NOTES
BLOOD COMPONENTS & FUNCTION

BLOOD COMPONENTS

osms.it/blood-components

BLOOD COMPONENT SEPARATION
- Blood components separate by density in centrifuge
  - *Heaviest layer:* erythrocytes
  - *Middle layer:* buffy coat
  - *Lightest layer:* plasma

ERYTHROCYTES
- Comprise 45% (hematocrit) of total blood volume
- Carry O_2 to tissues; bring CO_2 to lungs
- Biconcave discs (depressed center)
  - Fit through vessels, ↑ surface area (for gas exchange)
- No organelles
  - ↑ space for hemoglobins

BUFFY COAT
- Comprises < 1% of total blood volume
- Contains platelets, leukocytes
- Platelets clump together → seal damaged blood vessels
- Leukocytes ward off pathogens, destroy cancer cells, neutralize toxins

PLASMA
- Comprises 55% of total blood volume
- *No cells:* 90% water + proteins, electrolytes, gases
- *Albumin:* maintains oncotic pressure, acts as transport protein
- *Globulins:* antibodies, transport proteins
- *Fibrinogen:* involved in clot formation (helps platelets attach)
- *Electrolytes:* include sodium, potassium, calcium, chloride, carbonate

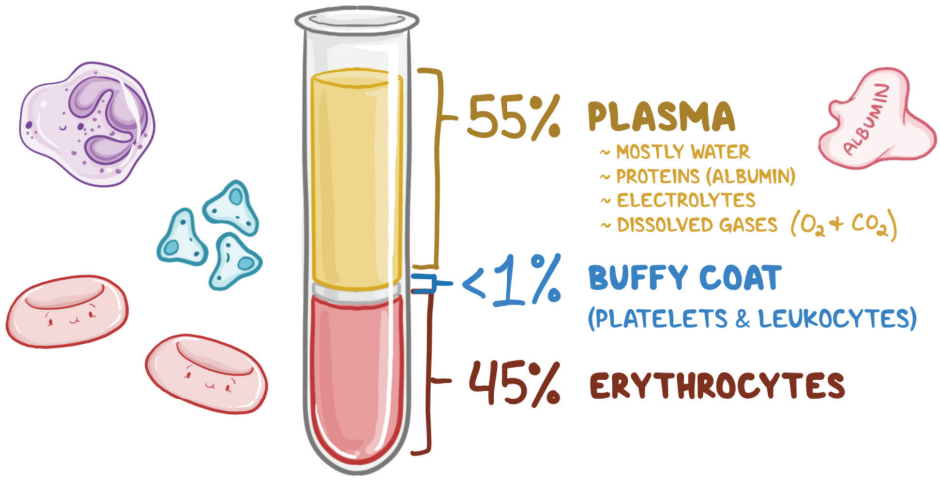

Figure 43.1 Blood components and their relative proportions.

PLATELET PLUG FORMATION (PRIMARY HEMOSTASIS)

osms.it/platelet-plug-formation-primary-hemostasis

- *Hemostasis:* blood-loss prevention
- *First two hemostasis steps:* platelets clump, form plug around injury site in five steps

PLATELET PLUG FORMATION STEPS

1. Endothelial injury

- Nerves, smooth muscle cells detect injury
- Trigger reflexive contraction of vessel (vascular spasm) → ↓ blood flow, loss
- Secretion of nitric oxide, prostaglandins stop; secretion of endothelin begins → further contraction

2. Exposure

- Damage to endothelial cells exposes collagen
- Damaged cells release Von Willebrand factor (binds to collagen)

3. Adhesion

- GP1B surface proteins on platelets bind to Von Willebrand factor

4. Activation

- Platelet changes shape (forms arms to grab other platelets), releases more von Willebrand factor, serotonin, calcium, ADP, thromboxane A2 (positive feedback loop)
- ADP, thromboxane A2 result in GPIIB/IIIA expression

5. Aggregation

- GPIIB/IIIA binds to fibrinogen, links platelets → platelet plug

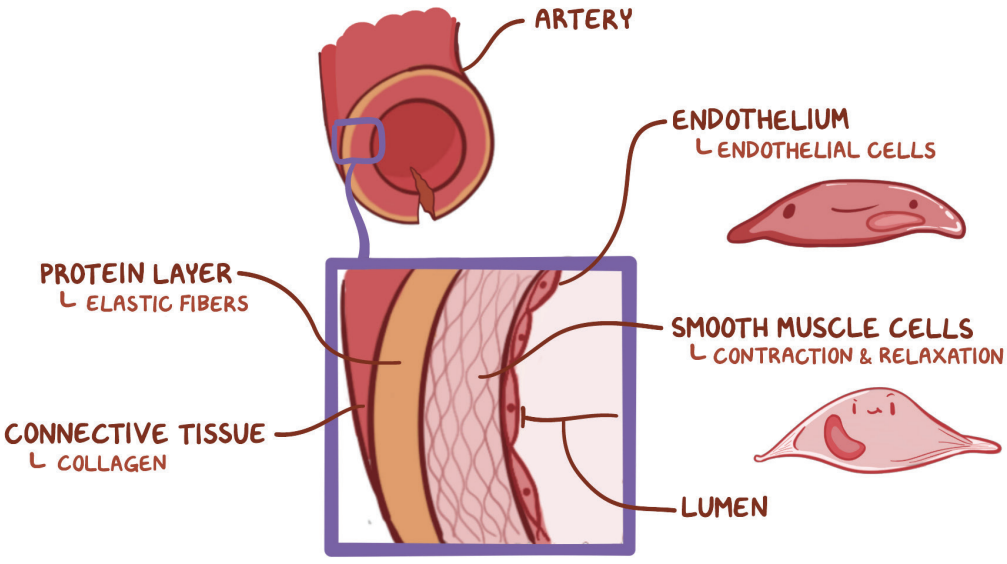

Figure 43.2 Layers of an arterial wall.

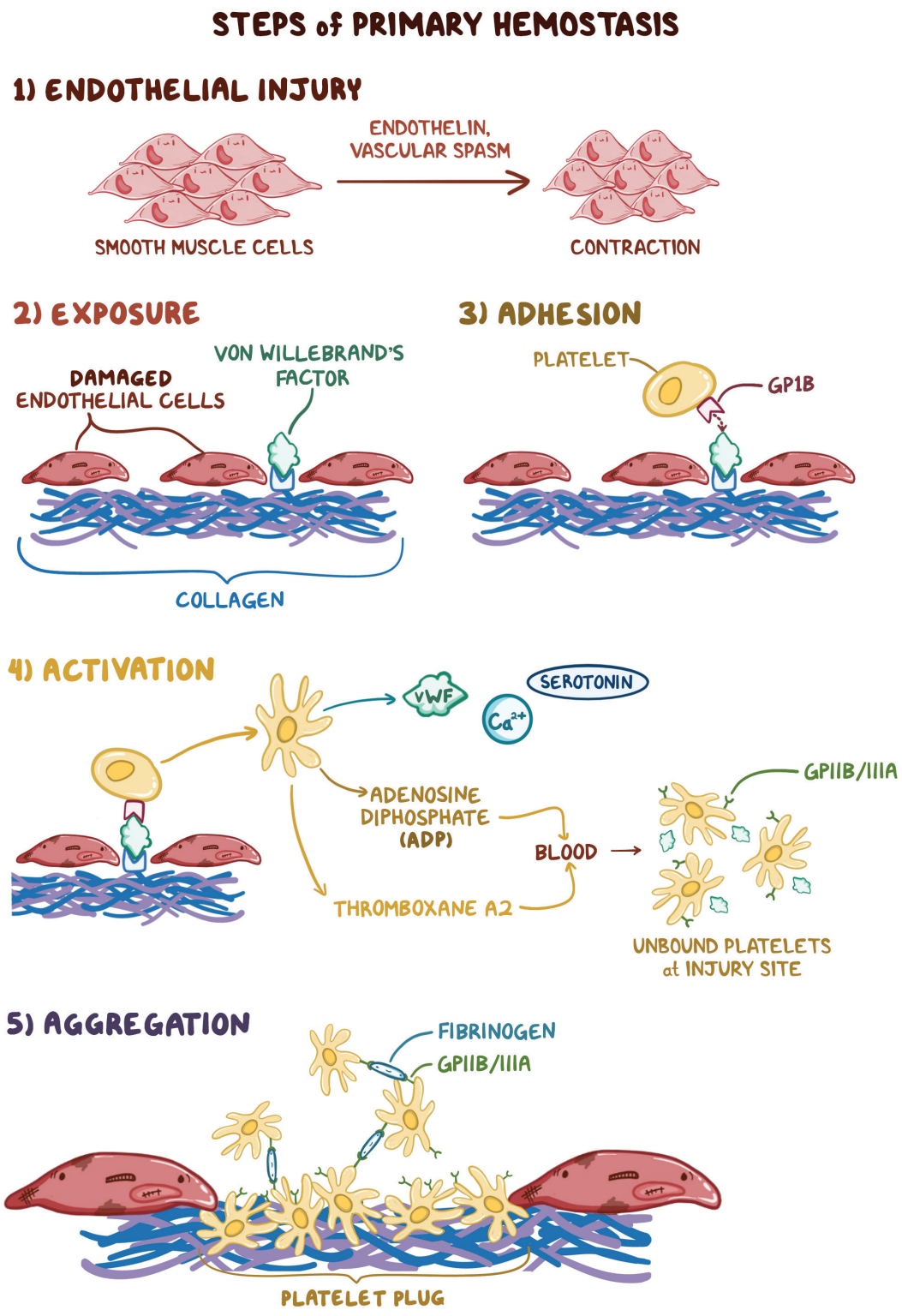

Figure 43.3 Platelet plug formation steps.

COAGULATION (SECONDARY HEMOSTASIS)

osms.it/coagulation-secondary-hemostasis

- *Last two hemostasis steps:* clotting factors activate fibrin, build fibrin mesh around platelet plug
- Begins with either extrinsic/intrinsic pathway; factor X activation → coagulation cascade (common pathway)

EXTRINSIC PATHWAY

1. Trauma damages blood vessel, exposes cells under endothelial layer
   - Tissue factor (factor III) embedded in membrane
2. Factor VII in blood binds to tissue factor, calcium → VIIa-TF complex

INTRINSIC PATHWAY

1. Circulating factor XII contacts negatively charged phosphates on platelets/subendothelial collagen → factor XIIa
2. Factor XIIa cleaves factor XI → factor XIa
3. Factor XIa + calcium cleaves factor IX → factor IXa
4. Factor IXa + factor VIIIa (binds to Von Willebrand factor) + calcium → enter the common pathway

COMMON PATHWAY

1. Factor X is cleaved → factor Xa
2. Factor Xa cleaves factor V → factor Va
3. Factor Xa + factor Va + calcium → prothrombinase complex
   - Prothrombin (factor II) → thrombin (factor IIa)
4. Thrombin activates platelets, cofactors (V, VIII, IX); cleaves fibrinogen, stabilizing factor (→ factor XIIIa + calcium → cross-links in mesh)

COAGULATION TESTS

- *Prothrombin time (PT):* tests extrinsic pathway
- *Activated partial thromboplastin time (aPTT):* tests intrinsic pathway

ROLE OF VITAMIN K IN COAGULATION

osms.it/vitamin-k-in-coagulation

- Vitamin K regulates blood coagulation
  - Converts coagulation factors into mature forms
- 12 coagulation factors: (I–XIII, no factor VI); factors II, VII, IX, X require vitamin K
- Quinone reductase reduces vitamin K quinone (dietary form) into vitamin K hydroquinone
- Vitamin K hydroquinone donates electrons to γ-glutamyl carboxylase, converting non-functional forms of II, VII, IX, X into functional forms
  - Adds chemical group made of one carbon, two hydrogens, one oxygen to glutamic acid residues on proteins
- After carboxylation step, vitamin K (as vitamin K epoxide) is converted back into vitamin K quinone via epoxide reductase
- Coagulation factors appear in all coagulation pathways

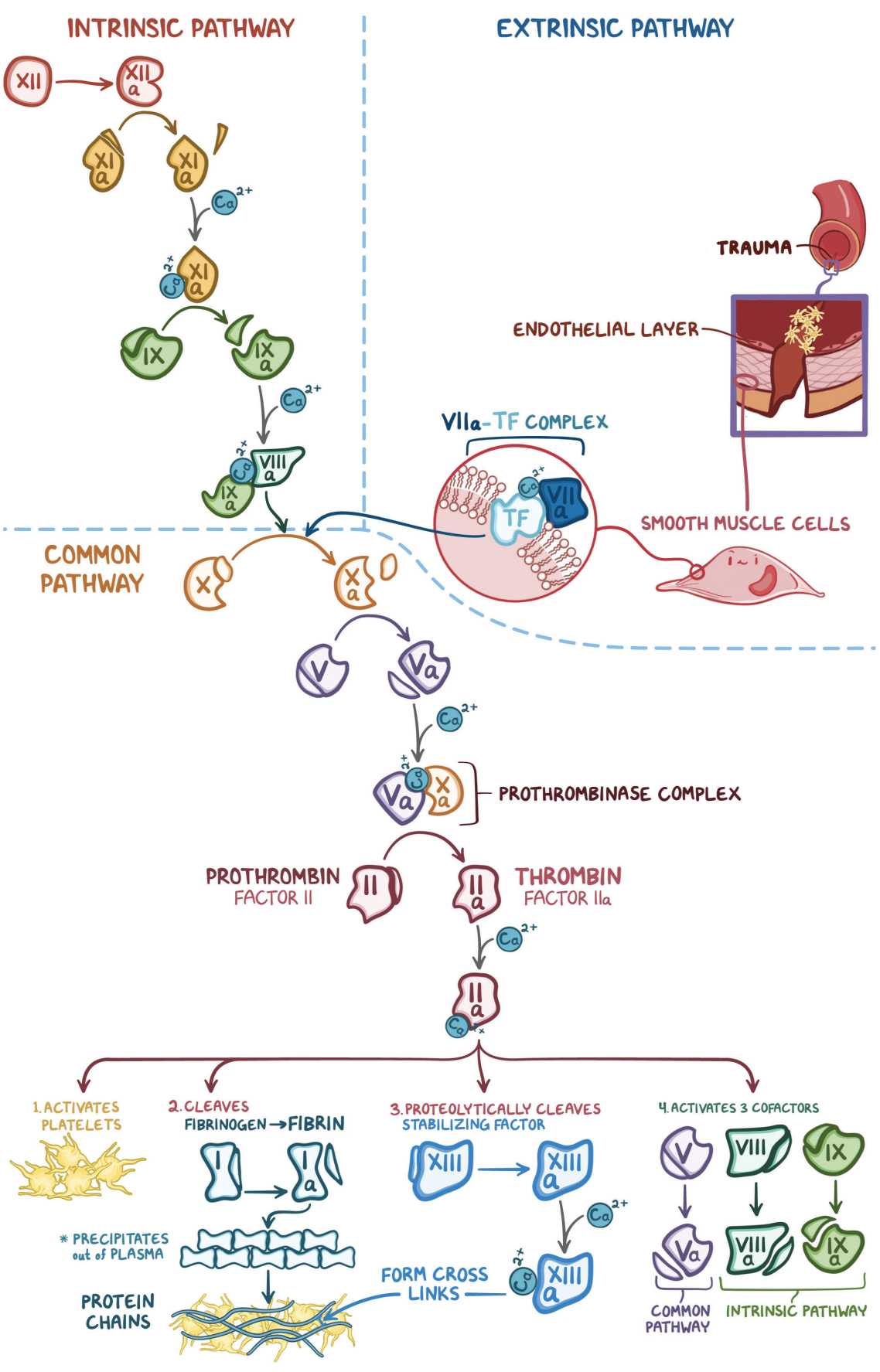

Figure 43.4 Coagulation steps, including the intrinsic, extrinsic, and common pathways.

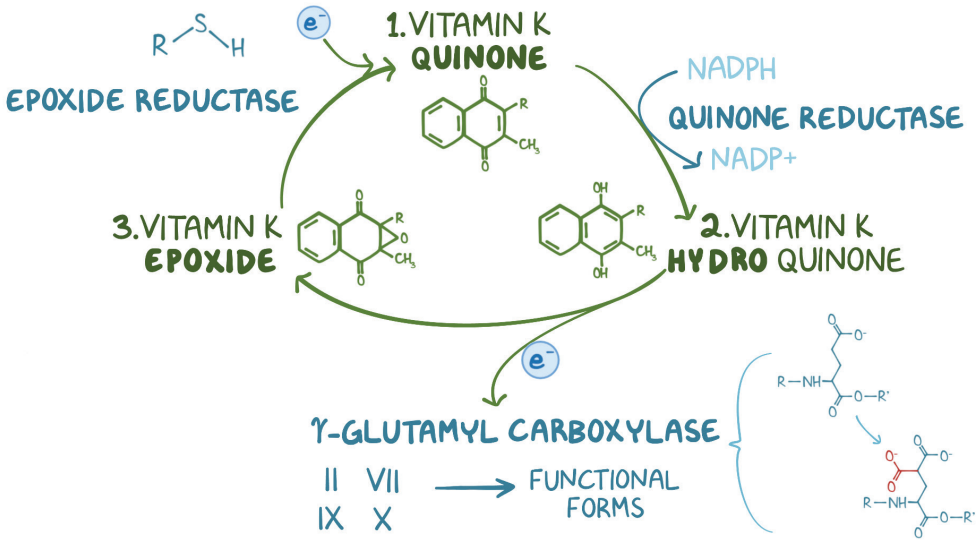

Figure 43.5 Vitamin K cycle. A single molecule of Vitamin K can be reused many times.

ANTICOAGULATION, CLOT RETRACTION & FIBRINOLYSIS

osms.it/clot-retraction-and-fibrinolysis

ANTICOAGULATION

- Occurs during primary, secondary hemostasis; regulates clot formation
- Prevents clots from growing too large → block blood flow, form emboli
- Regulation starts with thrombin (factor II)
  - Multiple pro-coagulative functions
  - Proteins C, S bind thrombomodulin-thrombin → cleaves, inactivates factors V, VIII
  - Antithrombin III binds thrombin/factor X → inactivates both (plus factors VII, IX, XI, XII with lower affinity)
- Other factors prevent platelets adhering during primary hemostasis
  - Nitric oxide, prostacyclin → ↓ thromboxane A2

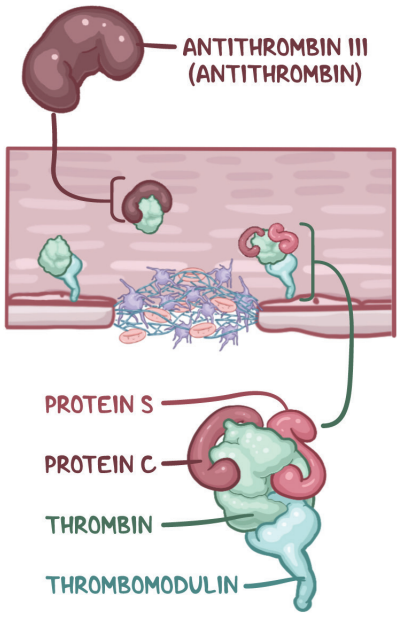

Figure 43.6 Proteins involved in anticoagulation. Thrombomodulin is found on the surface of intact epithelial cells lining blood vessels.

CLOT RETRACTION

- Occurs one hour after primary, secondary hemostasis
  - Contracts clot
- Platelets in clot express integrin αIIBβ3 → binds to fibrin expressing actin, myosin → lamellipodia contract, fibrin mesh tightens closing wood

FIBRINOLYSIS

- Occurs two days after primary, secondary hemostasis; degrades clot
- Plasminogen → plasmin (via tissue plasminogen activator)
- Plasmin proteases fibrin → clot dissolves

BLOOD GROUPS & TRANSFUSIONS

osms.it/blood-groups-and-transfusions

BLOOD TRANSFUSIONS

- *Blood transfusion:* person receives blood/elements of blood (usually through intravenous infusion)
  - *Homologous transfusion:* anonymous donor
  - *Autologous transfusion:* self-donor (e.g. in planned surgery)
- Blood is mixed with calcium oxalate to prevent coagulation, refrigerated/frozen for storage

BLOOD TYPING

- Transfusion blood types not compatible → autoimmune reaction (hemolytic transfusion reaction)
- Two classification systems (based on presence/absence of proteins)
  - ABO system
  - Rh system

ABO system

- Determined by type of glycoproteins found on red blood cells (RBCs)
  - Type A; type B; type A & B; type O (neither)
- Immune system produces antibodies against absent glycoproteins
- *Type AB:* no antibodies → universal recipients
- *Type O:* no antigens → universal donors

Rh system

- Determined by presence of Rh protein
  - Rh positive; Rh negative
- Rh+ can receive blood from either group
- Rh- can only receive Rh- blood

CROSS MATCHING

- Test to confirm donor's blood is safe for recipient
- Recipient serum is mixed with donor blood
  - *Agglutination reaction:* cannot receive

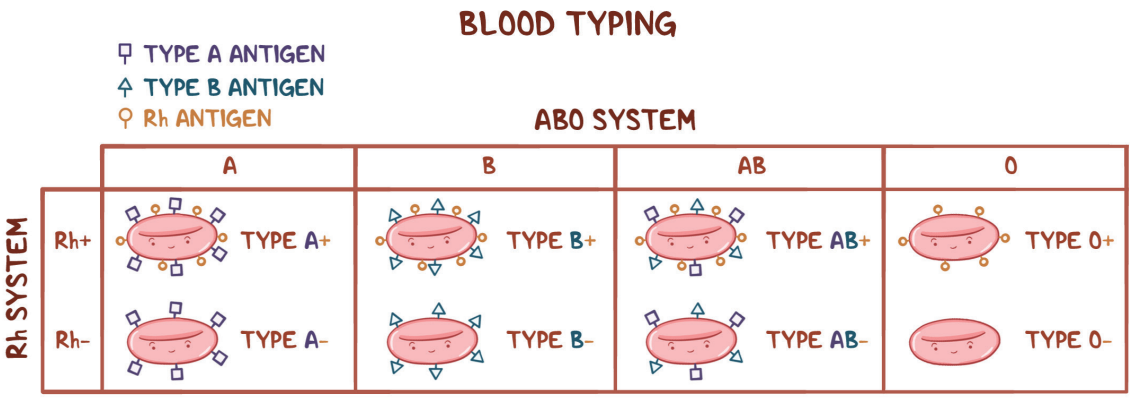

Figure 43.7 Blood types are reported as ABO group and Rh + or -. When both classification systems are combined, there are eight possible blood types: A+, A-, B+, B-, AB+, AB-, O+, O-.