

Blood

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Blood

- ⚡ only fluid tissue in body
- ⚡ specialized type of connective tissue
- ⚡ cellular & liquid components
 - living blood cells
 - AKA *formed elements*
 - suspended in a nonliving fluid matrix
 - » *plasma*

Major Components of Blood (fig 18.1)

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Formed Elements

- ⚡ 1) erythrocytes ~ RBCs
 - transport oxygen
 - constitute 45% of total vol (sample)
- ⚡ 2) leukocytes ~ WBCs
 - defend against ds
- ⚡ 3) platelets ~ cell fragments
 - help stop bleeding

Buffy Coat

- ⚡ thin, whitish layer
- ⚡ RBC-plasma jnc
- ⚡ contains WBCs and platelets
- ⚡ make up less than 1% bv

Plasma

- ⚡ non-living fluid component of blood
- ⚡ constitutes 55% of w hole blood
- ⚡ straw-colored sticky fluid
- ⚡ 90% water

Plasma

- ⚡ contains formed elements & over 100 diff dissolved solutes (Table 18.1)
 - nutrients
 - gases
 - hormones
 - wastes (urea, uric acid, lactic acid)
 - products of cell activity
 - ions
 - proteins

Plasma Proteins

- ⚡ constitute 8% of wt of plasma
 - albumin acct for 60% of wt
 - most abundant of plasma solutes
 - globulins acct for 36%
 - alpha, beta
 - transport proteins
 - gamma
 - antibodies released during immune response
 - clotting proteins acct for 4%
 - fibrinogen
 - prothrombin

Plasma Proteins

- ⚡ variety of functions
 - transport various solutes around the body
 - distribute heat throughout the body
 - maintain water balance
 - betw een blood & tissues
 - role in blood clotting
 - act as metabolic enzymes, hormones

Albumin

- accts for 60% of plasma proteins
- carrier to shuttle molecules through the circulation
- important blood buffer
- major blood protein contributing to plasma osmotic pressure (OP)
 - P keeps water in the bloodstream

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Physical Characteristics of Blood

- sticky, opaque fluid
 - due to presence of RBCs
 - major factor contributing to viscosity
 - sticky, thick
- characteristic metallic taste

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Physical Characteristics of Blood

- characteristic color
 - dependent on amt of oxygen present
 - scarlet red - high oxygen
 - dark red - poor oxygen

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Physical Characteristics of Blood

- slightly alkaline
 - pH between 7.35 and 7.45
- accounts for 8% of body wt
- avg vol (healthy adult)
 - males - 5-6 L
 - females - 4-5 L

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Functions of Blood

- distributive
 - oxygen and nutrients delivery to tissues
 - metabolic waste removal
 - hormone transport
- regulatory
 - body temp maintenance
 - blood pH constancy
 - adequate fluid volume

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Functions of Blood

- protective
 - hemostasis
 - bleeding stoppage
 - infection prevention

**Functions overlap & interact to maintain constancy of our internal environment*

***See page 652 for a detailed listing of overlapping fncs*

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Formed Elements

- cellular portion of blood
 - RBCs, WBCs, platelets
- unusual features
 - cells
 - survival time in bloodstream
 - a few days
 - most blood cells do not divide
 - continuously renewed by division of cells
 - bone marrow where they originate

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Table 35.2 Summary of Formed Elements of the Blood

Cell Type	Characteristics	Chemical*	Number of a Given Cell of Blood	Physical of Cell (approx. 10 ¹² /L)	Function
Erythrocytes (red blood cells)	Biconcave, anucleated disk; diameter 7-8 μm	Hb, Hg	4-6 billion	1.5-1.6 μm; 10-12 μm; 10-12 μm	Transport oxygen and remove carbon dioxide
Leukocytes (white blood cells)	Spherical, nucleated cells	None	4,000-11,000	10-15 μm	Phagocytosis
Platelets	Small, disc-shaped fragments; diameter 2-3 μm	None	100,000-400,000	2-3 μm	Clotting

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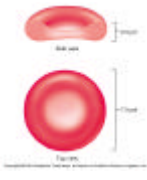
Cells

- ⚡ RBCs
 - have no nuclei or organelles
- ⚡ platelets
 - cell fragments
- ⚡ WBCs
 - complete cells
- ⚡ *RBCs vastly outnumber the other types

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Erythrocytes (RBCs)

- ⚡ small cell
- ⚡ ~7.5 μm (diameter)
- ⚡ biconcave disc shape
 - flattened w/ depressed ct
- ⚡ a miniature donut
- ⚡ mature
 - PM, lack nucleus & organelles



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Erythrocytes (RBCs)

- ⚡ bags of Hb
 - 97%
- ⚡ contain add'l proteins
 - fnc to maintain PM or promote changes in shape

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Erythrocytes (RBCs)

- ⚡ fnc
 - pick up oxygen in capillary beds of lungs & releases it to tissue cells
 - transports ~20% carbon dioxide back to lungs

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Hematocrit

- ⚡ measure of RBCs as a % of total bv
- ⚡ healthy male
 - 47% +/- 5%
- ⚡ healthy female
 - 42% +/- 5%
- ⚡ ~ 2.5 trillion RBCs in a healthy adult

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RBC & Hb

- ⚡ Hb binds easily & reversibly with oxygen
 - single RBC
 - ~250 trillion Hb molecules
 - carries ~ 1 billion molecules of oxygen
- ⚡ most oxygen carried in blood is bound to Hb

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RBC & Hb

- ⚡ normal Hb values
 - infants - 14-20 g/100 ml (blood)
 - adult male - 13-18 g/100 ml
 - adult female - 12-16 g/100 ml

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Hb

- ⚡ composed of protein
 - globin
 - bound to red heme pigment
 - 4 polypeptide chains
 - 2 alpha chains
 - 2 beta chains
 - each bounded to a ringlike iron containing heme group
- ⚡ each Fe atom
 - combine reversibly w/ 1 molecule of oxygen
- ⚡ 1 Hb molecule
 - transport 4 molecules of oxygen

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Physiological Jaundice

- ⚡ can occur in normal newborns
- ⚡ 3-4 days after birth
- ⚡ fetal RBCs are short lived
 - break down rapidly after birth
- ⚡ infant's liver is unable to process bilirubin fast enough

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Physiological Jaundice

- bilirubin
 - breakdown product of Hb pigment
 - accumulates in blood
 - deposits in body tissues

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Structural Characteristics of RBCs

- Contribute to gas transport fnc
- 1) small size & biconcave shape
 - large surface area (30% more)
- 2) over 97% Hb
- 3) lack mitochondria & generate ATP by anaerobic means
 - do not consume oxygen they transport

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Oxygen Loading

- lungs
- direction of transport
 - lungs to tissue cells
 - oxygen deficient blood moves through the lung
 - oxygen diffuses from lung air sacs to blood to RBC
 - binds to Hb
 - binds specifically to iron
 - oxyhemoglobin (new 3D shape, bright red)

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Oxygen Unloading

- reverse process
- tissues
- oxygen detaches from iron
 - Hb resumes its former shape
 - deoxyhemoglobin
 - reduced Hb
 - dark red
 - released oxygen diffuses from blood into tissue fluid and then into tissue cells

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Carbon Dioxide Transport

- 20% combines w/ Hb
 - binds to a.a. of globin
 - not heme group
 - formation of carbaminohemoglobin
 - occurs more readily when Hb is dissociated from O₂
- loading occurs in tissues
 - direction of transport is from tissues to lungs
 - where CO₂ is eliminated from the body

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Homeostatic Imbalances

- Hypoxia
 - decreased oxygen delivery to body tissues
- Hypoxemic hypoxia
 - decreased arterial pressure
 - caused by pulmonary ds
 - breathing too little oxygen
- CO poisoning
 - unique type of hypoxemic hypoxia

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CO

- CO
 - colorless, odorless gas
 - competes vigorously w/ oxygen for heme-binding sites
 - Hb affinity for CO is 200x's > O₂
 - highly successful competitor

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CO Poisoning

- dangerous
- no characteristic signs
- cyanosis, respiratory distress
- confused
- throbbing headache
- trt
 - 100% oxygen

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Hematopoiesis~Hemopoiesis

- blood cell formation
- occurs in red bone marrow
 - soft network of reticular connective tissue
 - immature blood cells
 - macrophages
 - fat cells
 - reticular cells
 - (fibroblasts secrete fibers)

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Hematopoiesis~Hemopoiesis

- red marrow
 - chiefly
 - bones of axial skeleton
 - girdles
 - proximal epiphyses of humerus & femur

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Hematopoiesis~Hemopoiesis

- each type of bc produced
 - different quantities
 - changing body needs
 - different regulatory factors
- as bc's mature
 - migrate through the thin walls of sinusoids
 - wide blood capillaries
 - enter the bloodstream

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Hematopoiesis~Hemopoiesis

- daily
 - the marrow turns out an oz of new blood
 - ~ 100 billion new cells
- formed elements have different fncs
 - important similarities
 - arise from same type of stem cell
 - hematopoietic stem cell - hematocytoblast
 - resides in red bone marrow

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Hematopoiesis~Hemopoiesis

- maturation pathways differ
 - cell is "committed" to a specific bc pathway
 - cell cannot change
- "commitment"
 - signal
 - appearance of membrane surface receptors
 - respond to specific hormones or GF
 - 'push' the cell to specialization

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Erythropoiesis

- erythrocyte production
 - RBCs begin as hemocytoblasts
 - proceed from
 - proerythroblast stage
 - erythroblast stage
 - normoblast stage
 - reticulocyte stages
 - erythrocyte

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Erythropoiesis

- 1) proerythroblast stage
 - committed cell stage
- 2) erythroblast stage
 - early stage
 - ribosome synthesis
 - late stage
 - Hb accumulation (*Hb synthesis & iron accumulation*)

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Erythropoiesis

- 3) normoblast stage
 - RBC transformed into a young reticulocyte (*RBC*)
 - ejection of the nucleus
- 4) reticulocyte stages (3-5 day process)
 - hemocytoblast to reticulocyte formation
 - young RBC
- 5) erythrocyte

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Erythropoiesis

- normoblast stage
 - ~34 % Hb accumulation
 - ejection of organelles
 - end of nuclear function
 - nucleus degeneration & pinching off
 - cell collapses inward
 - assumes biconcave shape

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Erythropoiesis

- reticulocyte (young RBC)
 - contains scant network of clumped ribosomes & RER
 - filled w/ Hb
 - enters bloodstream to transport oxygen
 - becomes fully mature RBC w/in 2 days of release
 - ribosomes degraded by IC enzymes
 - accts for 1-2% of all RBCs in blood (*healthy*)

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Erythropoiesis (fig 18.5)

The diagram illustrates the stages of erythropoiesis:

- Multipotential progenitor**: The starting cell.
- Proerythroblast**: The first committed stage.
- Erythroblast**: The second stage, showing nuclear condensation.
- Polychromatophilic erythroblast**: The third stage, characterized by a blue-gray cytoplasm.
- Reticulocyte**: The fourth stage, with a reddish-orange cytoplasm and a thin rim of blue.
- Mature erythrocyte**: The final stage, a fully formed red blood cell without a nucleus.

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Reticulocyte Counts

- used clinically
- rough ID of rate of RBC formation
- indicate abnormal rates of RBC formation

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Erythropoiesis Regulation

- # of circulating RBCs constant
 - new cells produced at rate of 2 mil/s
 - reflects balance between RBC production and destruction
 - too few RBCs
 - tissue hypoxia
 - oxygen deprivation
 - too many RBCs
 - increased viscosity

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Erythropoiesis Regulation

- hormonally
 - dependent on adequate supplies
 - Fe, a.a., certain B vitamins
 - direct stimulus
 - erythropoietin (EPO)
 - glycoprotein hormone
 - small amt circulate in blood at all times
 - sustains RBC production at a basal rate
 - produced by kidneys
 - w hen cells become hypoxic
 - also produced in liver

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Erythropoiesis Regulation

- stimulus
 - ↓ blood O₂
 - ↓ # of RBCs
 - hemorrhage
 - excess RBC destruction
 - O₂ availability
 - high altitudes
 - pneumonia
 - ↑ tissue demands for O₂
 - aerobic exercise
 - inhibition
 - ↑ RBCs or ↑ O₂ in bloodstream

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Erythropoiesis Regulation

- rate of EPO production
 - dependent on cell's ability to transport enough O₂ to meet tissue demands
- bloodborne EPO
 - stimulates red marrow "committed" RBCs
 - mature more rapidly
 - 1-2 days after ↓ EPO blood levels
 - ↑ rate of reticulocyte release

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Erythropoiesis Regulation (fig 18.6)

The diagram shows the feedback loop:

- Hypoxia** (low O₂) stimulates the **Kidneys** to release **EPO**.
- EPO** stimulates the **Bone Marrow** to produce **RBCs**.
- RBCs** increase **O₂ delivery**, which inhibits the **Kidneys** from releasing more EPO.
- Other stimuli** (like testosterone) also stimulate the **Kidneys** to release EPO.

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Erythropoiesis Regulation

- hypoxia
 - does not activate bone marrow directly
 - stimulates kidneys
 - release EPO
 - EPO stimulates red bone marrow
- other stimulants
 - testosterone
 - enhances EPO production by kidneys
 - ↑ RBC counts and Hb in males

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Erythropoiesis Regulation

- other stimulants
 - result in bursts of RBC production
 - chemicals released by
 - leukocytes
 - platelets
 - reticular cells

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Dietary Requirements for Erythropoiesis

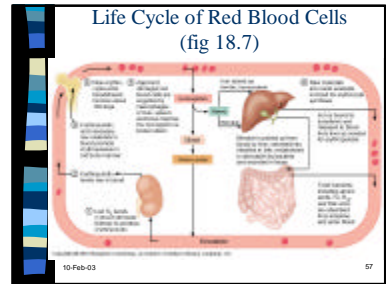
- proteins, lipids, CHO
- Fe
 - for Hb synthesis
 - available from diet
 - absorption into bloodstream
 - controlled by intestinal cells
 - body's supply
 - 65% is in Hb
 - remainder stored
 - liver, spleen, bone marrow

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Dietary Requirements for Erythropoiesis

- two B-complex vitamins
 - vitamin B₁₂
 - liver, meat, poultry, dairy products (except butter, egg)
 - folic acid
 - liver, orange juice, green veggies, beef, eggs, grains
- essential for DNA synthesis
 - developing RBCs

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Erythrocyte Disorders

- most are classified as anemias or polycythemias
- anemia
 - condition
 - blood has low O₂ carrying capacity
 - inadequate blood O₂ to support normal metabolism
 - fatigue, paleness, SOB, chills
 - symptom of disorders
 - not ds

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Anemia

- cause
 - 1) insufficient # of RBCs
 - blood loss
 - excessive destruction of RBCs
 - bone marrow failure
 - condition
 - A) hemorrhagic anemia
 - blood loss
 - B) hemolytic anemia
 - RBCs lyse or rupture prematurely
 - Hb abnormality, transfusion of mixed blood
 - bacterial or parasitic infection

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Anemia

- condition
 - C) hemolytic ds of newborn
 - AKA erythroblastosis fetalis
 - baby becomes anemic and hypoxic
 - result of Rh⁻ mother having an Rh⁺ baby
 - second pregnancy
 - ABs developed against fetus
 - ABs cross placenta & destroy baby's RBCs

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Anemia

- condition
 - C) aplastic anemia
 - destruction or inhibition of red marrow
 - bacterial toxins, drugs or radiation
- cause
 - 2) | Hb content
 - normal Hb molecules
 - fewer RBCs present
 - condition
 - A) nutritional anemia
 - iron deficiency anemia (microcyte - small, pale RBC)
 - 2nd result of hemorrhagic anemia
 - inadequate iron intake
 - impaired iron absorption

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Anemia

- condition
 - B) pernicious anemia
 - deficiency of vitamin B₁₂
 - deficiency in intrinsic factor needed for B₁₂ absorption by the stomach
- cause
 - 3) abnormal Hb
 - production of abnormal Hb
 - usually has a genetic basis
 - condition
 - A) sickle cell anemia
 - globin part of Hb is abnormal
 - RBCs are fragile, rupture prematurely
 - serious, incurable, sometimes fatal

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Polycythemia

- abnormal excess of RBCs
 - blood viscosity
 - sluggish flow of blood
 - dizziness
 - | RBC count

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Leukocytes (WBCs)

- only formed elements that are complete cells
 - nuclei, organelles
- protect the body from damage
 - bacteria
 - viruses
 - parasites
 - toxins
 - tumor cells

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Leukocytes

- grouped into two major categories
 - based on structural and chemical characteristics
- A. Granulocytes
 - contain specialized membrane bound cytoplasmic granules
 - neutrophil
 - basophil
 - eosinophil
- B. Agranulocytes
 - lack cytoplasmic granules
 - lymphocytes
 - monocytes

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Table 18.2 Summary of General Features of the Blood

Cell Type	Characteristics	Description*	Number of cells/mm ³ of blood	Percentage of cells/mm ³ of blood (U.S.)	Function
Red blood cells (erythrocytes)	Red, biconcave disk, 7-8 μm in diameter	Transport oxygen and carbon dioxide	4-5 million	45-50%	Transport oxygen and carbon dioxide
Leukocytes (white blood cells)			4,800-10,800		
Neutrophils		Phagocytosis	50-70%	50-70%	Phagocytosis
Eosinophils		Phagocytosis	1-4%	1-4%	Phagocytosis
Basophils		Phagocytosis	0.5-1%	0.5-1%	Phagocytosis
Lymphocytes		Immune response	20-40%	20-40%	Immune response
Monocytes		Phagocytosis	2-10%	2-10%	Phagocytosis

*Approximate values; actual values may vary.
†Percentages are approximate and may vary with age and sex.

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Differential WBC Count (fig 18.9)

- diagnostic tool
- gives a determination of relative proportion of individual WBC types
- order from most to least abundant
 - Never let monkeys eat bananas
 - neutrophils
 - lymphocytes
 - monocytes
 - eosinophils
 - basophils

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Leukocytosis

- condition of normal homeostatic response
 - bacterial or viral invasion of the body
- WBC count of over 11,000 cells mm³
- WBCs become mobilized for action
 - production of twice the # can appear w/in hours

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Histamine

- inflammatory chemical
- acts as a vasodilator
- attracts other WBCs to inflamed site
- present in basophils

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Macrophage

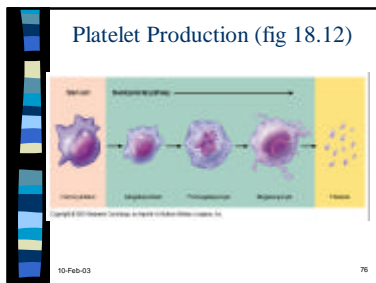
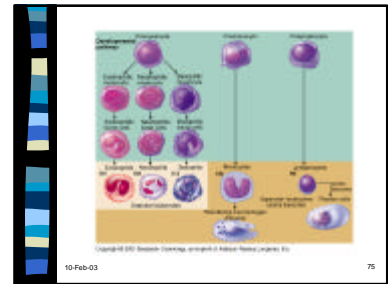
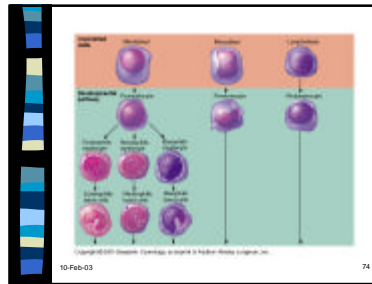
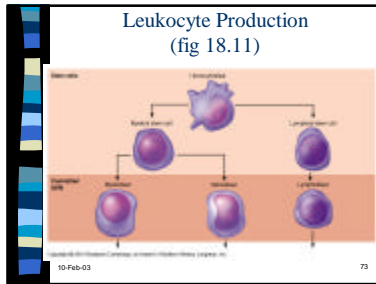
- phagocytic protective cell type
 - crucial to body's defense
- found
 - connective & lymphatic tissues
 - organs that phagocytize
 - cells
 - bacteria
 - other foreign debris
- originally monocytes
 - differentiate tissues

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Movement of Leukocytes

- 1) amoeboid
 - WBCs form flowing cytoplasmic extensions
 - move them along
- 2) positive chemotaxis
 - movement of WBCs toward molecules released by damaged cells or other WBCs
 - move to areas of tissue damage in large numbers
 - destroy foreign substances
- 3) diapedesis
 - slip out of the capillary blood vessels
 - part of the inflammatory response

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Hemostasis

- ↳ "plug-the-hole" defensive mechanism
 - prevention of blood loss
- ↳ response is fast, localized, carefully controlled
- ↳ series of rxns
 - involve many blood coagulation factors
 - normally present in plasma & other substances
 - released by platelets & injured tissue cells

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Events of Hemostasis

- ↳ 1) vessel damage
- ↳ 2) vessel spasm mechanism
 - constriction of blood vessel
 - vasoconstriction
 - triggered by
 - direct injury to smooth muscle
 - release of chemicals
 - reflexes from pain receptors
 - most effective in smaller by
 - reduce blood loss for 20-30 min
 - allow some time for blood clotting to occur

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Events of Hemostasis

- ↳ 3) platelet adhesion & agglutination
 - platelets undergo changes
 - swell and form spiky processes
 - become sticky and adhere to exposed collagen
 - platelets granules break down and release chemicals
 - serotonin
 - enhances vascular spasm
 - ADP
 - attracts more platelets to site
 - positive feedback mechanism
 - formation of platelet plug
 - temporarily seals break in vessel wall

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Events of Hemostasis

- ↳ 4) fibrin trap
 - thin, long threads
 - form a loose meshwork over the injured site
 - "molecular glue" for aggregated platelets
 - trap blood cells
 - blood clot (coagulation)

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Blood Clotting Mechanism

- ↳ damage to blood vessel
- ↳ release of clotting factors (CFs)
 - by platelets trapped at site and damaged by wall
- ↳ chain rxn events
 - initiated by CFs
- ↳ blood clot production
 - transformation from a liquid to a gel

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Blood Clotting (fig 18.13)

Three critical phases

- 1) CF + Ca form PA (prothrombin activator)
- 2) PA + Ca convert prothrombin (*plasma protein*) into thrombin (*enzyme*)
- 3) Thrombin + Ca convert fibrinogen (*soluble plasma protein*) into fibrin (*insoluble*)

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Intrinsic vs Extrinsic Clotting Mechanisms

both pathways

- initiate clotting
- usually triggered by same tissue damage
- many intermediates are activated only by platelet phospholipid (PF₃)
 - found on external surface of aggregated platelets
- result in formation of PA
 - subsequently clot in 10 to 15 sec

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Intrinsic vs Extrinsic Clotting Mechanisms

both pathways

- require Ca
- involve activation of series of procoagulants
 - inc as enzymes to activate the next
 - result in factor X activation
 - combines w/ Ca + thromboplastin (TF) OR PF₃ → PA
- go through the same 3 critical phases

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Intrinsic vs Extrinsic Clotting Mechanisms

intrinsic pathway

- slower
- all CFs are present in blood
- initiates clotting outside the body
 - test tube

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Intrinsic vs Extrinsic Clotting Mechanisms

extrinsic pathway

- faster
- initiates clotting inside the body
 - tissues
- tissue trauma causes release of TF
 - from injured cells
 - subsequently bypass several steps in intrinsic pathway

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Clot Retraction & Repair

platelet induced process

occurs w/in 30-60' post clot formation

- 1) platelets contract like muscle cells
- 2) serum is squeezed out
- 3) ruptured vessel edges are drawn together
- 4) vessel healing occurs simultaneously
 - vessel repaired
 - smooth muscle
 - connective tissue
 - endothelial cell proliferation and migration

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Heparin

natural anticoagulant

- granules of basophils and mast cells

ordinarily secreted in small amts into plasma

inhibitor of normal clot growth

- prevents a clot from becoming too large

inhibits thrombin

used clinically to prevent undesirable clotting

- patients at risk for heart attack or stroke

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Disorders of Hemostasis

two major disorders

- 1) thromboembolytic disorders
 - undesirable intravascular clotting
 - AKA "hemostasis" in the w rong place
- 2) bleeding disorders

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Thromboembolytic Disorders

A) thrombus

- clot develops and persists in an unbroken vessel
- blockage of circulation to cells
 - if clot too large
 - death of tissue

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Thromboembolytic Disorders

- ⚡ B) embolus
 - occurs when thrombus breaks away from bv wall & floats freely in bloodstream
 - no problem until it encounters a bv too narrow

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Bleeding Disorders

- ⚡ A) thrombocytopenia
 - platelet deficiency
- ⚡ B) impaired liver function
 - inability of liver to synthesize its usual supply of procoagulants
 - abnormal & severe bleeding
 - due to vitamin K deficiency
 - due to impaired liver fnc
 - » (vitamin K is needed for production of CFs)

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Bleeding Disorders

- ⚡ C) Hemophilias
 - several different hereditary bleeding disorders
 - similar signs and symptoms
 - managed clinically
 - transfusions of fresh plasma or
 - injections of purified CFs

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Leukocyte Disorders

- ⚡ 1) overproduction of abnormal leukocytes
 - A) leukemia
 - B) infectious mononucleosis
- ⚡ 2) abnormally low WBC
 - A) leukopenia
 - usually induced by drugs
 - glucocorticoids
 - anti-cancer agents

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Leukemia

- ⚡ group of cancerous conditions
 - involve WBCs
- ⚡ cells
 - unspecialized
 - mitotic
 - impair bone marrow fnc
- ⚡ named according to abnormal cell type primarily involved

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Leukemia

- ⚡ acute conditions
 - quick advancing
 - derived from blast cells
 - lymphoblasts
 - more serious forms
 - primarily affect children
- ⚡ chronic conditions
 - slow advancing
 - involves proliferation of later cell stages
 - myelocytes
 - occur more in the elderly

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Leukemia

- ⚡ immature WBCs flood into the bloodstream
- ⚡ bone marrow becomes occupied by cancerous leukocytes
- ⚡ symptoms
 - severe anemia
 - bleeding
 - fever
 - weight loss
 - bone pain

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Leukemia

- ⚡ trt
 - radiation
 - antileukemic drugs
- ⚡ fatal
 - w/o therapy

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Infectious Mononucleosis

- ⚡ highly contagious viral ds
- ⚡ children & young adults
- ⚡ caused by Epstein-Barr virus
- ⚡ excessive #s agranulocytes
- ⚡ symptoms
 - tired
 - achy
 - chronic sore throat
 - fever
 - no cure
- ⚡ recovery in a few weeks w/ rest

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Human Blood Groups

- RBC-PM bears highly specific glycoproteins on external surfaces
 - antigens-agglutinogens
- different blood types
 - one person's RBC proteins will be recognized as foreign
 - transfused into someone w/ diff RBC type
 - recipient's agglutinins (plasma ABs) clump the foreign antigen

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Human Blood Groups

- presence or absence of each antigen allows classification into blood groups
 - two agglutinogens (antigens)
 - type A
 - type B

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Human Blood Groups

- ABO blood group
 - A, B, AB, O
- O blood group
 - no agglutinogens
 - most common in all races
- AB blood group
 - has both agglutinogens
 - least prevalent
- A blood group
 - A agglutinin
- B blood group
 - B agglutinin

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Human Blood Groups

- preformed antibodies present in the plasma
 - agglutinins
 - act against RBCs carrying ABO antigens not present on a person's own RBC (fig 18.13)

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Human Blood Groups

- O blood type
 - possess neither A nor B antigen
 - possess anti-A and anti-B antibodies-
 - possess a and b agglutinins
- A blood group
 - possess A antigen
 - possess anti-B antibodies-
 - possess b agglutinins

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Human Blood Groups

- B blood group
 - possess B antigen
 - possess anti-A antibodies-
 - possess a agglutinins
- AB blood group
 - possess AB antigen
 - possess neither antibodies

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Rh Blood Groups

Blood Group	Rh Factor	Black	Asian	Hispanic	White	Frequency of Rh D ⁺ gene	Rh ⁺ phenotype	Red blood cell agglutination	Red blood cell survival
O	+	11	97	97	97	0.85	+	Agglutination	10-15% shorter
O	-	8	2	2	2	0.15	-	No agglutination	Normal
A	+	40	87	86	87	0.85	+	Agglutination	10-15% shorter
A	-	11	13	13	13	0.15	-	No agglutination	Normal
B	+	2	6	6	6	0.85	+	Agglutination	10-15% shorter
B	-	1	1	1	1	0.15	-	No agglutination	Normal
AB	+	1	1	1	1	0.85	+	Agglutination	10-15% shorter
AB	-	0	0	0	0	0.15	-	No agglutination	Normal

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Rh Blood Groups

- at least 8 different types of Rh agglutinogens
 - only 3 common
 - each is Rh factor
 - most Americans
 - 85% Rh+
 - RBCs carry the Rh antigen

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Rh Blood Groups

- anti-Rh antibodies are not spontaneously formed in blood of Rh- persons
 - unlike the ABO
 - if an Rh- person receives Rh+ blood
 - immune system produces anti-Rh AB against the foreign antigen

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Transfusion Reactions

- ⚡ occur when mismatched blood infused
- ⚡ donor's RBCs are attacked by the recipient's agglutinins
- ⚡ three problems
 - 1) oxygen carrying capacity of transfused blood cells are disrupted
 - 2) clumping of RBCs in small vessels hinders blood flow to tissues beyond those points
 - 3) Hb escaping into the blood stream enters the kidneys in [] — renal failure

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Transfusion Reactions

- ⚡ cause fever, chills, nausea, vomiting
- ⚡ trt
 - alkaline fluids to dilute and dissolve the Hb and get it out of the body
 - diuretics

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Blood Types

- ⚡ universal donor
 - O blood type
 - contains neither antigen
 - give transfusion to any group
- ⚡ universal recipient
 - AB blood type
 - lack both antibodies
 - receive transfusions from any group

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Complete Blood Count (CBC)

- ⚡ counts of different types of formed elements
- ⚡ hematocrit
- ⚡ tests for clotting factors
- ⚡ *see lab manual for add'l info

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Anemias & Aging

- ⚡ usually result of preexisting conditions
 - disorder
 - heart
 - blood vessels
 - immune system

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