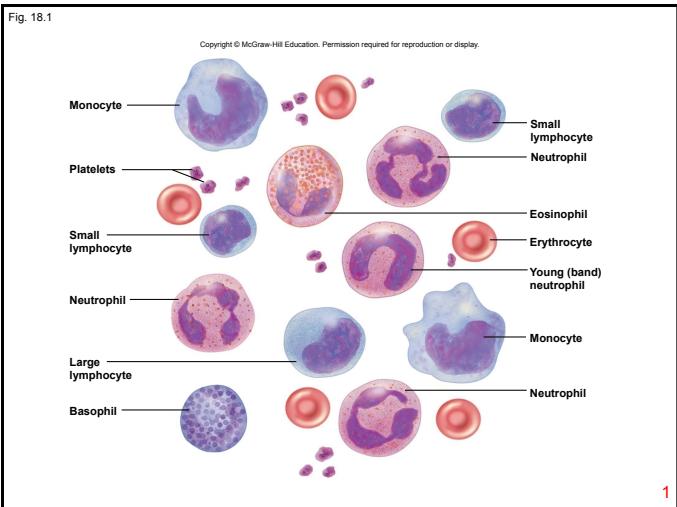
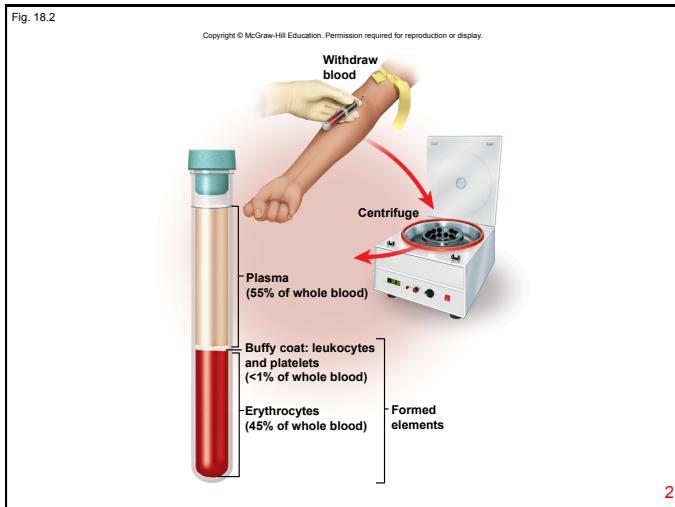


Fig. 18.1



1

Fig. 18.2



2

Table 18.2

Copyright © McGraw-Hill Education. Permission required for reproduction or display.

Blood Component*	Typical Values for Healthy Adults
Water	92% by weight
Protein	Total 6–8 g/dL
Globulins	60% of total protein; 3.2–3.5 g/dL
Fibrinogen	30% of total protein; 0.2–0.3 g/dL
Lipoproteins	70–110 mg/dL
Amino acids	33–51 mg/dL
Lactic acid	6–16 mg/dL
Total lipid	450–850 mg/dL
Cholesterol	120–220 mg/dL
HDL cholesterol	40–100 mg/dL
High-density lipoprotein (HDL)	30–80 mg/dL
Low-density lipoprotein (LDL)	62–185 mg/dL
Triglycerides (neutral fats)	40–350 mg/dL
Iron	50–150 µg/dL
Trace elements	Traces
Vitamins	Traces
Solutes	
Sodium ( $\text{Na}^+$ )	135–145 mEq/L
Calcium ( $\text{Ca}^{2+}$ )	9.2–10.4 mg/dL
Potassium ( $\text{K}^+$ )	3.5–5.0 mEq/L
Magnesium ( $\text{Mg}^{2+}$ )	1.2–1.8 mg/dL
Chloride ( $\text{Cl}^-$ )	100–106 mg/dL
Bicarbonate ( $\text{HCO}_3^-$ )	23–26.7 mg/dL
Phosphate ( $\text{HPO}_4^{2-}$ )	1.4–2.7 mg/dL
Sulfate ( $\text{SO}_4^{2-}$ )	0.6–1.2 mg/dL
Organic wastes	
Urea	10–20 mg/dL
Uric acid	1.5–8.0 mg/dL
Creatinine	0.6–1.1 mg/dL
Ammonia	0.2–0.8 mg/dL
Ammonium	0.1–0.9 mg/dL
Other components	
Dissolved CO <sub>2</sub>	2.0 mL/dL
Dissolved O <sub>2</sub>	0.29 mL/dL
Dissolved N <sub>2</sub>	0.98 mL/dL
Enzymes of diagnostic value	—

\*This table is intended as a reference of general relevance to this and later chapters. Concentrations refer to plasma only, not to whole blood.

3

Table 18.3

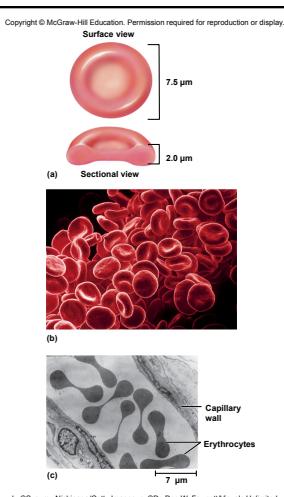
Copyright © McGraw-Hill Education. Permission required for reproduction or display.

TABLE 18.3 Major Proteins of the Blood Plasma	
Proteins	Functions
Albumin (60%)*	Responsible for colloid osmotic pressure; major contributor to blood viscosity; transports lipids, hormones, calcium, and other solutes; buffers blood pH
Globulins (36%)*	
Alpha ( $\alpha$ ) globulins	Transports hemoglobin released by dead erythrocytes
Haptoglobin	
Ceruloplasmin	Transports copper
Prothrombin	Promotes blood clotting
Others	Transport lipids, fat-soluble vitamins, and hormones
Beta ( $\beta$ ) globulins	
Transferrin	Transports iron
Complement proteins	Aid in destruction of toxins and microorganisms
Others	Transport lipids
Gamma ( $\gamma$ ) globulins	Antibodies; combat pathogens
Fibrinogen (4%)*	Becomes fibrin, the major component of blood clots

\*Mean percentage of the total plasma protein by weight

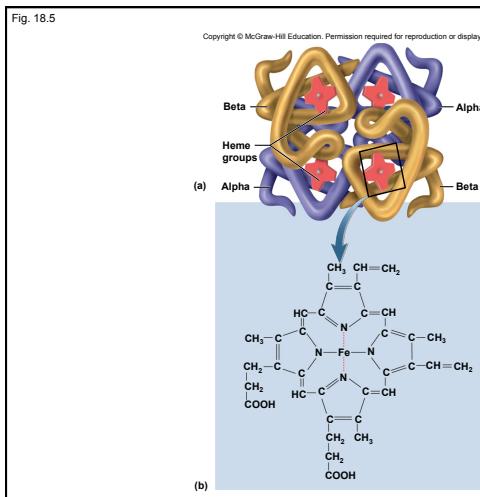
4

Fig. 18.4



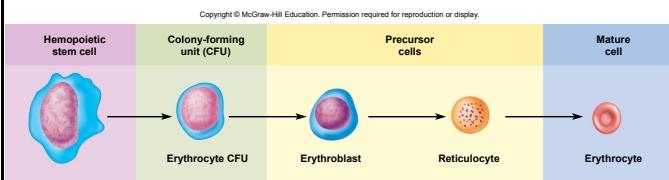
5

Fig. 18.5



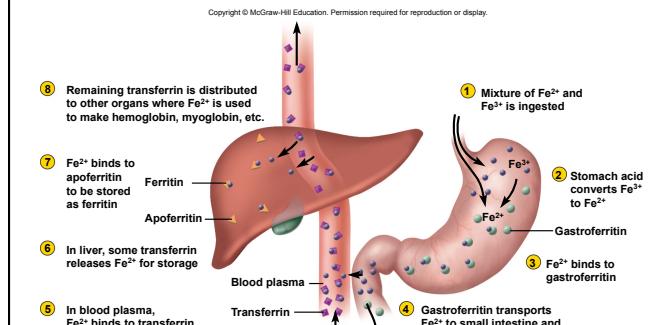
6

Fig. 18.6



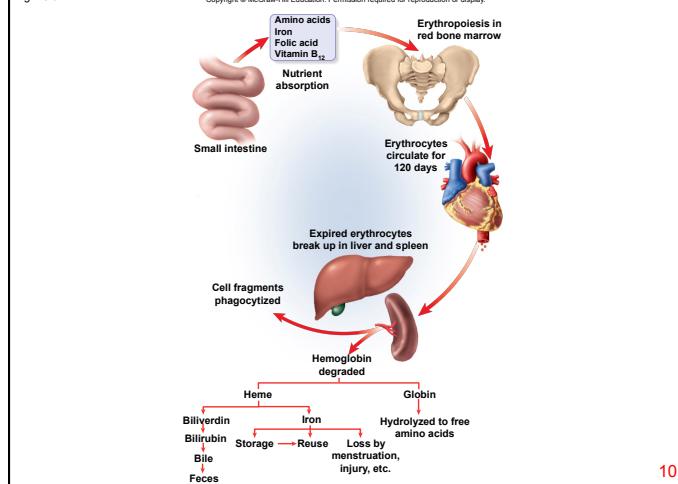
7

Fig. 18.7



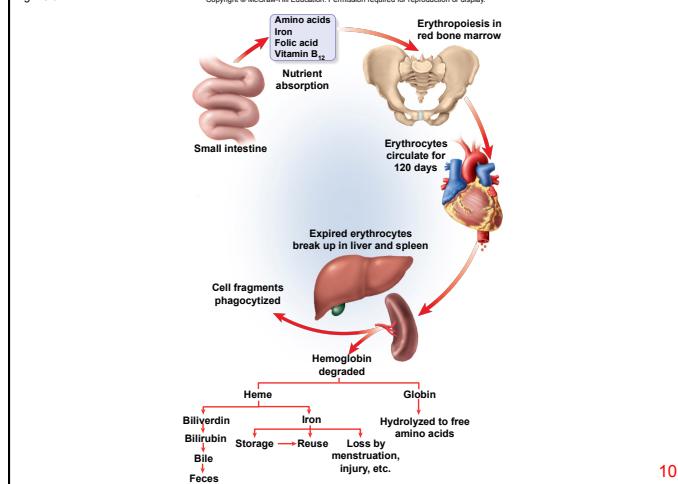
8

Fig. 18.8



9

Fig. 18.9



10

Table 18.5

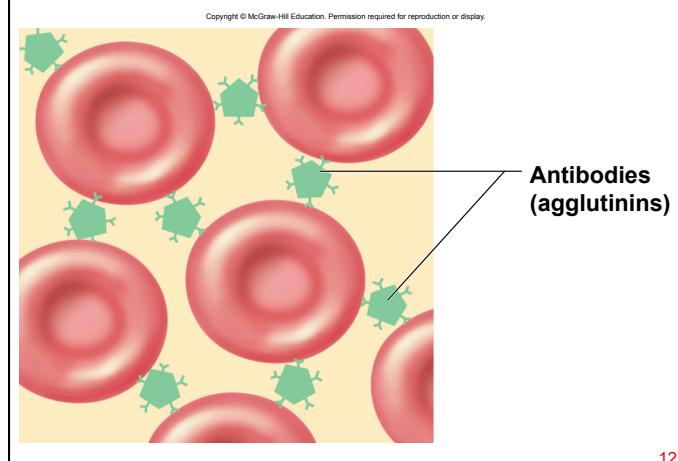
Copyright © McGraw-Hill Education. Permission required for reproduction or display.

TABLE 18.5 The ABO Blood Group				
Characteristics	ABO Blood Type			
	Type O	Type A	Type B	Type AB
Possible genotypes*	$ii$	$I^A I^A$ or $I^B I^B$	$I^A I^B$ or $I^B i$	$I^A I^B$
RBC antigen	None	A	B	A, B
Plasma antibody	Anti-A, anti-B	Anti-B	Anti-A	None
May safely receive RBCs of type	O	O, A	O, B	O, A, B, AB
May safely donate RBCs to	O, A, B, AB	A, AB	B, AB	AB
Frequency in U.S. population				
White	45%	40%	11%	4%
Black	49%	27%	20%	4%
Hispanic	63%	14%	20%	3%
Japanese	31%	38%	22%	9%
Native American	79%	16%	4%	< 1%

\* $I^A$  is the dominant allele for agglutinin A;  $I^B$  is the dominant allele for agglutinin B; and allele  $i$  is recessive to both of these.

11

Fig. 18.13



12

Fig. 18.16

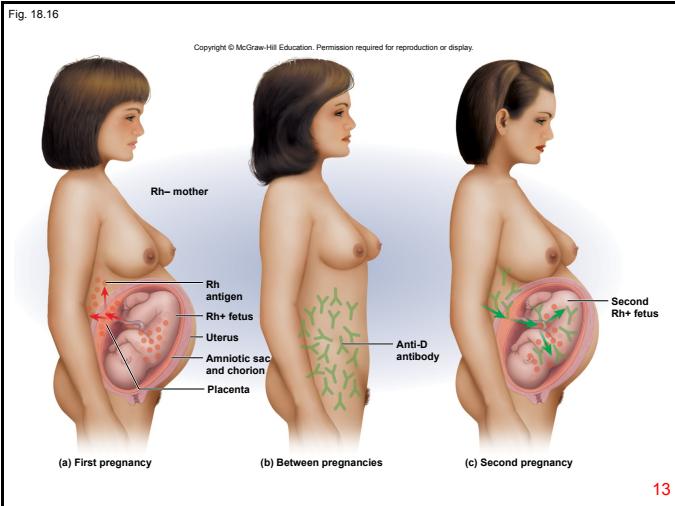


Fig. 18.17

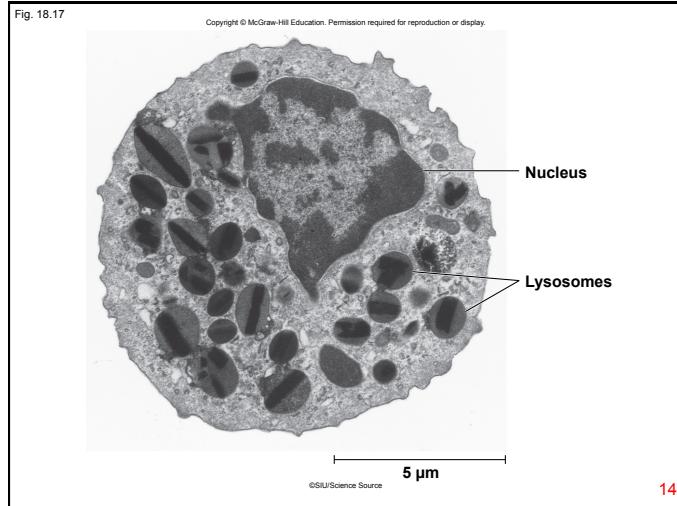


Table 18.6a

The White Blood Cells (Leukocytes)			
<b>Neutrophils</b>			
Percentage of WBCs	60% to 70%	Mean count	4,150 cells/μL
Diameter	9–12 μm		
Appearance*			
	• Reddish pink in S-1C-shaped array		
Differential count			
	• Increases in bacterial infections		
	• Phagocytize bacteria		
	• Release antimicrobial chemicals		
<b>Eosinophils</b>			
Percentage of WBCs	2% to 4%	Mean count	165 cells/μL
Diameter	10–14 μm		
Appearance*			
	• Nucleus usually has two large lobes connected by thin strand		
	• Large orange-pink specific granules in cytoplasm		
Differential count			
	• Present greatly from day to night, seasonally, and with phase of menstrual cycle		
	• Phagocytize antigen-antibody complexes, allergens, and inflammatory chemicals		
	• Release enzymes that weaken or destroy parasites such as worms		
<b>Basophils</b>			
Percentage of WBCs	<0.5%	Mean count	44 cells/μL
Diameter	8–10 μm		
Appearance*			
	• Nucleus large and U- to O-shaped but typically pale and obscured from view		
	• Coarse, abundant dark violet specific granules in cytoplasm		
Differential count			
	• Relatively stable		
	• Present in chickenpox, rashes, diabetes mellitus, myxedema, and polycythemia		
Functions			
	• Secrete histamine (a vasodilator), which increases blood flow to a tissue		
	• Secrete heparin (an anticoagulant), which promotes mobility of other WBCs by preventing clotting		

15

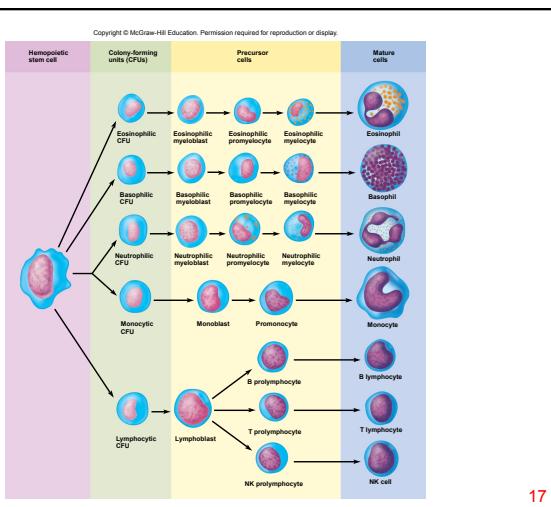
Table 18.6b

The White Blood Cells (Leukocytes) (continued)			
<b>Lymphocytes</b>			
Percentage of WBCs	25% to 33%	Mean count	2,185 cells/μL
Diameter			
Small class	8–9 μm	Medium class	10–12 μm
Large class	14–17 μm		
Appearance*			
	• Nucleus round, oval, or slightly dimpled on one side, of uniform or mottled dark violet color		
	• In small lymphocytes, nucleus fills nearly all of the cell and leaves only a scanty rim of clear, light blue cytoplasm		
	• In larger lymphocytes, cytoplasm is more abundant; large lymphocytes may be hard to differentiate from monocytes		
Differential count			
	• Increases in viral infections and immune responses		
Functions			
	• Several functional classes usually indistinguishable by light microscopy		
	• Destroy cancer cells, cells infected with viruses, and foreign cells		
	• Present antigens to activate other cells of immune system		
	• Coordinate actions of other immune cells		
	• Secrete antibodies		
	• Serve in immune memory		
<b>Monocytes</b>			
Percentage of WBCs	2% to 8%	Mean count	456 cells/μL
Diameter	12–15 μm		
Appearance*			
	• Nucleus ovoid, kidney-shaped, or horseshoe-shaped; violet		
	• Abundant cytoplasm with sparse, fine nonspecific granules		
	• Sometimes very large with stellate or polygonal shapes		
Differential count			
	• Increases in viral infections and inflammation		
Functions			
	• Differentiate into macrophages (large phagocytic cells of the tissues)		
	• Phagocytize pathogens, dead neutrophils, and debris of dead cells		
	• Present antigens to activate other cells of immune system		

\*Appearance pertains to bled film dried with Wright's stain. (Lymphocyte, Monocyte). ©Michael Ross/Science Source.

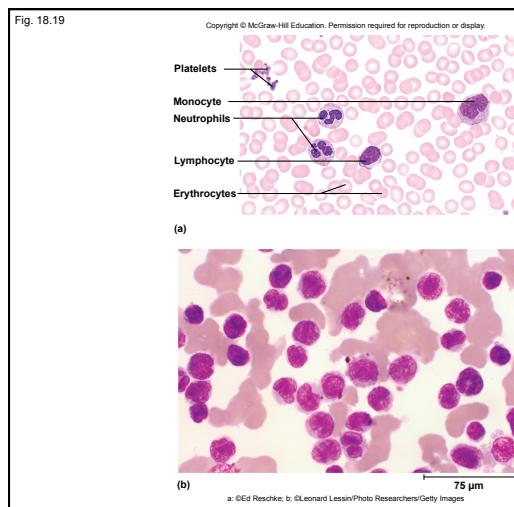
16

Fig. 18.18



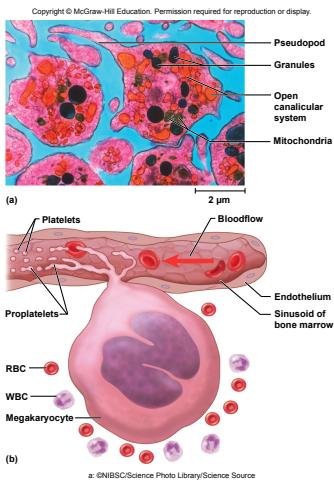
17

Fig. 18.19



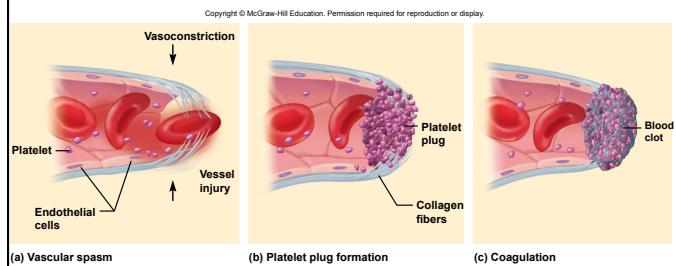
a: ©Ed Reschke; b: ©Leonard Lessin/Photo Researchers/Getty Images

Fig. 18.20



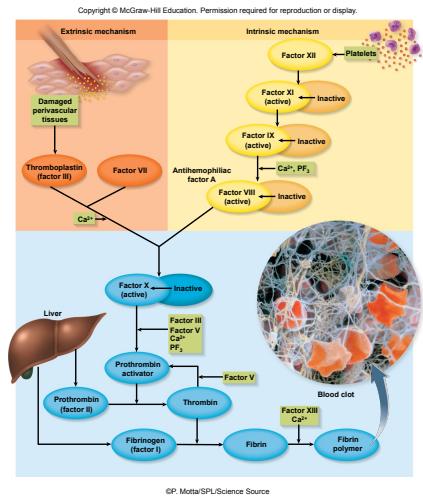
19

Fig. 18.21



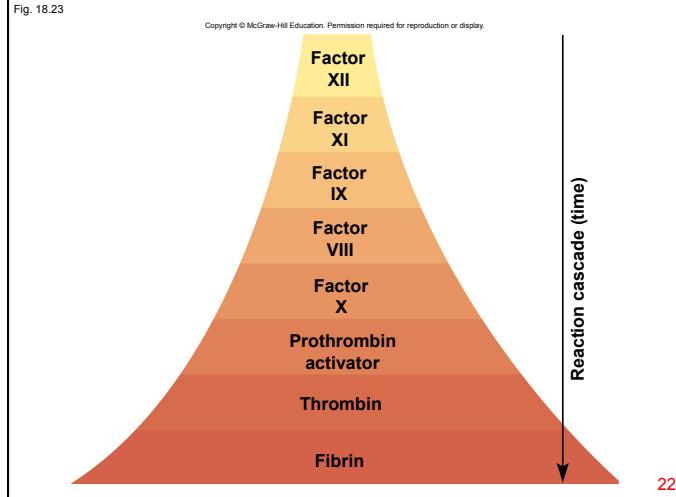
20

Fig. 18.22



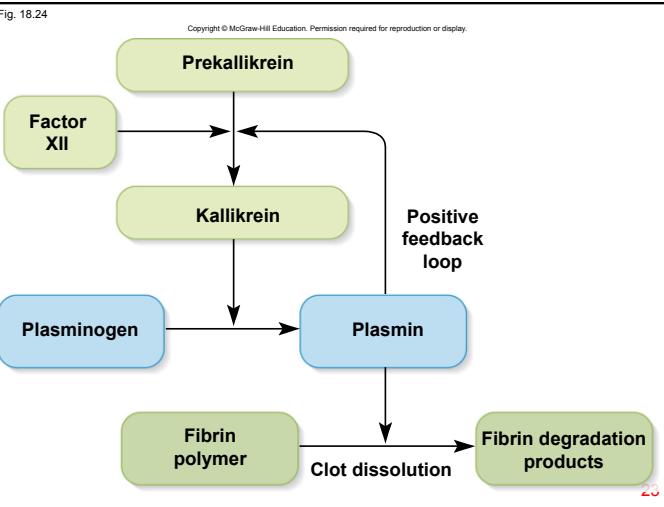
21

Fig. 18.23



22

Fig. 18.24



23