodes
- Lymph system
  - Capillaries carry "cleansed" lymph fluid to right lymphatic duct or left lymphatic duct (also called thoracic duct)
  - Lymphatic ducts drain into subclavian veins
    - Returned to circulation
  - Lymphedema = Too much interstitial fluid or reduced absorption
    - May occur as a complication of mastectomy or lumpectomy

Liver

- Functions as a filter→phagocytic Kupffer cells
- Stores excess iron
- Produces procoagulants essential to hemostasis and blood coagulation
  - Vitamin K

Gerontologic Considerations

- Can maintain adequate blood cell levels, but have decreased reserve
  - Hemoglobin levels decrease
  - Reticulocyte production less rapid
  - RBC's more fragile
  - Platelets w/ increased adhesiveness
  - More difficulty fighting infection – decreased lymphocyte function

Diagnostic Studies

- Laboratory Studies
  - Complete blood count
    - RBCs, WBCs, and platelets
      - Pancytopenia = Suppression of the entire CBC
  - Peripheral smear
    - Morphology of blood cells (size & appearance)

  - Red blood cells
    - Female: _____ million/mcL
    - Male: _____/mcL

      - Hemoglobin value (Hgb)
        - Male : _____ g/dL
        - Female: _____g/dL
      - Hematocrit value (Hct)
        - Male : _____%
        - Female: _____%
      - RBC indices
        - MCV (Mean Corpuscular Volume) – size of RBCs
        - MCH (Mean Corpuscular Hemoglobin) – weight
      - Erythrocyte sedimentation rate (ESR/Sed rate)
        - Nonspecific measure of inflammation

  - White blood cells
    - Total WBC count = _____ mcL (microliter)
      - Differential count
        - % of each type of leukocyte
          - Neutrophils: 50-70%
          - Eosinophils: 2-4%
          - Basophils: <2%
          - Lymphocytes: 20-40%
          - Monocytes: 4-8%
          - Bands: "Shift to left" refers to increase in number of immature neutrophils released (severe infection)

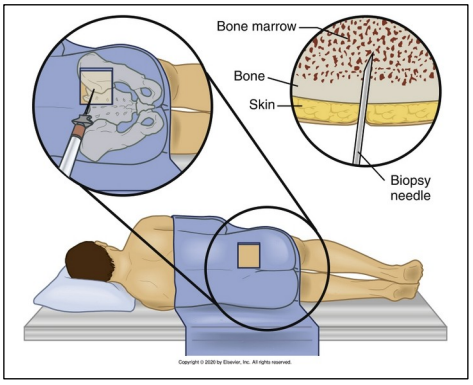
  - Platelet count
    - Usually _____/mcL (microliter)
    - Thrombocytopenia

        - Danger of spontaneous hemorrhage
    - Thrombocytosis
        - Danger of excessive clotting

- Blood Typing and Rh Factor

- <u>Iron Studies</u>
    - Serum iron
        - Females: 60 – 160 mcg/dL
        - Males: 80 – 180 mcg/dL
    - Total iron-binding capacity (TIBC)-) provides a measurement of all proteins that act to bind or transport iron between the tissues and bone marrow
    - Ferritin – stored iron
    - Transferrin saturation – amount of iron attached to transferrin (more accurate indicator of amt of iron in body)

- Radiologic Studies
    - Computed tomography (CT)
    - Magnetic resonance imaging (MRI)
- Biopsies – Bone marrow examinations and/or Lymph nodes
    - Bone marrow examinations
        - Diagnose causes of blood disorders, eval bone marrow function, or stage lymphomas or other CAs
        - Aspiration = liquid portion of bone marrow
        - Biopsy = Coring of bone
            - Pre-procedure
                - Informed consent
                - Side-lying or prone position
                - Sterile technique
            - Preferred site
                - Posterior iliac crest
                - Can also use
                    - Anterior iliac crest
                    - Sternum
    - Client Education
        - Local/systemic pain control
        - May feel brief pressure/pain
        - May hear crunching sound as needle enters bone



https://www.youtube.com/watch?v=HQWlcSp9Sls (Crash Course Review of Hematology)

https://www.youtube.com/watch?v=I7orwMgTQ5I&list=PL8dPuuaLjXtOAKed_MxxWBNaPno5h3Zs8&index=44
(Crash course Review of The Lymph System)