

BLOOD

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Blood

- Blood flows through a closed system
- The force that pushes blood through the vessels is the pumping action of the heart
- Three functions:
 - Transport
 - Regulation
 - Protection

Function of Blood

- Transport:
 - Oxygen to lungs
 - Waste from cells to organs for elimination from body
 - Ions, nutrients & hormones are transported in blood
- Regulation:
 - Fluid & electrolyte balance
 - Acid & base balance
 - Body temperature

Function of Blood

- Protection:
 - From infection
 - Clotting factors protect from excessive bleeding

Composition of Blood

- Blood is a connective tissue
- Color varies from bright red to darker blue which is related to the amount of oxygen in the blood
- Average adult has about 4-6 liters
- pH of blood is 7.35-7.45
- Blood is viscous; 4-5 times more viscous than water

Composition of Blood

- Hematopoiesis is the production of blood cells
 - Three types of blood cells:
 - Red—white—platelets
 - Two types of hematopoietic tissue
 - Red bone marrow & lymphatic tissue
 - Red bone marrow produces all three types of blood cells from one cell, the stem cell
 - The stem cell differentiates into either a RBC, WBC or platelet
 - The lymphocyte & monocyte originate in the bone marrow but some mature in the lymphatic tissue

Composition of Blood

- Contains two parts:
 - Plasma
 - Cells; AKA corpuscles
- Plasma:
 - liquid portion of blood
 - pale yellow in color
 - consisting mostly of water
 - Contains proteins, ions, nutrients, gases & waste

Composition of Blood

- Plasma:
 - Plasma proteins consist of albumin, clotting factors, antibodies & complements
 - Plasma proteins help:
 - **albumin** regulates fluid volume
 - **antibodies** protect body from pathogens
 - **clotting factors** prevent excessive blood loss
- Serum is plasma minus the clotting factors

Red Blood Cells

- Red Blood Cells
 - AKA: Erythrocytes
 - Transport oxygen to all cells
 - Most numerous cell at 4.5-6.0 million per microliter
 - Tiny concaved disc-shaped cells that have a thick outer rim & thin center
 - Shape makes them flexible allowing them to enter tiny blood vessels ensuring all cells receive oxygen

Red Blood Cells

- Red blood cell
 - Filled with large protein molecule called hemoglobin which is responsible for the transport of oxygen & small amounts of carbon dioxide
 - Iron, vitamin B₁₂, folic acid & protein are essential from hemoglobin synthesis

Red Blood Cells

- Erythropoietin:
 - Hormone responsible for production of RBC's
 - When the oxygen in the body tissues starts to decrease, the kidney senses the need for additional oxygen & secretes a hormone erythropoietin stimulating bone marrow production of RBC's
 - Blood transports the erythropoietin from the kidney to the bone marrow stimulating the release of RBC's into circulation
 - ↑ in RBC's in circulation ↑ oxygen to tissues which diminishes the stimulus for erythropoietin release from the kidneys which ↓ the bone marrow production of RBC's

Red Blood Cells

- Removal & Breakdown of RBC's
 - RBC's last about 120 days
 - RBC's do not reproduce because it does not contain a nucleus
 - Macrophages that line the spleen & liver remove RBC's from the blood by phagocytosis
 - The heme & globin are recycled
 - Deficiency in RBC's creates anemia

White Blood Cells

- White blood cells
 - AKA: Leukocytes
 - Several types
 - Protects body from pathogens by phagocytosis
 - Large, round & contain nuclei
 - White in color due to lack of hemoglobin
 - 5,000-10,000/microliter
 - When infection is present WBC's ↑
 - WBC's leave blood vessels & migrate to site of infection
 - Deficiency in WBC's is leukopenia
 - Elevation in WBC's is leukocytosis

White Blood Cells

- Types of WBC's
 - Granulocytes:
 - WBC's that contain granules
 - Three types:
 - Neutrophils
 - Basophils
 - Eosinophils
 - Agranulocytes:
 - Do not contain granules
 - Two types:
 - Monocytes
 - Lymphocytes

White Blood Cells

- Granulocytes:
 - Neutrophils:
 - Most common granulocyte
 - 55%-70% of total WBC's
 - Round cell that contains nucleus
 - Size of nucleus varies so called polymorphs or PMN's
 - Remains in blood only 10-12 hours
 - Role is phagocytosis
 - Quickly move to site of infection, begin phagocytosis of pathogens & remove dead debris
 - Pus is the accumulation of dead neutrophils, parts of cells & fluid
 - Deficiency of neutrophils is neutropenia or granulocytopenia

White Blood Cells

- Granulocytes:
 - Basophils:
 - Present in small numbers; 1% of WBC's
 - Little is known about basophils
 - Play role in inflammatory response through release histamine
 - Releases heparin which is thought to reduce formation of clots in lungs & liver

White Blood Cell

- Eosinophils:
 - Present in small amounts; 1% of WBC's
 - Little is known
 - Involved in inflammatory response; secretes chemicals that destroy certain parasites & increased in persons with allergies

White Blood Cells

- These three granulocytes stain different colors which are used to name them
 - Neutrophils do not stain deeply; relatively neutral; granules appear a light lavender color
 - Eosinophils stain deeply; bright pink
 - Basophils stain deeply; dark blue

White Blood Cells

- Agranulocytes:
 - Lymphocytes:
 - Produced in red bone marrow
 - Some mature in lymphoid tissue
 - Constitute 25%-38% of the WBC
 - Role in immune response
 - Monocytes:
 - Constitute 3% -8% of WBC
 - Role of phagocytosis; more efficient
 - Change into macrophages that either wander or are fixed

Platelets

- Platelets
 - AKA Thrombocytes
 - Are a piece or fragment of large megakaryocyte
 - Prevent blood loss
 - Tiniest formed element of blood
 - 150,000-450,000/microliter
 - Produced in red bone marrow from a large megakaryocyte
 - Lifespan is 5-9 days
 - Deficiency is called thrombocytopenia

Blood Testing

- Hematocrit:
 - is the percentage of blood cells in a sample of blood
 - 45% is blood cells & 55% is plasma
 - Of the 45% that is blood cells most are RBC's
 - Small layer between the plasma & RBC's is called buffy coat & consists of WBC's & platelets
 - A low test result indicates anemia because it is indicative of low RBC's
 - Normal range: Females 38-44 Males 43-49

Blood Testing

- Complete blood count (CBC)
 - Laboratory test provides normal constituents of blood
 - Includes:
 - RBC—WBC—platelets—hemoglobin—hematocrit
 - The percentage of each of the 5 types of WBC's is called differential count which is significant diagnostically because it tells what WBC is involved

Hemostasis

- Injury to a blood vessel often causes bleeding
- The process that stops the bleeding is called hemostasis
- Three events occur:
 - Blood vessel spasm
 - Formation of a platelet plug
 - Blood clotting

Hemostasis

1. Blood vessel spasm:
 - When the vessel is injured the smooth muscle in the vessel wall contracts or constricts
 - Decreases the diameter of vessel
 - Decreasing the amount of blood flow through the vessel
 - In a small vessel the spasm is enough to stop the bleeding; this is not the case in a larger vessel

Hemostasis

2. Formation of a Platelet Plug

- When a vessel is torn, the inner lining of the vessel activates platelets
- Platelets become sticky & adhere to the inner lining of damaged vessel & each other forming a platelet plug diminishing bleeding at site
- The plug is then invaded by blood clotting factors & evolves into a stable blood clot
- The platelets also secrete a chemical that stimulates vascular spasm & activates blood-clotting factors

Hemostasis

3. Blood Clotting:

- AKA coagulation
- Third step of process
- A blood clot forms by a series of chemical reactions forming a netlike structure called fibrin
- Blood flows through fibrin & catches large particles such as RBC's & platelets
- These particles help form the blood clot

Hemostasis

• Formation of Blood Clot:

- Three stages of chemical reaction
- 1. Stage I: injury to blood vessel wall activates clotting factors; circulate in blood in inactive form; when activated the clotting factors produce prothrombin activator (PTA)
- 2. Stage II: in the presence of calcium, platelet chemicals & PTA, prothrombin is activated to form thrombin
- 3. Thrombin activates fibrinogen which forms fibrin fibers or net; the net traps particles to form the clot

Clot Retraction

- Clot retraction:
 - After a clot forms, it begins to pull itself together becoming smaller
 - As it retracts, the edges of the injured blood vessel pull together
 - The pulling together slows bleeding
 - This sets the stage for healing & repair of the blood vessel

Anticoagulants

- Body must also prevent unnecessary blood clot formation
- Two important mechanism:
 - Endothelium of smooth muscle is shiny & smooth which allows blood to flow along surface easily
 - Secretion of heparin by mast cells which are concentrated around lungs & liver; these two sites are areas of stagnant blood; removes thrombin from clotting process

Anticoagulant Medication

- Anticoagulants are administered in an attempt to prevent the formation of a blood clot
- Two types:
 - Heparin & Coumadin
- Blood clot is called thrombus
- Process of blood clot formation is thrombosis
- A traveling thrombus is called embolus

Anticoagulant Testing

- PT: Prothrombin time is a coagulation test performed to measure the time it takes for a firm fibrin clot to form
 - Measures clotting activity of blood
- INR: International Normalized Ratio
 - INR = patient PT results compared to normal patient average
- PT & INR are performed to ensure therapeutic amounts oral anticoagulation medication is administered

Anticoagulant Testing

- APTT: Activated Partial Thromboplastin Time
 - Coagulation test evaluates the the time required for a fibrin clot to form
 - Detects congenital deficiencies in clotting factors
 - Evaluate hemostatic effects of conditions liver disease & other pathological conditions
 - Evaluate response to anticoagulant therapy with intravenous heparin therapy

Fibrinolysis

- Fibrinolysis is the process of clot dissolving after the clot has accomplished its task
- Tissue surrounding the injury forms Tissue plasminogen activator
- Tissue plasminogen activator activates plasminogen
- Plasmin plasminogen, which circulates in blood in its inactive form, forms Plasmin
- Plasmin dissolves the clot

Blood Types

- Blood is classified according to specific antigens on surface of RBC's
- We are born with antigen on cell membrane of RBC therefore we will not form antibodies against it
- 4 ABO types:
 - A—B—AB—O
- Antibodies are found in the plasma for each blood type as well; they bind to specific substance & inactivate them

Antigen-Antibody Interaction

- When a person of a specific blood type is given an incompatible blood type an antigen-antibody interaction occurs
- The antigen & antibody clump called agglutination
- Agglutination causes RBC's to lyse or burst called hemolysis
- Liberated hemoglobin clogs kidney causing kidney failure & rapid hemolysis can cause death
- To avoid reaction a person is typed & cross-matched to determine compatibility

Type & Crossmatch

- Type & cross match:
 - First the person's blood is determined
 - Then it is mixed with the recipients blood to determine compatibility
 - Any evidence of agglutination indicates incompatibility
 - Test is performed prior to administration of blood products to avoid adverse blood reaction

Blood Types

- A:
 - 40% have type A
 - RBC contains A antigens
 - Plasma has anti-B antibodies
 - Can receive from type A & O
 - Can donate blood to Type A & AB
- B:
 - 10% have type B
 - RBC contains B antigen
 - Plasma has anti-A antibodies
 - Can receive from type B & O
 - Can donate to Type B & AB

Blood Types

- AB:
 - 4% have type AB
 - RBC contains A & B antigens
 - Plasma has no antibodies
 - Can receive blood from A, B, AB, O
 - Universal recipient
 - Can donate to AB

Blood Types

- O:
 - 46% have type O
 - RBC has no antigens
 - Plasma contains Anti-A & Anti-B antibodies
 - Can receive blood from type O
 - Can donate blood to A, B, AB & O
 - Universal donor

Rh Classification

- Blood is also classified according to the Rh factor
- Rh factor is an antigen located on the surface of the RBC
- Named for the Rhesus monkey, in which it was first detected
- If RBC contains Rh factor, it is said to be Rh-positive (+)
- If RBC does not contain Rh factor, it is said to be Rh-negative (-)
- 85% of population is Rh-positive

Rh Classification

- Plasma does not carry anti-Rh antibodies
- In Two situations Rh-negative person can develop anti-Rh antibodies
 1. Administration of Rh-positive blood to an Rh-negative person
 - Rh antigen of Rh-positive donor stimulates the Rh-negative recipient to produce anti-Rh antibodies
 - The next time the recipient receives Rh positive blood the anti-Rh antibodies in the plasma of the recipient will attack the Rh antigen of Rh positive donor blood causing agglutination & hemolysis

Rh Classification

2. Rh-negative pregnant mother & a Rh-positive fetus
 - During the first pregnancy, the baby is delivered uneventfully
 - During childbirth, some of the baby's Rh-positive blood cross the placenta, enters the mother's circulation & mixes with her blood
 - This stimulates the production of anti-Rh antibodies
 - In second pregnancy, if fetus is Rh-positive, the Rh-antibodies move from the mother's circulation into the baby's circulation causing agglutination & hemolysis
