1 While shaving one morning, a 23-year-old man nicks his lip with a razor. Seconds after the injury, the bleeding stops. Which of the following mechanisms is most likely to reduce blood loss from a small dermal arteriole?

□ (A) Protein C activation
□ (B) Vasoconstriction
□ (C) Platelet aggregation
□ (D) Neutrophil chemotaxis
□ (E) Fibrin polymerization

Ans: 1 (B) The initial response to injury is arteriolar vasoconstriction, but this is transient, and the coagulation mechanism must be initiated to maintain hemostasis. Protein C is involved in anticoagulation to counteract clotting. Platelet aggregation occurs with release of factors such as ADP, but this takes several minutes. Neutrophils are not essential to hemostasis. Fibrin polymerization is part of secondary hemostasis after the vascular injury is initially closed.

2 A 73-year-old man was diagnosed 1 year ago with pancreatic adenocarcinoma. He now sees his physician because of a transient ischemic attack. On auscultation of the chest, a heart murmur is heard. Echocardiography shows a 1-cm nodular lesion on the superior aspect of the anterior mitral valve leaflet. The valve leaflet appears to be intact. The blood culture is negative. Which of the following terms best describes this mitral valve lesion?

□ (A) Adenocarcinoma
□ (B) Atheroma
□ (C) Chronic passive congestion
□ (D) Mural thrombus
□ (E) Petechial hemorrhage
□ (F) Phlebothrombosis
□ (G) Vegetation

Ans: 2 (G) A thrombotic mass that forms on a cardiac valve (or, less commonly, on the cardiac mural endocardium) is known as a vegetation. Such vegetations may produce thromboemboli. Vegetations on the right-sided heart valves may embolize to the lungs; vegetations on the left embolize systemically to organs such as the brain, spleen, and kidney. A so-called paradoxical embolus occurs when a right-sided cardiac thrombus crosses a patent foramen ovale and enters the systemic arterial circulation. Patients with cancer may have a hypercoagulable state (e.g., Trousseau syndrome, with malignant neoplasms) that favors the development of arterial and venous thromboses. An adenocarcinoma is a malignant neoplasm that arises from glandular epithelium, forming a mass lesion; endocardial metastases are quite rare. Atheromas form in arteries and do not typically involve the cardiac valves. Chronic passive congestion refers to capillary, sinusoidal, or venous stasis of blood within an organ such as the lungs or liver. Mural thrombi are thrombi that form on the surfaces of the heart or large arteries. The term typically is reserved for large thrombi in a cardiac chamber or dilated aorta or large aortic branch; it is not used to describe thrombotic lesions on cardiac valves. A petechial hemorrhage is a grossly pinpoint hemorrhage. Phlebothrombosis occurs when stasis in large veins promotes thrombosis formation.

3 A 21-year-old woman sustains multiple injuries, including fractures of the right femur and tibia and the left humerus, in a motor vehicle collision. She is admitted to the hospital, and the fractures are stabilized surgically. Soon after admission to the hospital, she is in stable condition. She suddenly becomes severely dyspneic, however, 2 days later. Which of the following complications is the most likely cause of this sudden respiratory difficulty?
□ (A) Right hemothorax
□ (B) Pulmonary edema  
□ (C) Fat embolism  
□ (D) Cardiac tamponade  
□ (E) Pulmonary infarction

Ans: 3 (C) The mechanism for fat embolism is unknown, in particular, why onset of symptoms is delayed 1 to 3 days after the initial injury (or 1 week for cerebral symptoms). The cumulative effect of many small fat globules filling peripheral pulmonary arteries is the same as one large pulmonary thromboembolus. Hemothorax and cardiac tamponade would be immediate complications after traumatic injury, not delayed events. Pulmonary edema severe enough to cause dyspnea would be unlikely to occur in hospitalized patients because fluid status is closely monitored. Pulmonary infarction may cause dyspnea, but pulmonary thromboembolus from deep venous thrombosis is typically a complication of a longer hospitalization.

4 For the past week, a 61-year-old man has had increasing levels of serum AST and ALT. On physical examination, he has lower leg swelling with grade 2+ pitting edema to the knees and prominent jugular venous distention to the level of the mandible. Based on the gross appearance of the liver, seen in the figure, which of the following underlying conditions is most likely to be present?

□ (A) Thrombocytopenia  
□ (B) Portal vein thrombosis  
□ (C) Chronic renal failure  
□ (D) Common bile duct obstruction  
□ (E) Congestive heart failure
The figure shows a so-called nutmeg liver caused by chronic passive congestion. The elevated enzyme levels suggest that the process is so severe that hepatic centrilobular necrosis also has occurred. The physical findings suggest right-sided heart failure. The regular pattern of red lobular discoloration seen in the figure is unlikely to occur in hemorrhage from thrombocytopenia, characterized by petechiae and ecchymoses. A portal vein thrombus would diminish blood flow to the liver, but it would not be likely to cause necrosis because of that organ’s dual blood supply. Hepatic congestion is not directly related to renal failure, and hepatorenal syndrome has no characteristic gross appearance. Biliary tract obstruction would produce bile stasis (cholestasis) with icterus.

5 A 55-year-old woman has had discomfort and swelling of the left leg for the past week. On physical examination, the leg is slightly difficult to move, but on palpation, there is no pain. A venogram shows thrombosis of deep left leg veins. Which of the following mechanisms is most likely to cause this condition?

- (A) Turbulent blood flow
- (B) Nitric oxide release
- (C) Ingestion of aspirin
- (D) Hypercalcemia
- (E) Immobilization

The most important and the most common cause of venous thrombosis is vascular stasis, which often occurs with immobilization. Turbulent blood flow may promote thrombosis, but this risk factor is more common in fast-flowing arterial circulation. Nitric oxide is a vasodilator and an inhibitor of platelet aggregation. Aspirin inhibits platelet function and limits thrombosis. Calcium is a cofactor in the coagulation pathway, but an increase in calcium has minimal effect on the coagulation process.

6 A 25-year-old woman who has had altered consciousness and slurred speech for the past 24 hours is brought to the emergency department. A head CT scan shows a right temporal hemorrhagic infarction. Cerebral angiography shows a distal right middle cerebral arterial occlusion. Within the past 3 years, she has had an episode of pulmonary
embolism. A pregnancy 18 months ago ended in miscarriage. Laboratory studies show a false-positive serologic test for syphilis, normal prothrombin time, elevated partial thromboplastin time, and normal platelet count. Which of the following is the most likely cause of these findings?

- (A) Disseminated intravascular coagulation
- (B) Factor V mutation
- (C) Hypercholesterolemia
- (D) Lupus anticoagulant
- (E) Von Willebrand disease

**Ans:** 6 (D) These findings are characteristic of a hypercoagulable state. The patient has antibodies that react with cardiolipin, a phospholipid antigen used for the serologic diagnosis of syphilis. These so-called antiphospholipid antibodies are directed against phospholipid-protein complexes and are sometimes called lupus anticoagulant because they are present in some patients with systemic lupus erythematosus (SLE). Lupus anticoagulant may occur in individuals with no evidence of SLE, however. Patients with lupus anticoagulant have recurrent arterial and venous thrombosis and repeated miscarriages. In vitro, these antibodies inhibit coagulation by interfering with the assembly of phospholipid complexes. In vivo, the antibodies induce a hypercoagulable state by unknown mechanisms. Disseminated intravascular coagulation is an acute consumptive coagulopathy characterized by elevated prothrombin time and partial thromboplastin time, and decreased platelet count. The prothrombin time and partial thromboplastin time are normal in patients with factor V (Leiden) mutation. Hypercholesterolemia promotes atherosclerosis over many years, and the risk of arterial thrombosis increases. Von Willebrand’s disease affects platelet adhesion and leads to a bleeding tendency, not to thrombosis.

8 A 49-year-old man is in stable condition after an infarction of the anterior left ventricular wall. He receives therapy with anti-arrhythmic and pressor agents. He develops severe breathlessness 3 days later, and an echocardiogram shows a markedly decreased ejection fraction.
He dies 2 hours later. At autopsy, which of the following microscopic changes is most likely to be present in the lungs?

- (A) Congestion of alveolar capillaries with fibrin and neutrophils in alveoli
- (B) Congestion of alveolar capillaries with transudate in alveoli
- (C) Fibrosis of alveolar walls with hemosiderin-laden macrophages in alveoli
- (D) Multiple areas of subpleural hemorrhagic necrosis
- (E) Purulent exudate in the pleural space
- (F) Purulent exudate in the mainstem bronchi

**Ans:** 8 (B) Acute left ventricular failure after a myocardial infarction causes venous congestion in the pulmonary capillary bed and increased hydrostatic pressure, which leads to pulmonary edema by transudation in the alveolar space. Neutrophils and fibrin would be found in cases of acute inflammation of the lung (i.e., pneumonia). Fibrosis and hemosiderin-filled macrophages (heart failure cells) would be found in long-standing, not acute, left ventricular failure. Subpleural hemorrhagic necrosis occurs if there are pulmonary thromboemboli. These thromboemboli can cause right-sided heart failure. Purulent exudate in the pleural space (empyema) or draining from bronchi results from bacterial infection, not heart failure.

9 A 27-year-old man is on a scuba diving trip to the Caribbean and descends to a depth of 50 m in the Blue Hole off the coast of Belize. After 30 minutes, he has a malfunction in his equipment and quickly returns to the boat on the surface. He soon experiences difficulty breathing, with dyspnea and substernal chest pain, followed by a severe headache and vertigo. About 1 hour later, he develops severe, painful myalgias and arthralgias. These symptoms abate within 24
hours. Which of the following mechanisms is the most likely cause of these symptoms?

□ (A) Disseminated intravascular coagulation
□ (B) Systemic vasodilation
□ (C) Venous thrombosis
□ (D) Tissue nitrogen emboli
□ (E) Fat globules in arterioles

Ans: 9 (D) These findings are characteristic of decompression sickness (the “bends”). At high pressures, such as occur during a deep scuba dive, nitrogen is dissolved in blood and tissues in large amounts. Ascending too quickly does not allow for slow release of the gas, and formation of small gas bubbles causes symptoms from occlusion of small arteries and arterioles. Hemorrhage or thrombosis from disseminated intravascular coagulation is more likely to occur in underlying diseases such as sepsis, and symptoms do not abate so quickly. Systemic vasodilation is a feature of some forms of shock. Venous thrombosis is more typically a complication of stasis, which does not occur in a physically active individual. Fat globules in pulmonary arteries are a feature of fat embolism, which usually follows trauma.

10 A 39-year-old woman comes to the physician because she has noticed a lump in her breast. Over the past 2 months, the left breast has become slightly enlarged compared with the right breast. On physical examination, the skin overlying the left breast is thickened, reddish orange, and pitted. Mammography shows a 3-cm underlying density, and a fine-needle aspirate of the density indicates carcinoma. Which of the following mechanisms best explains the gross appearance of the left breast?

□ (A) Venous thrombosis
□ (B) Lymphatic obstruction
(C) Ischemia
(D) Chronic passive congestion
(E) Chronic inflammation

**Ans:** 10 (B) Spread of the cancer to the dermal lymphatics produces a peau d'orange appearance of the breast. Because the breast has an extensive venous drainage, cancer or other focal mass lesions are unlikely to cause significant congestion and edema of the breast. Ischemia is rare in the breast because of the abundant arterial supply. Passive congestion does not involve the breast. Chronic inflammation is rare in breast tissue and is not associated with cancer.

11 A 29-year-old woman has a history of frequent nosebleeds and increased menstrual flow. On physical examination, petechiae and purpura are present on the skin of her extremities. Laboratory studies show normal partial thromboplastin time, prothrombin time, and platelet count, and decreased von Willebrand factor activity. This patient most likely has a derangement in which of the following steps in hemostasis?

(A) Vasoconstriction
(B) Platelet adhesion
(C) Platelet aggregation
(D) Prothrombin generation
(E) Prothrombin inhibition
(F) Fibrin polymerization
Ans: 11 (B) Von Willebrand's factor acts as a “glue” between platelets and the exposed extracellular matrix of the vessel wall after vascular injury. None of the other steps listed depends on von Willebrand's factor. Because the patient's prothrombin time is normal, a lack of prothrombin or the presence of an inhibitor is unlikely.

12 A 70-year-old man who was hospitalized 3 weeks ago for a cerebral infarction is ambulating for the first time. Within minutes of returning to his hospital room, he has sudden onset of dyspnea with diaphoresis. He cannot be resuscitated. The gross appearance of the hilum of the left lung at autopsy is shown in the figure. Which of the following risk factors most likely contributed to this finding?

□ (A) Venous stasis
□ (B) Pulmonary arterial atherosclerosis
□ (C) Lupus anticoagulant
□ (D) Bronchopneumonia
□ (E) Factor V mutation

Ans: 12 (A) The figure shows a large pulmonary thromboembolus. The most common risk factor is immobilization leading to venous stasis. These thrombi form in the large deep leg or pelvic veins, not in the pulmonary arteries. Coagulopathies from acquired or inherited disorders, such as those from lupus anticoagulant (antiphospholipid antibodies) or factor V (Leiden) mutation, are possible causes of thrombosis, but they usually manifest at a younger age. These causes also are far less common risks for pulmonary thromboembolism than venous stasis. Local inflammation from pneumonia may result in thrombosis of small vessels in affected areas.
13 A 25-year-old woman has had multiple episodes of deep venous thrombosis during the past 10 years and one episode of pulmonary thromboembolism during the past year. Prothrombin time, partial thromboplastin time, platelet count, and platelet function studies all are normal. Which of the following risk factors has most likely contributed to the patient's condition?

□ (A) Factor V mutation

□ (B) Antithrombin III deficiency

□ (C) Mutation in protein C

□ (D) Hyperhomocysteinemia

□ (E) Smoking cigarettes

_ans:_ 13 (A) Recurrent thrombotic episodes at such a young age strongly suggest an inherited coagulopathy. The factor V (Leiden) mutation affects 2% to 15% of the population, and more than half of all individuals with a history of recurrent deep venous thrombosis have such a defect. Inherited deficiencies of the anticoagulant proteins antithrombin III and protein C can cause hypercoagulable states, but these are much less common than factor V mutation. Although some cancers elaborate factors that promote thrombosis, this patient is unlikely to have cancer at such a young age; a 10-year history of thrombosis is unlikely to occur in a patient with cancer. Hyperhomocysteinemia is a less common cause of inherited risk of thrombosis than is factor V mutation. It also is a risk factor for atherosclerosis that predisposes to arterial thrombosis. Smoking promotes atherosclerosis with arterial thrombosis.

14 A 76-year-old woman is hospitalized after falling and fracturing her left femoral trochanter. Two weeks later, the left leg is swollen, particularly below the knee. She experiences pain on movement of the leg; on palpation, there is tenderness. Which of the following complications is most likely to occur after these events?
□ (A) Gangrenous necrosis of the foot
□ (B) Hematoma of the thigh
□ (C) Disseminated intravascular coagulation
□ (D) Pulmonary thromboembolism
□ (E) Fat embolism

Ans: 14 (D) The patient has deep and superficial venous thrombosis as a consequence of venous stasis from immobilization. The large, deep thrombi can embolize to the lungs, leading to death. Gangrene occurs from arterial, not venous, occlusion in the leg. Vessels with thrombi typically stay intact; if a hematoma had developed as a consequence of the trauma from the fall, it would be organizing and decreasing in size after 2 weeks. Disseminated intravascular coagulation is not a common complication in patients with thrombosis of the extremities or in patients recuperating from an injury. Fat embolism can occur with fractures, but pulmonary problems typically appear 1 to 3 days after the traumatic event.

15 A 12-year-old boy has a history of multiple soft tissue hemorrhages and acute upper airway obstruction from hematoma formation in the neck. On physical examination, he has decreased range of motion of the large joints, particularly the knees and ankles. He has no petechiae or purpura of the skin. Laboratory studies show normal prothrombin time, elevated partial thromboplastin time, and normal platelet count, but markedly decreased factor VIII activity. Which of the following mechanisms best describes the development of this disease?

□ (A) Decrease in a coagulation cascade component
□ (B) Decrease in membrane phospholipid
□ (C) Failure of platelet aggregation
□ (D) Failure of fibrin polymerization
(E) Inability to neutralize antithrombin III
(F) Inability of platelets to release thromboxane A2

Ans: 15 (A) Factor VIII, tissue factor (thromboplastin), and factor V act as cofactors or reaction accelerators in the clotting cascade. Factor VIII acts as a reaction accelerator for the conversion of factor X and factor Xa. The platelet surface provides phospholipid for assembly of coagulation factors. Platelet aggregation is promoted by thromboxane A2 and ADP. Thromboxane A2 is released when platelets are activated during the process of platelet adhesion. Fibrin polymerization is promoted by factor XIII. Antithrombin III inhibits thrombin to prolong the prothrombin time.

A 56-year-old man with a history of diabetes mellitus goes to the emergency department because he has had left-sided chest pain that radiates to the arm for the past 5 hours. Serial measurements of serum creatine kinase–MB levels show an elevated level 24 hours after the onset of pain. Partial thromboplastin time and prothrombin time are normal. Coronary angiography shows occlusion of the left anterior descending artery. Which of the following mechanisms is the most likely cause of thrombosis in this patient?

(A) Antibody inhibitor to coagulation
(B) Damage to endothelium
(C) Decreased antithrombin III level
(D) Decreased tissue plasminogen activator
(E) Mutation in factor V gene
(F) Stasis of blood flow
Atherosclerotic damage to vascular endothelium is the most common cause of arterial thrombosis; this damage occurs almost imperceptibly over many years. Inhibitors to coagulation, such as antiphospholipid antibodies, typically prolong the partial thromboplastin time, the prothrombin time, or both. Decreased levels of antithrombin III and mutation in the factor V gene are inherited causes of hypercoagulability; they are far less common than atherosclerosis of coronary vessels. Decreased production of tissue plasminogen activator from intact endothelial cells may occur in anoxia of the endothelial cells in veins with sluggish circulation. Stasis of blood flow is important in the low-pressure venous circulation.

An experiment is conducted in which platelet function is analyzed. A substance is obtained from the dense bodies (delta granules) of normal pooled platelets from healthy blood donors. When this substance is added to platelets obtained from patients with a bleeding disorder, no platelet aggregation occurs. Adding the substance to platelets from a normal control group induces platelet aggregation. Which of the following substances is most likely to produce this effect?

- (A) Adenosine diphosphate
- (B) Antithrombin III
- (C) Fibronectin
- (D) Fibrinogen
- (E) Plasminogen
- (F) Thromboxane A2
- (G) Von Willebrand factor

**Ans:** 17 (B) ADP is released from the platelet dense bodies and is a potent stimulator of platelet aggregation. ADP also stimulates further release of ADP from other platelets. Many other substances involved in hemostasis, such as fibrinogen, von Willebrand factor (vWF), and factor V, are stored in the α granules of platelets. Thromboxane A2, another powerful aggregator of platelets, is synthesized by the
cyclooxygenase pathway; it is not stored in dense bodies. Fibronectin forms part of the extracellular matrix between cells that “glues” them together. Plasminogen is activated to inhibit coagulation. Platelet aggregation requires active platelet metabolism; platelet stimulation by agonists such as ADP, thrombin, collagen, or epinephrine; the presence of calcium or magnesium ions and specific plasma proteins such as fibrinogen or vWF; and a platelet receptor, the glycoprotein IIb/IIIa (GPIIb/IIIa) complex. Platelet stimulation results in the generation of intracellular second messengers that transmit the stimulus back to the platelet surface, exposing protein-binding sites on GPIIb/IIIa. Fibrinogen or vWF then binds to GPIIb/IIIa and cross-links adjacent platelets to produce platelet aggregates. The patients in this experiment could have Glanzmann thrombasthenia, in which platelets are deficient or defective in the GPIIb/IIIa complex, do not bind fibrinogen, and cannot form aggregates, although the platelets can be stimulated by ADP, undergo shape change, and are of normal size.

19 In an experiment, thrombus formation is studied in areas of vascular damage. After a thrombus forms in an area of vascular injury, the propagation of the thrombus to normal arteries is prevented. Researchers identify a substance that diminishes thrombus propagation by binding to thrombin, converting it from a procoagulant to an anticoagulant that activates protein C. Which of the following substances is most likely to produce this effect?

- (A) Calcium
- (B) Fibrin
- (C) Platelet factor 4
- (D) Prothrombin
- (E) Thrombomodulin
- (F) Tumor necrosis factor

Ans: 19 (E) Thrombomodulin is present on intact endothelium and binds thrombin, which inhibits coagulation by activating protein C. Calcium is a cofactor that assists clotting in the coagulation cascade (ethylenediaminetetraacetic acid [EDTA] in some blood collection tubes binds calcium to prevent clotting). Fibrin protein forms a meshwork that is essential to thrombus formation. Platelet factor 4 is
released from the α granules of platelets and promotes platelet aggregation during the coagulation process. Prothrombin is converted to thrombin in the coagulation cascade. Tumor necrosis factor is not significantly involved in coagulation.

20 A 77-year-old woman with dysuria for 1 week now has a fever. On examination, she has a temperature of 37.9°C, pulse of 103/min, and blood pressure of 80/40 mm Hg. There is right flank pain. A urinalysis shows numerous white blood cells. Her plasma lactate is increased. Urine culture and blood culture grow Escherichia coli. Which of the following is most likely mediating her cardiovascular collapse through attachment to Toll-like cell receptors?

- (A) Complement C3b
- (B) Lipopolysaccharide
- (C) Nitric oxide
- (D) Platelet-activating factor
- (E) Toxic shock syndrome toxin-1
- (F) Tumor necrosis factor

**Ans:** 20 (B) The patient has septic shock from infection with gram-negative organisms that have lipopolysaccharide, which binds to cells via Toll-like receptor to initiate release of various cytokines such as tumor necrosis factor and interleukin-1 that produce fever. Macrophages are stimulated to destroy the organisms. Nitric oxide is released, promoting vasodilation and circulatory collapse. Complement C3b generated by bacteria via the alternative pathway acts as an opsonin. Platelet-activating factor mediates many features of acute inflammation and in large quantities can cause vasoconstriction and bronchoconstriction. Toxic shock syndrome toxin-1 is a superantigen released by staphylococcal organisms that is a potent activator of T lymphocytes, inducing cytokine release with septic shock.
22 A 49-year-old man with congestive heart failure develops Streptococcus pneumoniae after a bout of influenza. After recuperating for 2 weeks, he develops pleuritic chest pain. The pain is caused by the development of the lesion shown in the figure. Which of the following events has most likely occurred?

□ (A) Pulmonary infarction
□ (B) Chronic pulmonary congestion
□ (C) Pulmonary edema
□ (D) Acute pulmonary congestion
□ (E) Pulmonary venous thrombosis

Ans: 22 (A) The figure shows a hemorrhagic infarct on the pleura, a typical finding when a medium-sized thromboembolus lodges in a pulmonary artery branch. The infarct is hemorrhagic because the bronchial arterial circulation in the lung (derived from the systemic arterial circulation and separate from the pulmonary arterial circulation) continues to supply a small amount of blood to the affected area of infarction. Passive congestion, whether acute or chronic, is a diffuse process, as is edema, which does not impart a red color. Pulmonary venous thrombosis is rare.

23 A 58-year-old man with hyperlipidemia and severe atherosclerosis has had anginal pain for the past 24 hours. Laboratory findings show no increase in serum troponin I or creatine kinase–MB. The patient is in stable condition 2 weeks later and has no chest pain, but a small artery in the epicardium has undergone the changes seen in the figure. Which of the following terms best describes this finding in the epicardial artery?

□ (A) Air embolus
□ (B) Cholesterol embolus
□ (C) Chronic passive congestion
□ (D) Fat embolus
□ (E) Mural thrombus
□ (F) Organization with recanalization
□ (G) Phlebothrombosis

Ans: 2 3 (F) The figure shows an organizing thrombus in a small artery, with several small recanalized channels. Such a peripheral arterial occlusion was insufficient to produce infarction, as evidenced by the lack of enzyme elevation. Thrombi become organized over time if they are not dissolved by fibrinolytic activity. Air emboli are uncommon and usually the result of trauma. Air emboli on the arterial side can cause ischemia through occlusion even when very small, whereas on the venous side, more than 100 mL of air trapped in the heart may reduce cardiac output. Air emboli from decompression form when gases that became dissolved in tissues at high pressure bubble out at lower pressure in blood and tissues. Cholesterol emboli can break off from atheromas in arteries and proceed distally to occlude small arteries; however, because these emboli are usually quite small, they are seldom clinically significant. Chronic passive congestion refers to capillary, sinusoidal, or venous stasis of blood within an organ such as the lungs or liver. Fat emboli are globules of lipid that are most likely to form after traumatic injury, typically to long bones. Mural thrombi are thrombi that form on the surfaces of the heart or large arteries. After a thrombus has formed, it may become organized with ingrowth of capillaries, fibroblast proliferation, and macrophage infiltration, which eventually clears part or most of the clot, forming one or more new lumens (recanalization).

24 A 78-year-old woman falls in the bathtub and strikes the back of her head. Over the next 24 hours, she becomes increasingly somnolent. A head CT scan shows an accumulation of fluid beneath the dura, compressing the left cerebral hemisphere. Which of the following terms best describes this collection of fluid?

□ (A) Hematoma
□ (B) Purpura
□ (C) Congestion
(D) Petechia

(E) Ecchymosis

Ans: 24 (A) The patient has a subdural hematoma. A hematoma is a collection of blood in a potential space or within tissue. Purpura denotes blotchy hemorrhage on skin, serosal surfaces, or mucous membrane surfaces; areas larger than 1 to 2 cm are often called ecchymoses. Congestion occurs when there is vascular dilation with pooling of blood within an organ. Petechiae are pinpoint areas of hemorrhage.

25 A 28-year-old woman with a 15-year history of recurrent thrombosis from a prothrombin gene mutation develops septicemia after a urinary tract infection with Pseudomonas aeruginosa. Despite aggressive therapy, she dies of multiple organ failure. At autopsy, which of the following organs is most likely to be spared from the effects of ischemic injury?

(A) Brain

(B) Liver

(C) Kidney

(D) Heart

(E) Spleen

Ans: 25 (B) The liver has a dual blood supply, with a hepatic arterial circulation and a portal venous circulation. Infarction of the liver caused by occlusion of hepatic artery is uncommon. Cerebral infarction typically produces liquefactive necrosis. Infarcts of most solid parenchymal organs such as the kidney, heart, and spleen exhibit coagulative necrosis, and emboli from the left heart often go to these organs.
26 A 58-year-old woman diagnosed with breast cancer in the left breast underwent a mastectomy with axillary lymph node dissection. Postoperatively, she developed marked swelling of the left arm that has persisted for several months. On physical examination, her temperature is 36.9°C. The left arm is not tender or erythematous, and it is not painful to movement or touch. Which of the following best describes the mechanism for these findings?

- (A) Cellulitis
- (B) Congestive heart failure
- (C) Decreased plasma oncotic pressure
- (D) Lymphedema
- (E) Sodium and water retention
- (F) Phlebothrombosis

Ans: 26 (D) The surgery disrupted lymphatic return, resulting in functional lymphatic obstruction and lymphedema of the arm. The lymphatic channels are important in scavenging fluid and protein that have leaked into the tissues from the intravascular space. Although the amount of fluid that is drained through the lymphatics is not great, it can build up gradually. Cellulitis is caused by an infection of the skin and subcutaneous tissue, and displays erythema, warmth, and tenderness. Congestive heart failure can lead to peripheral edema, which is most marked in dependent areas such as the lower extremities and over the sacrum (in bedridden patients). Decreased plasma oncotic pressure from hypoalbuminemia, or sodium and water retention with heart or renal failure, leads to more generalized edema. Phlebothrombosis leads to swelling with pain and tenderness, but it is uncommon in the upper extremities.

27 A 61-year-old woman has had a fever and felt faint for the past 2 days. On physical examination, her temperature is
38.4°C, pulse is 101/min, respirations are 17/min, and blood pressure is 85/40 mm Hg. She has marked peripheral vasodilation. The serum lactic acid level is 6.8 mg/dL. Which of the following laboratory findings is most likely to be related to the cause of this clinical condition?

- (A) Elevated serum creatine kinase
- (B) Decreased Po2 on blood gas measurement
- (C) Blood culture positive for Escherichia coli
- (D) Increased blood urea nitrogen
- (E) Decreased hematocrit

**Ans:** 27 (C) The patient has septic shock with poor tissue perfusion, evidenced by the high lactate level. Vasodilation is a feature of septic shock, typically as a result of gram-negative endotoxemia. Elevated creatine kinase suggests an acute myocardial infarction, which produces cardiogenic shock. Decreased Po2 suggests a problem with lung ventilation or perfusion. Increased blood urea nitrogen concentration is a feature of renal failure, not the cause of renal failure. Decreased hematocrit suggests hypovolemic shock from blood loss.

28 A 15-year-old girl incurs a cut to the sole of her foot after stepping on a piece of broken glass. On examination, there is a superficial 0.5-cm laceration that ceases to bleed in 5 minutes after application of local pressure. Which of the following substances is most likely to limit thrombus formation to the local area of injury by inhibiting platelet activation?

- (A) Phospholipid
- (B) Platelet-activating factor
□ (C) Prostacyclin
□ (D) Tissue-type plasminogen activator
□ (E) Thrombomodulin
□ (F) Thromboxane

Ans: 28 (C) Endothelial injury releases tissue factor that drives the coagulation process and activates platelets. Adjacent intact endothelium generates prostacyclin via arachidonic acid metabolism. Prostacyclin and nitric oxide are powerful vasodilators and inhibitors of platelet aggregation. This limits thrombus formation to the area of injury. Phospholipid and platelet-activating factor are procoagulants that drive thrombosis and platelet activation. Tissue-type plasminogen activator promotes fibrinolytic activity after a thrombus has formed. Thrombomodulin binds to thrombin to form an anticoagulant that activates protein C, which then cleaves activated factor V and factor VIII. Thromboxane is generated via arachidonic acid metabolism in platelets to promote platelet activation and vasoconstriction.

30 A 60-year-old woman sustained fractures of the right femur, pelvis, and left humerus in a motor vehicle collision. The fractures were stabilized, and the patient's recovery was uneventful. During a physical examination 3 weeks later, the physician observes swelling and warmth in the left leg, and there is local pain and tenderness in the left thigh. Which of the following processes is most likely occurring in the femoral vein?
□ (A) Anasarca
□ (B) Chronic passive congestion
□ (C) Fat embolus formation
□ (D) Mural thrombosis
□ (E) Organization with recanalization
□ (F) Phlebothrombosis
Vegetation

Ans: 30 (F) Venous stasis favors the development of phlebothrombosis (venous thrombosis), particularly in the leg and pelvic veins. This is a common complication in hospitalized patients who are bedridden. The obstruction may produce local pain and swelling, or it may be asymptomatic. Such deep thrombi in large veins create a risk for pulmonary thromboembolism. Anasarca refers to marked generalized edema. Chronic passive congestion refers to capillary, sinusoidal, or venous stasis of blood within an organ such as the lungs or liver. Fat emboli are globules of lipid that are most likely to form after traumatic injury, typically to long bones. Mural thrombi are thrombi that form on the surfaces of the heart or large arteries. After a thrombus has formed, it may become organized with ingrowth of capillaries, fibroblast proliferation, and macrophage infiltration that eventually clears part or most of the clot, forming one or more new lumens (recanalization). Phlebothrombosis occurs when stasis in large veins promotes thrombosis formation, typically in leg and pelvic veins; because there is often clinically apparent swelling, warmth, and pain, the term thrombophlebitis is often employed regardless of whether true vascular inflammation is present. A vegetation is a localized thrombus formation on cardiac endothelium, typically a valve.

31 A 45-year-old woman who works as a bank teller notices at the end of her 8-hour shift that her lower legs and feet are swollen, although there was no swelling at the beginning of the day. There is no pain or erythema associated with this swelling. The woman is otherwise healthy and takes no medications; laboratory testing reveals normal liver and renal function. Which of the following mechanisms best explains this phenomenon?

- (A) Increased hydrostatic pressure
- (B) Lymphatic obstruction
- (C) Secondary aldosteronism
- (D) Hypoalbuminemia
- (E) Excessive water intake
Ans: 31 (A) The hydrostatic pressure exerted from standing leads to edema in dependent parts of the body. Lymphatic obstruction from infection or tumor can lead to lymphedema, but this is a chronic process. Secondary aldosteronism results from congestive heart failure and renal hypoperfusion, but this is a generalized process. Hypoalbuminemia leads to more generalized edema, although the effect is more pronounced in dependent areas. In a healthy patient, normal renal function would be sufficient to clear free water ingested orally.

32 A 23-year-old woman with an uncomplicated pregnancy develops sudden dyspnea with cyanosis and hypotension during routine vaginal delivery of a term infant. She has a generalized seizure and becomes comatose. Her condition does not improve over the next 2 days. Which of the following findings is most likely to be present in the peripheral pulmonary arteries?

- (A) Aggregates of red blood cells
- (B) Amniotic fluid
- (C) Fat globules
- (D) Gas bubbles
- (E) Thromboemboli

Ans: 32 (B) Amniotic fluid embolism rarely occurs in pregnancy, but it has a high mortality rate. The fluid reaches torn uterine veins through ruptured fetal membranes. Aggregates of red blood cells are seen in passive congestion. Fat globules are seen in fat embolism, usually after severe trauma. Gas bubbles in vessels from air embolism can be a rare event in some obstetric procedures, but it is an unlikely event in natural deliveries. Peripheral pulmonary thromboemboli are most likely to produce chronic pulmonary hypertension and develop over weeks to months.
A 7-year-old boy has had increasing lethargy for a week. On physical examination he has periorbital edema and pitting edema at the ankles, but is normotensive and afebrile. Laboratory studies show marked albuminuria. He is given a thiazide diuretic and his urine output increases and his edema resolves. Which of the following changes in his blood most likely potentiated his edema?

- (A) Decreased aldosterone
- (B) Decreased antidiuretic hormone
- (C) Decreased renin
- (D) Increased albumin
- (E) Increased cortisol
- (F) Increased sodium

**Ans:** 33 (F) This child has nephrotic syndrome with loss of albumin into the urine and hypoalbuminemia that decreases plasma oncotic pressure, leading to movement of intravascular water into the extravascular compartment to produce edema. In response, hypovolemia with renal hypoperfusion induces increased production of renin, angiotensin, and aldosterone, which promote sodium and water retention, further exacerbating his edema. Thiazide diuretics increase renal excretion of sodium. Hypovolemia would increase antidiuretic hormone output. Though corticosteroids are used to treat nephrotic syndrome caused by minimal change disease, the effect is probably to diminish abnormal T-cell function that is driving the glomerular damage. Cortisol leads to sodium retention, but not in response to hypovolemia.