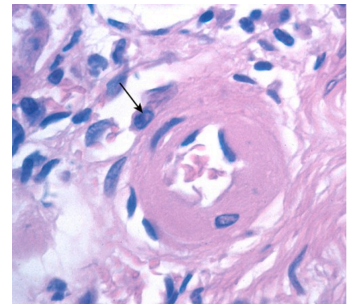


Blood Vessels MCQs

1. A 55-year-old woman has had dull, episodic headaches for the past year, but otherwise she feels fine and has had no major medical illnesses or surgical procedures during her lifetime. On physical examination, her temperature is 37° C, pulse is 70/min, respirations are 14/min, and blood pressure is 166/112 mm Hg. Her lungs are clear on auscultation, and her heart rate is regular. An abdominal ultrasound scan shows that the left kidney is smaller than the right kidney. A renal angiogram shows a focal stenosis of the left renal artery. Which of the following laboratory findings is most likely to be present in this patient?
- A. Anti-double-stranded DNA titer 1:512
 - B. C-ANCA titer 1:256
 - C. increased cryoglobulins in blood
 - D. Plasma glucose level 200 mg/dL
 - E. Marked elevation in HIV RNA
 - F. Plasma renin 15 mg/mL/hr

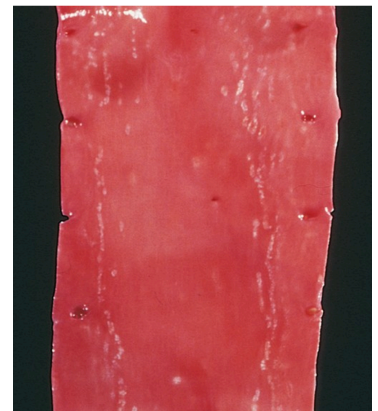
2. A clinical study is performed that includes a group of subjects whose systemic blood pressure measurements are consistently between 145/95 mm Hg and 165/105 mm Hg. They are found to have increased cardiac output and increased peripheral vascular resistance. Renal angiograms show no abnormal findings, and CT scans of the abdomen show no masses. Laboratory studies show normal levels of serum creatinine and urea nitrogen. The subjects take no medications. Which of the following laboratory findings is most likely to be present in this group of subjects?
- A. Decreased urinary sodium
 - B. Elevated plasma renin
 - C. Hypokalemia
 - D. Increased urinary catecholamines
 - E. Lack of angiotensin-converting enzyme

3. A 61-year-old man has reported increasing fatigue over the past year. Laboratory studies show a serum creatinine level of 4.7 mg/dL and urea nitrogen level of 44 mg/dL. An abdominal ultrasound scan shows that his kidneys are symmetrically smaller than normal. The representative high-magnification microscopic appearance of the kidneys is shown in the figure. These findings are most likely to indicate which of the following underlying conditions?
- A. Adenocarcinoma of the colon
 - B. *Escherichia coli* septicemia
 - C. Polyarteritis nodosa
 - D. Syphilitic endarteritis
 - E. Systemic hypertension

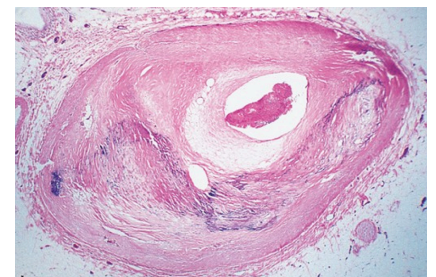


4. A 45-year-old man has had poorly controlled hypertension ranging from 150/90 mm Hg to 160/95 mm Hg for the past 11 years. Over the past 3 months, his blood pressure has increased to 250/125 mm Hg. On physical examination, his temperature is 36.9° C. His lungs are clear on auscultation, and his heart rate is regular. There is no abdominal pain on palpation. A chest radiograph shows a prominent border on the left side of the heart. Laboratory studies show that his serum creatinine level has increased during this time from 1.7 mg/dL to 3.8 mg/dL. Which of the following vascular lesions is most likely to be found in this patient's kidneys?
- A. Fibromuscular dysplasia
 - B. Granulomatous arteritis
 - C. Renal arterial stenosis
 - D. Necrotizing arteriolitis
 - E. Polyarteritis nodosa

5. A 12-year-old boy died of complications of acute lymphocytic leukemia. There is no family history of cardiovascular disease. The gross appearance of the aorta at autopsy is shown in the figure. Histologic examination of the linear pale markings is most likely to show which of the following features?
- A. Cap of smooth muscle cells overlying a core of lipid debris
 - B. Collection of foam cells with necrosis and calcification
 - C. Granulation tissue with a lipid core and areas of hemorrhage
 - D. Lipid-filled foam cells and small numbers of T lymphocytes
 - E. Cholesterol clefts surrounded by proliferating smooth muscle cells and foam cells



6. A 29-year-old man has had angina for the past year. There is a family history of cardiovascular disease. On examination, his blood pressure is 120/80 mm Hg. Laboratory studies show total serum cholesterol 185 mg/dL and glucose 85 mg/dL. A mutation involving a gene encoding for which of the following is most likely present in this man's family?
- Angiotensin
 - Apolipoprotein
 - Endothelin
 - Factor VIII
 - Von Willebrand factor
7. A cohort study is performed involving healthy adult men and women born 20 years ago. They are followed to assess development of atherosclerotic cardiovascular diseases. Multiple laboratory tests are performed yearly during this study. An increase in which of the following is most likely to indicate the greatest relative risk for development of one of these diseases?
- Anti-proteinase 3 (PR3)
 - C-reactive protein (CRP)
 - Cryoglobulin
 - Erythrocyte sedimentation rate (ESR)
 - Platelet count
8. A 50-year-old man has a 2-year history of angina pectoris that occurs during exercise. On physical examination, his blood pressure is 135/75 mm Hg, and his heart rate is 79/min and slightly irregular. Coronary angiography shows a fixed 75% narrowing of the anterior descending branch of the left coronary artery. He has several risk factors for atherosclerosis: smoking, hypertension, and hypercholesterolemia. Which of the following is the earliest event resulting from the effects of these factors?
- Alteration in vasomotor tone regulation
 - Conversion of smooth muscle cells to foam cells
 - Dysfunction from endothelial injury
 - Inhibition of LDL oxidation
 - Modification of hepatic lipoprotein receptors
9. A study is conducted involving persons with LDL cholesterol levels above 160 mg/dL. They are found to have increased oxidized LDL deposited in their arteries. As a consequence the arterial lumen, particularly at branch points, is decreased in size. Which of the following is the most likely pathologic change that develops initially in these areas of arterial narrowing?
- Endothelial cell disruption
 - Intimal thickening
 - Lymphocytic infiltrates
 - Platelet aggregation
 - Smooth muscle hypertrophy
10. A study of atheromatous plaques shows that release of growth factors, including PDGF, FGF, and TNF- α leads to increased extracellular matrix production. As a result, the size of the plaques increases. Which of the following cells is most likely to release these growth factors in the plaques?
- Endothelium
 - Fibroblast
 - Platelet
 - Smooth muscle
 - T lymphocyte
11. A 58-year-old woman has experienced chest pain at rest for the past year. On physical examination, her pulse is 80/min and irregular. The figure shows the microscopic appearance representative of her left anterior descending artery. Which of the following laboratory findings is most likely to be involved in the pathogenesis of the process illustrated?
- Elevated platelet count
 - Low HDL cholesterol
 - Low Lp(a)
 - Low plasma homocysteine
 - Positive VDRL



12. A 75-year-old man has experienced headaches for the past 2 months. On physical examination, his vital signs are temperature, 37° C; pulse, 68/min; respirations, 15/min; and blood pressure, 130/85 mm Hg. His right temporal artery is prominent, palpable, and painful to the touch. His heart rate is regular, and there are no murmurs. His erythrocyte sedimentation rate is 100 mm/hr. A temporal artery biopsy is performed, and the segment of temporal artery excised is grossly thickened and shows focal microscopic granulomatous inflammation. He responds well to corticosteroid therapy. Which of the following complications of this disease is most likely to occur in untreated patients?
- Blindness
 - Gangrene of the toes
 - Hemoptysis
 - Malignant hypertension
 - Renal failure
13. A 50-year-old man has had a chronic cough for the past 18 months. Physical examination shows nasopharyngeal ulcers, and the lungs have diffuse crackles bilaterally on auscultation. Laboratory studies include a serum urea nitrogen level of 75 mg/dL and a creatinine concentration of 6.7 mg/dL. Urinalysis shows 50 RBCs per high-power field and RBC casts. His serologic titer for C-ANCA (proteinase 3) is elevated. A chest radiograph shows multiple, small, bilateral pulmonary nodules. A transbronchial lung biopsy specimen shows a necrotizing inflammatory process involving the small peripheral pulmonary arteries and arterioles. Which of the following is the most likely diagnosis?
- Granulomatosis with polyangiitis
 - Fibromuscular dysplasia
 - Granuloma pyogenicum
 - Kaposi sarcoma
 - Polyarteritis nodosa
 - Takayasu arteritis
14. An 8-year-old child has had abdominal pain and dark urine for 10 days. Physical examination shows blotchy purple skin lesions on the trunk and extremities. Urinalysis shows hematuria and proteinuria. Serologic test results are negative for MPO-ANCA (P-ANCA) and PR3-ANCA (C-ANCA). A skin biopsy specimen shows necrotizing vasculitis of small dermal vessels. A renal biopsy specimen shows immune complex deposition in glomeruli, with some IgA-rich immune complexes. Which of the following is the most likely diagnosis?
- Giant cell arteritis
 - Henoch-Schönlein purpura
 - Polyarteritis nodosa
 - Takayasu arteritis
 - Telangiectasias
15. A 60-year-old woman noted the change seen in the figure while she was driving to work one morning. There was associated pain and numbness. Within 20 minutes after entering the warm office building, these problems disappeared. What pathologic process has most likely led to these findings?
- Calcification
 - Hypertension
 - Thrombosis
 - Vasculitis
 - Vasoconstriction



16. A 69-year-old woman has been bedridden while recuperating from a bout of viral pneumonia complicated by bacterial pneumonia for the past 2 weeks. Physical examination now shows some swelling and tenderness of the right leg, which worsens when she raises or moves the leg. Which of the following terms best describes the condition involving her right leg?
- Disseminated intravascular coagulation
 - Lymphedema
 - Thromboangiitis obliterans
 - Thrombosis of deep veins
 - Varicose veins

Answers and explanations:

1. Ans: F. This is a classic example of a secondary form of hypertension for which a cause can be determined. In this case, the renal artery stenosis reduces glomerular blood flow and pressure in the afferent arteriole, resulting in renin release by juxtaglomerular cells. The renin initiates angiotensin II-induced vasoconstriction, increased peripheral vascular resistance, and increased aldosterone, which promotes sodium reabsorption in the kidney, resulting in increased blood volume. Anti-double-stranded DNA is a specific marker for systemic lupus erythematosus. Anti-neutrophil cytoplasmic autoantibodies (ANCA) are markers for some forms of vasculitis, such as microscopic polyangiitis or ANCA-associated vasculitis. Some patients with hepatitis B or C infection can develop a mixed cryoglobulinemia with a polyclonal increase in IgG. Renal involvement in such patients is common, and cryoglobulinemic vasculitis then leads to skin hemorrhages and ulceration. Hyperglycemia is a marker for diabetes mellitus, which accelerates the atherogenic process and can involve the kidneys, usually bilaterally, promoting the development of hypertension. HIV infection is not related to hypertension.
2. Ans: A. The term *essential hypertension* (now applied when there is no obvious cause for moderate hypertension) was coined before hormonal control of blood pressure was understood, because it was thought that the high pressure was essential to force blood through narrowed arteries. Essential hypertension has several postulated theories for its cause. One theory is that there are defects in renal sodium homeostasis that reduce renal sodium excretion. The kidney retains sodium with water, increasing intravascular fluid volume, which drives increased cardiac output. The increased cardiac output is compensated by increasing peripheral vascular resistance, causing an increase in blood pressure. If angiotensin-converting enzyme (ACE) was absent, blood pressure would decrease because angiotensin I would not be converted to angiotensin II (drugs that act as ACE inhibitors are antihypertensives). An elevated plasma renin level is typical of renovascular hypertension, which can occur with narrowing of a renal artery. Hypertensive patients with hypokalemia also can have hyperaldosteronemia, which can be caused by an aldosterone-secreting adrenal adenoma. Increased urinary catecholamines can indicate increased catecholamine output from a pheochromocytoma.
3. Ans: E. The figure shows an arteriole with marked hyaline thickening of the wall, indicative of hyaline arteriosclerosis. Diabetes mellitus also can lead to this finding, which is most often seen in kidneys. Sepsis can produce disseminated intravascular coagulation with arteriolar hyaline thrombi. The debilitation that accompanies cancer tends to diminish the vascular disease caused by atherosclerosis. Syphilis can cause a vasculitis involving the vasa vasorum of the aorta. Polyarteritis can involve large to medium-sized arteries in many organs, including the kidneys; the affected vessels show fibrinoid necrosis and inflammation of the wall (vasculitis).
4. Ans: D. Malignant hypertension can suddenly complicate and be superimposed on less severe, benign essential hypertension. The arterioles undergo concentric thickening and luminal narrowing with malignant hypertension, called hyperplastic arteriosclerosis, and fibrinoid necrosis is a prominent feature. Fibromuscular dysplasia can involve the main renal arteries, with medial hyperplasia producing focal arterial obstruction. This process can lead to hypertension, but not typically malignant hypertension. A granulomatous arteritis is most characteristic of anti-neutrophil cytoplasmic autoantibody (ANCA)-associated granulomatous vasculitis, which often involves the kidney but typically involves lung and other organs. Hyaline arteriosclerosis is seen with long-standing essential hypertension of moderate severity. These lesions give rise to benign nephrosclerosis. The affected kidneys become symmetrically shrunken and granular because of progressive loss of renal parenchyma and consequent fine scarring. Polyarteritis nodosa produces a vasculitis that can involve the kidney.
5. Ans: D. The slightly raised, pale lesions shown in the figure are called *fatty streaks* and are seen in the aorta of almost all children older than 10 years. They are thought to be precursors of atheromatous plaques. T cells are present early in the pathogenesis of atherosclerotic lesions and are believed to activate monocytes, endothelial cells, and smooth muscle cells by secreting cytokines. T cells adhere to VCAM-1 on activated endothelial cells and migrate into the vessel wall. These T cells, activated by some unknown mechanism, secrete various proinflammatory molecules that recruit and activate monocytes and smooth muscle cells and perpetuate chronic inflammation of the vessel wall. Fatty streaks cause no disturbances in blood flow and are discovered incidentally at autopsy. All of the other lesions described are seen in fully developed atheromatous plaques. The histologic features of such plaques include a central core of lipid debris that can have cholesterol clefts and can be calcified. There is usually an overlying cap of smooth muscle cells. Hemorrhage is a complication seen in advanced atherosclerosis. Foam cells, derived from smooth muscle cells or macrophages that have ingested lipid, can be present in all phases of atherogenesis.

6. Ans: B. Lipoprotein(a) is an altered form of LDL cholesterol that has the apolipoprotein B-100 portion of LDL linked to apolipoprotein A, and an increase in Lp(a) is independently associated with a risk for endothelial dysfunction and atherogenesis. Apolipoprotein E promotes metabolism and clearance of LDL. Drugs such as statins that affect LDL receptor activity do not affect Lp(a) concentration. Early in the course of atheroma formation, angiotensin and its receptor may play a role in development of hypertension, which then becomes a risk factor for atherosclerosis. Endothelin is a vasoconstrictor with no known role in atherogenesis. Decreased factor VIII leads to abnormal bleeding. Von Willebrand factor is required for normal platelet adhesion to collagen, and its absence leads to abnormal bleeding.
7. Ans: B. CRP is an acute phase reactant that increases in response to inflammation. It causes endothelial cell activation, promotes thrombosis, and increases leukocyte adhesiveness in developing atheromas. Because atherogenesis is partly an inflammatory process, CRP is an independent predictor of cardiovascular risk. PR3 is one type of anti-neutrophil cytoplasmic autoantibody (ANCA) associated with some vasculitides such as microscopic polyangiitis. Cryoglobulins may be found with some forms of immune complex-mediated vasculitis. The ESR ("sed rate") is a nonspecific indicator of inflammation and therefore the internist's least favorite test; the ESR is best known to be markedly elevated with giant cell arteritis. Though platelets play a role in atheroma formation, the actual number of platelets is not a predictor of atherogenesis.
8. Ans: C. Atherosclerosis is thought to result from an initial endothelial injury and the subsequent chronic inflammation and repair of the arterial intima. All risk factors, including smoking, hyperlipidemia, and hypertension, cause biochemical or mechanical injury to the endothelium with resulting dysfunction that initiates smooth muscle migration with proliferation, as well as lymphocyte and monocyte-macrophage infiltration. Formation of foam cells occurs after the initial endothelial injury. Vasomotor tone does not play a major role in atherogenesis. Inhibition of LDL oxidation should diminish atheroma formation. Although lipoprotein receptor alterations can occur in some inherited conditions, these account for only a fraction of cases of atherosclerosis, and other lifestyle conditions do not affect their action.
9. Ans: B. The initial response of an arterial wall to injury is intimal thickening with neointimal smooth muscle cell proliferation and production of increased intimal extracellular matrix. Note that "injury" can be caused by inflammation, immune reactions, and toxins as well as the local physical trauma from hypertension and abnormal flow. The trauma does not produce immediate injury with endothelial cellular disruption, but a response of endothelial dysfunction that signals smooth muscle cell migration. This process takes years to show changes of vascular narrowing. As atheromatous plaques progress, there is participation by lymphocytes producing cytokines, as well as monocytes that are transformed to macrophages that accumulate lipid to evolve into foam cells. Eventually plaque disruption may incite platelet aggregation.
10. Ans: D. Growth factor release from activated platelets, macrophages, and vascular wall cells induces smooth muscle cell recruitment, medial smooth muscle migrate into the intima, proliferate, and synthesize extracellular matrix (ECM) in much the same way that fibroblasts fill in a wound. Endothelial cell injury initiates atherogenesis, but endothelial cells do not form a significant part of an atheroma. Platelets do not synthesize ECM. T cells secrete inflammatory cytokines that activate macrophages, endothelial cells, and smooth muscle cells.
11. Ans: B. The figure shows an arterial lumen that is markedly narrowed by atheromatous plaque complicated by calcification. Hypercholesterolemia with elevated LDL and decreased HDL levels is a key risk factor for atherogenesis. Although platelets participate in forming atheromatous plaques, their number is not of major importance. Thrombocytosis can result in thrombosis or hemorrhage. Levels of Lp(a) and homocysteine, if elevated, increase the risk of atherosclerosis. Syphilis (positive VDRL test result) produces endarteritis obliterans of the aortic vasa vasorum, which weakens the wall and predisposes to aortic aneurysm formation.
12. Ans: A. Giant cell (temporal) arteritis typically involves large to medium-sized external carotid artery branches in the head (especially temporal arteries), but also vertebral and ophthalmic arteries. Involvement of the latter can affect vision. Because involvement of the kidney, lung, and peripheral arteries of the extremities is much less common, renal failure, hemoptysis, and gangrene of toes are unusual complications of giant cell arteritis. There is no association between hypertension and giant cell arteritis, but some patients may have polymyalgia rheumatica.

13. Ans: A. Anti-neutrophil cytoplasmic autoantibody (ANCA)-associated vasculitis (granulomatosis with polyangiitis) is a form of hypersensitivity reaction to an unknown antigen characterized by necrotizing granulomatous inflammation that typically involves small to medium-sized vessels, although many organ sites may be affected. Pulmonary and renal involvement can be life-threatening. C-ANCA (antibodies mainly directed against neutrophil proteinase 3) are found in more than 90% of cases. Fibromuscular dysplasia is a hyperplastic medial disorder, usually involving renal and carotid arteries; on angiography, it appears as a "string of beads" caused by thickened fibromuscular ridges adjacent to less involved areas of the arterial wall. Granuloma pyogenicum is an inflammatory response that can produce a nodular mass, often on the gingiva or the skin. Kaposi sarcoma can produce plaque-like to nodular masses that are composed of irregular vascular spaces lined by atypical-appearing endothelial cells; skin involvement is most common, but visceral organ involvement can occur. Polyarteritis nodosa most often involves small muscular arteries, and sometimes veins. It causes necrosis and microaneurysm formation followed by scarring and vascular occlusion, mainly in the kidney, gastrointestinal tract, and skin of young to middle-aged adults. Takayasu arteritis is seen mainly in children and involves the aorta (particularly the arch) and branches such as the coronary and renal arteries, with granulomatous inflammation, aneurysm formation, and dissection.
14. Ans: B. In children, Henoch-Schönlein purpura is the multisystemic counterpart of the IgA nephropathy seen in adults. The immune complexes formed with IgA produce the vasculitis that affects mainly arterioles, capillaries, and venules in skin, gastrointestinal tract, and kidney. In older adults, giant cell arteritis is seen in external carotid branches, principally the temporal artery unilaterally. Polyarteritis nodosa is seen most often in small muscular arteries and sometimes veins, with necrosis and microaneurysm formation followed by scarring and vascular occlusion. This occurs mainly in the kidney, gastrointestinal tract, and skin of young to middle-aged adults. Takayasu arteritis is seen mainly in children and involves the aorta (particularly the arch) and branches such as coronary and renal arteries, with granulomatous inflammation, aneurysm formation, and dissection. Telangiectasias are small vascular arborizations seen on skin or mucosal surfaces
15. Ans: E. The "red, white, and blue" changes shown represent Raynaud phenomenon, which can be a primary exaggerated vasoconstriction without an underlying disease. In older persons, an underlying disease, such as an autoimmune disease, should be sought. Hyperviscosity may underlie this phenomenon. In younger persons it is "primary" and likely vasomotor hyperreactivity. Calcification with medial calcific sclerosis tends to involve arteries that are small and muscular, but larger than those of hands or feet; it is often an incidental finding on a radiograph. Hypertension may drive atherosclerosis, but not marked vasoconstriction. Thrombosis is unlikely to develop and subside so quickly. Vasculitis likewise is not an evanescent phenomenon.
16. Ans: D. Phlebothrombosis (but most often called thrombophlebitis) is a common problem that results from venous stasis with prolonged immobilization. Phlebothrombosis may be a better (but less often used) term because there is little or no inflammation, but the former term is well established. Disseminated intravascular coagulation more often results in hemorrhage, and edema is not the most prominent manifestation. Lymphedema takes longer than 2 weeks to develop and is not caused by bed rest alone. Thromboangiitis obliterans is a rare form of arteritis that results in pain and ulceration of extremities. Varicose veins are dilated, tortuous superficial veins and can thrombose, but they are not related to bed rest, and they do not predispose to pulmonary thromboembolism, as does thrombosis of deeper, larger veins.

The Heart MCQs

1. An 82-year-old woman has had increasing fatigue for the past 2 years. During this time, she has experienced paroxysmal dizziness and syncope. On physical examination, she is afebrile. Her pulse is 44/min, respirations are 16/min, and blood pressure is 100/65 mm Hg. On auscultation, the lungs are clear, and no murmurs are heard. An echocardiogram shows a normal-sized heart with normal valve motion and estimated ejection fraction of 50%. After parasympathetic (vagal) stimulation, the heart rate slows and becomes irregular. An abnormality involving which of the following is most likely to be present in this patient?

 - A. Atrioventricular node
 - B. Bundle of His
 - C. Left bundle branch
 - D. Parasympathetic ganglion
 - E. Right bundle branch
 - F. Sinoatrial node
 - G. Sympathetic ganglion
2. A neonate developing normally has a newborn checkup. On physical examination, there is a systolic murmur. Echocardiography reveals a muscular defect of the intraventricular septum. A checkup 30 years later fails to reveal either a murmur or a flow defect between the ventricles. Which of the following cells most likely proliferated and led to disappearance of the defect?

 - A. Adipocytes
 - B. Conduction cells
 - C. Endothelial cells
 - D. Fibroblasts
 - E. Mesothelial cells
 - F. Stem cells
3. In a clinical study of tetralogy of Fallot, patients are examined before surgery to determine predictors observed on echocardiography that correlate with the severity of the disease and the need for more careful monitoring. A subset of patients is found to have more severe congestive heart failure, poor exercise tolerance, and decreased arterial oxygen saturation levels. Which of the following is most likely to predict a worse clinical presentation for these patients?

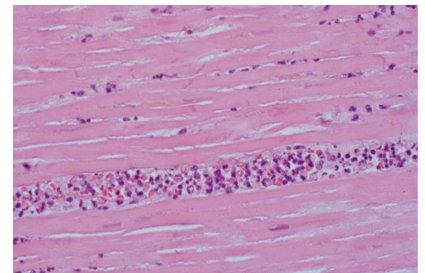
 - A. Degree of pulmonary stenosis
 - B. Diameter of the tricuspid valve
 - C. Presence of an atrial septal defect
 - D. Size of the ventricular septal defect
 - E. Thickness of the left ventricle
4. A 60-year-old man has had angina on exertion for the past 6 years. A coronary angiogram performed 2 years ago showed 75% stenosis of the left circumflex coronary artery and 50% stenosis of the right coronary artery. For the past 3 weeks, the frequency and severity of his anginal attacks have increased, and pain sometimes occurs even when he is lying in bed. On physical examination, his blood pressure is 110/80 mm Hg, and pulse is 85/min with irregular beats. An ECG shows ST segment elevation. Laboratory studies show serum glucose, 188 mg/dL; creatinine, 1.2 mg/dL; and troponin I, 1.5 ng/mL. Which of the following is most likely to explain these findings?

 - A. Atheromatous plaque fissure with thrombosis
 - B. Constrictive pericarditis with calcification
 - C. Endomyocardial fibrosis
 - D. Extensive myocardial fiber hypertrophy
 - E. Left ventricular mural thrombosis
 - F. Mitral valve prolapse with regurgitation

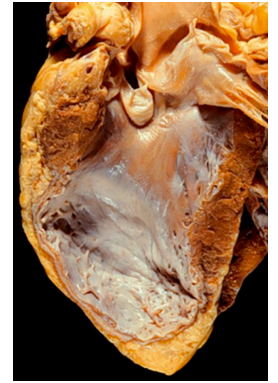
5. A 56-year-old man experiences episodes of severe substernal chest pain every time he performs a task that requires moderate exercise. The episodes have become more frequent and severe over the past year, but they can be relieved by sublingual nitroglycerin. On physical examination, he is afebrile, his pulse is 78/min and regular, and there are no murmurs or gallops. Laboratory studies show creatinine, 1.1 mg/dL; glucose, 130 mg/dL; and total serum cholesterol, 223 mg/dL. Which of the following cardiac lesions is most likely to be present in this man?
- A. Calcific aortic stenosis
 - B. Coronary atherosclerosis
 - C. Restrictive cardiomyopathy
 - D. Rheumatic mitral stenosis
 - E. Serous pericarditis
 - F. Viral myocarditis


6. A retrospective study of myocardial infarction is performed to analyze patterns of cardiac injury. One pattern of injury involves the posterior left ventricular wall and septum. Which of the following pathologic abnormalities is most likely to produce this pattern?
- A. Ascending aortic dissection
 - B. Left anterior descending arterial plaque rupture
 - C. Left circumflex arterial vasculitis
 - D. Right coronary sinus embolization
 - E. Right posterior descending arterial thrombosis

7. A 48-year-old woman has had increasing dyspnea for the past 2 days. She experiences sudden cardiac arrest. The representative light microscopic appearance of her left ventricular free wall is shown in the figure. Which of the following is the most likely diagnosis?



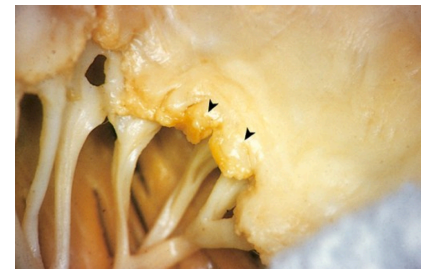
- A. Acute rheumatic myocarditis
 - B. Cardiomyopathy
 - C. Myocardial infarction
 - D. Septic embolization
 - E. Viral myocarditis
8. A study of ischemic heart disease analyzes cases of individuals hospitalized with acute chest pain in which myocardial infarction was documented at autopsy. The gross and microscopic appearances of the hearts are correlated with the degree of coronary atherosclerosis and its complications, clinical symptoms, and therapies given before death. Hemorrhage and contraction bands in necrotic myocardial fibers are most likely to be seen with infarction in which of the following settings?
- A. Acute coronary vasculitis
 - B. Anti-arrhythmic drug usage
 - C. Angioplasty with stent placement
 - D. Septic embolization
 - E. Thrombolytic therapy
9. A 45-year-old man experiences crushing substernal chest pain after arriving at work one morning. Over the next 4 hours, the pain persists and begins to radiate to his left arm. He becomes diaphoretic and short of breath, but waits until the end of his 8-hour shift to go to the hospital. An elevated serum value of which of the following laboratory tests would be most useful for diagnosis of this patient on admission to the hospital?
- A. ALT
 - B. AST
 - C. CK-MB fraction
 - D. C-reactive protein
 - E. LDH-1
 - F. Lipase



10. A 69-year-old man with metabolic syndrome had chest pain and an elevated serum troponin I level 1 year ago. He was treated in the hospital with anti-arrhythmic agents for 1 week. An echocardiogram showed an ejection fraction of 28%. He now has markedly reduced exercise tolerance. On physical examination, his temperature is 37° C, pulse is 68/min, respirations are 17/min, and blood pressure is 130/80 mm Hg. Diffuse crackles are heard on auscultation of the lungs. The representative gross appearance of his heart is shown in the figure. Which of the following complications of this disease is the patient most likely to develop?
- A. Atrial myxoma
 - B. Cardiac tamponade
 - C. Constrictive pericarditis
 - D. Hypertrophic cardiomyopathy
 - E. Infective endocarditis
 - F. Systemic thromboembolism
11. A 50-year-old man has sudden onset of severe substernal chest pain that radiates to the neck. On physical examination, he is afebrile, but has tachycardia, hyperventilation, and hypotension. No cardiac murmurs are heard on auscultation. Emergent coronary angiography shows a thrombotic occlusion of the left circumflex artery and areas of 50% to 70% narrowing in the proximal circumflex and anterior descending arteries. Which of the following complications of this disease is most likely to occur within 1 hour of these events?
- A. Myocardial rupture
 - B. Pericarditis
 - C. Valvular insufficiency
 - D. Ventricular fibrillation
 - E. Thromboembolism
12. A study of persons receiving emergent medical services is conducted. It is observed that 5% of persons with sudden cardiac arrest who receive cardiopulmonary resuscitation survive. Which of the following is the most likely mechanism for cardiac arrest in these survivors?
- A. Arrhythmia
 - B. Infarction
 - C. Inflammation
 - D. Valve failure
 - E. Ventricular rupture
13. A 56-year-old man has worsening cough and orthopnea for the past 2 years. On physical examination, he has dullness to percussion at both lung bases and diffuse crackles in the upper lung fields. He is afebrile. Echocardiography shows marked left ventricular hypertrophy and severe aortic stenosis. The representative gross appearance of the opened heart is shown in the figure. A coronary angiogram shows no significant coronary arterial narrowing. Which of the following underlying conditions best accounts for his findings?
- 
14. A 35-year-old woman has had palpitations, fatigue, and worsening chest pain during the past year. On physical examination, she is afebrile. Her pulse is 75/min, respirations are 15/min, and blood pressure is 110/70 mm Hg. Auscultation of the chest indicates a midsystolic click with late systolic murmur. A review of systems indicates that the patient has one or two anxiety attacks per month. An echocardiogram is most likely to show which of the following?
- A. Aortic valvular vegetations
 - B. Mitral valve prolapse
 - C. Patent ductus arteriosus
 - D. Pulmonic stenosis
 - E. Tricuspid valve regurgitation

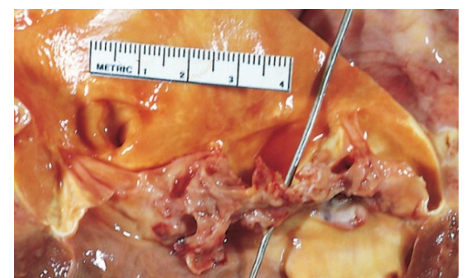
15. An 11-year-old boy had a sore throat, no cough, tonsillar exudates, and 38.3° C fever 3 weeks ago, and a throat culture was positive for group A β -hemolytic *Streptococcus*. On the follow-up examination, the child is afebrile. His pulse is 85/min, respirations are 18/min, and blood pressure is 90/50 mm Hg. On auscultation, a diastolic mitral murmur is audible, and there are diffuse rales over both lungs. Over the next 2 days he has several episodes of atrial fibrillation accompanied by signs of acute left ventricular failure. Which of the following pathologic changes occurring in this child's heart is most likely to be the cause of the left ventricular failure?
- A. Amyloidosis
 - B. Fibrinous pericarditis
 - C. Mitral valve fibrosis
 - D. Myocarditis
 - E. Tamponade
 - F. Verrucous endocarditis

16. A 14-year-old girl has fever and chest pain 2 weeks after having a mild upper respiratory tract infection. On physical examination, her temperature is 37° C, pulse is 90/min, respirations are 20/min, and blood pressure is 85/45 mm Hg. A friction rub is audible on auscultation of the chest. A chest radiograph shows pulmonary edema. An echocardiogram shows small vegetations at the closure line of the mitral and aortic valves. An endomyocardial biopsy shows focal interstitial aggregates of mononuclear cells enclosing areas of fibrinoid necrosis. Her condition improves over the next month. The representative gross appearance of the affected heart is shown in the figure. Which of the following cardiac abnormalities is most likely to occur in this patient?



- A. Constrictive pericarditis
 - B. Dilated cardiomyopathy
 - C. Left ventricular aneurysm
 - D. Myxoma
 - E. Valvular stenosis
17. A 10-year-old girl develops subcutaneous nodules over the skin of her arms and torso 3 weeks after a bout of acute pharyngitis. She manifests choreiform movements and begins to complain of pain in her knees and hips, particularly with movement. A friction rub is heard on auscultation of her chest. An abnormality detected by which of the following serum laboratory findings is most characteristic of the disease affecting this girl?
- A. Antistreptolysin O antibody titer
 - B. Antinuclear antibody titer
 - C. Creatinine level
 - D. Rapid plasma reagin test
 - E. Troponin I level

18. A 25-year-old man was found dead at home by the apartment manager, who had been called by the decedent's employer because of failure to report to work for the past 3 days. An external examination by the medical examiner showed splinter hemorrhages under the fingernails and no signs of trauma. The gross appearance of the heart at autopsy is shown in the figure. Which of the following laboratory findings is most likely to provide evidence for the cause of his disease?



- A. Elevated anti-streptolysin O titer
- B. Positive ANCA serology
- C. Increased creatine kinase-MB (CK-MB) fraction
- D. High double-stranded DNA autoantibody titer
- E. Positive blood culture for *Staphylococcus aureus*

19. A 19-year-old man has had a low-grade fever for 3 weeks. On physical examination, his temperature is 38.3° C, pulse is 104/min, respirations are 28/min, and blood pressure is 95/60 mm Hg. A tender spleen tip is palpable. There are splinter hemorrhages under the fingernails and tender hemorrhagic nodules on the palms and soles. A heart murmur is heard on auscultation. Which of the following infectious agents is most likely to be cultured from this patient's blood?
- A. Coxsackievirus B
 - B. *Mycobacterium tuberculosis*
 - C. *Pseudomonas aeruginosa*
 - D. Viridans streptococci
 - E. *Trypanosoma cruzi*.
20. A 71-year-old woman has had a 10-kg weight loss accompanied by severe nausea and vomiting of blood for the past 8 months. On physical examination, she is afebrile. Laboratory studies show hemoglobin, 8.4 g/dL; platelet count, 227,100/mm³; and WBC count, 6180/mm³. Biopsy specimens obtained by upper gastrointestinal endoscopy show adenocarcinoma of the stomach. CT scan of the abdomen shows multiple hepatic masses. CT scan of the head shows a cystic area in the right frontal lobe. Her condition is stable until 2 weeks later, when she develops severe dyspnea. A chest CT scan shows areas of decreased pulmonary arterial attenuation. Which of the following cardiac lesions is most likely to be present in this woman?
- A. Calcific aortic valvular stenosis
 - B. Constrictive pericarditis
 - C. Epicardial metastatic carcinoma
 - D. Left ventricular mural thrombosis
 - E. Nonbacterial thrombotic endocarditis
21. A 41-year-old woman has had increasing dyspnea for the past week. On physical examination, temperature is 37.3° C, pulse is 85/min, respirations are 20/min, and blood pressure is 150/95 mm Hg. There is dullness to percussion over the lung bases. A chest radiograph shows large bilateral pleural effusions and a normal heart size. Laboratory findings include serum creatinine, 3.1 mg/dL; urea nitrogen, 29 mg/dL; troponin I, 0.1 ng/mL; WBC count, 3760/mm³; hemoglobin, 11.7 g/dL; and positive ANA and anti-double-stranded DNA antibody test results. Which of the following cardiac lesions is most likely to be present in this patient?
- A. Calcific aortic stenosis
 - B. Hemorrhagic pericarditis
 - C. Nonbacterial thrombotic endocarditis
 - D. Libman-Sacks endocarditis
 - E. Mural thrombosis
 - F. Rheumatic verrucous endocarditis
22. A 44-year-old woman with rheumatic heart disease with aortic stenosis undergoes valve replacement with a bioprosthesis. She remains stable for the next 8 years and then develops diminished exercise tolerance. Which of the following complications involving the bioprosthesis has most likely occurred?
- A. Embolization
 - B. Hemolysis
 - C. Myocardial infarction
 - D. Paravalvular leak
 - E. Stenosis
23. A 50-year-old man with a history of infective endocarditis has increasing fatigue. He receives a bileaflet tilting disk mechanical mitral valve prosthesis. After surgery, he is stable, and an echocardiogram shows no abnormal valvular or ventricular function. Which of the following pharmacologic agents should he receive regularly after this surgical procedure?
- A. Aspirin
 - B. Ciprofloxacin
 - C. Cyclosporine
 - D. Digoxin
 - E. Propranolol
 - F. Warfarin

24. A 25-year-old man suffers a sudden cardiac arrest. He is resuscitated. On examination his vital signs are normal. Echocardiography shows that the left ventricle is normal but there is marked thinning with dilation of the right ventricle. MR imaging of his chest shows extensive fibrofatty replacement of the myocardium, but no inflammation. Which of the following is the most likely cause for his findings?
- A. Cardiomyopathy
 - B. Chagas disease
 - C. Hypertension
 - D. Long QT syndrome
 - E. Radiation therapy
25. An 86-year-old man has had increasing dyspnea and reduced exercise tolerance for the past 7 years. On physical examination, he is afebrile and has a blood pressure of 135/85 mm Hg. An irregularly irregular heart rate averaging 76/min is audible on auscultation of the chest. Crackles are heard at the bases of the lungs. A chest radiograph shows mild cardiomegaly and mild pulmonary edema. Echocardiography shows slight right and left ventricular wall thickening with reduced left and right ventricular wall motion, reduced left ventricular filling, and an ejection fraction estimated to be 25%. An endomyocardial biopsy specimen shows amorphous pink-staining deposits between myocardial fibers, but no inflammation and no necrosis. Echocardiography would most likely show which of the following functional cardiac disturbances?
- A. Dynamic obstruction to ventricular outflow
 - B. Impaired ventricular diastolic filling
 - C. Increased end-systolic volume
 - D. Mitral and tricuspid valvular insufficiency
 - E. Reduced ejection fraction

Answers and explanations:

1. Ans: F. The pacemaker for the heart is the sinoatrial (SA) node, with a natural rhythm near 70/min and a normal range of 60/min to 100/min. Other parts of the cardiac conduction system pass along this rate. Rates less than 60/min are defined as bradycardia, and rates greater than 100/min are defined as tachycardia. Bradyarrhythmias less than 50/min suggest an SA node disorder. SA node dysfunction may worsen with cardioactive drugs, such as cardiac glycosides, β -adrenergic blockers, calcium channel blockers, and amiodarone. An increase in sinus rate results from an increase in sympathetic tone acting via β -adrenergic receptors or a decrease in parasympathetic tone acting via muscarinic receptors, or both. Abnormalities involving the other listed options are unlikely to produce such a pronounced and consistent bradycardia.
2. Ans: F. Native cardiac stem cells can proliferate and replace cardiac myocytes throughout life, but these stem cells are most active in neonates. They have the potential to respond to injury. Some ventricular septal defects do close during life. Research is ongoing regarding methods for inducing stem cell proliferation. Of the remaining cells listed, adipocytes enlarge with aging. Endothelial cells may proliferate to produce more coronary collateral channels in response to exercise training, and they can resurface vascular grafts. Fibroblasts respond to injury by producing collagenous scar tissue that reduces contractility.
3. Ans: A. In tetralogy of Fallot, the severity of the obstruction to the right ventricular outflow determines the direction of flow. If the pulmonic stenosis is mild, the abnormality resembles a ventricular septal defect, and the shunt may be from left to right with no cyanosis. With significant pulmonary outflow obstruction, the right ventricular pressure may reach or exceed systemic vascular resistance, and the blood would be shunted from right to left, producing cyanotic heart disease. Even if pulmonic stenosis is mild at birth, the pulmonary orifice does not expand proportionately as the heart grows, and cyanotic heart disease supervenes.
4. Ans: A. Marked coronary artery occlusion with this degree of stenosis prevents adequate perfusion of the heart when myocardial demand is increased during exertion. He has angina on exertion and recently developed unstable angina, which is manifested by increased frequency and severity of the attacks and angina at rest. The ST segment elevation suggests a developing acute coronary syndrome with myocardial ischemia, but the lack of cardiac enzyme elevation suggests infarction has not yet occurred. In most patients, unstable angina is induced by disruption of an atherosclerotic plaque followed by a mural thrombus and possibly distal embolization, vasospasm, or both. An acute myocardial infarction (MI) can lead to focal fibrinous pericarditis, but it is unlikely to lead to extensive scarring that surrounds the heart. Fibrosis is a late finding from healing of infarction. Hypertrophy of the heart is unlikely to progress significantly in this case because there is neither hypertension nor a valvular lesion. Mural thrombosis may develop on the endocardial surface overlying an infarction, and may fill a ventricular aneurysm following an MI. An acute MI may be complicated by papillary muscle rupture with mitral valve insufficiency.
5. Ans: B. Angina pectoris typically occurs when coronary artery narrowing exceeds 75%. His risk factors include hyperglycemia (diabetes mellitus) and hypercholesterolemia. Calcific aortic stenosis leads to left-sided congestive heart failure (CHF), and the extra workload of the left ventricle may cause angina pectoris. Calcific aortic stenosis (in the absence of a congenital bicuspid aortic valve) is rarely symptomatic at 50 years of age, however. Cardiomyopathies result in heart failure, but without chest pain. Patients with rheumatic heart disease are affected by slowly worsening CHF. Pericarditis can produce chest pain, although not in relation to exercise, and it is not relieved by nitroglycerin. Viral myocarditis may last for weeks, but not for 1 year, and pain may be present at rest.
6. Ans: E. Myocardial infarction results from occlusion of large coronary arterial branches, and in most cases an occluding thrombus is present. The posterior left ventricle and septum are supplied by the posterior descending artery. The left circumflex artery supplies the lateral left ventricular wall, whereas the left anterior descending artery supplies the anterior left ventricle. An aortic dissection that extends proximally may cause tamponade, compressing the heart, great vessels, and even coronary arteries, but this is much less likely a cause for myocardial infarction than atherosclerotic coronary arterial disease. The coronary sinus is where venous blood from the myocardium drains into the right atrium.
7. Ans: C. The figure shows intensely eosinophilic myocardial fibers with loss of nuclei, all are indicative of coagulative necrosis. The deeply red-stained transverse bands are called *contraction bands*. Neutrophils infiltrate between myocardial fibers. This pattern is most likely caused by a myocardial infarction (MI) that is approximately 24 to 48 hours old. Chest pain is present in most but not all cases of MI. Rheumatic myocarditis is characterized by minimal myocardial necrosis with foci of granulomatous inflammation (Aschoff bodies). There is no significant inflammation with restrictive cardiomyopathies such as amyloidosis or hemochromatosis. Septic emboli result in focal abscess formation. In viral myocarditis, there is minimal focal myocardial necrosis with round cell infiltrates.

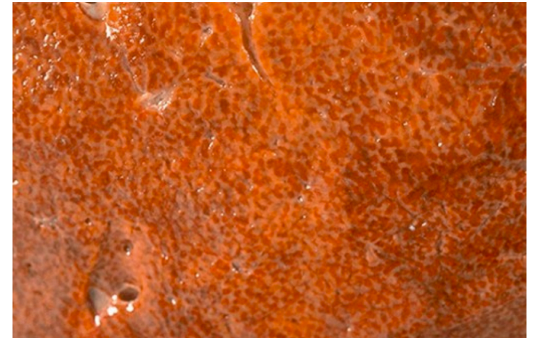
8. Ans: E. Reperfusion of an ischemic myocardium by spontaneous or therapeutic thrombolysis changes the morphologic features of the affected area. Reflow of blood into vasculature injured during the period of ischemia leads to mitochondrial dysfunction, followed by leakage of blood into the tissues (hemorrhage). Contraction bands are composed of closely packed hypercontracted sarcomeres. They are most likely produced by exaggerated contraction of previously injured myofibrils that are exposed to a high concentration of calcium ions from the plasma. The damaged cell membrane of the injured myocardial fibers allows calcium to penetrate the cells rapidly. Free radical formation and release of leukocyte enzymes further potentiate myocardial cell death. Hemorrhage would not be a prominent feature in the other listed options. Vasculitides involving the heart are uncommon; Takayasu arteritis can involve coronary arteries, but is most often a rare pediatric condition. Drugs used to control arrhythmias during acute coronary syndromes are unlikely to have hemorrhage as an adverse event. Angioplasty per se does not increase the risk for hemorrhage, and stents help to keep the artery open longer. Septic embolization from infected valvular vegetations to a coronary artery is uncommon, although such emboli may produce focal necrosis and hemorrhage.
9. Ans: C. Of the enzymes listed, CK-MB is the most specific for myocardial injury from the acute myocardial infarction (MI) described in this patient. The levels of this enzyme begin to increase within 2 to 4 hours of ischemic myocardial injury. ALT elevation is more specific for liver injury. AST is found in various tissues; elevated levels are not specific for myocardial injury. The elevation of lactate dehydrogenase (LDH)-1 compared with LDH-2 suggests myocardial injury, but LDH activity peaks 3 days after an MI. C-reactive protein is elevated with inflammatory processes, but is nonspecific; it has been used as a predictor of acute coronary syndromes. Lipase is a marker for pancreatitis.
10. Ans: F. The figure shows an enlarged and dilated heart with a large ventricular aneurysm with a thin wall and white fibrous endocardial surface. Such an aneurysm most likely results from weakening of the ventricular wall at the site of a prior healed myocardial infarction. Because of the damage to the endocardial lining, with stasis and turbulence of blood flow in the region of the aneurysm, mural thrombi are likely to develop. When detached, thrombi in the left side of the heart embolize to the systemic circulation and can cause infarcts elsewhere. An atrial myxoma is the most common primary cardiac neoplasm, but it is rare and is not related to ischemic heart disease. Cardiac rupture with tamponade is most likely to occur 5 to 7 days after an acute myocardial infarction. Constrictive pericarditis follows a previous suppurative or tuberculous pericarditis. Hypertrophic cardiomyopathy is not related to ischemic heart disease, but 50% of cases are familial and may be related to genetic mutations in genes encoding for cardiac contractile elements. Infective endocarditis is more likely to complicate valvular heart disease or septal defects.
11. Ans: D. In the period immediately after coronary thrombosis, arrhythmias are the most important complication and can lead to sudden cardiac death. It is believed that, even before ischemic injury manifests in the heart, there is greatly increased electrical irritability predisposing to dysrhythmias. Myocardial rupture, valvular insufficiency from papillary muscle involvement, and pericarditis occur several days later. Another complication is a left ventricular aneurysm, a late complication of the healing of a large transmural infarction; a mural thrombus may fill an aneurysm and become a source of emboli. If portions of the coronary thrombus break off and embolize, they enter smaller arterial branches in the distribution already affected by ischemia. Valvular insufficiency from a ruptured papillary muscle would occur later in the course.
12. Ans: A. The most common cause for sudden cardiac arrest is ischemic heart disease. The risk for sudden death is increased with worsening atherosclerotic coronary arterial narrowing. However, the first event with an acute coronary syndrome is typically an arrhythmia, and this is why resuscitation, including defibrillation, can be successful, and survivors may have no ECG or enzyme changes to suggest myocardial infarction has occurred. Inflammation with infarction or infection takes days to develop. A sudden valvular incompetence from papillary muscle rupture, or wall rupture, may complicate an infarction 3 to 7 days following the initial event.
13. Ans: A. The bicuspid valve shown has a tendency to calcify with aging, which eventually can result in stenosis, left ventricular hypertrophy, and left-sided heart failure with pulmonary edema. In individuals with congenitally bicuspid valves, symptoms often appear by 50 to 60 years of age. By contrast, calcific aortic stenosis of tricuspid valves manifests in the seventh or eighth decade. Ischemic heart disease, expected with diabetes mellitus, does not lead to valvular stenosis. In infective endocarditis, the patient would have an infection, and the valve would tend to be destroyed, leading to insufficiency. In Marfan syndrome, loss of elastic tissue in the media leads to aortic root dilation, producing aortic valvular insufficiency. Systemic hypertension accounts for left ventricular hypertrophy, but the aortic valve is not affected.

14. Ans: B. A floppy (prolapsed) mitral valve is usually asymptomatic. When symptomatic, it can cause fatigue, chest pain, and arrhythmias. Some cases are linked to clinical depression and anxiety, and others are associated with Marfan syndrome. Valvular vegetations suggest endocarditis, and a murmur is likely to be heard with infective endocarditis causing valvular insufficiency. A patent ductus arteriosus causes a shrill systolic murmur. Pulmonic stenosis is most often a congenital heart disease. Tricuspid regurgitation is accompanied by a rumbling systolic murmur.
15. Ans: D. This boy developed acute left ventricular failure, an uncommon but serious complication of acute rheumatic fever. Pancarditis with pericarditis, endocarditis, and myocarditis develop during the acute phase. Myocarditis led to dilation of the ventricle so severe that the mitral valve became incompetent. Rheumatic heart disease is now uncommon, and the number of children that require prophylactic antibiotic therapy to prevent just one case is >10,000. Chronic inflammatory conditions may produce reactive systemic amyloidosis, but this is unlikely to occur given the limited and episodic nature of the streptococcal infection that causes rheumatic heart disease. Fibrinous pericarditis can produce an audible friction rub, but it is not constrictive, and the amount of fluid and fibrin are not great, so no tamponade occurs. Myocardial necrosis associated with myocarditis is patchy, and the ventricle does not rupture to produce tamponade. Fibrosis and fusion of the mitral valve leaflets develop over weeks to months and indicate chronic rheumatic valvulitis. Verrucous vegetations are small and may produce a murmur, but they do not interfere greatly with valve function and do not tend to embolize.
16. Ans: E. The mitral valve in the figure shows shortening and thickening of the chordae tendineae typical of chronic rheumatic valvulitis, and the small verrucous vegetations (*arrowheads*) are characteristic of superimposed acute rheumatic fever. Valvular scarring can follow years after initial group A streptococcal infection. Rheumatic heart disease develops after the immune response directed against the bacterial antigens (similar to cardiac antigens, and thus a form of molecular mimicry) damages the heart because streptococcal antigens cross-react with the heart. The mitral and aortic valves are most commonly affected, so right ventricular dilation from tricuspid involvement is less likely. In almost all cases, the fibrinous pericarditis seen during the acute phase with friction rub resolves without significant scarring, and constrictive pericarditis does not typically develop. Although there is myocarditis with acute rheumatic fever, it does not lead to dilated cardiomyopathy. A left ventricular aneurysm is a complication of ischemic heart disease. Primary cardiac neoplasms, including myxoma, are rare and not related to infection.
17. Ans: A. Acute rheumatic fever can involve any or all layers of the heart. Because rheumatic fever follows group A streptococcal infections, the antihyaluronidase, anti-DNase, and anti-streptolysin O (ASO) titers are often elevated. The strains of group A streptococci that lead to acute rheumatic fever are less likely to cause glomerulonephritis, so an elevated creatinine level is unlikely. The ANA level could be elevated in systemic lupus erythematosus, which is most likely to produce a serous pericarditis. A positive rapid plasma reagin test suggests syphilis, but the clinical features here are not those of syphilis, and cardiovascular syphilis is one form of tertiary syphilis that develops decades after initial infection. Cardiac troponins are markers for ischemic myocardial injury. Although their levels may be elevated because of the acute myocarditis that occurs in rheumatic fever, this change is not a characteristic of rheumatic heart disease.
18. Ans: E. The aortic valve shown has large, destructive vegetations. The probe passes through a perforated leaflet, typical of infective endocarditis caused by highly virulent organisms such as *Staphylococcus aureus*. The verrucous vegetations of acute rheumatic fever are small and nondestructive, and the diagnosis is suggested by an elevated anti-streptolysin O titer. A positive ANCA determination suggests a vasculitis, which is unlikely to involve cardiac valves. An elevated creatine kinase-MB level suggests myocardial, not endocardial, injury. A positive double-stranded DNA finding suggests systemic lupus erythematosus, which can produce nondestructive Libman-Sacks endocarditis.
19. Ans: D. Prolonged fever, heart murmur, mild splenomegaly, and splinter hemorrhages suggest a diagnosis of infective endocarditis. The valvular vegetations with infective endocarditis are friable and can break off and embolize. The time course of weeks suggests a subacute form of bacterial endocarditis resulting from infection with a less virulent organism, such as viridans streptococci. Group A streptococci are better known as a cause for rheumatic heart disease, with noninfectious vegetations. *Pseudomonas aeruginosa* is more likely to cause an acute form of bacterial endocarditis that worsens over days, not weeks; this organism is more common as a nosocomial infection or it may occur in injection drug users. Coxsackievirus B and *Trypanosoma cruzi* are causes of myocarditis. Tuberculosis involving the heart most often manifests as pericarditis.

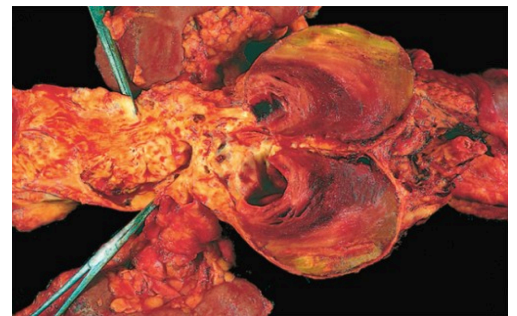
20. Ans: E. So-called marantic vegetations may occur on any cardiac valve, but tend to be small and do not damage the valves. They have a tendency to embolize, however. They can occur with hypercoagulable states that accompany certain malignancies, especially mucin-secreting adenocarcinomas. Thrombosis can occur anywhere, but is most common in leg veins, predisposing to pulmonary thromboembolism. This paraneoplastic state is known as *Trousseau syndrome*. Calcific aortic stenosis occurs at a much older age, usually in the eighth or ninth decade, and produces obstruction but not embolism. Cardiac metastases are uncommon, and they tend to involve the epicardium; they do not explain embolism with cerebral infarction in this case. A metastatic tumor can encase the heart to produce constriction, but this is rare. Mural thromboses occur when cardiac blood flow is altered, as occurs in a ventricular aneurysm or dilated atrium, but persons with malignancies likely have no or minimal ischemic heart disease.
21. Ans: D. Libman-Sacks endocarditis is an uncommon complication of systemic lupus erythematosus (SLE) that has minimal clinical significance because the small vegetations, although they spread over valves and endocardium, are unlikely to embolize or cause functional flow problems. Calcific aortic stenosis may be seen in older individuals with tricuspid valves, or it may be a complication of bicuspid valves. Although pericardial effusions are common in active SLE, along with pleural effusions and ascites from serositis, they are usually serous effusions, and no significant hemorrhage or scarring occurs. The vegetations of nonbacterial thrombotic endocarditis are prone to embolize. Mural thrombi are most likely to form when cardiac chambers are dilated, or there is marked endocardial damage. Rheumatic heart disease is an immunologic disease based on molecular mimicry; serologic tests would be positive for anti-streptolysin O (ASO), not ANA.
22. Ans: E. Bioprostheses made from pig valves are subject to wear and tear. The leaflets may calcify, resulting in stenosis, or they may perforate or tear, leading to insufficiency. Thrombosis with embolization is unlikely to occur with bioprostheses that are indicated for persons who cannot receive anticoagulant therapy; it is an uncommon complication of mechanical prostheses, lessened by anticoagulant therapy. Hemolysis is not seen in bioprostheses and is rare in modern mechanical prostheses. Myocardial infarction from embolization or from a poorly positioned valve is rare. Paravalvular leaks are rare complications of the early postoperative period.
23. Ans: F. Anticoagulant therapy is necessary for patients with mechanical prostheses to prevent potential thrombotic complications. If the patient is unable to take anticoagulants, use of a bioprosthesis (porcine valve) may be considered. Aspirin in low doses is used to reduce the risk for acute coronary syndromes. Antibiotic therapy with agents such as ciprofloxacin is not indicated, unless the patient has an infection or requires prophylactic antibiotic coverage for surgical or dental procedures. Cyclosporine or other immunosuppressive agents are not indicated because allogeneic tissue was not transplanted (a bioprosthesis also is essentially immunologically inert). Digoxin is not indicated because the patient's cardiac function has improved. A β -blocker such as propranolol is not needed in the absence of chronic cardiac failure.
24. Ans: A. Arrhythmogenic right ventricular cardiomyopathy (arrhythmogenic right ventricular dysplasia) is most likely an autosomal dominant inherited condition with abnormal desmosomal adhesion proteins in myocytes. Infections of the heart are accompanied by inflammation, though a late finding in Chagas disease is ventricular fibrosis with ventricular wall thinning. Hypertension leads to ventricular hypertrophy. There is no characteristic gross or microscopic finding with long QT syndrome caused by myocyte channelopathies. Prior radiation therapy results in fibrosis, but it is not likely to be localized to the right ventricle; improving techniques that focus the beam and synchronize it with breathing motion reduce cardiac damage when treating chest cancers.
25. Ans: B. Reduced cardiac chamber compliance is a feature of the restrictive form of cardiomyopathy. Cardiac amyloidosis may be limited to the heart (so-called senile cardiac amyloidosis derived from transthyretin protein) or may be part of organ involvement in systemic amyloidosis derived from serum amyloid-associated (SAA) protein or, in multiple myeloma, derived from light chains (AL amyloid). Incidental isolated atrial deposits of amyloid are derived from atrial natriuretic peptide. Myocardial fiber dysfunction markedly reduces ventricular compliance. Dynamic left ventricular outflow obstruction is characteristic of hypertrophic cardiomyopathy. Valvular insufficiency of mitral and tricuspid valves can occur with dilated cardiomyopathy, which also reduces contractility and ejection fraction with increased end-systolic volume.

Thromboembolism

1. A 58-year-old man with pulmonary emphysema has a 10-year history of congestive heart failure. 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. His serum levels of AST and ALT are increased. The representative gross appearance of his liver is shown in the figure. Which of the following underlying conditions is most likely to be present in this man?



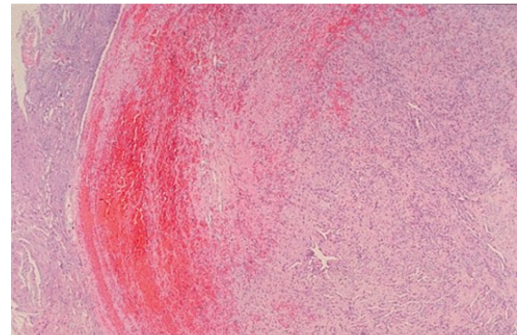
- A. Chronic renal failure
 - B. Common bile duct obstruction
 - C. Congestive heart failure
 - D. Portal vein thrombosis
 - E. Thrombocytopenia
2. A 60-year-old woman with a history of diabetes mellitus has had left-sided chest pain radiating to the arm for the past 5 hours. Serial measurements of serum creatine kinase-MB levels show an elevated level 24 hours after the onset of pain. Partial thromboplastin time (PTT) and prothrombin time (PT) 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
3. A 21-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. Laboratory tests show that her prothrombin time (PT), partial thromboplastin time (PTT), platelet count, and platelet function studies all are normal. Which of the following risk factors is the most common cause for such a coagulopathy?
- A. Antithrombin III deficiency
 - B. Factor V mutation
 - C. Hyperhomocysteinemia
 - D. Mutation in protein C
 - E. Occult malignancy
 - F. Oral contraceptive use
 - G. Smoking cigarettes
4. A 71-year-old man with a history of diabetes mellitus died of an acute myocardial infarction. At autopsy, the aorta, opened longitudinally and with the superior aspect of the kidneys below the forceps, appeared as shown in the figure. Which of the following complications associated with this aortic disease would most likely have been present during his life?



5. A 55-year-old woman following major abdominal surgery has had discomfort and swelling of her left leg for the past week. On physical examination, the leg is slightly difficult to move, and on palpation there is tenderness. A Doppler sonogram shows thrombosis of deep left leg veins. Which of the following mechanisms is most likely to contribute to her condition?
- A. Hypercalcemia
 - B. Immobilization
 - C. Ingestion of aspirin
 - D. Nitric oxide release
 - E. Turbulent blood flow

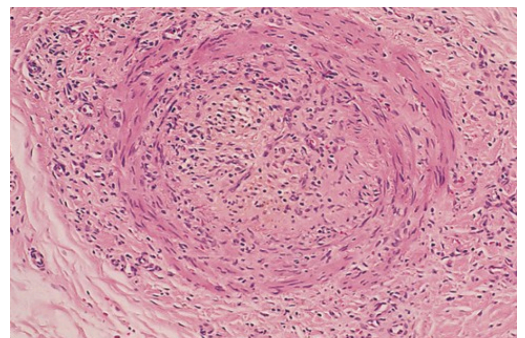
6. A 75-year-old man is hospitalized after falling and fracturing his left femoral trochanter. Two weeks later, the left leg is swollen, particularly below the knee. He experiences pain on movement of the leg; on palpation, there is swelling and tenderness. Which of the following complications is most likely to occur in this man?
- A. Disseminated intravascular coagulation
 - B. Fat embolism syndrome
 - C. Gangrenous necrosis of the foot
 - D. Hematoma of the thigh
 - E. Pulmonary thromboembolism

7. A 65-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, while still in the hospital, she has swelling and warmth in the left leg, and there is local pain and tenderness in the left thigh. Which of the following processes, as shown in the figure, is most likely occurring in her left femoral vein?



- A. Atherosclerosis
- B. Chronic passive congestion
- C. Inflammation
- D. Mural thrombosis
- E. Phlebothrombosis
- F. Vegetation

8. A 59-year-old woman with hyperlipidemia has had anginal pain for the past 24 hours. Laboratory findings show no increase in serum troponin I or creatine kinase-MB. She 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 this epicardial artery?



- A. Air embolus
- B. Cholesterol embolization
- C. Chronic passive congestion
- D. Fat embolism syndrome
- E. Mural thrombosis
- F. Organization with occlusion
- G. Phlebothrombosis

9. A 77-year-old woman has a brief fainting episode. She was diagnosed 1 year ago with pancreatic adenocarcinoma. On auscultation of her chest, a heart murmur is heard. Echocardiography shows a 1-cm nodular lesion on the superior aspect of an intact anterior mitral valve leaflet. A blood culture is negative. Which of the following terms best describes this mitral valve lesion?

- A. Atheroma
- B. Chronic passive congestion
- C. Mural thrombus
- D. Myxoma
- E. Phlebothrombosis
- F. Vegetation

10. A 70-year-old man was hospitalized 3 weeks ago for a cerebral infarction. He is now 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. Antiphospholipid antibody
- B. Bronchopneumonia
- C. Factor V mutation
- D. Leg vein thrombosis
- E. Pulmonary arterial atherosclerosis

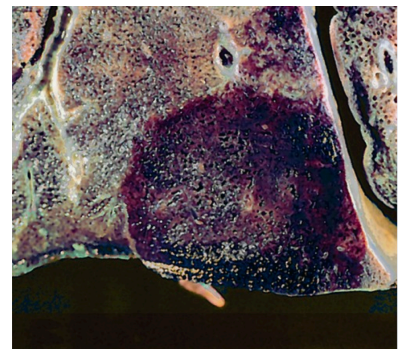
11. A 32-year-old man is involved in a vehicular accident and sustains fractures of the right femur and tibia and the left humerus. The fractures are stabilized surgically. He is in stable condition for 2 days, but then suddenly becomes severely dyspneic. Which of the following complications from his injuries is the most likely cause of his sudden respiratory difficulty?

- A. Cardiac tamponade
- B. Fat embolism
- C. Pulmonary edema
- D. Pulmonary infarction
- E. Right hemothorax

12. A 22-year-old woman with an uncomplicated pregnancy develops sudden dyspnea with cyanosis and hypotension intrapartum 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 her peripheral pulmonary arteries?

- A. Aggregates of platelets
- B. Amniotic fluid
- C. Fat globules
- D. Gas bubbles
- E. Thromboemboli

13. A 53-year-old man with congestive heart failure develops pulmonary *Streptococcus pneumoniae* infection after a bout of influenza. After recuperating for 2 weeks, he notes 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 in this man?



- A. Acute pulmonary congestion
- B. Chronic pulmonary congestion
- C. Pulmonary edema
- D. Pulmonary infarction
- E. Pulmonary venous thrombosis

14. A 44-year-old man with dilated cardiomyopathy and heart failure develops left atrial mural thrombosis. He develops the complication shown in the figure, manifested by hematuria. Which of the following is the best term for this complication?



- A. Abscess
- B. Ischemic infarct
- C. Liquefactive necrosis
- D. Multiorgan failure
- E. Venous thrombosis

15. 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*. She develops multiple infarcts and organ failure over the next 2 weeks. Which of the following organs is most likely to be spared from the effects of ischemic injury in this woman?

- A. Brain
- B. Heart
- C. Kidney
- D. Liver
- E. Spleen

ANSWERS:

1. Ans: C. The figure shows a so-called nutmeg liver caused by chronic passive congestion from congestive heart failure. The elevated enzyme levels suggest that the process is so severe that hepatic centrilobular necrosis has also occurred. The physical findings suggest right-sided heart failure that can occur with pulmonary emphysema and pulmonary arterial hypertension. Biliary tract obstruction would produce bile stasis (cholestasis) with icterus. Hepatic congestion is not directly related to renal failure, and hepatorenal syndrome has no characteristic gross appearance. 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. The regular pattern of red lobular discoloration seen in the figure is unlikely to occur in hemorrhage from thrombocytopenia, characterized by petechiae and ecchymoses.
2. Ans: B. Atherosclerotic damage to vascular endothelium is the most common cause of arterial thrombosis; this damage accumulates almost imperceptibly over many years. Diabetes mellitus types I and II accelerate atherosclerosis. Inhibitors to coagulation, such as antiphospholipid antibodies, typically prolong the partial thromboplastin time (PTT), the prothrombin time (PT), 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 thrombosis within the low-pressure venous circulation.
3. Ans: B. 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. 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. 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. Oral contraceptive usage contributes to risk for thrombosis, but mainly in older women, particularly past age 40 years. Smoking promotes atherosclerosis with arterial thrombosis.
4. Ans: B. The figure shows a mural thrombus at the right, filling an atherosclerotic aortic aneurysm below the renal arteries. Diabetes mellitus accelerates and worsens atherosclerosis, including peripheral muscular arteries. One possible complication of mural thrombosis is embolization, which occurs when a small piece of the clot breaks off. The embolus is carried distally and may occlude the popliteal artery, which is an end artery for the lower leg. A venous thrombus, not arterial, produces leg swelling from edema. Because the thrombus is in the arterial circulation, an embolus would not travel to the lungs. The thrombus is below the renal arteries. Although platelets contribute to the formation of thrombi, the platelet count does not decrease appreciably with formation of a localized thrombus, and a generalized process such as disseminated intravascular coagulation is needed to consume enough platelets to cause thrombocytopenia.
5. Ans: B. The most important and the most common cause of venous thrombosis is vascular stasis, which often occurs with immobilization. Calcium is a cofactor in the coagulation pathway, but an increase in calcium has minimal effect on the coagulation process. Aspirin inhibits platelet function and limits thrombosis. Nitric oxide is a vasodilator and an inhibitor of platelet aggregation. Turbulent blood flow may promote thrombosis, but this risk factor is more common in fast-flowing arterial circulation.
6. Ans: E. He has deep venous thrombosis as a consequence of venous stasis from immobilization. The large, deep thrombi in leg veins can embolize to the lungs, leading to death. 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. Gangrene typically 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.

7. Ans: E. 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. 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. The figure shows alternating pink platelet-fibrin and RBC layers (lines of Zahn) at the left. 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) as shown at the right of the figure. Atherosclerosis occurs in arteries, not veins. Chronic passive congestion refers to capillary, sinusoidal, or venous stasis of blood within an organ such as the lungs or liver. Vasculitis typically involves the vascular wall with inflammatory cell infiltrates. Mural thrombi are thrombi that form on the surfaces of the heart or large arteries. A vegetation is a localized thrombus formation on cardiac endothelium, typically a valve.
8. Ans: F. The figure shows an organizing thrombus in a small artery. 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. 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; there can be formation of one or more new lumens (recanalization). 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. When gases that became dissolved in tissues at high pressure bubble out at decompression with lower pressure in blood and tissues, then air emboli form. 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.
9. Ans: F. 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 malignant neoplasms may have a hypercoagulable state (Trousseau syndrome) that favors the development of arterial and venous thromboses. Atherosclerosis occurs within arteries, not the chambers of the heart. Endocardial metastases are quite rare. 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 myxoma is a primary neoplasm of the heart that usually arises on an atrial surface; it is not associated with malignancies elsewhere. Phlebothrombosis occurs when stasis in large veins promotes thrombosis formation.
10. Ans: D. The figure shows a large pulmonary thromboembolus. The most common risk factor is immobilization leading to venous stasis with phlebothrombosis, often called thrombophlebitis, since the lower extremities may be swollen and tender, but there is minimal inflammation. 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 peripheral areas of lung. Pulmonary atherosclerosis occurs with long-standing pulmonary hypertension, not the factors driving systemic arterial atherosclerosis.
11. Ans: B. The mechanism for fat embolism is unknown, in particular, why onset of symptoms is delayed 1 to 3 days after the initial injury (or up to 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. Cardiac tamponade and hemothorax 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 thromboembolism from deep venous thrombosis is typically a complication of a longer hospitalization.

12. Ans: 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 platelets represent localized thrombosis, an unlikely event in the lungs. 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.
13. Ans: D. The figure shows a dark red hemorrhagic infarction extending to the pleura, a typical finding when a medium-sized thromboembolus lodges in a peripheral 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 interstitium in the affected area of infarction. Persons with underlying heart or lung disease are at greater risk for pulmonary 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.
14. Ans: B. The figure shows a pale ischemic infarction of the renal cortex extending nearly to the renal capsule, a typical finding when a medium-sized arterial thromboembolus lodges in a peripheral renal artery branch. The infarct is wedge-shaped, typical for many parenchymal organs, because there is minimal collateral circulation. An abscess is a form of liquefactive necrosis from a localized collection of neutrophils in association with infection, and though it could be yellowish, it is likely to be round. Liquefactive necrosis from arterial occlusion and infarction occurs in the brain. Multiorgan failure occurs with shock, and whole organs are affected by ischemia. Venous thrombosis tends to produce hemorrhagic lesions.
15. Ans: D. 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.