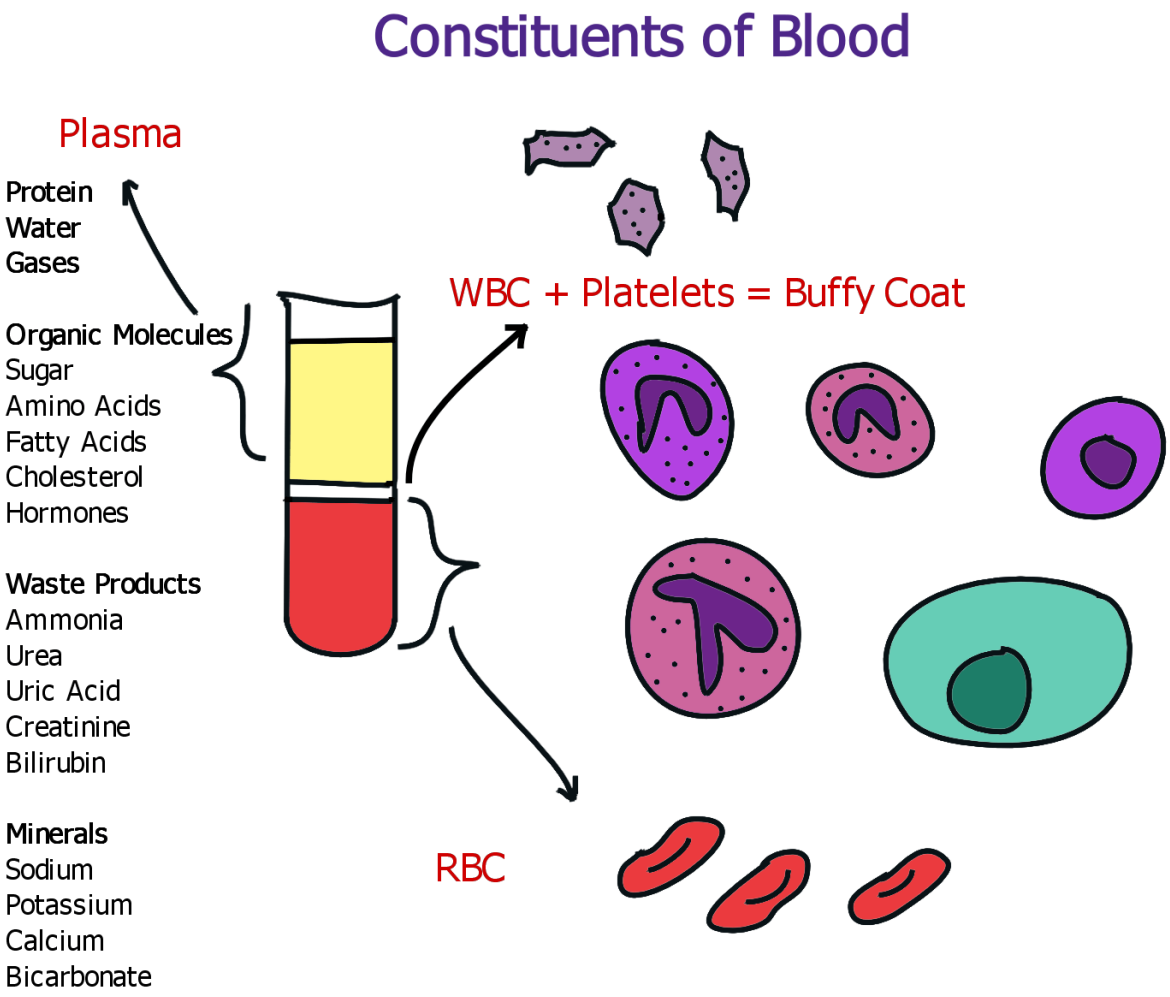
Card 1: Average Adult Blood Volume and Blood Plasma Properties

Content:

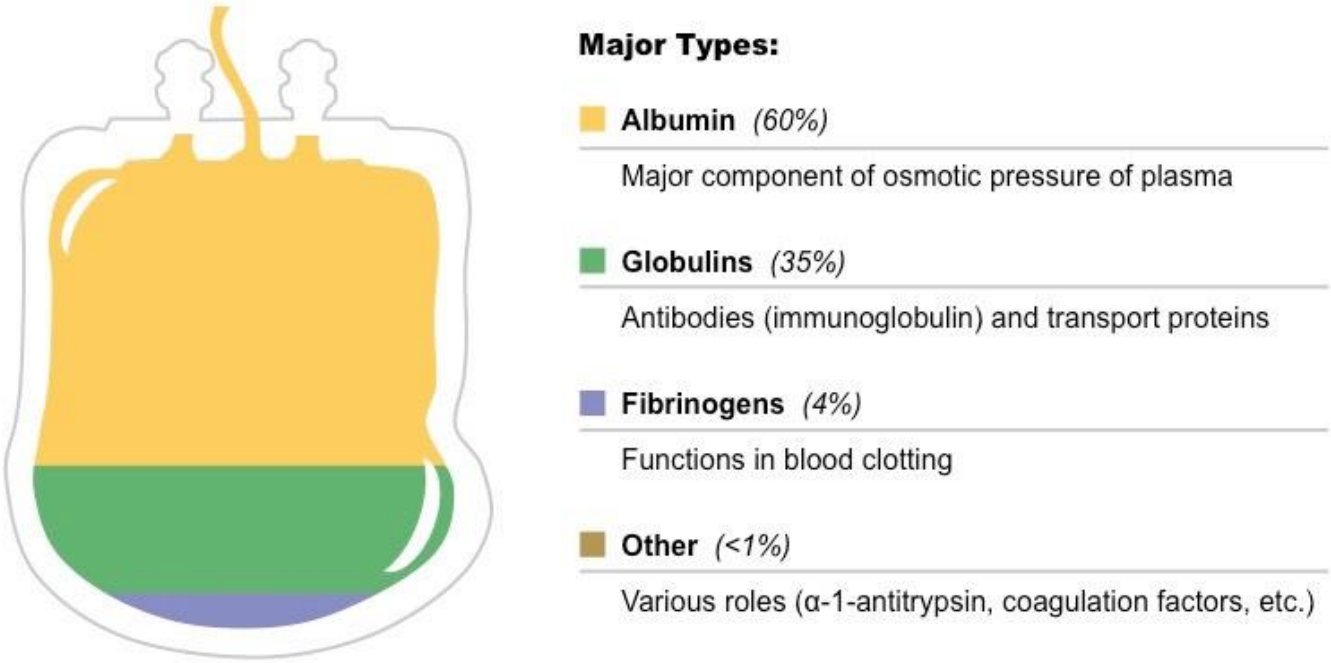
- **Blood Volume:**
  Quantity: ~5 dm^3 (5 liters).
  Mass: ~5 kg (similar density to water).
- **Plasma Properties:**
  - **Composition:** ~95% water with solutes like glucose, urea, electrolytes, and hormones.
  - **Heat Capacity:** Plasma helps absorb and distribute heat, regulating body temperature.
- **Additional Key Facts:**
  1. Plasma's pH is approximately 7.4, which is tightly regulated for enzyme activity.
  2. Plasma carries clotting factors like **prothrombin and fibrinogen**, essential for wound healing.
  3. Plasma transports carbon dioxide in three forms: dissolved in plasma, bound to hemoglobin, and as **bicarbonate ions (HCO_3^-)**.



Card 2: Solutes and Plasma Proteins

Content:

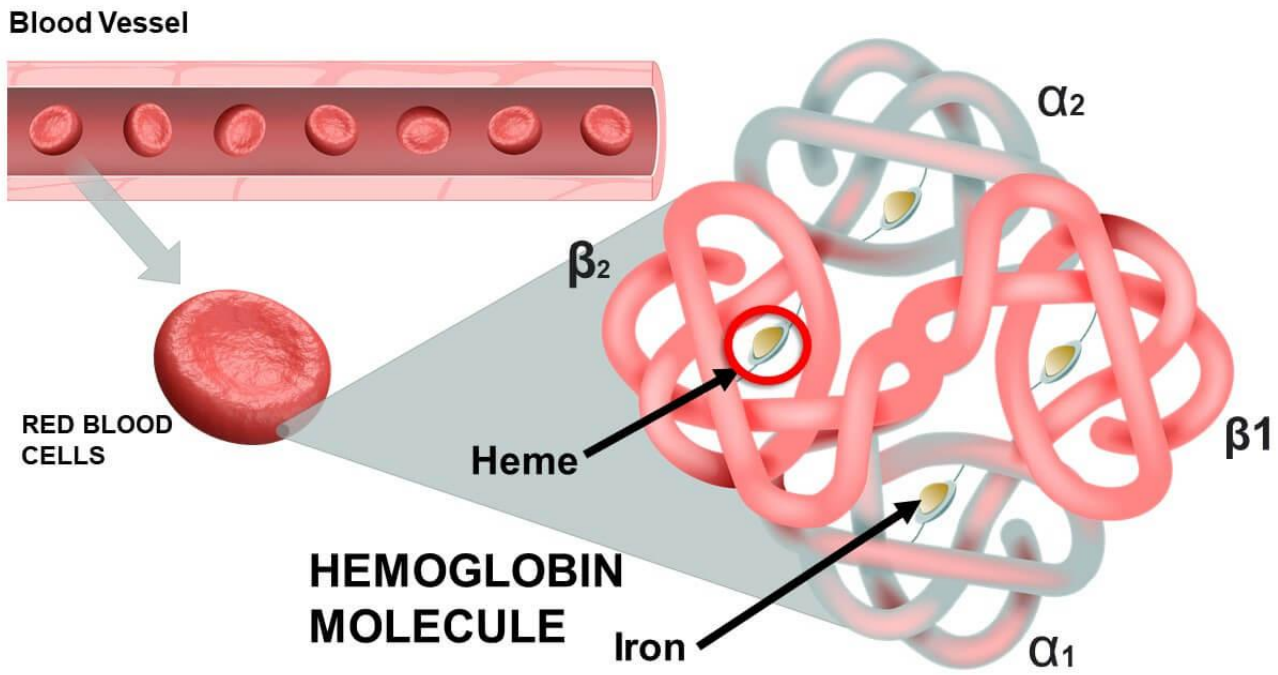
- **Solutes in Plasma:**
  Glucose, urea, and electrolytes (e.g., sodium, potassium).
  Function: Transport nutrients and remove waste.
- **Plasma Proteins:**
  - **Albumin:** Maintains osmotic pressure.
  - **Globulins:** Immunity (e.g., antibodies).
  - **Fibrinogen:** Blood clotting.
  - **Origin:** Synthesized in the liver.
    Function: Contribute to blood volume, pressure, and physiological functions.
- **Additional Key Facts:**
  1. Plasma proteins help buffer blood pH, maintaining homeostasis.
  2. Electrolytes like **chloride ions (Cl^-)** regulate osmotic balance and electrical potential in cells.
  3. **Serum** is plasma without clotting factors, used in diagnostic tests.



Card 3: Red Blood Cells (RBCs)

Content:

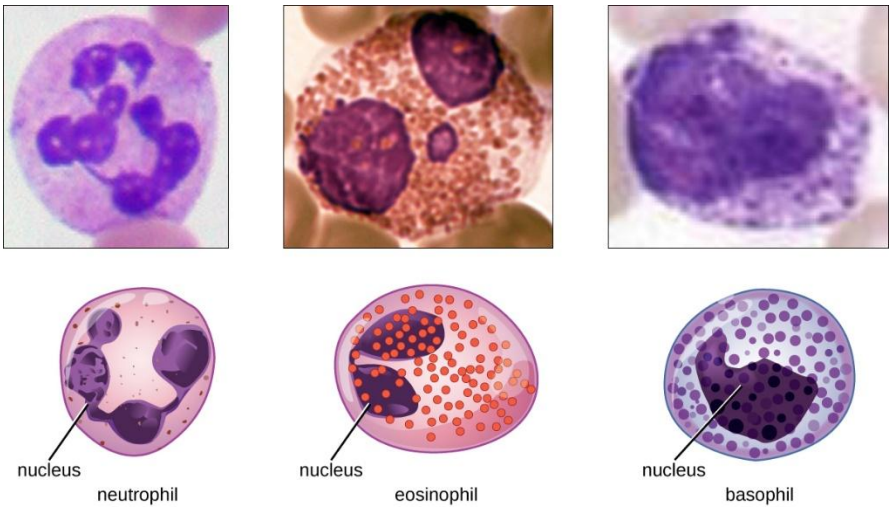
- **Quantity:** ~2.5×10^{13} cells.
- **Structure:**
  - Biconcave disc shape (increases surface area).
  - Diameter: ~7 µm, flexible to pass through capillaries.
  - No nucleus or organelles (maximizes hemoglobin storage).
- **Function:**
  - **Oxygen transport:** Hemoglobin binds oxygen in lungs, releases in tissues.
  - **Carbon dioxide transport:** Secondary role.
- **Lifespan:** ~120 days; removed in the liver; produced in the bone marrow.
- **Additional Key Facts:**
  1. Hemoglobin is a **quaternary protein** made of four polypeptide chains, each with a heme group.
  2. RBCs are produced in the bone marrow under the influence of **erythropoietin**, a hormone released by the kidneys.
  3. A deficiency in RBCs leads to **anemia**, resulting in reduced oxygen transport.



Card 4: White Blood Cells (WBCs) - Granulocytes

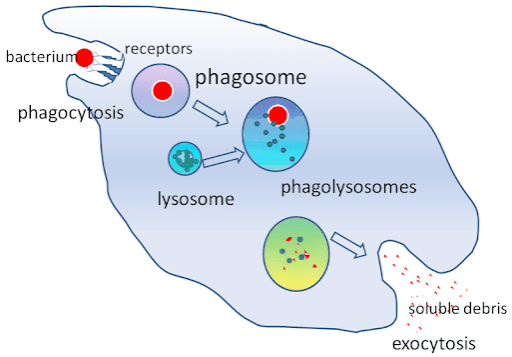
Types of Granulocytes

1. **Neutrophils**
   - **Function:** First line of defense; phagocytosis of bacteria and debris.
   - **Structure:** Multi-lobed nucleus, pale-staining granules.
2. **Eosinophils**
   - **Function:** Combat parasitic worms (helminths) and mediate allergic reactions.
   - **Structure:** Bi-lobed nucleus, granules stain red/orange with eosin dye.
   - **Example:** Release toxic proteins from granules to kill parasites too large for phagocytosis.
3. **Basophils**
   - **Function:** Release histamine and other chemicals during allergic reactions and inflammation.
   - **Structure:** Bi-lobed or S-shaped nucleus, large dark-staining granules obscure the nucleus.
   - **Example:** Basophils release histamine to increase blood flow and make blood vessels leaky, enabling other immune cells to access the infection site.



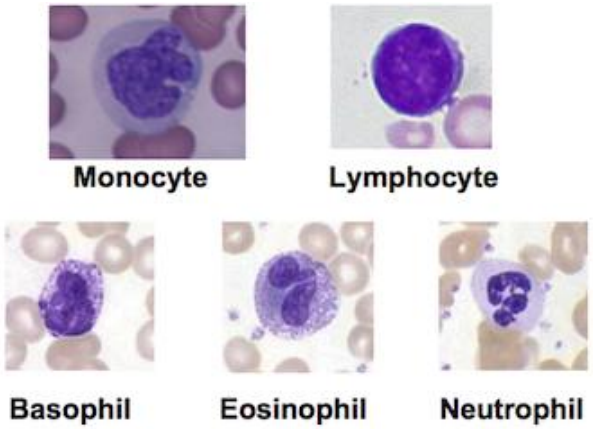
Example in Action:
When bacteria invade a wound:

- **Chemotaxis:** Neutrophils are attracted to the site by chemical signals (e.g., cytokines or complement proteins).
- **Recognition:** Neutrophils identify bacteria via receptors.
- **Engulfment:** They engulf bacteria into phagosomes, which fuse with lysosomes to form phagolysosomes.
- **Destruction:** The bacteria are destroyed by enzymes and reactive oxygen species.
- **Outcome:** Dead neutrophils, bacteria, and tissue form pus, indicating infection control.



Card 5: White Blood Cells (WBCs) - Agranulocytes

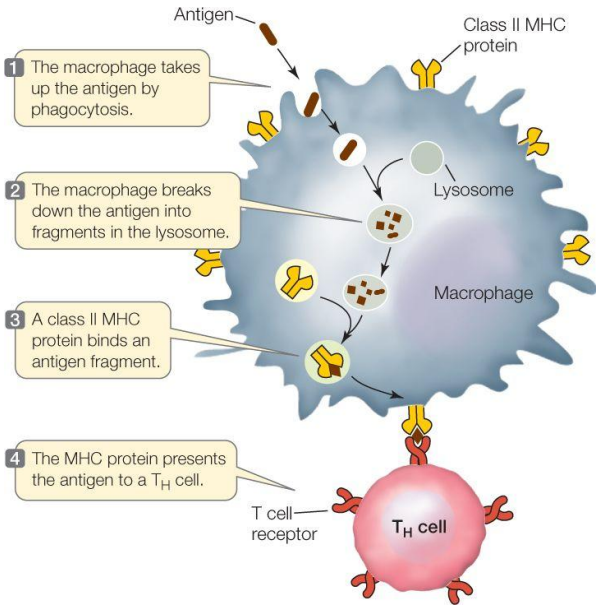
- **Agranulocytes:** WBCs without visible granules.
    - **Lymphocytes:**
        - Function: Adaptive immunity (T cells, B cells, and Natural Killer cells).
        - Large, round nucleus with scant cytoplasm.
    - **Monocytes:**
        - Function: Phagocytosis and antigen presentation.
        - Large kidney/U-shaped nucleus.
        - Can differentiate into macrophages or dendritic cells.



- **Additional Key Facts:**
    1. T cells mature in the **thymus**, while B cells mature in the **bone marrow**.
    2. Natural Killer (NK) cells are part of the **innate immune system**, killing infected or cancerous cells.
    3. Monocytes are largest WBCs, accounting for **2-10% of total WBCs**.

Macrophage Fighting Bacteria

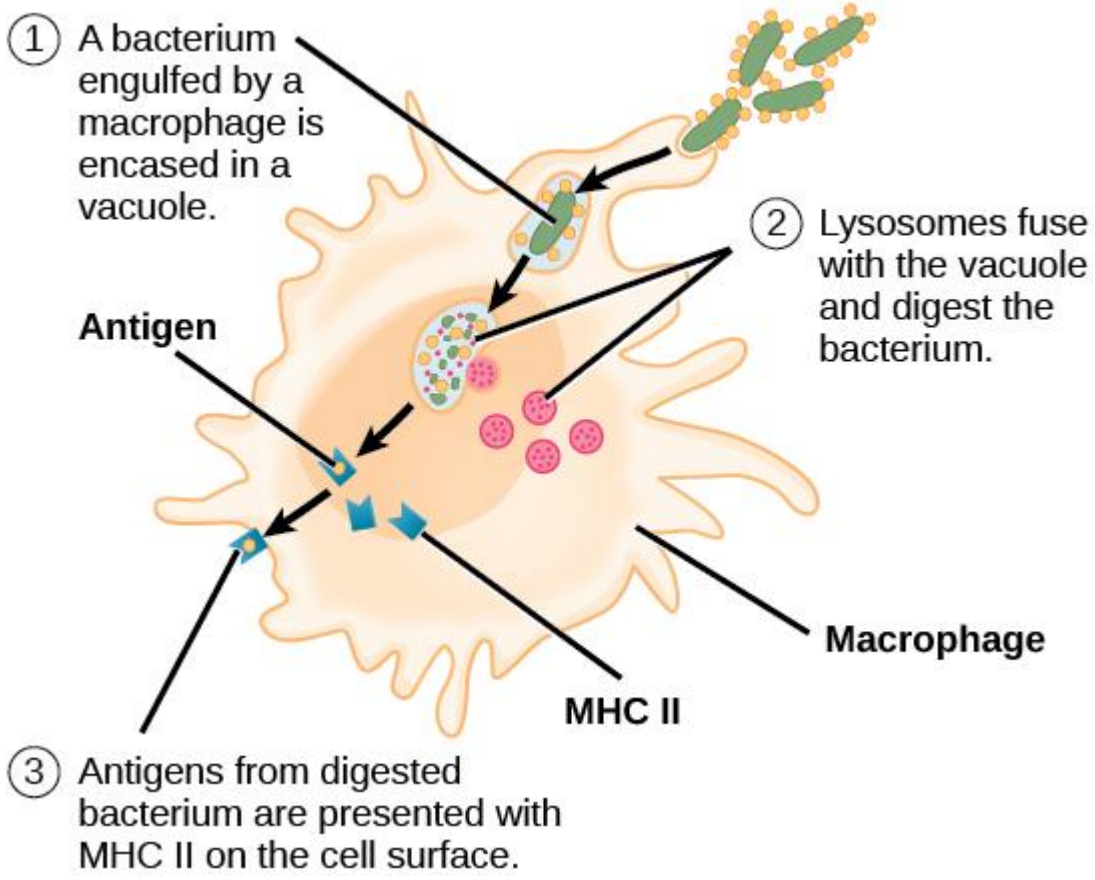
1. **Phagocytosis (Innate Immunity):**
    - **Recognition:** A macrophage identifies bacteria using receptors or via opsonization (antibodies and complement proteins coating the bacteria).
    - **Engulfment:** The macrophage surrounds and engulfs the bacteria, forming a **phagosome**.
    - **Digestion:** The phagosome fuses with a lysosome (forming a **phagolysosome**) where enzymes and reactive oxygen species digest the bacteria.
    - **Waste Removal:** Any leftover material is released.
2. **Antigen Presentation (Connecting to Adaptive Immunity):**
    - **Processing:** The macrophage processes bacterial proteins (antigens).
    - **Displaying:** Antigens are presented on the macrophage's surface, bound to **MHC Class II** molecules.
    - **T Cell Activation:** Helper T cells recognize the antigen-MHC complex, activating the T cell to signal other immune cells (e.g., B cells and cytotoxic T cells).



Card 6: Macrophages and Dendritic Cells

Content:

- **Macrophages:** Derived from monocytes.
  - Function:
    - Phagocytosis of pathogens, dead cells, and debris.
    - Antigen presentation to T cells.
  - Feature: Larger with cytoplasmic extensions.
- **Dendritic Cells:** Derived from monocytes.
  - Function: Specialized in antigen presentation after phagocytosis.
- **Additional Key Facts:**
  1. Macrophages are found in specific tissues and have unique names, e.g., **Kupffer cells** in the liver.
  2. Dendritic cells are most abundant in **skin and mucosal tissues**, where they capture pathogens.
  3. Both macrophages and dendritic cells play a vital role in triggering the **adaptive immune response**.



Card 7: Phagocytic Cells

Content:

- **Primary Phagocytes:**
  - **Neutrophils:** First responders to infection.
  - **Monocytes:** Phagocytic in blood; precursors to macrophages.
  - **Macrophages:** Efficient phagocytes in tissues.
  - **Dendritic Cells:** Antigen presentation specialists.
- **Secondary Phagocytes:**
  - **Eosinophils:** Mild phagocytosis of antigen-antibody complexes.

Process of Phagocytosis

1. **Chemotaxis**
   - Phagocytes are attracted to the infection site by chemical signals (e.g., cytokines, complement proteins).
2. **Recognition and Binding**
   - Phagocytes identify pathogens using receptors (e.g., PRRs binding to PAMPs).
   - Opsonization (coating by antibodies or complement proteins) enhances binding.
3. **Engulfment**
   - The phagocyte extends its membrane around the pathogen, forming pseudopodia.
   - The pathogen is enclosed in a vesicle called a **phagosome**.
4. **Phagolysosome Formation**
   - The phagosome fuses with a lysosome to form a **phagolysosome**, which contains digestive enzymes.
5. **Digestion**
   - Enzymes and reactive oxygen species (ROS) in the phagolysosome break down the pathogen.
6. **Waste Removal**
   - Undigested waste is expelled from the phagocyte by exocytosis.
7. **Antigen Presentation (if applicable)**
   - Macrophages and dendritic cells display pathogen fragments on their surface to activate T cells.