

Blood

Types of blood cells

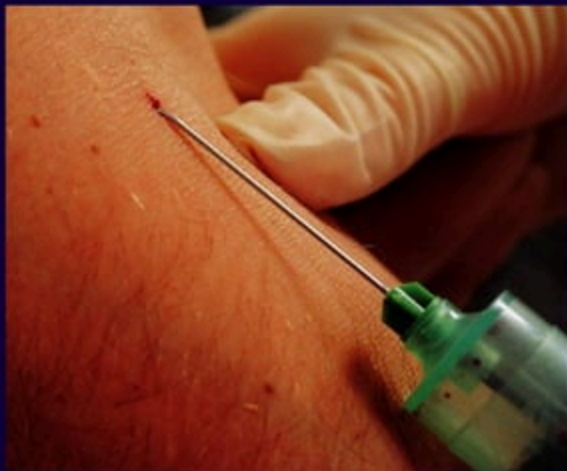
Synthesis of blood cells

Function of blood

Dr. Salman Khan

BLOOD

- Provides a mechanism for rapid transport of nutrients, waste products, respiratory gases and cells
- Powered by the pumping action of the heart



Introduction

- Cardiovascular System
 - System made up of blood vessels, blood and heart. Major function is to transport nutrients, gases and hormones to the cells and pick up wastes from cells to transport them to areas of body where they are excreted
- Lymphatic System
 - Network of vessels that return the fluid escaped from blood vessels back to the bloodstream
 - Includes lymphocytes, lymphoid tissue and lymphoid organs which fight infections and give immunity to disease
- Circulatory System
 - Together the cardiovascular system and lymphatic system make up the circulatory system

Functions Of Blood

- Transportation - the blood transports dissolved gases, nutrients, hormones and metabolic wastes.
- Protection - the blood restricts fluid losses through damaged vessels. Platelets in the blood and clotting proteins minimize blood loss when a blood vessel is damaged.
- Regulation
 - Blood regulates the pH and electrolyte composition of the interstitial fluids.
 - Blood regulates body temperature.

Composition Of Blood

- Contains cellular and liquid components
- A specialized connective tissue
 - Blood cells – formed elements
 - Plasma – fluid portion and fibrinogen
- Blood volume
 - Males: 5 – 6 liters
 - Females: 4 – 5 liters
- The pH of blood is about 7.35-7.45

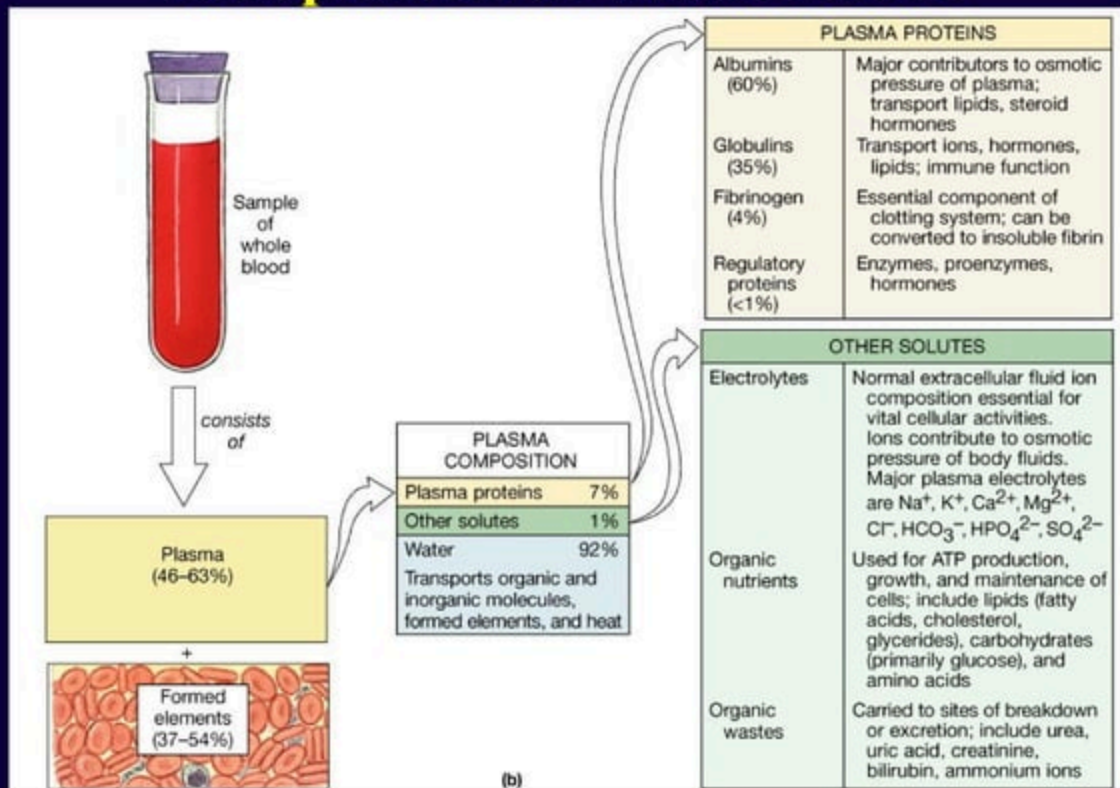
Formed Elements

- Blood cells
 - Erythrocytes, leukocytes, and platelets
- Staining of blood cells
 - Acidic dye – eosin – stains pink
 - Basic dye – methylene blue – stains blue and purple

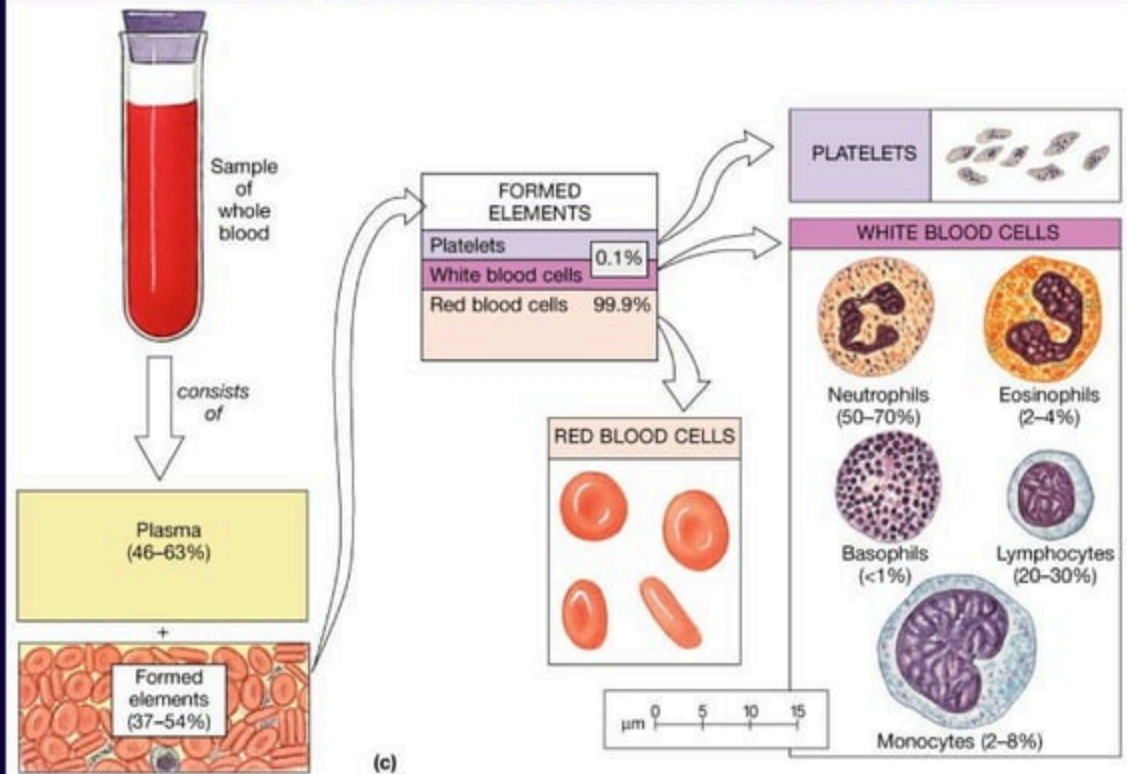
Blood Plasma

- Straw-colored, sticky fluid portion of blood
- Approximately 90% water
- Contains:
 - Ions – Na⁺ and Cl⁻
 - Nutrients – sugars, amino acids, lipids, cholesterol, vitamins and trace elements
 - Three main proteins - Albumin (60%), globulin (35%), fibrinogen (4%)
 - Dissolved Gasses – including O₂ and CO₂
 - Waste Products – other protein wastes such as urea and bilirubin

Composition of Whole Blood

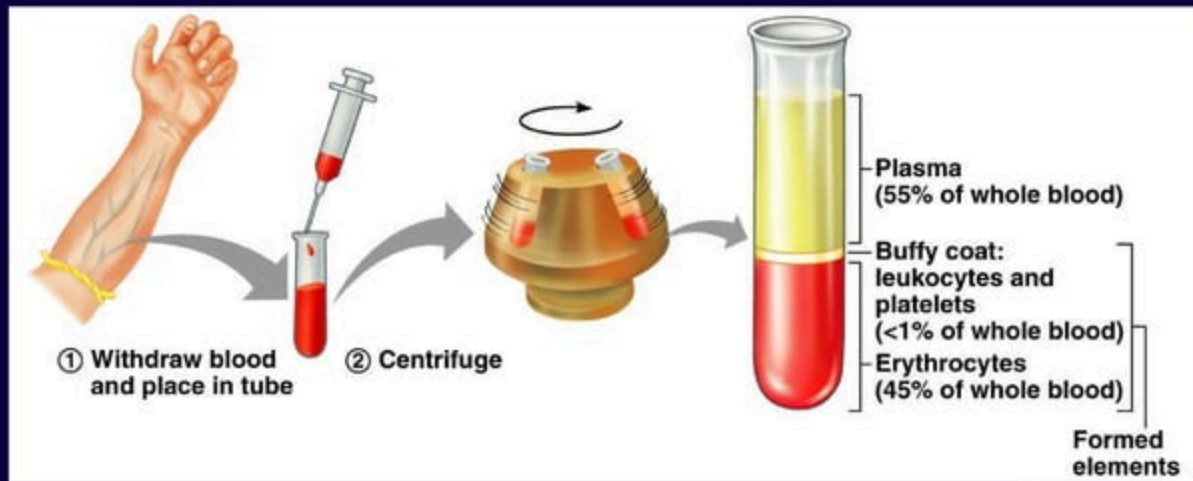


Composition of Whole Blood

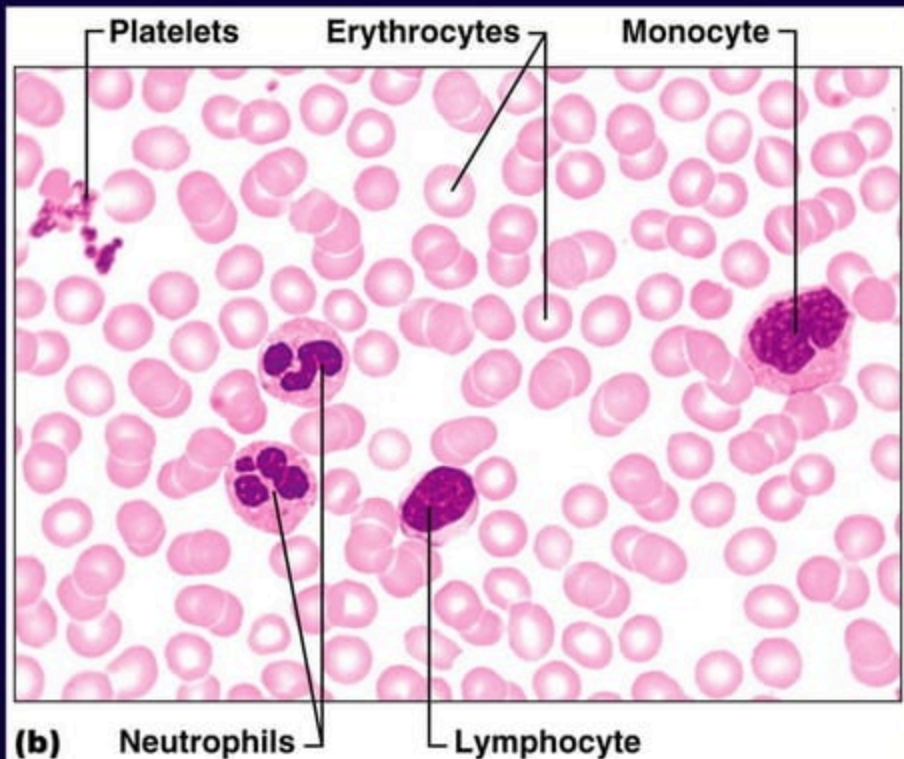


Overview: Composition of Blood

- Hematocrit – measure of % RBC
 - Males: $47\% \pm 5\%$
 - Females: $42\% \pm 5\%$



Wright's Stain

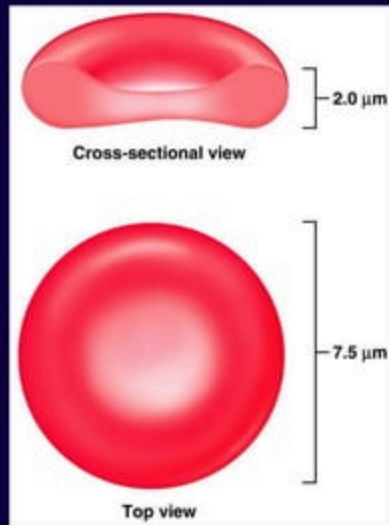


Erythrocytes – Red Blood Cells (RBCs)

- Oxygen-transporting cells
 - 7.5 μm in diameter (diameter of capillary 8 – 10 μm)
- Most numerous of the formed elements
 - Females: 4.3 – 5.2 million cells/cubic millimeter
 - Males: 5.2 – 5.8 million cells/cubic millimeter
- Made in the red bone marrow in long bones, cranial bones, ribs, sternum, and vertebrae
- Average lifespan 100 – 120 days

RBC Structure And Function

- Have no organelles or nuclei
- Hemoglobin – oxygen carrying protein
 - Each RBC has about 280 million hemoglobin molecules
- Biconcave shape – 30% more surface area

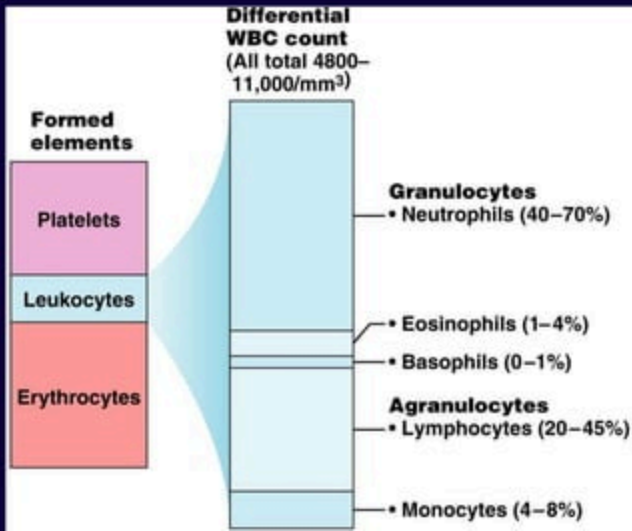


Leukocytes – White Blood Cells (WBCs)

- Protect the body from infectious microorganisms
- 4,800 – 11,000/cubic millimeter
- Function outside the bloodstream in loose connective tissue
- Diapedesis – circulating leukocytes leave the capillaries
- WBCs have a nucleus and are larger than RBCs
- Most produced in bone marrow
- Lifespan of 12 hours to several years

Leukocytes – White Blood Cells (WBCs)

- Two types of leukocytes
 - Granulocytes
 - Agranulocytes
- Differential WBC Count
 - Never
 - Let
 - Monkeys
 - Eat
 - Bananas

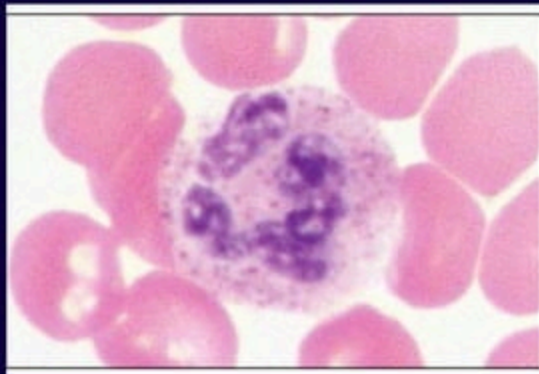


White Blood Cells

Type Of White Blood Cells	% By Volume Of WBC	Description	Function
Neutrophils	60 – 70 %	Nucleus has many interconnected lobes; blue granules	Phagocytize and destroy bacteria; most numerous WBC
Eosinophils	2 – 4 %	Nucleus has bilobed nuclei; red or yellow granules containing digestive enzymes	Play a role in ending allergic reactions
Basophils	< 1 %	Bilobed nuclei hidden by large purple granules full of chemical mediators of inflammation	Function in inflammation medication; similar in function to mast cells
Lymphocytes (B Cells and T Cells)	20 – 25 %	Dense, purple staining, round nucleus; little cytoplasm	the most important cells of the immune system; effective in fighting infectious organisms; act against a specific foreign molecule (antigen)
Monocytes	4 – 8 %	Largest leukocyte; kidney shaped nucleus	Transform into macrophages; phagocytic cells

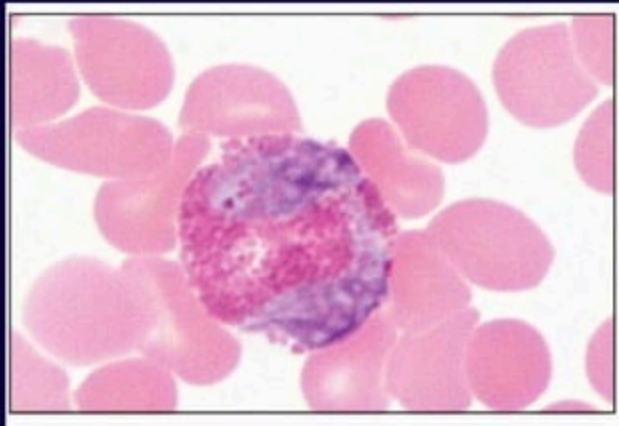
Granulocytes

- Neutrophils – most numerous WBC
 - Phagocytize and destroy bacteria
 - Nucleus – has two to six lobes
 - Granules pick up acidic and basic stains



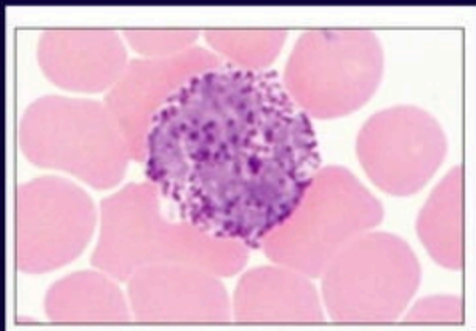
Granulocytes

- Eosinophils – compose 1 – 4% of all WBCs
 - Play roles in ending allergic reactions, parasitic infections



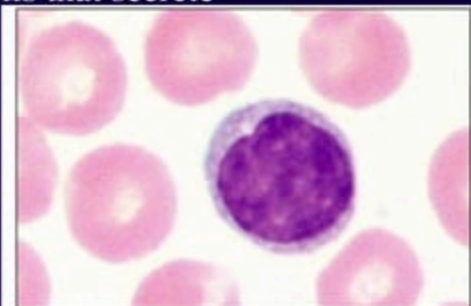
Granulocytes

- Basophils – about 0.5% of all leukocytes
 - Nucleus – usually two lobes
 - Granules secrete histamines
 - Function in inflammation mediation, similar in function to mast cells



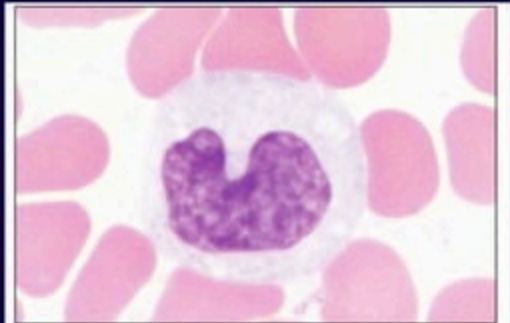
Agranulocytes

- Lymphocytes – compose 20 – 45% of WBCs
 - The most important cells of the immune system
 - Nucleus – stains dark purple
 - Effective in fighting infectious organisms
 - Act against a specific foreign molecule (antigen)
- Two main classes of lymphocyte
 - T cells – attack foreign cells directly
 - B cells – multiply to become plasma cells that secrete antibodies



Agranulocytes








- Monocytes – compose 4–8% of WBCs
 - The largest leukocytes
 - Nucleus – kidney shaped
 - Transform into macrophages
 - Phagocytic cells



Summary of Formed Elements

TABLE

17.1 Summary of Formed Elements of the Blood

Cell Type	Illustration	Description*	Number of Cell per mm ³ (μl) of Blood	Duration of Development (D) and Life Span (LS)	Function
Erythrocytes (red blood cells; RBCs)		Biconcave, anucleate disc; salmon-colored; diameter 7–8 μm	4–6 million	D: 5–9 days LS: 100–120 days	Transport oxygen and carbon dioxide
Leukocytes (white blood cells, WBCs)		Spherical, nucleated cells	4800–11,000		
Granulocytes					
• Neutrophils		Nucleus multilobed; inconspicuous cytoplasmic granules; diameter 12–14 μm	3000–7000	D: 7–11 days LS: 6 hours to a few days	Destroy bacteria by phagocytosis
• Eosinophils		Nucleus bilobed; red cytoplasmic granules; diameter 12–15 μm	100–400	D: 7–11 days LS: about 5 days	Turn off allergic responses and kill parasites
• Basophils		Nucleus bilobed; large blue-purple cytoplasmic granules; diameter 10–14 μm	20–50	D: 3–7 days LS: a few hours to a few days	Release histamine and other mediators of inflammation
Agranulocytes					
• Lymphocytes		Nucleus spherical or indented; pale blue cytoplasm; diameter 5–17 μm	1500–3000	D: days to weeks LS: hours to years	Mount immune response by direct cell attack (T cells) or via antibodies (B cells)
• Monocytes		Nucleus U- or kidney-shaped; gray-blue cytoplasm; diameter 14–24 μm	100–700	D: 2–3 days LS: months	Phagocytosis; develop into macrophages in tissues
Platelets		Discoid cytoplasmic fragments containing granules; stain deep purple; diameter 2–4 μm	150,000–500,000	D: 4–5 days LS: 5–10 days	Seal small tears in blood vessels; instrumental in blood clotting

*Appearance when stained with Wright's stain.

Platelets

- Structure
 - Small cellular fragments; originate in bone marrow from giant cell megakaryocyte
 - Contain several clotting factors – calcium ions, ADP, serotonin
- Function
 - Involved in stopping bleeding when a blood vessel is damaged; Process is called hemostasis

Blood Cell Formation

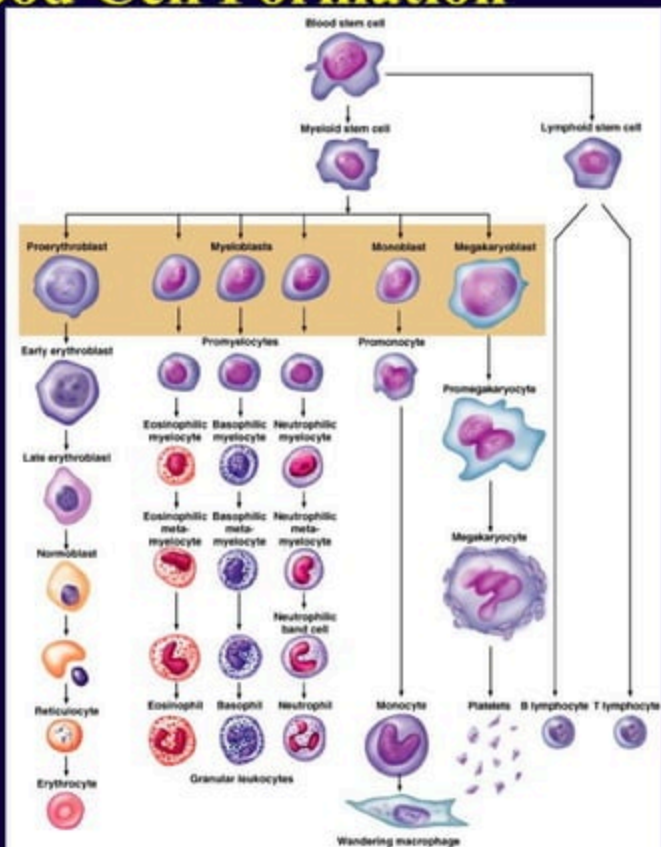
- Hematopoiesis – process by which blood cells are formed
- 100 billion new blood cells formed each day
- Takes place in the red bone marrow of the humerus, femur, sternum, ribs, vertebra and pelvis
 - Red marrow – actively generates new blood cells
 - Contains immature erythrocytes
 - Remains in epiphyses, girdles, and axial skeleton
 - Yellow marrow – dormant
 - Contains many fat cells
 - Located in the long bones of adults
 - Tissue framework for red marrow
 - Reticular connective tissue

Cell Lines in Blood Cell Formation

- All blood cells originate in bone marrow
- All originate from one cell type
 - Blood stem cell (pluripotential hematopoietic stem cell)
 - Lymphoid stem cells - give rise to lymphocytes
 - Myeloid stem cells - give rise to all other blood cells

Cell Lines in Blood Cell Formation

- Genesis of erythrocytes
 - Committed cells are proerythroblasts
 - Remain in the reticulocyte stage for 1–2 days in circulation
 - Make up about 1–2% of all erythrocytes
- Formation of leukocytes
 - Granulocytes form from myeloblasts
 - Monoblasts enlarge and form monocytes
- Platelet-forming cells from megakaryoblasts, break apart into platelets



The Blood Throughout Life

- First blood cells develop with the earliest blood vessels
- Mesenchyme cells cluster into blood islands
- Late in the second month the liver and spleen take over blood formation
- Bone marrow becomes major hematopoietic organ at month 7

RBC life span and circulation

- Replaced at a rate of approximately 3 million new blood cells entering the circulation per second
- Damaged or dead RBCs are recycled by phagocytes
- Components of hemoglobin individually recycled
 - Heme stripped of iron and converted to biliverdin, then bilirubin
- Iron is recycled by being stored in phagocytes, or transported throughout the blood stream bound to transferrin

Red Blood Cell Turnover

