Which of the following cells play a crucial role in the pathogenesis of alveolar-capillary damage in adult respiratory distress syndrome (ARDS)?

A. CD4-positive lymphocytes
B. CD8-positive lymphocytes
C. Eosinophils
D. Mast cells
E. Neutrophils

Explanation:

The correct answer is E. ARDS, pathologically referred to as diffuse alveolar damage, is a clinical syndrome of acute respiratory failure resulting from diffuse injury to the alveolar/capillary barrier. Such injury may be caused by a great variety of initiating insults, the most frequent of which are shock, severe trauma, sepsis, and gastric aspiration. All these different forms of injury result in recruitment of neutrophils within the alveolar capillaries. Neutrophils release chemokines that attract histiocytes and produce oxygen radicals, prostaglandins, and proteases that damage alveolar epithelium. Formation of hyaline membranes is due to a combination of plasma fluid extravasation and alveolar cell necrosis.

CD4+ (helper) lymphocytes (choice A), CD8+ (cytotoxic) lymphocytes (choice B), eosinophils (choice C), and mast cells (choice D) have been implicated in a number of pulmonary diseases, but not in diffuse alveolar damage.

An animal is made diabetic by injection of a drug that destroys pancreatic β cells. Removal of which of the following organs would most likely produce a decrease in blood glucose concentration in this animal?

A. Anterior pituitary
B. Colon
C. Gonads
The correct answer is A. Two of the secretions of the anterior pituitary affect the sensitivity of peripheral tissues to the action of insulin. Growth hormone has a direct effect on liver and muscle to decrease insulin sensitivity. This may be partly through a growth hormone-induced decline in insulin receptors or to unknown post-receptor defects. In excess, growth hormone is "diabetogenic," and about 25% of patients with acromegaly have diabetes. ACTH indirectly has anti-insulin effects by virtue of the cortisol secretion it evokes. Like growth hormone, cortisol also decreases insulin sensitivity in peripheral tissues. A third anterior pituitary hormone, TSH, also tends to increase blood glucose levels. In this case, the effect is probably mediated mostly through increased glucose absorption by the gut. Patients with hyperthyroidism can sometimes exhibit a postprandial glucosuria because of excessive intestinal glucose absorption. In diabetic animals, the removal of the anterior pituitary may lower blood glucose by increasing tissue sensitivity to whatever insulin remains.

Removal of the colon (choice B) should have little effect on blood glucose since dietary glucose is absorbed in the small intestine.

Sex steroids secreted by the gonads (choice C) have little effect on blood glucose concentration.

The kidney (choice D) plays an important role in reabsorbing filtered glucose. In diabetes, the tubular reabsorption maximum is exceeded and glucose spills over into the urine. The loss of glucose in the urine helps to reduce the severity of the plasma hyperglycemia. Removal of the kidneys would, if anything, make the hyperglycemia worse.

Pancreatectomy (choice E) would make the hyperglycemia worse by removing the source of any remaining insulin.

A 33-year-old woman gives birth to a baby girl. The next day, she begins to bleed from her vagina and from venipuncture sites. Laboratory studies demonstrate decreased platelets, prolonged prothrombin time (PT) and partial thromboplastin time (PTT), and increased fibrin split products. These features are most consistent with which of the following?

A. Disseminated intravascular coagulation

B. Hemophilia A
C. Severe liver disease

D. Vitamin K deficiency

E. Von Willebrand's disease

Explanation:

The correct answer is A. The patient is experiencing disseminated intravascular coagulation (DIC), a feared, and often life-threatening complication of many other disorders, including amniotic fluid embolism, infections (particularly gram-negative sepsis), malignancy, and major trauma. The diagnosis is suspected when both a decrease in platelets and a prolongation of PT and PTT times are observed. The observed hematologic abnormalities are due to consumption of platelets and clotting factors, caused by extensive microclot formation with accompanying fibrinolysis (reflected by the increased fibrin split products). The D-dimer assay measures cross-linked fibrin derivatives, and is a specific test for fibrin degradation products.

Hemophilia (choice B) will alter the PTT without affecting the other indices.

Severe liver disease (choice C) produces alterations comparable to those in vitamin K deficiency, and platelets can also be decreased secondary to a generalized metabolic marrow dysfunction, but fibrin split products would not be increased.

Vitamin K deficiency (choice D) is associated with alterations in both PT and PTT, but platelets will not be decreased, nor will fibrin split products be increased.

Von Willebrand's disease (choice E) produces impaired platelet adhesion and increases the bleeding time as well as the PTT, but will not produce the other features described.

A 54-year-old woman presents with a pansystolic murmur along the lower left sternal border radiating rightward to the midclavicular line. The murmur is medium pitched, has a blowing quality, and increases slightly on inspiration. An S3 is audible along the lower left sternal border. Jugular venous pressure is elevated, and a prominent "v" wave is visible. Which of the following is the most likely etiology of the S3?

A. Aortic stenosis

B. Mitral regurgitation
C. Pulmonic stenosis

D. Tricuspid regurgitation

E. Volume overloaded left ventricle

F. Volume overloaded right ventricle

Explanation:

The correct answer is F. The origin and radiation of the pansystolic murmur suggest tricuspid valve incompetence. This is further supported by its pitch and quality, and by the fact that it increases on inspiration when cardiac volume increases. The regurgitant blood flow from the ventricle during systole increases jugular venous blood pressure and atrial v wave amplitude. The origin of the S3 sound, which occurs during early rapid filling, is the filling of a volume-overloaded right ventricle. The right ventricle overload is caused by the combination of systemic venous return and the return of the regurgitated blood volume into the right ventricle. Right ventricular failure and dilatation, with enlargement of the tricuspid valve orifice, is the most common cause of tricuspid regurgitation and is often secondary to pulmonary hypertension or left ventricular failure.

Aortic stenosis (choice A) causes a harsh, shrill, midsystolic, crescendo-decrescendo murmur and would not necessarily elevate right heart (and so jugular venous) pressures. It is often associated with an S4 (late rapid filling) rather than an S3.

Mitral regurgitation (choice B) causes a soft, blowing, pansystolic murmur and is associated with an S3. It would elevate left atrial pressures, not right atrial (and so jugular venous) pressures.

Pulmonic stenosis (choice C) would also cause a crescendo-decrescendo murmur, not an S3.

Tricuspid regurgitation (choice D) is the source of the murmur but not the source of the S3 sound.

A volume-overloaded left ventricle (choice E) could cause an S3, but tricuspid regurgitation will not cause a volume overload in the left ventricle.

A routine physical examination demonstrates hypercalcemia in a 40-year-old man. Circulatory levels of parathyroid hormone are also elevated. Exploratory surgery of the neck reveals diffuse hyperplasia of all four parathyroid glands. Which of the following screening studies would most likely be helpful in confirming the diagnosis of multiple endocrine neoplasia, type I (MEN I)?
A. Pentagastrin-simulated calcitonin secretion

B. Serum epinephrine

C. Serum gastrin

D. Serum norepinephrine

E. Urinary adrenaline:noradrenaline ratio

Explanation:

The correct answer is C. In multiple endocrine neoplasia, type I (MEN I), parathyroid hyperplasia and/or adenomata are associated with pancreatic and duodenal endocrine tumors and endocrine hyperplasia. The most common secretory product of the pancreatic and duodenal endocrine lesions is gastrin. Pituitary adenomata may also occur in MEN I.

Pentagastrin-stimulated calcitonin secretion (choice A) is a marker for medullary carcinoma of the thyroid, which is a component of MEN II.

Epinephrine (adrenaline) is produced by pheochromocytomas that occur as part of MEN II; serum epinephrine levels (choice B) and urinary adrenaline:noradrenaline ratios (choice E) may be used for screening for pheochromocytomas.

Serum norepinephrine (choice D) is usually not helpful in the diagnosis of pheochromocytoma, since serum catecholamines can be increased by hypoglycemia, strenuous exertion, and central nervous system disease.

A 40-year old man complains of increasing difficulty in swallowing over the past 3 years. He reports a feeling of pressure in his chest occurring 2-3 seconds after swallowing a solid bolus. He also experiences regurgitation of undigested food eaten hours previously. A radiograph taken after swallowing barium shows a distended esophageal body with a smooth tapering at the lower esophageal sphincter. Manometry shows the absence of esophageal peristalsis with swallowing and a lower esophageal sphincter that fails to relax. What is the most likely diagnosis?

A. Achalasia
B. Diffuse esophageal spasm

C. Incompetent lower esophageal sphincter

D. Oropharyngeal dysphagia

E. Scleroderma

Explanation:

The correct answer is A. Achalasia is an acquired esophageal motility disorder that slowly develops. The motility is abnormal due to the loss of inhibitory enteric neurons of the esophageal body and lower esophageal sphincter. Both vasoactive intestinal peptide and nitric oxide function as inhibitory neurotransmitters here, and the presence of both is decreased in achalasia. Radiographs typically show a dilated esophagus that tapers at the lower esophageal sphincter, producing a so-called "bird's beak." Because of the poor motility, ingested food is regurgitated and can lead to aspiration symptoms. Heartburn can occur due to production of lactic acid in the esophagus as the retained ingestate is fermented. Manometric demonstration of absent peristalsis in the esophageal body and poor relaxation of the lower esophageal sphincter with a swallow confirm the diagnosis.

The primary complaint with diffuse esophageal spasm (choice B) is mid-sternal pain that can be misdiagnosed as cardiac pain. The pain is caused by prolonged contraction of the entire esophageal body. Symptoms can be brought on by eating certain hot or cold meals. A manometric study may show poor peristalsis in the smooth muscle portion of the esophageal body, but lower esophageal sphincter function is unaffected.

The primary complaint with incompetent lower esophageal sphincter (choice C) is heart burn and regurgitation due to gastroesophageal reflux. Endoscopic examination of the esophagus may reveal inflammation, erosions, and even ulcers. A manometric study would show lower-than-normal resting tone in the lower esophageal sphincter, or a sphincter that relaxes inappropriately.

The fact that the patient's symptoms do not occur until 2-3 seconds after a swallow suggests that oropharyngeal dysphagia (choice D) is not the diagnosis. The presence of cough, hoarseness, or nasal regurgitation commonly occurs with this disorder. Oropharyngeal dysphagia is often due to neurological or muscle disorders like stroke, amyotrophic lateral sclerosis, muscular dystrophy, or myasthenia gravis.

Scleroderma (choice E) is a connective tissue disease in which esophageal smooth muscle is gradually replaced by dense collagenous material. Manometry would show poor esophageal peristalsis and decreased lower esophageal sphincter tone. Significant acid reflux with resultant esophagitis is almost universal.
A 42-year-old-woman is admitted to the hospital because of syncopal attacks and difficulty breathing. She had undergone mitral valve replacement 8 years ago. X-ray shows pulmonary congestion and an enlarged heart. A phonocardiogram did not show a systolic murmur. Pressure tracings from the aorta, left ventricle, and left atrium are shown in the diagram. Which of the following diagnoses best accounts for these findings?

A. Aortic regurgitation
B. Aortic stenosis
C. Mitral regurgitation
D. Mitral stenosis

Explanation:

The correct answer is D. It is evident that the patient has mitral obstruction because the left atrial pressure is greater than the left ventricular pressure toward the end of diastole, when blood is flowing from the left atrium into the left ventricle. The mitral valve replaced 8 years ago had undergone thrombosis resulting in obstruction of the mitral orifice. The very high left atrial pressure resulting from the thrombosed valve has caused pulmonary edema, which accounts for the dyspnea.

The aortic pressure and left ventricular pressure tracings are nearly superimposed during systole in the diagram, which eliminates the possibility of aortic regurgitation (choice A) or aortic obstruction (choice B).
Mitral regurgitation (choice D) is characterized by a greatly elevated left atrial pressure toward the end of systole. The increase in pressure is caused by backward flow of blood from the left ventricle into the left atrium through the leaky mitral valve. The leak occurs during systole, and is characterized by a systolic murmur, which was not noted in the patient. The left atrial pressure is normal at the end of diastole with mitral regurgitation because blood flows unimpeded from the atrium into the ventricle when the mitral valve is open.

A patient with complaints of somnambulism has fallen asleep. She passes from light sleep into a deeper sleep. Just before she experiences an episode of somnambulism, her electroencephalogram is likely to show

A. alpha waves
B. beta waves
C. delta waves
D. sleep spindles and K-complexes
E. theta waves

Explanation:

The correct answer is C. Delta waves are low-frequency, high-amplitude waveforms that herald the arrival of the deepest type of non-REM sleep, stage 4 sleep. It is during this stage of sleep that somnambulism (sleepwalking) occurs.

Alpha waves (choice A) are characteristic of relaxed wakefulness.

Beta-like activity (choice B) is characteristic of either alert wakefulness or REM sleep.

Sleep spindles and K-complexes (choice D) are characteristic of stage 2 sleep, which is a deeper sleep that occupies roughly 45% of the sleep cycle.

Theta waves (choice E) are characteristic of light sleep (stage 1).
A 51-year-old male smoker presents with fever and a cough productive of greenish-yellow sputum. The patient states that he has had a morning cough with excessive mucus production for the past 5 years. Which of the following abnormalities would most likely be found in this patient?

A. Apical cavitary lesions on x-ray

B. Curschmann spirals in his sputum

C. Elevated salt levels in his sweat

D. Enlarged hilar lymph nodes on x-ray

E. Increased Reid index

Explanation:

The correct answer is E. This patient presents with symptoms suggestive of acute infection (elevated temperature, greenish-yellow sputum) on a background of chronic bronchitis, which is common in smokers. Hyperplasia and hypertrophy of mucous glands in chronic bronchitis causes them to be present at deeper levels in the bronchial wall than usual. The ratio of the gland depth to the total thickness of the bronchial wall is termed the Reid index, which would be increased in this patient.

Apical cavitary lesions (choice A) might be indicative of cavitary tuberculosis. This condition is not associated with excessive mucus production. Hemothysis and weight loss might also be expected as clinical findings.

Curschmann spirals (choice B) are found in asthmatic patients and represent mucus casts of small airways. This patient does not have the typical episodic history of acute asthmatic attacks with acute dyspnea as the major clinical problem.

Elevated sodium chloride levels in sweat (choice C) are present in cystic fibrosis. This condition has an onset in early life and is associated with excessive production of thick mucus, which predisposes to infection of the airways and permanent damage.

Enlarged hilar lymph nodes (choice D) might suggest bronchogenic carcinoma or a granulomatous process, which would be less likely than chronic bronchitis. In addition, patients with carcinoma often present with hemothysis and weight loss, rather than excessive mucus production.
A neurological examination of a 47-year-old woman reveals a normal corneal reflex in her right eye, but no consensual corneal reflex in her left eye. Which of the following additional findings might be expected?

A. Absence of pupillary light reflex of the left eye

B. Hyperacusis of the left ear

C. Inability to abduct the right eye

D. Loss of pain and temperature of the left face

E. Loss of taste from the anterior two-thirds of the right tongue

F. Ptosis of the left eye

Explanation:

The correct answer is B. The first trick to this question is to determine where the lesion is. The corneal reflex is tested by touching a cotton wisp to the eye. A normal response would be blinking of the ipsilateral eye as well as the contralateral eye (consensual reflex). The afferent limb of the corneal reflex is contained within the ophthalmic division of the ipsilateral ophthalmic nerve (V1), the efferent limb is by both (right and left) facial nerves (VII). This woman had a normal corneal reflex in her right eye, indicating a normal right V1 and right VII. However, she lacked a consensual reflex, indicating an abnormal left VIIth nerve. The next trick to this question is to determine what other signs a lesion in the left VIIth nerve could produce. A lesion in the left VIIth would also produce hyperacusis (increased sensitivity to sound) in the left ear because of paralysis of the stapedius muscle, which ordinarily dampens sound transmission through the middle ear.

The absence of a pupillary light reflex of the left eye (choice A) could be caused either by a lesion of the left optic nerve (CN II; afferent limb) or by a lesion of the left oculomotor nerve (CN III; efferent limb).

The inability to abduct the right eye (choice C) could be caused by a lesion of the right abducens nerve (CN VI), which innervates the lateral rectus muscle.

Loss of pain and temperature of the left face (choice D) could be caused by a lesion of the spinal nucleus of V. This nucleus is located in the medulla, and receives pain and temperature information from the face via the trigeminal nerve (CN V).

Loss of taste from the anterior two-thirds of the right tongue (choice E) could result from a lesion of the right CN VII.
Ptosis of the left eye (choice F) could result from a lesion of the left oculomotor nerve (CN III) because of denervation of the levator palpebrae muscle. A lesion of the left VII would result in the inability to close the left eye.

A 29-year-old woman with a history of irregular menses becomes amenorrheic. She had no problems conceiving her first child at the age of 23, but she has been trying unsuccessfully to become pregnant for the past two years. She also notes a weight gain of about 3 kg, increasing fatigue, puffy face and marked cold intolerance. A complete blood count (CBC) reveals a Hb of 11.1 and an MCV of 90. Physical exam reveals a moderate-sized diffuse enlargement of the thyroid gland. Which of the following thyroid profiles would most likely be seen in this woman?

A. Low T3, low T4, high TSH
B. Low T3, low T4, low TSH
C. Low T3, high T4, low TSH
D. High T3, low T4, low TSH
E. High T3, high T4, low TSH

Explanation:

The correct answer is A. This woman is experiencing signs and symptoms of hypothyroidism, the most common cause of which is chronic thyroiditis, or Hashimoto's thyroiditis. It is an autoimmune disorder, mostly affecting women, in which antithyroid antibodies are produced. The immune response results in autoimmune destruction of the thyroid gland, rendering it less able to produce thyroid hormone, causing hypothyroidism. Some other symptoms of hypothyroidism are weakness, fatigue, coarse hair, constipation, hoarseness, and hearing loss. Since the thyroid cannot produce thyroid hormone, both T3 and T4 would be low. In trying to compensate for low thyroid hormone levels, the pituitary gland releases excess TSH to stimulate the thyroid gland to make more thyroid hormone.
The work diagrams in the figure above show changes in left ventricular volume and pressure during one cardiac cycle from a normal heart (diagram A) and following aortic valvular disease (diagram B). Which of the following is expected to be increased in the heart depicted in diagram B as compared to the normal heart depicted in diagram A?

A. Coronary artery oxygen content

B. Coronary blood flow during diastole

C. Coronary blood flow during systole

D. Coronary vein oxygen content

E. Myocardial oxygen tension (pO2)

Explanation:

The correct answer is B. Coronary blood flow is regulated almost entirely by the metabolic requirements of the cardiac muscle. The heart depicted in diagram B has aortic stenosis. The peak systolic pressure of the left ventricle has increased from a normal value of about 125 mm Hg to about 190 mm Hg. This increase in systolic pressure has increased the stroke work output of the heart depicted by diagram B. The stroke work output is equal to the area enclosed by the volume-pressure diagram. This increase in stroke work output increases the oxygen consumption of the heart, thereby decreasing the content of oxygen in the venous effluent flowing from the heart (choice D) as well as the oxygen tension (pO2) in the myocardium (choice E). It should be clear that increasing myocardial oxygen consumption will not affect the amount of oxygen in the blood (arterial oxygen content, choice A) entering the heart through the coronary arteries.

The heart normally uses about 70% of the oxygen in the arterial blood flowing through the coronary circulation.
Because there is not much oxygen left in the blood, increases in blood flow are required to supply the heart with additional amounts of oxygen, i.e., oxygen extraction cannot be increased to a large extent. One other problem is that blood flow falls to low levels during systole because the coronary blood vessels are compressed by the contracting muscle. The increase in peak systole pressure caused by aortic stenosis compresses the coronary vessels even more than normal, causing systolic blood flow to decrease greatly (choice C). This decrease in systolic flow coupled with the increase in myocardial oxygen consumption that occurs with aortic stenosis causes blood flow to increase greatly during diastole.

A child is 2 standard deviations below the expected mean height for his age. He also has delayed bone maturation and a goiter. Analysis of genetic material reveals a point mutation in the thyroid hormone receptor. Which of the following laboratory results would be expected in this patient?

A. Decreased radioactive iodine uptake test (RAIU)
B. Decreased resin T3 uptake test
C. Decreased plasma TSH concentration
D. Increased basal metabolic rate (BMR)
E. Increased plasma T4 concentration

Explanation:

The correct answer is E. Generalized resistance to thyroid hormone is a rare genetic abnormality (Refetoff's syndrome). It results from mutations of the thyroid hormone receptor gene. Depending on the severity of the disorder, patients may only be mildly affected or may exhibit striking hypothyroid-like symptoms including decreased BMR (not increased, choice D). Growth can be stunted, there may be deaf mutism, and attention span may be short. Because the thyroid hormone resistance is generalized, the normal negative feedback effects of T4 and T3 at the hypothalamus and pituitary are also deficient. This would lead to an increased plasma TSH concentration (not decreased, choice C). Because of the increase in plasma TSH, iodine trapping by the thyroid follicular cells will be increased, leading to an increase in RAIU (not decreased, choice A) and an increase in serum T4. Because of the increase in serum T4, the equilibrium between T4 and thyroxine binding globulin (TBG) will be shifted toward increased bound T4 with a concomitant decrease in free TBG binding sites. In the resin T3 uptake test, the added radioactive T3 would thus preferentially bind to the resin and not the TBG, producing an increase in resin T3 uptake (not decrease, choice B).
A morbidly obese (450 lb) individual presents to the emergency department in respiratory distress. Arterial blood gas studies show a PCO2 of 55 mm Hg, a PO2 of 60 mm Hg, and a pH of 7.28. Chest X-ray films are unremarkable, with no evidence of emphysema, tumor, fibrosis, pulmonary infarction, or other disease. Auscultation reveals a rapid but regular heart beat, and the pulse is strong. Which of the following is the most likely explanation of the patient's arterial hypoxemia?

A. Decreased capacity for pulmonary diffusion

B. Decreased surface area of alveolar capillary membranes

C. Hypoventilation of central origin

D. Hypoventilation of peripheral origin

E. Inequalities of ventilation and perfusion

Explanation:

The correct answer is D. It is conceptually worth subclassifying hypoxemia in terms of the groups of the causes listed in the answers. In this case, the patient has no evidence of primary pulmonary or cardiovascular disease, and is known to be morbidly obese. Morbidly obese individuals are vulnerable to the Pickwickian syndrome (after a character in a Dickens novel), in which pressure from a fatty neck causes intermittent airway obstruction. The many other causes of hypoventilation of peripheral origin include suffocation, submersion, skeletal abnormalities, trauma, phrenic nerve paralysis, polio, and tetanus.

Causes for decreased capacity for pulmonary diffusion (choice A) of O2 include processes such as respiratory distress syndrome, emphysema, pulmonary fibrosis, and some granulomatous processes such as sarcoidosis.

Causes for decreased surface area of alveolar capillary membranes (choice B) include resection or compression of the lung and emphysema.

The usual cause of hypoventilation of central origin (choice C) is respiratory center depression by morphine or barbiturates.

Causes for inequalities of ventilation and perfusion (choice E) include chronic bronchitis, asthma, emphysema, bronchiectasis, some granulomatous processes, and tumors.
Cardiac catheterization was performed on a 51-year-old woman because of a 9-month history of worsening fatigue and shortness of breath. What is the most likely diagnosis based on the pressures shown above?

A. Aortic regurgitation
B. Aortic stenosis
C. Mitral regurgitation
D. Mitral stenosis

Explanation:

The correct answer is D. The pulmonary wedge pressure (which is used as an estimate of left atrial pressure) is elevated to 30 mm Hg and the pulmonary artery pressure is elevated to 45/25 mm Hg. The left ventricular end-diastolic pressure is normal but is not equal to the pulmonary wedge pressure. A pressure gradient of 25 mm Hg (30 - 5) across the mitral valve is a clear indication of stenosis. The fatigue and shortness of breath result from mild pulmonary edema caused by the increase in pulmonary capillary pressure. One can surmise that the pulmonary capillary pressure is elevated because pressures are elevated at the arterial and venous ends of the pulmonary circulation.

In aortic regurgitation (choice A), blood flows backward through the aortic valve during diastole when the valve is closed. Left ventricular end-diastolic pressure (and pulmonary wedge pressure) may be elevated with chronic aortic regurgitation once the myocardium has failed, but aortic regurgitation itself will not result in a pressure gradient across the mitral valve.

In aortic stenosis (choice B), the blood is ejected from the left ventricle into the aorta through a
smaller-than-normal opening. Because the resistance to ejection of blood is high, the left ventricular pressure increases greatly with normal systolic pressure in the aorta.

Mitral regurgitation (choice C) means backward flow of blood through the mitral valve during systole. This accumulation of extra amounts of blood in the left atrium during ventricular systole leads to an elevation in the pulmonary wedge pressure (which is used as an estimate of left atrial pressure).

A patient comes in to the doctor because of a chronic cough. He notes occasional streaks of blood in his sputum. Chest x-ray reveals multinodular, cavitating lesions in the apical posterior segments of both lungs with evident satellite lesions. The condition described is likely to occur in the apices of the lungs because they

A. are better perfused than the base
B. are more acidic than the base
C. contain more alveolar macrophages than the base
D. have a higher PO2 than the base
E. ventilate better than the base

Explanation:

The correct answer is D. The presentation is typical for reactivation pulmonary tuberculosis. The patient may also note fever, malaise, and weight loss. The high PO2 found in the upper portion of the lungs provides a favorable environment for growth of Mycobacterium tuberculosis, leading to reactivation tuberculosis. (In contrast, primary tuberculosis tends to occur in the lower and middle lobes, where small infectious particles are most likely to lodge after being inhaled.)

Ventilation increases from the top to the bottom of the lung, so choice E is wrong. Perfusion increases even more rapidly than ventilation, so choice A is also wrong. As a result, the ventilation-perfusion ratio decreases from the top to the bottom of the lung. The higher ratio at the apex of the lung results in a relatively elevated PO2 at that location.

The apex of the lung has a higher pH than the base, so choice B is wrong. Because the ventilation-perfusion ratio is higher at the apex, PCO2 would be lower, thus increasing the pH.
Regional differences in the density of alveolar macrophages (choice C) are not known to cause the described predisposition.

A 35-year-old female, hospitalized after a motor vehicle accident, develops acute gastric stress ulcers. Increases in which of the following normal physiological parameters may have contributed to this condition?

A. Bicarbonate transport
B. Epithelial regenerative capacity
C. Mucosal blood flow
D. Mucus secretion
E. Pepsin production

Explanation:

The correct answer is E. Pepsin production is a normal physiologic activity of the stomach that, in conditions of stress, may overwhelm the stomach's weakened defenses and result in gastric ulceration. Gastric acid production is another condition that may increase and cause acute ulceration. Furthermore, these two factors may remain unchanged and still result in gastric ulcers if the gastric defenses are weakened by stress. All of the other choices represent normal defensive forces in the stomach.

Increased bicarbonate transport (choice A) would protect the gastric epithelium from the potentially harmful acidity of the gastric contents. The adherent mucus is relatively alkaline, providing local protection to the superficial mucosa.

Gastric epithelial cells can normally replicate rapidly, allowing mucosal defects to be rapidly repaired. Increasing the regenerative capacity of the epithelium (choice B) would have a protective effect against ulceration.

The gastric mucosa is richly supplied with blood, providing the epithelial cells with an ample supply of nutrients, oxygen, and bicarbonate to contend with the harsh gastric microenvironment. Stress ulcers are associated with compromised gastric blood flow, not increased flow (choice C).

Mucus protects the gastric epithelium by virtue of being water insoluble, impermeable to pepsin, and slowly permeated by acid (H+). Increasing mucus production (choice D) has a protective effect for the gastric mucosa.
In emphysema, the destruction of many alveolar walls changes the compliance of the respiratory system. Which of the following clinical observations is directly related to this change in compliance?

A. Barrel chest

B. Chronic cough

C. Excessive mucus production

D. Long, slow, deep breathing pattern

E. Pink face

Explanation:

The correct answer is A. A barrel chest with increased anterior/posterior diameter is commonly observed in patients with long-standing, severe emphysema. This change in chest shape occurs because these patients, who have high compliance of the lung proper, tend to function with their lungs to some degree "over-inflated" compared to people with normal lung compliance. This over-inflation limits their ability to take further deep breaths. (The "balloon" of emphysematous lung remains compliant, but the "box" of the chest wall is not very compliant and limits the volume of air that can be inhaled). Patients with moderately severe emphysema are able to maintain an adequate lung ventilation by taking many short breaths (compare with choice D); this physiology is sometimes expressed by describing these patients as "pink puffers" (choice E).

Chronic cough (choice B) in emphysema patients is not directly related to the change in compliance.

Excessive mucus production (choice C) is more characteristic of chronic bronchitis than of emphysema.

A 54-year-old alcoholic presents with complaints of tremors and muscle twitching. Physical examination reveals the presence of Trousseau's sign. Laboratory data show that serum magnesium is < 1 mEq/L (normal, 1.4 - 2.2 mEq/L). Which of the following findings would be most consistent with this information?

A. Decreased serum calcium
B. Decreased serum phosphate

C. Increased bone density

D. Increased plasma parathyroid hormone concentration

E. Increased urinary cAMP concentration

Explanation:

The correct answer is A. Malnutrition associated with chronic alcoholism can lead to a severe magnesium deficiency. The effect of low serum magnesium on parathyroid hormone secretion (PTH) depends on severity and duration. An acute decrease in serum magnesium will increase PTH secretion, while a prolonged severe deficiency results in decreased PTH secretion. There is also evidence that the action of PTH is decreased with chronic magnesium deficiency. Hence, this patient is suffering from "functional" hypoparathyroidism. The low serum calcium can produce weakness, tremors, muscle fasciculations, and seizures. A positive Trousseau's sign indicates the presence of latent tetany. It is observed by inflating a blood pressure cuff above systolic blood pressure for at least 2 minutes. A positive reaction consists of the development of carpal spasm, with relaxation occurring within seconds after deflating the cuff. In patients with magnesium deficiency, magnesium administration will produce a prompt rise in plasma PTH with subsequent restoration of serum calcium concentration to normal.

With functional hypoparathyroidism bone density would be decreased (not increased, choice C).

The combination of decreased PTH secretion (not increased, choice D) and decreased effectiveness of PTH produce hypocalcemia and hyperphosphatemia (not hypophosphatemia, choice B).

Urinary cAMP would probably be decreased (not increased, choice E), given the low PTH.

A child who has had abnormal development of the membranous bones has a broad skull with associated facial and dental anomalies. Which other bones are most likely to also be affected?

A. Clavicles

B. Femurs
C. Metatarsals

D. Phalanges

E. Tibias

Explanation:

The correct answer is A. In a syndrome called cleidocranial dysostosis, absence of part of the clavicles accompanies a broad skull, and facial and dental anomalies. Note that you could also have answered this question by noting that of the bones listed, only the clavicles form by intramembranous ossification.

The femurs (choice B), metatarsals (choice C), phalanges (choice D), and tibias (choice E) are cartilaginous (formed by endochondral ossification) rather than membranous bones.

A 50-year-old man presents to his doctor with diarrhea, flushing, and wheezing. Physical examination is significant for a grade II/VI diastolic murmur located at the right sternal border at the 4th intercostal space. Which of the following substances is most likely to be elevated in this patient's urine?

A. 5-HIAA

B. HVA

C. Phenylalanine

D. Selegiline

E. Vanillylmandelic acid (VMA)

Explanation:

The correct answer is A. 5-HIAA is a metabolite of serotonin, a major secretory product of carcinoid tumors. The signs and symptoms of carcinoid syndrome include diarrhea, flushing, and wheezing. The cardiac abnormalities are commonly concentrated in the right heart because carcinoid secretory products are degraded or detoxified in the lung.
HVA (choice B) is a breakdown product of dopamine through the MAO or COMT metabolism pathways.

Phenylalanine (choice C) is an essential amino acid that is used to synthesize tyrosine, the precursor of the catecholamines (dopamine, norepinephrine, and epinephrine).

Selegiline (choice D) is a MAO-B inhibitor that inhibits the degradation of dopamine. It is used in the treatment of Parkinson's disease.

VMA (choice E) is a metabolite of epinephrine that is elevated in the urine of individuals with pheochromocytoma.

A 26-year-old male is brought to a physician because of a head injury. His wife states that she and her husband were walking on the sidewalk when he suddenly fell to the ground and hit his head. She said similar episodes had occurred before, but this was the first time that he had been injured. Cardiovascular evaluation is unrevealing. An electroencephalogram administered at the appropriate time would probably reveal which of the following types of seizures?

A. Absence

B. Atonic

C. Myoclonic

D. Tonic

E. Tonic-clonic

Explanation:

The correct answer is B. Atonic or "drop" seizures are characterized by a sudden loss of postural muscle tone that lasts only a few seconds. Although consciousness may be impaired briefly, there is rarely postictal confusion. A very brief seizure may cause only a drop of the head, but a longer seizure may cause the patient to slump to the ground. This type of seizure may be quite dangerous because of the risk of head injury with a sudden fall. Drugs prescribed for this condition include valproic acid, clonazepam, felbamate, vigabatrin, and lamotrigine.

Absence seizures (choice A), also known as petit mal seizures, are characterized by blank stares and an absence of any change in position. They typically occur in children. Drugs used in this disorder include
ethosuximide, valproic acid, and clonazepam.

Myoclonic seizures (choice C) are characterized by sudden, brief muscle jerks that may involve part of the body or the whole body. A physiologic form of myoclonus occurring in healthy individuals is the sudden jerking movement that sometimes occurs while falling asleep. Drugs used for this condition include valproic acid and clonazepam.

Tonic seizures (choice D) are characterized by the sudden onset of sustained axial and limb muscle contraction. Pure tonic seizures tend to occur in children.

Tonic-clonic seizures (choice E), also known as grand mal seizures, are characterized by an initial phase with tonic contraction of muscles throughout the body. After a short time, the seizure evolves into the clonic phase, in which periods of muscle relaxation are superimposed on muscle contraction. There is a significant postictal phase. Drugs used for this disorder include carbamazepine, phenytoin, and valproic acid.

A cyanotic infant is discovered to have a ventricular septal defect, an overriding aorta, right ventricular hypertrophy, and complete pulmonic stenosis. Which of the following accompanying congenital anomalies permits survival in this patient?

A. Bicuspid aortic valve
B. Ostium secundum defect
C. Patent ductus arteriosus
D. Patent foramen ovale
E. Preductal coarctation of aorta

Explanation:

The correct answer is C. The ductus arteriosus connects the aorta with the pulmonary artery. If it remains patent after birth, it allows oxygenated blood to flow from the aorta to the pulmonary artery. In this patient with tetralogy of Fallot with complete right ventricular outflow obstruction, this anastomosis is a crucial source of blood to the pulmonary vasculature.
A bicuspid aortic valve (choice A) may be asymptomatic but can lead to infective endocarditis, left ventricular overload, and sudden death. It is a common cause of aortic stenosis. It would not benefit a patient with tetralogy of Fallot in any way.

Ostium secundum defect (choice B) is the most common form of atrial septal defect (ASD). ASD is an acyanotic congenital heart disease that would not improve cardiovascular function in a patient with tetralogy of Fallot.

A patent foramen ovale (choice D) is a slit-like remnant of communication between the left and right atria in the fetus. It is usually not of clinical significance.

A preductal coarctation of the aorta (choice E) involves narrowing of the aorta proximal to the opening of the ductus arteriosus. This would prevent adequate blood flow through a possible life-preserving PDA and would result in the patient's demise.

A 14-year-old male presents with type I diabetes mellitus. His mother wants to know if the boy's brother might also have an increased risk of getting the disease. Which of the following genotypes, if present in the brother, would be associated with the greatest risk of developing diabetes?

A. B27/B27
B. DR2/DR2
C. DR2/DR4
D. DR3/DR3
E. DR3/DR4

Explanation:

The correct answer is E. A heterozygous individual with HLA-DR3 and HLA-DR4 has a 33-fold greater relative risk for developing diabetes than individuals without these two HLA antigens.

Homozygous individuals with HLA-B27 (choice A) are more likely to develop ankylosing spondylitis and Reiter's disease.

Patients who are homozygous for HLA-DR2 (choice B) have a reduced risk of diabetes mellitus. Individuals with
the HLA-DR4 allele have an increased risk of diabetes. Heterozygotes for HLA-DR2 and HLA-DR4 (choice C) likely have an intermediate risk.

Individuals who are positive for the HLA-DR3 antigen (choice D) have three times the risk of developing diabetes mellitus.

A patient hospitalized with pneumonia has a thyroid hormone panel ordered along with other routine blood work. Serum T3 is decreased, but serum T4 and TSH are within the normal range. From this information, the physician concludes that the patient

A. has low T3 syndrome (euthyroid sick syndrome)

B. has primary hypothyroidism

C. should be treated with thyroxine replacement

D. will also exhibit decreased serum reverse T3 concentration

E. will also exhibit increased activity of 5'-monodeiodinase in peripheral tissues

Explanation:

The correct answer is A. The low T3 syndrome or "euthyroid sick syndrome" occurs with certain systemic illnesses like pneumonia or septicemia, after major surgery, and with malnutrition or starvation. Whatever the cause, the syndrome is characterized by a decrease, not increase (choice E), in 5'-monodeiodinase activity in peripheral tissues like liver and kidney. As a consequence the conversion of circulating T4 to T3 is impaired and blood levels of T3 decrease. The decrease in serum T3 is thought to be a protective adaptation to decrease catabolic processes during the illness or shortage of energy substrates.

Primary hypothyroidism (choice B) is characterized by decreased serum T4 and increased serum TSH. In the euthyroid sick syndrome, serum T4 and TSH are usually within the normal range.

Because the low T3 is probably a protective adaptation, treatment with thyroxine replacement (choice C) is of little benefit and may actually be harmful. Once the patient recovers from the illness or malnutrition, serum levels of T3 gradually return to normal on their own.

A normal step in the breakdown of reverse T3 also involves the action of 5'-monodeiodinase, which converts
reverse T3 to 3,3'-diiodothyronine. Hence, with the low T3 syndrome, serum concentration of reverse T3 is increased, not decreased (choice D), due to decreased breakdown.

A 48-year-old male is seen for persistent edema. Initial laboratory studies indicate that he has nephrotic syndrome, and a renal biopsy is diagnostic of membranous glomerulonephritis. Which of the following substances will be elevated in the plasma in this patient?

A. Albumin

B. Ammonia

C. Cholesterol

D. Glucose

E. Potassium

Explanation:

The correct answer is C. The nephrotic syndrome describes a group of laboratory findings associated with glomerular diseases which share the common characteristic of "leaky glomeruli." Large biochemicals, normally unable to cross out of glomerular capillaries into Bowman's space, are lost into the urine. Serum proteins are lost in large quantities and can be detected as both hypoproteinemia and massive proteinuria. Albumin (choice A), a relatively small plasma protein (MW 66,000) is lost very readily, leading to hypoalbuminemia. Serum concentrations of small compounds such as potassium (choice E) and glucose (choice D), which are highly permeable in the normal glomerulus, are unaffected by glomerulonephritides producing the nephrotic syndrome. Similarly, blood urea nitrogen is unaffected, and serum ammonia levels (choice B) are unchanged. The final component of the nephrotic syndrome (besides hypoproteinemia, hypoalbuminemia and massive proteinuria) is hyperlipidemia. It is apparently a function of both increased hepatic fat synthesis and decreased fat catabolism. Increased cholesterol (choice C), triglycerides, and lipoproteins are found in serum in membranous glomerulonephritis, and these lipids leak into the urine, producing lipiduria.

A patient with mild congestive heart failure is treated with high-dose furosemide and diureses 25 pounds of fluid. A complete blood count (CBC) taken before the diuresis shows an RBC count of 4 million/mm³; a CBC taken after diuresis shows a RBC count of 7 million/mm³. Which of the following is the most likely explanation?
A. Cyanotic heart disease

B. Increased erythropoietin

C. Polycythemia vera

D. Relative polycythemia

E. Renal cell carcinoma

Explanation:

The correct answer is D. This is an example of relative polycythemia, in which there is an increased hematocrit or RBC count without a true increase in the total number of body RBCs. What usually happens in these cases is a significant reduction in plasma volume due to processes such as dehydration, vomiting, diarrhea, or diuresis.

Cyanotic heart disease (choice A), via appropriate erythropoietin secretion, can cause secondary absolute polycythemia.

Increased erythropoietin (choice B), whether appropriately or inappropriately secreted, can cause secondary absolute polycythemia.

Polycythemia vera (choice C) causes primary absolute polycythemia with usually low erythropoietin levels.

Renal cell carcinoma (choice E), via inappropriate erythropoietin secretion, can cause secondary absolute polycythemia.

An elderly female with a history of alcoholic disease develops jaundice and marked anasarca. Which of the following is the most likely pathophysiology of her persistent edema?

A. Lymphatic obstruction

B. Reduced central venous pressure
C. Reduced plasma oncotic pressure

D. Sodium retention

E. Venous thrombosis

Explanation:

The correct answer is C. Hepatic failure occurring in cirrhosis reduces the capacity of the liver to synthesize sufficient quantities of plasma proteins (mostly albumin) necessary to maintain plasma oncotic pressure. Low plasma oncotic pressure allows fluid from the intravascular fluid component to move into the interstitial space, producing plasma volume contraction and edema.

Lymphatic obstruction (choice A) occurs as a result of mechanical blockage of lymphatics by tumor, inflammatory processes, or certain parasitic infections. Cirrhosis does not lead to lymphatic obstruction.

Reduced central venous pressure (choice B) does not cause edema. Conversely, increased central venous pressure, which may arise with congestive heart failure, thrombosis, or cirrhosis can lead to increased hydrostatic pressure and edema.

Sodium retention (choice D) is an important cause of edema in patients with poor renal perfusion. The kidneys respond by retaining sodium and increasing plasma volume in an effort to increase renal blood flow. Sodium retention in cirrhosis is secondary to the decrease in plasma oncotic pressure and consequent decrease in plasma volume.

Venous thrombosis (choice E) can lead to edema; however, the diminished synthesis of coagulation proteins in cirrhosis predisposes to bleeding, not thrombosis.

Physical examination of a neonate is remarkable for a holosystolic murmur. There is no cyanosis. Echocardiography demonstrates an ostium primum defect in the lower part of the interatrial septum that is accompanied by malformations of the adjacent atrioventricular valves. These lesions are most likely associated with which of the following disorders?

A. Cystic fibrosis

B. Down syndrome
C. Gaucher disease

D. Marfan syndrome

E. Turner syndrome

Explanation:

The correct answer is B. The most common type of atrial septal defect is the ostium secundum type. Children with Down syndrome, however, are frequently afflicted with the ostium primum type of atrial septal defects, which may be accompanied by tricuspid and mitral valve malformations. More complex atrioventricular septal defects may also occur in this disorder. Children exhibiting these lesions should be specifically evaluated for chromosomal abnormalities. Clinically, the lesions produce left-to-right shunts with late cyanosis (after the right ventricle hypertrophies in response to developing lung disease from the increased blood flow in the pulmonary system).

Neither cystic fibrosis (choice A) nor Gaucher disease (choice C) is specifically associated with cardiovascular defects.

Dissecting aortic aneurysm is associated with Marfan syndrome (choice D).

Turner syndrome (choice E) is associated with coarctation of the aorta.

An 18-year-old male comes to the university clinic supported by his roommates because he cannot walk. He describes a rapidly evolving weakness affecting his legs and feet starting 2 days ago. On physical examination he cannot move his feet or ankles and he can barely raise his thighs off the bed. He has symmetrical hyporeflexia of the legs, but his sensorium is completely intact. Scanning his chart, the physician notes that he was treated 10 days previously for an upper respiratory tract infection. The immunological response producing the patient's symptoms is most intense at which of the following locations?

A. Lateral corticospinal tracts

B. Neuromuscular junction

C. Precentral gyrus

D. Skeletal muscles
E. Spinal motor nerves

Explanation:

The correct answer is E. The patient has developed Guillain-Barré syndrome, also known as inflammatory polyneuropathy. This presentation is classic—rapidly evolving limb weakness with symmetrical hyporeflexia but normal sensation. The syndrome frequently follows viral infections and may evolve into complete paralysis with respiratory failure. Guillain-Barré syndrome is thought to be an autoimmune disease. The clinical course is correlated with a chronic inflammatory infiltrate and demyelination of peripheral nerves, especially spinal and cranial motor nerve roots.

Inflammation localized to a small portion of spinal cord (lateral corticospinal tracts; choice A) or cerebral cortex (precentral gyrus; choice C) may occur in progressive multifocal leukoencephalopathy (PML) or in multiple sclerosis (MS). PML occurs in the immunosuppressed, and MS presents with hyperreflexia (upper motor neuron signs).

The classic autoimmune disease involving the neuromuscular junction (choice B) is myasthenia gravis. Although the weakness caused by myasthenia gravis may affect the legs, extraocular muscles are involved in the majority of cases, and isolated limb weakness is rare.

Diseases primarily affecting the skeletal muscle (choice D) include autoimmune inflammatory myopathies such as dermatomyositis and polymyositis, which typically affect the proximal limb muscles more than the distal musculature. Inclusion body myositis is a slowly developing disease that is asymmetrical and occurs in older individuals.

A 74-year-old woman with type II diabetes mellitus, hypertension, and end-stage renal failure has been dialysis-dependent for several years. She develops a fracture of the left femoral head. Tissue taken from the fracture at the time of internal fixation is noted to have increased osteoclastic activity, with notable tunnel-like dissection by osteoclasts into the bony trabeculae. Increased levels of which of the following hormones is most likely to be responsible for this lesion?

A. Calcitonin

B. Cortisol

C. Erythropoietin
D. Glucagon

E. Parathyroid hormone

Explanation:

The correct answer is E. The patient has developed hyperparathyroidism, a well-recognized sequela of chronic renal failure. This condition is caused by high levels of serum phosphate and low serum calcium, which stimulate the release of parathyroid hormone (PTH) in an effort to normalize the calcium/phosphate ratio. PTH stimulates osteoblasts to become osteoclasts, which dissolve the bone reservoir of calcium and release it into the blood. This condition, known as renal osteodystrophy, may lead to osteomalacia and osteitis fibrosa cystica, which is classically associated with dissecting osteitis, as described in this question.

Calcitonin (choice A), which serves to lower serum calcium levels, is produced in small quantities in chronic renal failure, as serum calcium is already pathologically low.

Excess cortisol (choice B; Cushing's syndrome) may produce osteoporosis and pathologic fractures, but there is no relationship between chronic renal failure and cortisol excess. Cushing's syndrome is generally secondary to adrenal or pituitary adenomas or primary adrenal hyperfunction.

Erythropoietin (choice C) production is deficient in chronic renal failure. Excess erythropoietin activates erythrocyte precursors, but does not activate osteoclasts.

Glucagon (choice D) excess is a very rare entity, occurring in a minority of islet cell tumors, and is not associated with renal failure. High glucagon produces a transitory skin rash, anemia, and a form of diabetes mellitus.

A 25-year-old male reports episodic "spells" characterized by palpitations, sweating, nervousness, and feelings of anxiety. On examination, the man's blood pressure is 165/95 mm Hg. Plasma norepinephrine is 450 pg/mL (normal, 150-400 pg/mL), plasma epinephrine is 115 pg/mL (normal, 25-100 pg/mL), and 24-hour urinary VMA is 11 mg (normal, < 8 mg). Which of the following is the most likely cause of the patient's hypertension?

A. 11-beta-hydroxylase deficiency

B. Conn's syndrome

C. Pheochromocytoma
D. Renin-secreting tumor

E. Unilateral renal artery stenosis

Explanation:

The correct answer is C. A pheochromocytoma is a tumor arising from chromaffin cells that secretes excess catecholamines (norepinephrine, epinephrine, or both). It is one endocrine cause of hypertension, due to peripheral vasoconstriction and/or increased cardiac output. While most patients have higher than normal baseline plasma levels of catecholamines, it is not uncommon for paroxysmal symptomatic episodes to be superimposed upon the basal problem. These "attacks" may occur several times a week (or more often) and last for up to 15 minutes. During an attack, respiration can increase, the patient may become aware of a forceful pounding of the heart that progresses to include a throbbing headache, and peripheral vasoconstriction can raise body temperature and lead to reflex sweating. Marked anxiety may also accompany the episode. Diagnosis can be confirmed by measuring increased plasma or urinary catecholamines or their metabolites.

11-beta-hydroxylase deficiency (choice A) is a congenital disorder than can cause hypertension due to excessive production of the weak mineralocorticoid, deoxycorticosterone, by the inner two zones of the adrenal cortex. This results in excessive renal retention of sodium and water and subsequent hypertension. While the hypertension is usually present from birth, a late-onset variant of this disorder has been described in which the symptoms do not present until late childhood or adolescence. Virilization is also present due to excessive secretion of adrenal androgens.

Conn's syndrome (choice B) is another endocrine cause of hypertension. In this case, the increase in blood pressure is due to excessive renal retention of sodium and water resulting from the increased plasma concentration of aldosterone. The paroxysmal symptoms and increased catecholamines present in this patient are not present with primary hyperaldosteronism.

Renin-secreting tumors (choice D) are rare and can be confused with primary hyperaldosteronism. The excessive secretion of renin by the tumor can increase the formation of angiotensin II with subsequent hyperaldosteronism. Sodium and water retention, together with hypokalemia, are present. Increased plasma renin and plasma aldosterone are suggestive of a renin-secreting tumor, whereas primary hyperaldosteronism would present as increased plasma aldosterone, but decreased plasma renin.

Unilateral renal artery stenosis (choice E) produces an angiotensin II-dependent form of hypertension. Decreased renal perfusion, often due to atherosclerosis or fibromuscular hyperplasia of the renal arteries, results in increased renin secretion and subsequently increased plasma angiotensin II. The resultant increase in aldosterone secretion and arteriolar vasoconstriction contributes to the hypertension.
A 74-year-old woman, in otherwise good health, tripped and injured her right leg 2 days previously and has been bedridden since the accident. Two hours ago, she became delirious. On physical examination, her temperature is 99 F, blood pressure is 120/70 mm Hg, heart rate is 110, and respiratory rate is 32. Pulse oximetry shows an oxygen saturation of 80%, and a chest x-ray film is normal. Which of the following is the most likely diagnosis?

A. Acute cerebral hemorrhage

B. Acute cerebral infarction

C. Myocardial infarction

D. Pulmonary infarction

E. Pulmonary thromboembolism

Explanation:

The correct answer is E. Hip fracture and prolonged bed rest are classic risk factors for the development of pulmonary thromboemboli (PE). Common clinical manifestations of PE are hypoxia (due to ventilation/perfusion mismatch) despite a normal chest x-ray, tachycardia, and delirium in older patients.

Cerebral hemorrhage (choice A) might cause delirium but would not directly cause hypoxia unless the patient was hypoventilating (e.g., because of brainstem involvement).

Cerebral infarction (choice B) could produce delirium but would not directly cause hypoxia unless the patient was hypoventilating.

Myocardial infarction (choice C) could account for delirium and tachycardia, but not for hypoxia with a normal chest x-ray. Severe congestive heart failure after myocardial infarction could cause hypoxia due to pulmonary edema, but the chest x-ray would not be normal.

Pulmonary infarction (choice D) may cause delirium, tachycardia, and hypoxia, but the chest x-ray may be abnormal. A chest x-ray performed within 12-36 hours after a pulmonary infarct may reveal a peripherally located, wedge-shaped infiltrate.
A 26-year-old woman with sickle cell anemia develops pneumonia, and as a complication, develops very painful focal ischemia in the muscles and joints. Which part of the renal vasculature would be most vulnerable to similar damage during this sickle cell crisis?

A. Arcuate arteries

B. Glomerular capillaries

C. Interlobular arteries

D. Renal artery

E. Vasa recta

Explanation:

The correct answer is E. Sickling crises can be triggered by hypoxia caused by high altitude or pneumonia. The very high osmolarity of the renal medulla particularly favors sickling of erythrocytes in the vasa recta. The resultant ischemia can cause a patchy papillary necrosis, proteinuria, and sometimes, cortical scarring.

Larger blood vessels such as the arcuate arteries (choice A), interlobar arteries (choice C), and renal arteries (choice D) are usually not occluded by sickled cells.

The glomerular capillaries (choice B) are small enough to be occluded by sickled cells, but they are well oxygenated and the blood within them is not hypertonic, so the glomerular capillaries are significantly less likely to become occluded then the vasa recta.

In retinitis pigmentosa, "night-blindness" is an early symptom of visual loss. Which of the following explains this phenomenon?

A. Cones are relatively preserved compared to ganglion cells

B. Cones are relatively preserved compared to rods

C. Ganglion cells are relatively preserved compared to cones
D. Ganglion cells are relatively preserved compared to rods

E. Rods are relatively preserved compared to cones

Explanation:

The correct answer is B. Retinitis pigmentosa is a familial degenerative disease of the retina that most often has recessive genetics. The initial problem appears to be alterations in the pigmented epithelium below the retina, particularly in the most anterior portions of the retina. The pigmented epithelial cells become disrupted and leak pigment, which accumulates along the attenuated blood vessels (and can be seen with an ophthalmoscope). A consequence of this damage is that the rod cells that are normally nutritionally supported and "groomed" by the pigment epithelium also undergo degenerative changes. Since the cones are relatively preserved, day vision is preserved, but night vision, which is highly dependent on rods, begins to decay. With disease progression, vision is completely or nearly completely lost and the retina becomes so distorted that only a single row of cone nuclei with scattered stumpy cone remnants is all that remains of the photoreceptor layer.

A 32-year old women complains of amenorrhea since delivery of a baby 15 months previously, despite the fact that she did not breast feed her baby. The delivery was complicated by excessive hemorrhage that required transfusion of 2.5 liters of blood. She has also been fatigued and has gained an additional 10 pounds since the baby was born. Laboratory data show the following:

Serum LH < 1 IU/L (normal, 4-24 IU/L)

Serum estradiol 5 pg/mL (normal, 20 - 100 pg/mL)

Serum TSH 0.1 mU/L (normal, 0.5 - 5 mU/L)

Serum GH 3 ng/mL (normal, < 5 ng/mL)

Serum ACTH 28 pg/mL (normal, 10 - 50 pg/mL)

Serum prolactin 2 ng/mL (normal, <20 ng/mL)

Injection of 500 µg of TRH failed to produce the expected rise in both serum TSH and prolactin. Which of the following diagnoses most likely explains the findings in this patient?
A. Hashimoto's thyroiditis

B. Isolated gonadotropin deficiency

C. Primary amenorrhea

D. Prolactinoma

E. Sheehan's syndrome

Explanation:

The correct answer is E. Sheehan's syndrome is hypopituitarism due to ischemic damage to the pituitary resulting from excessive hemorrhage during parturition. The pituitary is enlarged during pregnancy; it is more metabolically active, and more susceptible to hypoxemia. Furthermore, the blood vessels in the pituitary may be more susceptible to vasospasm because of the high estrogen. In about 30% of women who hemorrhage excessively during parturition, some degree of hypopituitarism eventually becomes manifest. The symptoms depend on how much of the pituitary is damaged and what cell types are destroyed. The patient described above exhibited persistent amenorrhea after delivery of her infant. This is due to destruction of pituitary gonadotrophs and diminished secretion of gonadotropins (LH). There also appears to have been significant destruction of lactotrophs since TRH injection failed to induce an increase in prolactin. Had the women attempted to breast-feed her infant, a failure to lactate mostly likely would have occurred. This case is also characterized by secondary hypothyroidism. The low TSH and failure to respond to TRH injection is confirmatory. Corticotrophs appear to have been spared since plasma ACTH is normal. It is not clear whether somatotrophs were damaged. Further testing would be needed to see if GH reserve is diminished.

Hashimoto's thyroiditis (choice A) is an autoimmune disorder that produces primary hypothyroidism. Because of diminished negative feedback effects of T4, serum TSH is usually increased (not decreased).

Isolated gonadotropin deficiency (choice B) produces amenorrhea and is associated with low serum LH and estradiol. Hypogonadotropic hypogonadism can occur in female athletes that over-train, in anorexia nervosa, in obesity, or with other emotional or physical stresses. However, other pituitary hormones are unaffected (by definition isolated gonadotropin deficiency only involves a decrease in gonadotropins).

Primary amenorrhea (choice C), by definition, means failure of menstrual cycles to ever begin. Since this woman has delivered a baby, primary amenorrhea is highly unlikely.

A prolactinoma (choice D) is a functional pituitary tumor that secretes excessive prolactin. This can cause amenorrhea by suppressing the GnRH-pituitary-gonad axis. The patient described above has decreased prolactin secretion.
A 40-year-old man presents to his physician with complaints of substernal pain radiating to his left shoulder, occurring when he is at rest. The pain improves when he gets up and moves around, and responds to sublingual nitroglycerin. This patient's symptoms are thought to be caused by which of the following processes?

A. Coronary artery atherosclerosis
B. Coronary artery embolism
C. Coronary artery spasm
D. Coronary artery thrombosis
E. Coronary artery vasculitis

Explanation:

The correct answer is C. The pattern of angina described is called Prinzmetal's variant angina, and is believed to be due to coronary artery spasm occurring during rest. Up to 75% of patients with this disorder can be shown to have a fixed obstruction within 1 cm of the site of arterial spasm. Patients with Prinzmetal's angina are often younger than patients with unstable angina secondary to coronary atherosclerosis. The diagnosis may be confirmed by observing a spontaneous coronary artery spasm (or provoking one by administering ergonovine or acetylcholine, or instructing the patient to hyperventilate) during angiography.

Atherosclerosis (choice A) is the cause of typical angina that occurs with exertion.

Embolism (choice B) in the coronary arteries is somewhat unusual, but can occur if a plaque from the aorta breaks off and lodges in a coronary vessel.

Thrombosis (choice D) characteristically produces unstable or crescendo angina with worsening chest pain.

Vasculitis (choice E) can uncommonly cause angina, notably as part of Kawasaki's disease.

A 21-year-old woman attempted suicide by taking an overdose of barbiturates. On arrival in the emergency department, her blood pressure is 95/65 and her pulse is 105 per minute. The physician in the intensive care
unit orders arterial blood gases. Which of the following values would you expect in this patient?

A. PO2 = 45, PCO2 = 45, pH = 7.45
B. PO2 = 55, PCO2 = 70, pH = 7.50
C. PO2 = 65, PCO2 = 35, pH = 7.45
D. PO2 = 75, PCO2 = 60, pH = 7.30
E. PO2 = 98, PCO2 = 60, pH = 7.20

Explanation:

The correct answer is D. Barbiturate overdose causes respiratory depression, resulting in carbon dioxide retention (producing increased PCO2 and decreased pH) and hypoxemia (decreased PO2). In other words, the patient has respiratory acidosis. You should look for a low PO2, high PCO2, and acidotic pH. Choices A, B, C, and E do not fulfill these requirements. Note that choice C might be expected in a patient who is hyperventilating to the point of respiratory alkalosis: diminished O2 (the usual drive for hyperventilation in nonpsychiatric hyperventilation), diminished CO2, and mildly alkalotic pH.

A baby is born prematurely at 28 weeks gestational age with a birthweight of 1200 g. Ventilation with high partial pressures of oxygen is started, but the neonatologist is concerned about the possible development of retinopathy of prematurity (formerly called retrolental fibroplasia). What is the underlying mechanism by which this retinal lesion may develop?

A. Ganglion cell degeneration
B. Inappropriate vascular proliferation
C. Optic nerve degeneration
D. Pigment deposition in retina
E. Pigmented epithelium degeneration
The correct answer is B. The underlying lesion in retinopathy of prematurity (retrolental fibroplasia) is an inappropriate proliferation of vessels in the inner layers of the retina. If the process is disrupted early, the retina may heal with little residual damage. However, persistence of the process predisposes for permanent damage due to exudation, hemorrhage, and secondary detachment of the retina.

Ganglion cell and optic nerve degeneration (choices A and C) are features of retinal damage due to glaucoma.

Pigment deposition in the retina (choice D) is unrelated to retinopathy of prematurity.

Pigmented epithelium degeneration (choice E) is a feature of retinitis pigmentosa and also of senile macular degeneration.

A 45-year-old male complains of fatigue and increased frequency of urination. Questioning reveals that he is somewhat confused. Physical examination reveals a 5'10", 240 lb. individual whose fat is centrally distributed. Urine is positive for glucose, but negative for ketones. A blood sample drawn from this patient is likely to exhibit which of the following compared to that of a normal individual?

A. Decreased concentration of C-peptide

B. Decreased pH

C. Increased antibodies against islet cell proteins

D. Increased concentration of β-hydroxybutyrate

E. Increased osmolarity

The correct answer is E. An obese adult with glucosuria, but not ketonuria, likely has type 2 diabetes mellitus. Type 2 diabetes is characterized by insulin resistance resulting in hyperglycemia and increased serum osmolarity. The dehydration associated with osmotic diuresis makes the hyperosmolarity worse. As the osmolarity increases above 330 mOsm/L, the osmotic loss of water from neurons is sufficient to produce coma. In nonketotic, hyperosmolar coma, blood glucose values can range from 800 to 2,400 mg/dL and produce
serum osmolarities of 330-440 mOsm/L.

Since type 2 diabetes is due to insulin resistance, plasma levels of insulin are usually normal to increased. Because &beta; cells secrete insulin and C-peptide in a 1:1 ratio, plasma concentration of C-peptide would also be normal to increased (not decreased, choice A) in type 2 diabetes.

Even small amounts of insulin are sufficient to prevent ketosis. In type 2 diabetes there is enough insulin effect to prevent significant lipolysis and subsequent formation of excess ketone bodies. Hence, acidosis (choice B) is not typically associated with this disorder. Since &beta;-hydroxybutyrate is a ketone body, its concentration in plasma is not likely to be increased (choice D).

While there is a significant autoimmune component to type 1 diabetes, type 2 diabetes is not associated with increased circulating antibodies (choice C) against &beta; cell proteins such as glutamic acid decarboxylase.

A 7-year-old child is brought to the pediatrician because of increased thirst and bed-wetting. Despite an increased appetite, she has lost 5 pounds over the past month. A dipstick test of a urine sample reveals the presence of glucose. A blood sample drawn from this patient is most likely to exhibit which of the following compared to that of a normal individual?

A. Decreased concentration of &beta;-hydroxybutyrate

B. Decreased concentration of hemoglobin A1c

C. Decreased osmolarity

D. Increased antibodies against glutamic acid decarboxylase (GAD)

E. Increased concentration of C-peptide

Explanation:

The correct answer is D. A child with glucosuria, polyuria, polydipsia, and weight loss despite increased appetite is likely to have type 1 diabetes mellitus. This form of diabetes has an important autoimmune component to its etiology. As many as 85% of patients have islet cell autoantibodies in their blood in the first few weeks after onset of the disease. Most of these antibodies are directed against glutamic acid decarboxylase, an enzyme that is present in &beta; cells.
The insulin deficiency associated with autoimmune destruction of the β cells leads to increased breakdown of triglycerides with a consequently increased rate of formation of ketone bodies. The primary ketone body produced is β-hydroxybutyrate (choice A), the blood level of which is increased (not decreased) in type 1 diabetes. If untreated, type 1 diabetes can rapidly progress to ketoacidosis and coma.

Insulin deficiency leads to decreased glucose uptake and hyperglycemia. The increase in blood glucose results in increased glycosylation of hemoglobin in red blood cells. Hence, the hemoglobin A1c concentration will be increased, not decreased (choice B), reflecting long-standing hyperglycemia.

Another consequence of the increased blood glucose is increased serum osmolarity (not decreased, choice C). If the osmolarity exceeds 330 mOsm/L, consciousness begins to be impaired.

β cell destruction in type 1 diabetes leads to decreased secretion of insulin. Since insulin and C-peptide are released on a 1:1 ratio by the β cells, the secretion of C-peptide is also decreased (not increased, choice E). Insulin is first synthesized as preproinsulin, with an initial leader sequence of hydrophobic amino acids that allows the developing protein to be extruded from the ribosomes into the rough endoplasmic reticulum. The "pre" segment is then cleaved off, leaving proinsulin. Proinsulin is packaged into secretory granules within the Golgi, and as the granules bud off, enzymes cleave the precursor into insulin and C-peptide.

A 67-year-old man presents to his doctor's office for an insurance physical. During blood pressure measurement, the nurse notes that systolic sounds are heard with the cuff completely deflated. The blood pressure is 180/60 mm Hg. Physical examination reveals bounding pulses and a high-pitched, blowing diastolic murmur, heard best along the left sternal border. Which of the following is the most likely diagnosis?

A. Aortic regurgitation
B. Aortic valve obstruction
C. Cardiac tamponade
D. Heart failure
E. Hypovolemia

Explanation:

The correct answer is A. The case described is typical for aortic regurgitation. In aortic regurgitation, blood
flows backward through the aortic valve during diastole when the valve is closed. The arterial pulse pressure is widened, often to over 100 mm Hg (normal pulse pressure is 30 to 50 mm Hg), and in extreme cases the systolic pressure can be elevated to over 250 mm Hg with a depression in the diastolic pressure. Note that the pulse pressure is 180-60 = 120 mm Hg in this case. The aortic pressure falls greatly during diastole because blood from the aorta regurgitates backward into the ventricle through the leaky aortic valve. The increase in systolic pressure most likely results from the large increase in stroke volume, which is secondary to an increase in the end diastolic volume. The diastolic murmur of aortic regurgitation is typically a high-pitched, blowing, decrescendo murmur, best heard along the left sternal border over the third intercostal space.

The pulse pressure is decreased in aortic valve obstruction (choice B), cardiac tamponade (choice C), heart failure (choice D), and hypovolemia (choice E).

A 46-year-old woman presents to her doctor complaining of weakness and fatigue. On physical examination, her physician notices a 10-pound weight gain since her last visit 6 months ago. Her blood pressure is 160/100 mm Hg. Blood tests reveal serum Na+ 155 mEq/L, K+ 2.8 mEq/L, and a decreased serum renin. Which of the following is the most likely diagnosis?

A. Cushing's syndrome
B. Diabetes mellitus
C. Pheochromocytoma
D. Primary aldosteronism
E. Secondary aldosteronism

Explanation:

The correct answer is D. Primary aldosteronism (Conn's syndrome) is a condition of hyperaldosteronism originating in the adrenal gland. The causes include an aldosterone-secreting adrenocortical adenoma, hyperplasia of the zona glomerulosa, and very rarely, an adrenal carcinoma. It is characterized by hypertension secondary to sodium retention, hypokalemia, and a decreased serum renin due to a negative feedback of increased blood pressure on renin secretion.

Cushing's syndrome (choice A) is the result of increased glucocorticoid production, particularly cortisol. Physical signs typically include "moon facies," truncal obesity, "buffalo hump," and purple abdominal striae.
Diabetes mellitus (choice B) is a condition of inadequate insulin production that presents with hyperglycemia and ketoacidosis.

Pheochromocytoma (choice C) is a rare tumor of chromaffin cells occurring most commonly in the adrenal medulla. The tumor secretes epinephrine and norepinephrine, resulting in secondary hypertension.

Secondary aldosteronism (choice E) results from an activation of the renin-angiotensin system caused by renal ischemia, edema, and renal tumors. In contrast to primary aldosteronism, secondary aldosteronism is associated with increased serum renin.

A 65-year-old man with hyperlucent lung fields develops extreme shortness of breath over a period of about 15 minutes. Chest x-ray shows a shift of the mediastimum to the right, and the lung field on the left appears even more hyperlucent than before, with the exception of a white shadow near the heart border. Which of the following is the most probable cause of the patient's current problem?

A. Bronchogenic carcinoma
B. Pleural effusion
C. Pulmonary embolism
D. Rupture of an emphysematous bulla
E. Tuberculosis

Explanation:

The correct answer is D. The patient's initial hyperlucent lung fields strongly suggest the presence of emphysema. The radiologic findings after the increase in shortness of breath are consistent with free air in the chest, which has collapsed the left lung and caused a shift in the location of the mediastinum. Such air might have been introduced by rupture of a bulla. Small pneumothoraces are usually well tolerated, but larger ones may require decompression (the needle from a syringe is sometimes used), or even surgical correction if bullae continue to leak air.

Bronchogenic carcinoma (choice A) would be expected to produce a mass lesion.
Pleural effusion (choice B) usually develops slowly, and causes a whitening of lung fields when fluid is present.

Pulmonary embolism (choice C) can cause a sudden shortness of breath, but would not cause an increase in the lucency of the lung fields.

Tuberculosis (choice E) would be expected to produce a mass lesion in the lung.

A 2-year-old infant with uncomplicated coarctation of the aorta appears to be in good health. Growth and development are normal. The constriction is located just distal to the subclavian arteries. Which of the following is decreased in this patient?

A. Blood flow in the upper body
B. Blood flow in the lower body
C. Blood pressure in the upper body
D. Vascular resistance in the upper body
E. Vascular resistance in the lower body

Explanation:

The correct answer is E. In fully compensated aortic coarctation, blood flow is normal in the upper and lower body (choices A and B) despite an increased arterial pressure (about 50% higher) in the upper body (choice C) compared to the pressure in the lower body. Because resistance = pressure/blood flow, it is clear that resistance must be lower in the lower portions of the body. The mechanism of this decrease in resistance below the constriction (and increased resistance above the constriction) is autoregulation of blood flow. The small arteries and arterioles dilate (or constrict) in accordance with the metabolic needs of the tissues ensuring that each tissue receive an adequate amount of blood flow. Thus, the increase in blood pressure in the upper body leads to constriction of the arterioles, which increases vascular resistance (choice D), and the lower pressure below the coarctation leads to dilation of the arterioles, which decreases vascular resistance in the lower body.

In which of the following conditions would oxygen therapy be most effective in alleviating hypoxia?
A. Anemia due to blood loss

B. Edematous tissues

C. Emphysema

D. Localized circulatory deficiencies

E. Right-to-left cardiac shunts

Explanation:

The correct answer is C. Chronic pulmonary emphysema is characterized by distention of small air spaces distal to the respiratory bronchioles and destruction of alveolar septa. Long-term cigarette smoking is the usual cause. The marked loss of lung parenchyma associated with emphysema leads to a decrease in the diffusion capacity of the lungs, which reduces their ability to oxygenate blood and remove carbon dioxide. When arterial hypoxemia is persistent and severe, oxygen therapy should therefore be considered.

Oxygen therapy is less effective for treating the hypoxia associated with anemia (choice A), edematous tissues (choice B), localized circulatory deficiencies (choice D), and right-to-left cardiac shunts (choice E), because in each case, there is already adequate oxygen available in the alveoli. The problem in each of these situations is inadequate transport of oxygen to the tissues, blunting the effects of increasing the oxygen tension of the inspired air. Oxygen therapy will nonetheless increase the amount of dissolved oxygen carried in the blood, which may be life-saving in some instances.

A middle-aged woman comes to her physician's office with complaints of visual difficulties. A review of systems and physical examination are unremarkable except for her eye exam. When a light is shined in her right eye, there is no pupillary response in either eye. However, upon shining a light in her left eye, both ipsilateral and contralateral pupillary responses are apparent. Her extraocular movements are intact. What is the most likely location of her lesion?

A. Oculomotor nerve, left side

B. Oculomotor nerve, right side

C. Optic nerve, left side
D. Optic nerve, right side

E. Trochlear nerve, left side

F. Trochlear nerve, right side

Explanation:

The correct answer is D. Know your cranial nerves! This woman has a "Marcus-Gunn pupil," with a defect in the afferent pathway of the optic nerve (in this case on the right side). Recall that the afferent limb of the pupillary light reflex is the optic nerve (CN II); the efferent limb is the oculomotor nerve (CN III; parasympathetic fibers). When light is shined into her right eye, because her right optic nerve is not functioning properly, the light signal is not transmitted to the CNS, resulting in no pupillary response. As light is shined into her left eye, the left optic nerve transmits the signal to the CNS, which then sends an outbound signal through both the right and left oculomotor nerves to cause pupillary constriction in both eyes.

The oculomotor nerve (choices A and B) innervates all extraocular muscles except the lateral rectus (innervated by the abducens nerve), and the superior oblique (innervated by the trochlear nerve; choices E and F). The oculomotor nerve also mediates pupillary constriction (parasympathetic fibers), eyelid opening (levator palpebrae), and innervates the ciliary muscle (allowing accommodation).

A patient with a lesion of the left optic nerve (choice C) would have no pupillary responses in either eye when shining a light in the left eye; pupillary responses would be present in both eyes when shining a light in the right eye.

On a routine physical examination for medical insurance, a midsystolic ejection murmur is detected in the pulmonic area of a 35-year-old female executive. The cardiac examination also revealed a prominent right ventricular cardiac impulse and wide and fixed splitting of the second heart sound. An EKG showed a right axis deviation and chest x-ray showed enlargement of the right ventricle and atrium. Which of the following is the most likely diagnosis?

A. Aortic stenosis

B. Atrial septal defect

C. Mitral regurgitation
D. Mitral stenosis

E. Pulmonary valve stenosis

Explanation:

The correct choice is B. The classic findings in atrial septal defect are a prominent right ventricular cardiac impulse, a systolic ejection murmur heard in the pulmonic area and along the left sternal border, and fixed splitting of the second heart sound. These findings are due to an abnormal left to right shunt through the defect, creating a volume overload on the right side. The increase in volume on the right side creates the flow murmur, the dilatation of the right-sided chambers, and the delayed closure of the pulmonic valve, all of which are present in this case.

Aortic stenosis (choice A) is also associated with a systolic ejection murmur. The murmur is usually loudest at the right sternal border and radiates upward to the jugular notch. This condition is associated with left ventricular hypertrophy.

Mitral regurgitation (choice C) would present with a systolic murmur as well. However, left atrial enlargement would be seen before right ventricular enlargement.

Mitral stenosis (choice D) would present with an "opening snap" and a diastolic murmur.

Pulmonary valve stenosis (choice E) causes an increase in right ventricular pressure resulting in right ventricular hypertrophy and pulmonary artery dilatation. A crescendo-decrescendo murmur may be heard if the stenosis is severe. Right atrial enlargement would not be present.

During a boxing match, a contestant is "knocked out" by a blow to the lateral skull. He recovers after a few minutes, and is asymptomatic for the next 12 hours. He then develops a severe headache, changes in mental status, nausea, and vomiting. Which of the following is the most likely diagnosis?

A. Basilar skull fracture

B. Epidural hemorrhage

C. Intracerebral hemorrhage

D. Subarachnoid hemorrhage
E. Subdural hematoma

Explanation:

The correct answer is B. All of the lesions listed in the answers can occur in brain trauma. However, the scenario described is classic for epidural hemorrhage. In this scenario, a severe blow to the lateral skull causes both skull fracture and laceration of the middle meningeal artery (know the name of this artery, as it is frequently tested), leading to a momentary loss of consciousness, which is followed by a lucid (asymptomatic) period of 1-48 hours before the patient's neurologic condition deteriorates. This scenario is frequently tested in examinations, but you should be aware that in real clinical life, there may be no initial loss of consciousness and the patient may not have sought medical help for skull trauma.

Basilar skull fractures (choice A) are usually located in the vicinity of the petrous bone or along the sphenoid bone. Clinical signs of basilar skull fracture include hemotympanum (blood visible behind the tympanic membrane), delayed ecchymosis over the mastoid process (Battle's sign), or periorbital ecchymosis (“raccoon sign”). CSF leakage (sometimes from the nose), or pneumocephalus may also occur.

Intracerebral hemorrhage (choice C) is most often due to hypertension, anticoagulant use, cerebral amyloid angiopathy, or cocaine and/or methamphetamine abuse.

Subarachnoid hemorrhage (choice D) is most commonly caused by rupture of a cerebral berry aneurysm, but may also be associated with arteriovenous malformations or intraparenchymal hemorrhage.

Subdural hematomas (choice E) are due to rupture of the bridging veins between the periosteal dura and the superficial cerebral veins. Blood accumulates below the dura, producing symptoms of increased intracranial pressure in minutes to hours (acute subdural hematomas), or after weeks or months (chronic subdurals, often seen in the elderly). An acute subdural may present like an epidural hemorrhage, but a forceful blow to the lateral skull producing skull fracture is generally associated with an epidural, rather than a subdural, bleed.

A 77-year-old black male is recovering in a rehabilitation center 10 days after having sustained a massiveanterolateral infarction of the left ventricle. He suddenly develops paralysis of the entire right half of the body, including facial and eye muscles. Which of the following complications of myocardial infarction is most likely to have precipitated this event?

A. Calcific coronary atherosclerosis
B. Electromechanical dissociation

C. Left bundle branch block

D. Myocardial rupture

E. Ventricular mural thrombus

Explanation:

The correct answer is E. This patient has suffered a cerebrovascular accident as a consequence of thromboemboli emanating from a mural thrombus formed over the recent myocardial infarction. Mural thrombus frequently develops over a previously infarcted segment of myocardium, especially when the infarction is large and a ventricular aneurysm develops. Ischemic damage to the endocardium, soluble factors released by the injured myocardium, and altered wall kinetics that produce sluggish blood flow all favor mural thrombus formation. One important consequence of a mural thrombus is thromboembolism to the systemic circulation, producing a stroke, as in this patient's case.

Calcific coronary atherosclerosis (choice A) is very likely responsible for the patient's original myocardial infarction. Coronary atherosclerosis is not a consequence of myocardial infarction, and it does not directly predispose to the development of embolic strokes. Complicated atherosclerotic lesions in the carotid or cerebral circulation, however, may directly lead to a cerebrovascular accident.

Electromechanical dissociation (EMD; choice B) is a catastrophic event that frequently leads to sudden death, not stroke. In EMD, although a normal potential is transmitted through the myocardium, no pulse of arterial blood is sent to the systemic circulation. EMD may occur as a consequence of pericardial tamponade, massive pulmonary embolism, or myocardial toxins that prevent normal cardiac muscle contraction.

Left bundle branch block (choice C) represents failure of electrical transmission along the Purkinje fibers to the left ventricular myocardium. Bundle branch blocks are important causes of arrhythmia, but are not responsible for cerebrovascular accidents.

Myocardial rupture (choice D) is an infrequent consequence of myocardial infarction that typically occurs approximately 1 week after the infarction. If scarring of the infarcted segment does not keep pace with necrosis and digestion of the infarcted tissue, the myocardium can rupture under the high intraventricular pressures, and pericardial tamponade generally ensues. Myocardial rupture rapidly leads to acute heart failure, not stroke.
Pulmonary artery pressure:
22/7 mm Hg
Pulmonary wedge pressure:
10 mm Hg
Left ventricular pressure:
170/5 mm Hg
Aortic pressure:
120/80 mm Hg

A 50-year-old male complaining of chest pain is admitted to the emergency room. He is taken to the cardiac catheterization laboratory on the same day. Selected pressures are shown above. What is the most likely diagnosis?

A. Aortic regurgitation
B. Aortic stenosis
C. Mitral regurgitation
D. Mitral stenosis

Explanation:
The correct answer is B. This patient has aortic stenosis. In aortic stenosis, the blood is ejected from the left ventricle through a smaller-than-normal opening. Because the resistance to ejection of blood is high, the left ventricular pressure can sometimes increase to over 250 mm Hg with normal systolic pressure in the aorta. Note that in this patient, the left ventricular peak systolic pressure has increased to 170 mm Hg, the aortic systolic pressure is normal at 120 mm Hg, and a 50 mm Hg gradient exists across the aortic valve during systole.

In aortic regurgitation (choice A), blood flows backward through the aortic valve during diastole when the valve is closed. Left ventricular systolic pressure and aortic systolic pressure are nearly the same with pure aortic regurgitation.

Mitral regurgitation (choice C) means there is backward flow of blood through the mitral valve during systole. This accumulation of extra blood in the left atrium during ventricular systole leads to an elevation in the pulmonary wedge pressure (which is used as an estimate of left atrial pressure).
In mitral stenosis (choice D), blood must flow from the left atrium into the left ventricle through a smaller-than-normal opening. Because the resistance to blood flow through the mitral valve is higher than normal, the left atrial pressure (estimated by the pulmonary wedge pressure) is often several mm Hg higher than the left ventricular end diastolic pressure.

A 63-year-old man with essential hypertension has gone several weeks without taking his medications. He arrives at the emergency room with a severe laceration on his right hand after falling on a broken beer bottle. He has a heart rate of 90 beats per minute and a blood pressure of 170/115. Which of the following is most likely to be decreased in the skeletal muscles of his legs?

A. Adenosine levels
B. Arterial blood pressure
C. Arteriolar resistance
D. Blood flow
E. Venous oxygen concentration

Explanation:

The correct answer is A. The skeletal muscles of the body have a normal blood flow even when blood pressure is chronically elevated. Organs and tissues in which the vasculature has primarily a nutritive function (e.g., brain, heart, and skeletal muscle) regulate their blood flow in accordance with the metabolic needs of the tissues. These tissues exhibit short-term autoregulation of blood flow such that the increase in flow caused by an elevated arterial pressure is minimized by constriction of the arterioles. The constriction is caused in part by decreased levels of adenosine (an endogenous vasodilator) in the tissues. The rate of adenosine production in a tissue is a function of its metabolic rate, which is not affected significantly by an increase in systemic pressure. When blood flow to the muscle increases, the adenosine is literally washed from the muscle, lowering the tissue levels of adenosine. The decrease in adenosine concentration causes small arteries and arterioles in the muscle to constrict and this increase in resistance (choice C) maintains blood flow (choice D) at a normal rate in the face of increased arterial pressure (choice B). The overall process is called autoregulation of blood flow.

Venous oxygen concentration (choice E) does not decrease in the skeletal muscles of hypertensives because blood flow is maintained at an adequate level to meet the nutritional demands of the muscles.
Which of the following conditions would mostly likely be associated with chronic gastritis (Type A) resulting from autoimmune destruction of parietal cells?

A. Decreased growth of luminal bacteria
B. Decreased likelihood of developing gastric carcinoma
C. Decreased plasma concentration of gastrin
D. Increased production of macrocytic red blood cells
E. Increased secretion of pancreatic bicarbonate

Explanation:

The correct answer is D. Autoimmune destruction of parietal cells would lead to decreased secretion of gastric acid and intrinsic factor. The diminished availability of intrinsic factor would result in poor absorption of dietary vitamin B12. Over time, the vitamin B12 deficiency could lead to pernicious anemia, which is characterized by increased production of macrocytes (megaloblasts) by the bone marrow.

Because of the decrease in gastric acid secretion, luminal bacteria (choice A) would most likely exhibit increased (not decreased) growth. One of the functions of HCl secreted by the parietal cells is to sterilize the gastric lumen.

Patients with Type A gastritis have an increased likelihood of developing gastric carcinoma (not decreased, choice B).

A decrease in acid secretion leads to increased secretion of gastrin (not decreased, choice C) by antral G cells. This is because low gastric pH (less than 3) inhibits gastrin secretion via paracrine release of somatostatin from cells in the gastric mucosa that can sense the acidity. With decreased parietal cells, the pH of the gastric lumen would rise and remove this inhibitory component.

Because less acid would be delivered to the duodenum with parietal cell destruction, less secretin would be released into the blood. This would result in decreased pancreatic bicarbonate secretion (not increased, choice E).
A 55-year-old hypertensive man develops sudden onset of excruciating pain beginning in the anterior chest, and then radiating to the back. Over the next 2 hours, the pain moves downward toward the abdomen. Which of the following is the most probable diagnosis?

A. Aortic dissection
B. Aortic valve stenosis
C. Atherosclerotic aneurysm
D. Myocardial infarction
E. Syphilitic aneurysm

Explanation:

The correct answer is A. This patient has an aortic dissection (formerly called dissecting aneurysm), a potentially fatal condition that is too often confused clinically with myocardial infarction. The most important clinical clue is that the pain shifts with time. Non-invasive techniques such as transesophageal echocardiography, computed tomography (CT), and magnetic resonance imaging (MRI) are increasingly useful in making this diagnosis.

Aortic valve stenosis (choice B) would not be expected to produce severe chest pain of acute onset.

This patient's clinical history does not suggest either an atherosclerotic (choice C) or a syphilitic (choice E) aneurysm. Even if he had one of these types of aneurysms and it had begun to rupture, the distinctive feature of severe pain moving downward would probably not be present.

Myocardial infarction (choice D) is the major diagnosis most often confused with this patient's condition. The movement of the pain is the major clinical tip-off suggesting that this is not the correct answer.

A neurologist gives a car accident victim a neurological examination. As part of the examination, he presents the patient with a picture of a dog and asks her to talk about it. She seems unable to name or recognize the picture. He then asks her to copy a picture of the dog, which she is able to do, although she still is unable to identify the animal as a dog. Which of the following is the most appropriate diagnosis?
A. Agnosia

B. Alexia

C. Aphasia

D. Apraxia

E. Dyslexia

Explanation:

The correct answer is A. Agnosia is the inability to recognize, despite adequate sensation. This patient has a type of agnosia known as visual agnosia, which is the inability to recognize familiar objects despite the ability to see. The fact that she could copy a picture of the dog indicates that she has adequate visual acuity, visual fields, and perception. If this patient had only visual agnosia, if she were to hear a dog bark (auditory) or pet a dog (tactile), then she would be able to recognize and name the dog. Prosopagnosia is a special type of visual agnosia in which a person is unable to recognize faces. There are also other types of agnosias, including auditory and tactile agnosias.

Alexia (choice B) is an acquired reading disorder due to brain damage. People with this disorder can comprehend words that are spelled out loud, and can understand words and letters that are written on the palm, but they cannot read.

Aphasia (choice C) is an acquired disorder of language due to brain damage. Examples are Broca's aphasia and Wernicke's aphasia.

Apraxia (choice D) is the loss of the ability to carry out certain movements correctly in response to stimuli that normally elicit them. This occurs even though the patient has no sensory loss, no weakness, and no disturbance of language comprehension.

Dyslexia (choice E) is a developmental reading disorder.

A 62-year-old man is admitted to the hospital because of symptoms of congestive heart failure, which have been present for the past few years. Fifteen years before admission, the man sustained a knife wound to the left supraclavicular area. Physical examination reveals signs of a large, left subclavian arteriovenous fistula. Which of the following is expected to be present in this man?
A. Decreased heart rate

B. Decreased stroke volume

C. Decreased mixed venous oxygen content

D. Increased resting cardiac output

E. Increased diastolic blood pressure

F. Increased systemic vascular resistance

Explanation:

The correct answer is D. Increased cardiac output can be demonstrated when there is a large fistula that involves a major artery such as the aorta, subclavian artery, femoral artery, common carotid artery, or iliac artery. The increase in cardiac output caused by the fistula is roughly equal to the blood flow through the fistula.

The increase in cardiac output is associated with increases in both heart rate (choice A) and stroke volume (choice B).

The mixed venous oxygen content (choice C) is increased because oxygenated arterial blood flows through the fistula into the venous system.

The diastolic blood pressure (choice E) falls because blood can rapidly exit the arterial system through the fistula, but mean blood pressure is maintained relatively constant secondary to increased blood volume caused by renal retention of salt and water.

Because blood is shunted from an artery to a vein through a low resistance pathway, the systemic vascular resistance (choice F) is decreased.

A couple presents to a clinic for work-up of infertility after 5 years of unprotected intercourse. The wife denies any medical problems and notes regular menstrual cycles. The husband states that he has had chronic sinusitis and lower respiratory tract infections. Physical examination of the woman is unremarkable. Examination of the
man is remarkable for dextrocardia. Further work-up of the husband will most likely reveal

A. azoospermia

B. germinal cell aplasia

C. immotile sperm

D. isolated gonadotropin deficiency

E. varicocele

Explanation:

The correct answer is C. The husband is suffering from Kartagener's syndrome, an autosomal recessive disorder characterized by infertility, situs inversus, chronic sinusitis, and bronchiectasis. The underlying cause of these varied manifestations are defects in the dynein arms, spokes of microtubule doublets of cilia in the airways and the reproductive tract. Since sperm motility is dependent on the functioning of cilia, infertility frequently accompanies this disorder. Situs inversus occurs because ciliary function is necessary for cell migration during embryonic development.

Azoospermia (choice A) is not a feature of Kartagener's syndrome, as sperm production or survival is not affected in this disorder.

Germinal cell aplasia (choice B), also known as Sertoli only syndrome, is characterized by oligospermia or azoospermia.

Isolated gonadotropin deficiency (choice D) is characterized by delayed or incomplete pubertal maturation.

Varicocele (choice E) results in an increased testicular temperature, decreasing the count of normal, viable sperm.

A patient with long-standing constipation enters a clinical research study. After a complete physical examination, a small intraluminal balloon is inserted through the anus to the rectum. Transducers are also inserted to measure internal and external anal sphincter pressures. Inflation of the rectal balloon causes the external anal sphincter to contract, but the internal anal sphincter, which exhibits normal tone, fails to relax and the urge to defecate is not sensed. Which of the following structures is most likely damaged?
A. Internal anal sphincter

B. External anal sphincter

C. Pelvic nerve

D. Pudendal nerve

E. Rectum

Explanation:

The correct answer is C. The defecation reflex that is evoked when the rectum is distended involves three responses: 1) the internal anal sphincter relaxes, 2) the external anal sphincter contracts, and 3) a conscious urge to defecate is perceived. This neural reflex involves the pelvic nerve, which provides the parasympathetic preganglionic innervation to the internal anal sphincter (composed of smooth muscle) and also carries the sensory afferent information from the rectum to the spinal cord, and the pudendal nerve, which carries the somatic efferent inputs to the external anal sphincter (composed of skeletal muscle). In the patient described above, the pelvic nerve is most likely damaged since neither the reflex relaxation of the internal anal sphincter nor the urge to defecate is evoked by rectal distention.

Damage to the internal anal sphincter (choice A) would most likely cause resting tone to be low and, if anything, lead to fecal incontinence rather than constipation. Furthermore, damage to the internal anal sphincter could not explain the failure of the appearance of the urge to defecate.

The external anal sphincter (choice B) appears to function normally since distention of the rectum evokes the expected contraction. The normal contraction of the external anal sphincter also suggests that the pudendal nerve (choice D) is intact.

Since distention of the rectum (choice E) evoked the contraction of the external anal sphincter, it too appears to be functioning normally.

A 60-year-old man complains of difficulty arising from a chair and initiating new movements. On exam, you notice a resting hand tremor and cogwheel rigidity. Which of the following amino acids is the precursor for the neurotransmitter that is deficient in the brain of this patient?
A. Glutamate

B. Glycine

C. Histidine

D. Tryptophan

E. Tyrosine

Explanation:

The correct answer is choice E. This question requires three steps of logic. First, figure out the diagnosis (a classic case of Parkinson's disease), then remember which neurotransmitter is involved in the disease (dopamine), and finally, recall which amino acid serves as the precursor for that neurotransmitter (tyrosine). The hydroxylation of tyrosine by tyrosine hydroxylase results in DOPA, which is then decarboxylated to dopamine. Note that norepinephrine and epinephrine are also tyrosine derivatives, as are the melanins and the thyroid hormones, thyroxine and triiodothyronine.

The other answer choices are also precursors of specialized products:

Glutamate (choice A) can be converted to the inhibitory neurotransmitter GABA by the action of glutamate decarboxylase.

Glycine (choice B) is involved in the synthesis of both creatine (along with arginine and S-adenosylmethionine) and heme (along with succinyl-CoA).

Histidine (choice C) can be decarboxylated to histamine, an important inflammatory mediator.

Tryptophan (choice D) can be converted to serotonin by a hydroxylation reaction (tryptophan hydroxylase) followed by a decarboxylation reaction.

A 40-year-old woman presents to the emergency department because of hematuria. Laboratory analyses show significant proteinuria, bacteria and white cells in the urine, and a blood urea nitrogen (BUN) of 40 mg/dL with a creatinine of 4.0 mg/dL. Ultrasonography reveals enlarged kidneys, and she is given a provisional diagnosis of polycystic renal disease. Which of the following is likely to be decreased in this patient?
A. Creatinine clearance

B. Extracellular sodium concentration

C. Glucose clearance

D. Plasma creatinine levels

E. Plasma inulin levels

Explanation:

The correct answer is A. Polycystic kidney disease leads to progressive decrements in renal function, eventually resulting in renal failure (evidenced by the increased BUN and creatinine). These abnormalities are caused by a reduction in glomerular filtration rate (GFR), which produces a decrease in creatinine clearance. The production of creatinine, a waste product of metabolism, bears a direct relation to the muscle mass of an individual and is independent of renal function. Because creatinine is freely filtered by the glomerulus, but not secreted or reabsorbed to a significant extent, the renal clearance of creatinine is approximately equal to the GFR. Therefore, creatinine clearance is commonly used to assess renal function in the clinical setting.

The extracellular sodium concentration (choice B) is not expected to change significantly in this patient.

Glucose (choice C) is not normally excreted, so glucose clearance is normally zero. Thus, is not possible for glucose clearance to be decreased.

Plasma creatinine concentration (choice D) increases when GFR decreases.

Inulin clearance is used to estimate GFR. However, inulin is foreign to the body, and inulin plasma levels (choice E) are normally zero.

Two diabetic patients are seen by a clinician. The first patient is a 16-year-old boy who 2 years previously had presented with polyuria and polydipsia. The second patient is a 65-year-old woman whose diabetes was identified by the presence of hyperglycemia on a routine blood glucose screen 10 years previously. Compared to the 65-year-old patient with diabetes, the 16-year-old diabetic is more likely to

A. be obese
The 16-year-old probably has type 1 (juvenile onset) diabetes mellitus, while the 65-year-old probably has type 2 (maturity onset) diabetes mellitus. These two types of diabetes differ in many respects. Ketoacidosis is more apt to develop in type 1 diabetes.

type 2 diabetics tend to be obese (choice A), while type 1 diabetics are often thin.

type 1 is usually apparently due to viral or immune destruction of beta cells, while type 2 is apparently usually due to increased resistance to insulin; consequently the 65-year-old, rather than the 16-year-old, is more likely to have relatively high endogenous levels of insulin (choice B).

type 2 diabetes can often be controlled with oral hypoglycemic agents (choice C), while type 1 diabetics generally require insulin. Note that some type 2 diabetics also may require insulin as the disease evolves.

type 1 diabetes has a strong association with HLA-DR3 and HLA-DR4 (choice E), while type 2 does not have any strong HLA associations.

A 69-year-old man involved in a motorcycle accident loses an estimated 1 L of blood from a severed artery in his leg. Constriction of which of the following types of blood vessels is most important for minimizing the decrease in mean systemic filling pressure caused by this blood loss?

A. Aorta and large arteries

B. Arterioles

C. Capillaries
The correct answer is E. The venous system serves as an important blood reservoir for the circulation. When blood is lost from the body and blood pressure begins to fall, pressure reflexes are elicited that send sympathetic nerve signals to venules and veins causing them to constrict. By "tightening" the circulation and taking up much of the "slack" caused by the blood loss, nearly normal function can usually be restored with up to a 20% loss of blood volume.

The mean systemic filling pressure (MSFP) is the pressure that exists in all parts of the circulation when the heart has been stopped and the blood volume has become redistributed in the system until all pressures are at equilibrium. The MSFP is thus a measure of the "tightness" with which the circulatory system is filled with blood. The more the system is filled (i.e., when MSFP increases), the easier it is for blood to flow into the heart, which tends to increase venous return.

Constriction of the arterial system has relatively little effect on mean systemic filling pressure because the arterial system (choices A, B, and D) contains a relatively small volume of blood.

Capillaries do not constrict because they do not contain smooth muscle cells in their walls (choice C).

A 20-year-old male is evaluated for persistent gynecomastia. Physical examination reveals the presence of abnormally small, firm testes. Testicular biopsy shows fibrosis and hyalinization of the seminiferous tubules. The Leydig cells are present in clumps and are hyperplastic. Chromosomal analysis shows the presence of an XXY genotype. Which of the following laboratory findings would be most likely in this individual?

A. Decreased plasma estrogen

B. Decreased plasma follicle stimulating hormone

C. Decreased plasma luteinizing hormone

D. Decreased plasma testosterone

E. Increased plasma inhibin
The correct answer is D. Klinefelter's syndrome is characterized by an XXY genotype and is associated with seminiferous tubule dysgenesis. In this disorder, there are usually few symptoms before puberty, which may be delayed. At puberty, the seminiferous tubules fail to enlarge normally and instead undergo fibrosis and hyalinization. The result is an inability to produce sperm. The Leydig cells are hyperplastic and clumped together, and do not function normally (secretion of testosterone is decreased). As a consequence, plasma levels of LH are increased (not decreased, choice C) due to the loss of feedback inhibition. The increased LH stimulates the Leydig cells to increase estrogen (not decreased, choice A) secretion. The increased estrogen:testosterone ratio is responsible for the gynecomastia, small penis, sparse body hair, and other feminized features of Klinefelter's syndrome. Because of dysgenesis of the seminiferous tubules, the secretion of inhibin is reduced (not increased, choice E). Low plasma levels of inhibin result in increased plasma FSH (not decreased, choice B) due to loss of feedback inhibition at the pituitary.

The pressure tracings from the thoracic and abdominal aorta shown above were obtained from a 3-month-old infant who exhibited dyspnea, difficulty feeding, and poor weight gain. Physical examination reveals a weak femoral pulse compared to the radial pulse. Which of the following is likely to be higher than normal in this infant?

A. Femoral artery wall thickness
B. Abdominal aorta wall thickness

C. Left ventricular wall thickness

D. Resting blood flow in leg muscles

E. Renal blood flow

Explanation:

The correct answer is C. The infant has a coarctation of the aorta. In this condition, the heart must pump against a higher-than-normal pressure. The left ventricle responds to this increased pressure load by undergoing hypertrophy, i.e., the wall thickness of the left ventricle increases as the myocytes enlarge. A similar process occurs when there is systemic hypertension. The increased blood pressure in the upper body (above the coarctation) also produces arterial hypertrophy, increasing the thickness of the vessel walls.

The wall thickness of the abdominal aorta (choice B), femoral artery (choice A), and other arteries below the constriction may decrease in response to the lower than normal pressures.

Although one might predict a lower-than-normal blood flow to the kidneys (choice E), leg muscles (choice D), and other organs below the coarctation, if the body can compensate fully for the coarctation, blood flow will be normal in these low-pressure areas of the body.

A 45-year-old man suffering from glomerulonephritis has a creatinine clearance of 50 mL/min. His medical records indicate that his creatinine clearance was 100 mL/min about 1 year ago. Assuming that there has been no change in his diet, which of the following changes can be expected in this patient compared to 1 year ago?

A. A 2-fold decrease in blood urea nitrogen concentration

B. A 2-fold decrease in creatinine excretion rate

C. A 2-fold increase in creatinine excretion rate

D. A 2-fold increase in creatinine reabsorption

E. A 2-fold increase in plasma creatinine concentration
The correct answer is E. Creatinine clearance is used clinically to estimate glomerular filtration rate (GFR). Therefore, the 50% decrease in creatinine clearance in this patient suggests that GFR has decreased by 50% over the past year. Because creatinine is freely filtered but not reabsorbed (choice D), the filtration rate and excretion rate of creatinine are equal during steady state conditions. When GFR decreases, the rate of creatinine excretion will also decrease, causing the rate of creatinine excretion to fall below the rate of creatinine production. The result is an increase in plasma creatinine concentration. When plasma creatinine levels have increased by 2-fold, normal amounts of creatinine can then again be excreted (compare to choices B and C) because the excretion rate of creatinine is equal to the product of GFR and plasma creatinine concentration. In summary, when GFR decreases, the plasma creatinine concentration continues to increase until the rate of creatinine filtration (and excretion) becomes equal to the rate of creatinine production by the body.

The blood urea nitrogen concentration (choice A) increases when GFR is reduced.

A 42-year-old Caucasian woman with no history of prior surgery complains of extreme weakness and fatigability that has persisted for the past 5 months. She reports nausea and stomach cramps and has had trouble keeping solid foods down. She is hypotensive while sitting, and her blood pressure falls even more upon standing. She notes increased freckling around her eyes, and on examination, her palmar creases appear darkened. Serum potassium is 6.5 mEq/L. Which of the following is the most likely diagnosis?

A. Addison's disease
B. Conn's syndrome
C. Cushing's syndrome
D. Nelson's syndrome
E. Secondary adrenal insufficiency
F. Tertiary adrenal insufficiency

Explanation:

The correct answer is A. Addison's disease usually occurs because of autoimmune destruction of the adrenal
cortex (all three zones are typically involved), resulting in decreased secretion of cortisol, aldosterone, and adrenal androgens. Hyperpigmentation is the classical physical finding, resulting from increased serum ACTH due to loss of negative feedback inhibition by cortisol at the pituitary and/or hypothalamus. The increase in pigmentation may occur because the first 13 amino acids of ACTH are identical to alpha-melanocyte stimulating hormone. Low serum levels of cortisol produce gastrointestinal symptoms such as nausea, vomiting, and anorexia. Fatigability and weakness are almost always reported. Blood pressure is usually low and orthostatic hypotension may be present, because arterioles are less responsive to the constrictor effects of catecholamines in the absence of cortisol. The cardiovascular symptoms are worsened by the loss of blood volume due to aldosterone deficiency. Hyperkalemia is a manifestation of the low serum aldosterone; hyponatremia may also be present.

Conn's syndrome (choice B) results from hypersecretion of aldosterone. It is characterized by hypertension, hypernatremia, and hypokalemia.

Cushing's syndrome (choice C) occurs because of excessive secretion of cortisol. It is characterized by central obesity, buffalo hump, moon facies, hypertension, and if anything, hypokalemia.

Nelson's syndrome (choice D) results in extreme hyperpigmentation. It can occur in patients who have had adrenalectomy to treat Cushing's disease. It results because of excessive secretion of ACTH from a pituitary adenoma that is no longer being restrained by the suppressive effect of cortisol. The patient mentioned above has no history of adrenalectomy.

Both secondary (choice E) and tertiary (choice F) adrenal insufficiency result in low serum levels of ACTH. The subsequent hypocortisolism can produce the gastrointestinal complaints and fatigability, but not hyperkalemia. With deficiency of CRH or ACTH, serum aldosterone usually remains in the normal range, and signs of mineralocorticoid deficiency are not present. Furthermore, low serum levels of ACTH would not produce hyperpigmentation.

A 64-year-old woman had a cerebrovascular accident 6 months ago. Her past medical history is remarkable for hyperthyroidism and atrial fibrillation. She initially presented with slurred speech and right hemiparesis. The hemiparesis resolved, but her speech is still agrammatic and nonfluent, and she has difficulty finding words and completing sentences. Her comprehension is intact, and she appears frustrated when she attempts to speak. The remainder of the neurologic examination is normal. Which of the following best describes her deficit?

A. Apraxia

B. Broca aphasia
C. Dysarthria

D. Global aphasia

E. Wernicke aphasia

Explanation:

The correct answer is B. Broca aphasia, caused in this case by an embolus to the Broca area (inferior frontal gyrus), is often associated with hemiparesis. The aphasia is characterized by slow, nonfluent speech with deficits in word finding. Because comprehension is normal, patients are typically aware of the problem and appear frustrated.

Apraxia (choice A) is a deficit of purposeful movement caused by a central lesion.

Dysarthria (choice C) is a deficit in speech articulation with normal grammar and word finding.

Global aphasia (choice D) is usually caused by large infarcts in the distribution of the middle cerebral artery. It is characterized by elements of Broca and Wernicke aphasia (i.e., an inability to generate or comprehend fluent speech).

Wernicke aphasia (choice E), caused by lesions in Wernicke area, is characterized by fluent speech that has a normal tempo, but is filled with incorrect words and neologisms. The patient is unable to comprehend speech.

A 44-year-old woman presents with a chief complaint of a sharp, stabbing pain in her chest for the past 12 hours. A careful history reveals that the patient experienced a myocardial infarct 3 years ago. The woman refuses to lie down in the examining room and instead leans forward, stating that it allows her to breathe more easily. Physical examination is unremarkable. The ECG demonstrates diffuse ST segment elevations with upright T waves. Chest radiographs appear normal. Creatine kinase (MB fraction) is normal. Which of the following is the most likely diagnosis?

A. Acute pericarditis

B. Dissecting aortic aneurysm

C. Myocardial infarction

D. Stable angina
E. Unstable angina

Explanation:

The correct answer is A. All of the answer choices represent common cardiovascular causes of chest pain. However, only pericarditis and dissecting aortic aneurysms will produce sharp, knife-like pains. Patients with pericarditis relieve their pain by sitting and leaning forward. The characteristic ECG patterns of pericarditis include diffuse ST elevations with upright T waves. While a pericardial rub is diagnostic of pericarditis, its presence is not necessary for diagnosis, and the physical examination may well be unrevealing. Typically, in uncomplicated pericarditis, both chest radiographs and cardiac isoenzyme levels appear normal.

Pericarditis can be differentiated from dissecting aortic aneurysms (choice B) on the basis of clinical findings. The pain associated with dissecting aortic aneurysms is usually unrelated to breathing, while the pain associated with pericarditis is related to breathing.

Myocardial infarcts (choice C), as well as stable (choice D) and unstable angina (choice E), typically produce more visceral types of pain.

A 30-year old male complains of fatigue and diffuse skeletal pain. He has a history of Crohn's disease, which led to resection of the terminal ileum 3 years previously. Steatorrhea and diarrhea have continued since the surgery. Laboratory tests show that serum calcium is 7.5 mg/dL, serum phosphate is 2.5 mg/dL, and serum parathyroid hormone (N-terminal) is 750 pg/mL. Which of the following is the most likely cause of these findings?

A. Osteoporosis

B. Paget's disease

C. Primary hypoparathyroidism

D. Renal failure

E. Vitamin D deficiency
Explanation:

The correct answer is E. Whenever serum calcium and phosphate are both decreased, vitamin D deficiency should be considered. In this case, the vitamin D deficiency is due to fat malabsorption, including the fat-soluble vitamin D, subsequent to ileal resection. If more than 100 cm of the ileum are removed, primary bile acid production by the liver cannot keep up with bile salt loss in the stool. The total bile salt pool decreases and fat absorption, including the fat-soluble vitamins is poor. Serum calcium is low because of decreased dietary absorption. Serum parathyroid hormone increases in response to the low calcium. Serum phosphate is low because of decreased dietary absorption and increased renal excretion (due to the increased parathyroid hormone). With vitamin D deficiency, the bones demineralize, producing osteomalacia. Clinical manifestations often go unnoticed. Vague complaints of weakness and bone pain may be present. Radiographs of bones in osteomalacia typically reveal the presence of pseudo fractures along the inner aspects of the femur, the pubic rami, and the outer edges of the scapulas, upper fibula, and metatarsals. These radiolucent bands, which are perpendicular to the bone surface, may occur because of pulsations of major arteries that cross the bone.

Osteoporosis (choice A) is characterized by loss of bone mass, both matrix and mineral. It is usually asymptomatic, and serum levels of calcium, phosphate, and parathyroid hormone are within the normal range. The first hint of bone loss comes because of a fracture in the wrist, hip, or vertebra. Dual-energy radiography, or other similar techniques, can be used to directly quantify the degree of bone loss.

In Paget's disease (choice B), bone mineral turnover is increased compared to normal. Its cause is unknown, but may be due to a slow virus that infects osteoclast cells. Both osteoblast and osteoclast activity is increased in focal areas of the bone. The disease is usually asymptomatic, the chief complaint being bone pain over the lesions. Laboratory findings include increased serum alkaline phosphatase, but serum calcium and parathyroid hormone levels are usually normal.

With primary hypoparathyroidism (choice C), serum calcium is decreased and serum parathyroid hormone is decreased, but serum phosphate is also increased (not decreased). Serum phosphate is increased because urinary excretion is diminished subsequent to the decrease in parathyroid hormone.

In renal failure (choice D), an increase (not decrease) in serum phosphate subsequent to decreased urinary excretion is a primary manifestation. Serum calcium is decreased because the hyperphosphatemia drives the equilibrium between calcium and phosphate toward hydroxyapatite crystals. This, in turn, produces an increase in parathyroid hormone secretion with subsequent bone demineralization (renal osteodystrophy).

A three-year-old child is brought to the emergency room after inhaling a peanut. The peanut has lodged in the right mainstem bronchus, largely occluding it. The child is cyanotic, and non-invasive transcutaneous monitoring reveals a PO2 of 60 mm Hg. Which of the following mechanisms best accounts for the child's hypoxemia?
A. Decreased capacity of pulmonary diffusion

B. Decreased PO2 in inspired air

C. Hypoventilation of central origin

D. Hypoventilation of peripheral origin

E. Inequalities of ventilation and perfusion

Explanation:

The correct answer is E. Inequalities of ventilation and perfusion contribute to hypoxia in many settings. In this case, blood goes to both lungs (perfusion), but air is prevented from entering one of the lungs (ventilation). Because the right lung is being perfused, but not ventilated, hypoxemia ensues when the deoxygenated blood from the right lung mixes with oxygenated blood from the left lung. If the inadequate ventilation of the lung persists long enough, the lung tissue itself can be damaged, causing a secondary local dilation of arterioles, making the problem even worse. Peanuts are notorious for producing this type of problem in young children because of their size and shape, which allows them to lodge in the trachea or main bronchus after aspiration.

Decreased diffusion capacity (choice A) can occur when the blood-gas barrier is thickened (e.g., diffuse interstitial fibrosis, sarcoidosis, asbestosis, respiratory distress syndrome), when the surface area of the blood-gas barrier is reduced (e.g., pneumonectomy, emphysema), or when less hemoglobin is available to carry oxygen (e.g., anemia, pulmonary embolism).

Decreased PO2 in inspired air (choice B) is seen at high altitudes and when the settings are wrong during artificial ventilation.

Hypoventilation of central origin (choice C) is seen in morphine and barbiturate overdose.

Hypoventilation of peripheral origin (choice D) is seen in poliomyelitis and chest trauma.

Small-cell carcinoma of the lung complains of muscle weakness, fatigue, confusion, and weight loss; examination is unremarkable. Serum sodium is found to be 120 mEq/L. Which of the following laboratory results would also be expected in this patient?
Answer is C. Bronchogenic carcinomas can secrete ectopic vasopressin (ADH), leading to the inappropriate ADH (SIADH). As long as water intake is not decreased, the increased plasma not decreased, choice B) causes excessive water reabsorption by the renal distal tubule and ect. The increased total body water can explain the weight gain. Edema is usually absent because water is distributed to both intracellular and extracellular volumes. The extra plasma water dilutional hyponatremia, which can explain the weakness, fatigue, and confusion. There will also be decrease in serum osmolarity. With SIADH, the urine sodium is usually increased (not decreased, compared to normal. This leads to an inappropriately concentrated urine. The volume expansion in the excessive water retention may be responsible for the increased urinary sodium. Volume could increase plasma ANP (not decrease, choice A) and increase renal sodium excretion. The tension would also inhibit renin secretion from the kidney with subsequent decrease in plasma not increase, choice E). Decreased plasma aldosterone would then allow for increased renal sodium.

visits her pediatrician because of primary amenorrhea. Breast development occurred as puberty, but axillary and pubic hair is still fine and unpigmented. She is 5' 5" tall and weighs 105 lb. Investigation reveals a shortened vagina with no discernible cervix or uterus. Serum LH concentration is decreased compared to normal. Which of the following is the most likely cause of the amenorrhea?

- 17alpha-hydroxylase deficiency
- Complete androgen resistance
- Constitutional delay in the onset of menses
The answer is B. This individual has an XY karyotype and testes (probably abdominal), but because of androgen resistance, developed a female phenotype in utero. In the absence of androgen receptors, the external genital slit will differentiate into a vagina with clitoris and labia. However, the vagina will not regress because Müllerian regression factor secreted by the testes will prevent the formation of a uterus. The Wolffian ducts will also degenerate in the absence of androgen receptors. At puberty, the testes will respond to the increased LH by increasing testosterone secretion. Masculinization is not possible due to the absence of androgen receptors, however, significant gonadal or peripheral effects of testosterone to estrogen will produce breast enlargement and other female secondary sex characteristics. LH will remain high because of the absence of negative feedback by the testosterone. Pubic and axillary hair development, which is also androgen-driven, will not occur.

17-alpha-hydroxylase deficiency (choice A) are born with normal female internal reproductive tract and genitalia. This is because the "default" program is for the female phenotype to develop in utero. In the absence of 17-alpha-hydroxylase deficiency, sex steroids (estrogen in the case of females) cannot be synthesized and affected females will not mature sexually at puberty, but will remain infantile. Since the patient exhibited breast development, 17-alpha-hydroxylase deficiency is unlikely. Furthermore, the absence of a uterus and uterine tubes is not consistent with 17-alpha-hydroxylase deficiency.

A delay in onset of menses (choice C) may occur in certain families. It is thought to be due to slow development of the hypothalamic-pituitary-gonadal axis. However, growth velocity and development of breasts and pubic hair occurs normally. A uterus and uterine tubes would be present since there is no disorder in development.

Prolactinemia (choice D) can suppress the hypothalamic-pituitary-gonadal axis and produce amenorrhea, which cannot explain the absence of pubic and axillary hair or the absence of a uterus and uterine tubes.

Turner syndrome (choice E) occurs in females with the XO genotype. They are typically short in stature, rarely menstruate. The germinal tissue in the ovaries is replaced with fibrous streaks. The internal reproductive tract is reduced. Estrogen secretion is diminished (primary ovarian disorder) which leads to an increase in LH and FSH. The weight of the above patient makes Turner's syndrome unlikely. Furthermore, Turner's syndrome could not explain the absence of a uterus and uterine tubes.
Case to her physician that she feels light-headed and has even fainted during defecation. This is likely an example of syncope due to which of the following mechanisms?

- Asthma
- Hyperventilation
- Hypovolemia
- Node disease
- Valsalva mechanism

Answer is E. Syncope has a broad differential diagnosis, since fainting can be produced by a wide range of mechanisms. All of the mechanisms listed in the answers can produce syncope, but only the Valsalva mechanism (in which high intra-abdominal pressures trigger a reflex fall in cardiac output) is specifically associated with defecation. This mechanism can also produce fainting during weight-lifting and with the use of certain positions.

- Seizures” (nonepileptic; choice A) are fainting spells that occur because a patient holds his or her breath, typically related to anxiety, can also cause fainting.
- Patients who are hypovolemic (choice C) due to medical reasons (hemorrhage, acute sodium or water loss, Addison's disease, etc.) tend to be hypotensive and may faint.
- Cardiac arrhythmias (choice D) are prone to fainting spells.

Anterior pituitary adenomas are most likely to present with which of the following?

- Acromegaly
- Cushing's disease
- Gigantism
- Hypopituitarism
- Hyperpituitarism
Answer is D. Pituitary adenomas are benign neoplasms of the anterior lobe associated with excess secretion. Depending on which cell type is affected, different clinical syndromes may be present. They may occur at any age, and affect both sexes, but most commonly affect men between the ages of 20 and 50. They are rare and may have an association with MEN I (pituitary adenoma, parathyroid hyperplasia, pancreatic islet adenoma). Prolactinomas are the most common type of pituitary adenomas, resulting from the growth of the lactotroph cells in the anterior pituitary. Young women with prolactinomas present with amenorrhea, galactorrhea, and infertility. Men usually have impotence and decreased libido.

Choice A) is generally caused by a functional adenoma secreting excess growth hormone. This occurs after the epiphyses of the long bones have fused and causes thickening and increased density of the bones and skin. Systemic manifestations include arthritis, insulin resistance, cardiomegaly, and decreased renal function. This syndrome is the result of a corticotroph adenoma producing excess ACTH, which stimulates adrenal hypersecretion. It is less common than prolactinoma or null cell (no hormone) adenoma. This syndrome refers to ACTH-dependent hyperadrenalism, whereas Cushing’s syndrome refers to hyperadrenalinism from any cause. Obesity, hypertrichosis, and amenorrhea are the usual clinical results.

Diabetes insipidus (choice C) is due to disease of the posterior pituitary leading to vasopressin (antidiuretic hormone; ADH) deficiency and is not associated with pituitary adenoma. Although the etiology is approximately one-third of cases, others are associated with craniopharyngiomas. The disorder is characterized by polyuria, thirst, and polydipsia.

Choice E) is often associated with gonadotroph adenoma (uncommon). Clinically, it causes acquired hypogonadism in men, as well as headache and visual disturbances.

Assume that patient A is suffering from carbon monoxide (CO) poisoning and patient B has iron deficiency anemia. Assume that the normal hemoglobin binds 50% of the available O2-binding sites on the hemoglobin, and that the anemic patient has 50% less amount of hemoglobin. Patient A is more at risk of tissue hypoxia because CO causes binding of hemoglobin to CO, reducing the availability of oxygen for tissue use.
ease in diffusing capacity

Ease in the P50 of Hb for O2

Lower decrease in the concentration of arterial oxygen

Reduced rate of O2 binding to available Hb

Arterial hypoxemia, while anemia does not

Answer is B. The P50 is defined as the partial pressure of oxygen necessary to bind 50% of hemoglobin. CO will decrease the P50 of Hb for O2. Another way of stating this is that CO left-shifts the hemoglobin dissociation curve. CO is deadly because it not only binds hemoglobin with a greater affinity than does O2 (240 times better), it also left-shifts the curve, thereby making it more difficult to unload O2 to tissues.

CO diminishes the diffusing capacity of the lung (choice A). CO is routinely used to measure diffusing
diffusion of oxygen in arterial blood will be approximately the same for both cases (choice C). If the concentration will be slightly greater in the patient with CO poisoning because CO2 left-shifts the curve, therefore the available binding sites of Hb for O2 will be slightly more saturated.

CO changes the rate of O2 binding to Hb (choice D). It does, however, bind to hemoglobin with a 240 times greater affinity than does oxygen.

These conditions will cause arterial hypoxemia (choice E).

The table depicts blood pressure values taken from six adults. Which set of values is most consistent with hypotension?
Diastolic pressure (mm Hg)

eectable

The answer is D. A patient with aortic regurgitation, caused by insufficiency of the aortic valve, has a pressure (the difference between systolic and diastolic pressure). In fact, during diastole, the pressure precipitously drops as the blood flows from the aorta back into the left ventricle through the aortic valve. Systolic pressure remains relatively normal since it depends on the left ventricular systolic pressure.

This is associated with reduced systolic pressure and relatively preserved diastolic pressure, such as 120/80 mm Hg (choice B), since the left ventricle is unable to pump a normal amount of blood through a stenotic valve.

A pressure of 50/undetectable mm Hg (choice A) is characteristic of acute shock.

A pressure of 120/80 mm Hg (choice C) is considered within normal limits in healthy adults, whereas values above 140/90 mm Hg are definitely in the range of hypertension, although mild.

A pressure of 220/130 mm Hg (choice E) is typical of malignant hypertension, a severe condition that may threaten complications if not promptly treated.
This subject to recurrent attacks of asthma. A careful clinical history reveals that the asthma most frequently after aspirin administration. Which of the following is the pathogenetic mechanism of asthma?

- release of bronchoconstrictor mediators
- increased sensitivity to vagal stimulation
- inhibition of cyclooxygenase pathway
- I hypersensitivity reaction
- IV hypersensitivity reaction

The answer is C. Aspirin-induced asthma is an infrequent form of asthma. It is related to the direct action of aspirin on the metabolism of arachidonic acid. Aspirin inhibits the cyclooxygenase pathway without affecting the lipoxygenase pathway, leading to a decreased ratio of prostaglandins to leukotrienes (bronchoconstrictors). The disrupted balance between these two groups of acid metabolites leads to bronchoconstriction in predisposed patients.

Release of bronchoconstrictor substances (choice A) is one of several pathogenetic mechanisms that may precipitate asthma, triggered by inhalation of a number of chemicals, including epoxy resins, plastics, toluene, formaldehyde, and penicillin products.

Vagal stimulation (choice B) plays an essential role in non-atopic asthma. This variety of asthma, AKA asthma, is initiated by viral infections of the upper respiratory tract (e.g., common cold and flu), to lower the threshold of respiratory mucosa to parasympathetic (vagal) stimulation. Recall that vagal stimulation exerts a bronchoconstrictor influence on the lungs.

Hypersensitivity reactions (choice D) are crucial in the pathogenesis of atopic asthma following prior exposure to a number of allergens. T-cell activation instructs B cells to produce IgE directed against a given allergen. After re-exposure, IgE on the surface of mast cells binds the allergen and induces mast cell degranulation. The mediators released from mast cells cause bronchospasm and recruit more inflammatory cells such as eosinophils, lymphocytes, and basophils.
...sensitivity reactions (choice E) do not occur in asthma.

An infant is taken to the pediatrician because of dyspnea, difficulty in feeding, and poor weight gain. Physical examination reveals tachypnea, a weak femoral pulse compared to the radial pulse, and a 30 mm Hg difference in systolic pressure between the upper and lower extremities. Which of the following is the most likely diagnosis?

- Aortic coarctation
- Mitral regurgitation
- Cardiac tamponade
- Heart failure
- Hypovolemia

The answer is A. Some of the major clinical manifestations of aortic coarctation in infants are given in the options. More than 95% of the coarctations (constrictions) occur just distal to the left subclavian artery in the ductus arteriosus. Thus the constriction usually occurs at a point beyond the arterial branches to the head and arms but proximal to the kidneys. Collateral vessels in the body wall carry much of the blood to the lower body and a very high resistance exists between the upper and lower aorta. The arterial pressure in the upper body is about 50% higher than the pressure in the lower body. The lower-than-normal pressure in the renal arteries causes renal retention of salt and water, restoring the blood pressure at the level of the renal arteries to near-normal levels, but leading to hypertension in the upper body, i.e., above the level of the constriction.

No evidence of mitral regurgitation (choice B), cardiac tamponade (choice C), heart failure (choice D), nor hypovolemia (choice E) cause a difference in systolic pressure between the upper and lower parts of the body.

A patient presents with complaints of moderate weight loss over the past 6 months, heat intolerance, and fine tremors in the hands. Physical examination reveals the presence of a diffuse goiter and palpitations. Which of the following laboratory findings would be expected in this individual?
Answer is E. The description given above is of an individual with Graves' disease. Hypersecretion of TSH because of stimulation of the TSH receptor by thyroid-stimulating immunoglobulins results in movement of thyroglobulin from the colloid to the plasma. The presence of exophthalmos is thought the autoimmune disorder in Graves' disease. It is postulated that the thyroid and orbital muscles common antigen. Lymphocytic infiltration and inflammation of orbital muscle then produces the thy.

Choice A) is increased in Graves' disease. Because of excessive stimulation of the thyroid by the stimulating immunoglobulins, radioactive iodine uptake (choice B), which assesses iodine trapping, is

increase in free T4 due to hypersecretion by the thyroid shifts the equilibrium between free and bound T4 increase in thyroxine binding globulin (TBG)-bound hormone. Concomitantly, the concentration of TBG falls. Hence, the radioactive T3 in the resin T3 uptake test would preferentially bind to the resin take would be increased (not decreased, choice C).

plasma levels of T4 will feed back to the hypothalamus and pituitary and decrease the secretion increase, choice D). In Graves' disease, TSH is not controlling the thyroid gland; thyroid-stimulating ulins take over this function.

her four-year-old daughter to a pediatrician because she has noticed that the child has started and the child's urine leaves lots of "bubbles" in the toilet. On physical examination, there is edema, especially noticeable in dependent regions and under the eyes. Which of the following constituents is probably present in abnormally high concentration and accounts for the bubbles?
Answer is A. The combination of edema and frothy urine suggests nephrotic syndrome. Urine with
edema content is more able to form stable bubbles than is normal urine, and may be a clue that a patient
notices.

Choice B) in urine cannot be detected grossly, and would not cause frothy urine.

We can detect a sweet smell to urine that contains large amounts of glucose (choice C), and Greek
were known to taste urine to diagnose diabetes, but the presentation suggests nephrotic syndrome.

Choice D) in urine cannot be detected grossly, and would not cause frothy urine.

Urine with a high urea (choice E) content looks darker in color, and is not necessarily frothy.

The patient exhibits short stature, obesity, mental retardation, and shortened 3rd and 5th metacarpals.
Serum calcium is low, serum phosphate is high, and serum parathyroid hormone (PTH) is increased. Injection of
PTH decreases urinary cAMP. Red blood cells exhibit a 50% decrease in the expression of the stimulatory
receptor. This patient most likely has

- primary hyperparathyroidism
- primary hypoparathyroidism
- secondary hyperparathyroidism
Answer is C. Pseudohypoparathyroidism is due to end organ insensitivity to PTH. This results in hyperphosphatemia, and decreased serum levels of 1,25 (OH)2 vitamin D, as would be expected in hypoparathyroidism. However, serum PTH concentration is increased as a normal response to the low Ca level. The biochemical defect in some of these patients has been shown to be decreased expression of the parathyroid hormone (PTH) receptor. PTH acts by increasing intracellular cAMP, the reduction in Gs could explain the target cell cAMP deficiency. Failure of injected PTH to increase urinary cAMP can confirm the end organ insensitivity. The developmental defects (mental retardation, shortened metacarpals or metatarsals, etc.) is not seen in true hypoparathyroidism (choice A) presents with hypercalcemia and hypophosphatemia due to increased concentration of PTH.

Hypoparathyroidism (choice B) also presents with hypocalcemia, but is associated with decreased serum phosphate. Furthermore, kidney responsiveness to injected PTH should be normal.

Pseudohypoparathyroidism (choice D) is a rare genetic disorder. These patients present with the same skeletal defects as in pseudohypoparathyroidism, but have normal serum levels of calcium and PTH.

Vitamin D deficiency (choice E), serum calcium may be decreased and serum PTH increased. However, serum phosphate is usually decreased. This is partly due to the decrease in absorption of dietary phosphate and partly due to increased renal excretion of phosphate because of the increased PTH. Furthermore, the developmental and end organ insensitivity to PTH would not be present with vitamin D deficiency.

Hemorrhaging from the umbilical stump of a neonate specifically suggests deficiency of which of the following coagulation factors?

- Factor VIII
- Factor IX
Hereditary factor XIII deficiency is an autosomal recessive condition that is unusual in factor deficiencies in that the presentation is often at birth, when the umbilical stump bleeds sometimes leading to the neonate's death. Factor XIII is necessary to stabilize clot formation, and, clots will rapidly lyse. Cutaneous and muscular hematomas are common in affected patients. Major surgery and trauma can occur, including bleeding into the central nervous system. Spontaneous bleeding in affected women is common. A factor XIII concentrate is available for treatment.

A woman presents with complaints of amenorrhea over the past six months. The woman is 5'5", exhibits excessive terminal hairs on the face, chest, back, and lower abdomen. Ultrasound shows that ovaries are significantly enlarged. Serum LH concentration is increased compared to normal, while serum estradiol concentration is decreased. Biopsy of an ovary from this patient would most likely show which of the following?

- Atrophied theca cells
- Hyperthecosis with chromosomal mosaicism
- Hyperplastic granulosa cells
- Increased numbers of cystic follicles
- Atrophied theca cells

Answer is D. Polycystic ovary syndrome often results in amenorrhea because of excessive ovarian production secondary to increased plasma LH. The initiating event in this disorder is not known, but is thought to be excessive secretion of GnRH by the hypothalamus. The pituitary responds to the abnormal
RH release by increasing LH secretion, but decreasing FSH secretion. The increased LH causes hyperplasia (not atrophy, choice A) and excessive androgen secretion. With low FSH levels, the ovaries would be atrophied (not hyperplastic, choice C) and would have insufficient aromatase activity to convert androgen to estrogen. The high local androgen concentration may be responsible for the numerous small cystic follicles. One or both of the ovaries are often significantly enlarged. The association with polycystic ovarian syndrome is likely due to the increased ovarian secretion of genes with chromosomal mosaicism (choice B) is typical of Turner's syndrome. Individuals with the 46,XY karyotype typically have hypogonadism, in part, because of abnormal ovarian development. The ovary may develop two cell lines with varying chromosomal composition. Turner's syndrome is characterized by a wide spectrum of physical abnormalities (short stature, webbed neck, shield chest) that are not present in this syndrome.

One or both ovaries are often significantly enlarged. The presence of seminiferous tubules in the gonad (choice E) of a phenotypic female would suggest testicular feminization syndrome. In this syndrome, XY genotypic males are produced that lack androgen receptors. An individual exhibits female phenotypic external genitalia and secondary sex characteristics, a male voice, and menstrual cycles never begin. The absence of androgen receptors would also preclude the development of hirsutism.

An otherwise healthy woman presents to her physician with complaints of fatigue and dyspnea. Physical examination reveals normal breath sounds and the presence of third and fourth heart sounds. Chest x-ray reveals clear lung fields but right ventricular enlargement, main pulmonary artery enlargement, and right ventricular hypertrophy. Electrocardiogram shows right axis deviation and right ventricular hypertrophy. Left ventricular function appears normal on echocardiography. Serologic studies show antinuclear antibodies. Which of the following pathological findings would this patient also show, either at autopsy or if an endomyocardial biopsy was taken?

- Thrombus of the right atrium
- Thrombosis and scarring of the left ventricle
- Endemic pulmonary vasculopathy
- Pulmonary artery stenosis
- Pulmonary fibrosis
The presentation described is classic for pulmonary hypertension, and, more specifically, the primary idiopathic form of pulmonary hypertension. This rare condition is suspected of being associated with collagen vascular diseases, since up to 50% of patients have antinuclear antibodies (despite the absence of typical findings of other autoimmune disease). Also, a similar, known secondary form of pulmonary hypertension is sometimes seen in patients with a wide variety of collagen vascular diseases, including systemic lupus erythematosus, polymyositis, dermatomyositis, systemic sclerosis, and adult and juvenile forms of rheumatoid arthritis. A wide variety of other conditions have also been associated with pulmonary hypertension, including shunts, left atrial hypertension, chronic hypoxia, pulmonary vascular reaction, hepatic cirrhosis, and sickle cell disease. Both primary and secondary forms of pulmonary hypertension are associated with prominent changes in the pulmonary vasculature, which can include proliferation of smaller arteriolar walls, concentric hypertrophy of the intima (“onion skinning”), and a distinctive lesion (plexogenic pulmonary vasculopathy) in which the smallest arteriolar walls become partially occluded by endothelial (or possibly mesenchymal) cells and sometimes, matrix. The prognosis of untreated pulmonary hypertension is poor. However, the use of the vasodilator sildenafil with anticoagulation can slow the course (fatal in about 3 years in untreated patients). If the pulmonary hypertension is secondary, therapy of the primary disease can be helpful.

Atrial fibrillation with mural thrombus (choice A) formation is uncommon in primary pulmonary hypertension.

Enlargement of the main pulmonary artery excludes pulmonary artery stenosis (choice D).

Pulmonary fields exclude severe pulmonary fibrosis (choice E).

Marked unconjugated hyperbilirubinemia. No hemolysis can be demonstrated and other liver tests are normal. There is no bilirubin found in the urine. This infant's condition continues to deteriorate after 2 weeks of age. To which of the following conditions did the infant most likely succumb?

- Carter-Najjar syndrome, Type I
- Carter-Najjar syndrome, Type II
Johnson syndrome

Crigler-Najjar syndrome

Rotor's syndrome

The answer is A. The diseases listed in the answers are all inherited disorders of bilirubin metabolism and are commonly discussed together. Crigler-Najjar syndrome (choices A and B) and Gilbert's syndrome (choice E) are both unconjugated hyperbilirubinemas, while Dubin-Johnson syndrome (choice C) and Rotor syndrome (choice D) are conjugated hyperbilirubinemas. Crigler-Najjar syndrome (particularly the type I variant) is severe and extremely serious (with the presentation given in the question stem) while Gilbert's syndrome is completely benign. The type II variant of Crigler-Najjar is intermediate in severity between Gilbert's syndrome and Gilbert's syndrome. Dubin-Johnson and Rotor syndrome are also relatively benign; Dubin-Johnson is distinguished from Rotor syndrome by the presence of a black pigment of unknown composition in the liver.

A boy is brought in to clinic by his mother because of elongation and swelling of his right leg. After taking a history, it is found that the boy is found to have multiple arteriovenous fistulas involving small cutaneous and muscular arteries and veins. Which of the following would be increased in a blood sample taken from the femoral vein?

A. Hemoglobin content
B. Hematocrit
C. Bilirubin content
D. Sodium concentration
E. Protein concentration

The answer is C. Congenital arteriovenous fistulas are often associated with limb swelling and visible pulsations when the fistulas are large, cosmetic changes when the fistulas are in the

Crigler-Najjar syndrome

Rotor's syndrome

The answer is A. The diseases listed in the answers are all inherited disorders of bilirubin metabolism and are commonly discussed together. Crigler-Najjar syndrome (choices A and B) and Gilbert's syndrome (choice E) are both unconjugated hyperbilirubinemas, while Dubin-Johnson syndrome (choice C) and Rotor syndrome (choice D) are conjugated hyperbilirubinemas. Crigler-Najjar syndrome (particularly the type I variant) is severe and extremely serious (with the presentation given in the question stem) while Gilbert's syndrome is completely benign. The type II variant of Crigler-Najjar is intermediate in severity between Gilbert's syndrome and Gilbert's syndrome. Dubin-Johnson and Rotor syndrome are also relatively benign; Dubin-Johnson is distinguished from Rotor syndrome by the presence of a black pigment of unknown composition in the liver.
tissues and skin, and varicose veins in unusual locations. The venous pressure is frequently higher in the skin is often warmer compared to the opposite extremity. Because blood flowing through the vein-paased the tissues of the extremity, the oxygen content of venous blood from the involved limb is compared to the opposite limb. In fact, increased venous oxygen content is a pathognomonic sign of a venous fistula.

If the femoral venous blood has bypassed the tissues, its carbon dioxide content (choice A) is lower compared to venous blood of the opposite extremity, i.e., it should be closer to that of arterial blood.

Hematocrit (choice B) is slightly greater compared to arterial hematocrit because of a "chloride shift" of blood cells as they pass through the microcirculation. This small increase in hematocrit will be seen with arteriovenous fistula as venous blood is diluted with arterial blood that has bypassed the extremity.

The reason for sodium concentration (choice D) or total protein concentration (choice E) to be affected is related to the arteriovenous fistula, as these are normally similar in arterial and venous blood.

The patient is referred to a gastroenterologist because of multiple intractable gastric and duodenal peptic ulcers. Measurement of his basal acid output (BAO) reveals marked elevation of gastric acid secretion. CT scan demonstrates a two centimeter mass in the head of the pancreas. Which of the following hormones is most likely caused by this mass?

- PTH
- Epinephrine
- Cortisol
- Insulin
- Somatostatin

The answer is C. The patient has Zollinger-Ellison syndrome, in which a duodenal or pancreatic endocrine tumor causes hypersecretion of gastric acid. Two-thirds of these tumors are related to MEN I, which also causes parathyroid hyperplasia/adenomas and pituitary adenomas.
MEN I is present, multiple duodenal gastrin-secreting microadenomas may be seen. H2 blockers and pump inhibitors may provide symptomatic relief. Definitive treatment consists of surgical removal of the tumor, when feasible.

Choice A) is usually secreted by medullary carcinoma of the thyroid; rarely, calcitonin gene-related peptide (CGRP) is secreted by pancreatic endocrine tumors.

Choice B) is secreted by pheochromocytoma.

Endocrine tumors may also secrete vasoactive intestinal peptide (VIP, choice E), parathyroid hormone (choice D), parathyroid hormone-related peptide, insulin, glucagon, somatostatin, ACTH, or growth hormone (GHRH). Secretion of these hormones is less common than secretion of gastrin, specifically suggested by the peptic ulcer history.

A female presents with complaints of difficulty reading. Ophthalmologic examination is remarkable for opacifications in her eyes, consistent with cataract formation. In which of the following structures are opacifications located?

- Aqueous humor
- Cornea
- Lens
- Optic nerve

The answer is C. Cataracts are lens opacifications. It is not known whether senile cataracts represent normal opacification with age. Cataracts may occur as a consequence of diabetes mellitus, thyroid disorders, or congenital infections. They are successfully treated at present with lens extractions and implantation of prosthetic lenses.

Lacrimal (choice A) is continually replaced due to active secretion by the ciliary body. As such, it does
opacification; it is in constant flux.

Opacification (choice B) is generally a consequence of squamous metaplasia, in which the transparent, squamous cells are replaced by opaque, keratinized, squamous cells. Squamous metaplasia is a process, usually due to friction injury to the cornea or vitamin A deficiency.

Choice (D) is not transparent, and it does not undergo opacification injury. It may, however, develop prolonged bleeding following a dental extraction. The child is referred to a hematologist. Evaluation of the child's hematologic parameters demonstrates a prolonged partial thromboplastin time. Which of the following platelet abnormalities would most likely be found in this patient?

- Normal platelet morphology
- Reduced platelet adhesion
- Reduced platelet primary aggregation
- Reduced release of platelet vesicles
- Reduced secondary aggregation of platelets

Answer is B. This child probably has autosomal dominant von Willebrand's disease, in which an inherited factor (which also carries factor VIII in the blood) causes a defect in the initial formation of platelets to a damaged vessel wall. Since factor VIII levels are also consequently low, the thromboplastin time is also prolonged. Defects in platelet adhesion are also seen in Bernard-Soulier syndrome.

Normal platelet morphology (choice A) is not seen in von Willebrand's disease, but may be observed with aplastic anemia due to bone marrow damage. Normal platelet morphology may also be observed after splenectomy.
ary platelet aggregation (choice C) are seen in thrombosthenia, which is caused by a deficiency in the glycoprotein GpIIb-IIIa complex.

ease of platelet vesicles (choice D) or secondary aggregation (choice E) are seen in storage pool spiron use.

cose-6-phosphate dehydrogenase (G6PD) deficiency develops a urinary tract infection. Free rates by responding neutrophils create an oxidant stress, and RBCs are rapidly overwhelmed. As vascular hemolysis begins, serum levels of which of the following will decrease?

bin

citive protein
	ron

globin

globin

swer is D. Haptoglobin (or alpha-2 globulin) is a serum protein that promptly binds to free
in the serum, forming a tight complex. The haptoglobin-hemoglobin complex is quickly cleared from the reticuloendothelial system, which allows the hemoglobin to be salvaged instead of lost into the vascular hemolysis from any cause is rapidly followed by a dramatic drop in serum haptoglobin.

choice A) is synthesized in the liver and spleen as an end-product of heme degradation. Serum levels would not change until the haptoglobin in the blood was completely saturated, and free began to circulate. In this circumstance, serum bilirubin would increase, not decrease.

tein (choice B) is an acute phase reactant produced by the liver in increased quantity in response
on. This patient's urinary tract infection would increase C-reactive protein levels, but the hemolysis further affect them.

ion (choice C) does not change appreciably in intravascular hemolysis. Ferrous iron in the red
complexed to hemoglobin, and this complex is not broken in hemolysis.

The oxidized form of hemoglobin (choice E) increases in the blood along with free hemoglobin in vascular hemolysis.

A man complains to his physician at his yearly checkup that his legs begin to ache about half way through a daily 2-mile walk. The pain subsides within 1 or 2 minutes after he stops walking. He also complains of erectile dysfunction. Which of the following is most likely to be decreased in this man?

- Partial oxygen content
- Partial pulse at the ankle
- Venous extraction in his leg muscles
- General vascular resistance
- Serum lipid levels

The answer is B. This man has arteriosclerotic occlusive disease. The intimal plaque of arteriosclerosis narrows the lumen of his arteries. The classic symptom is intermittent claudication, which is the pain that muscle feels when it does not receive an adequate blood flow during exercise. Impotence is another complaint. The arterial pulse at the ankle is decreased because the pressure pulse cannot be effectively transmitted through the narrowed arteries.

Partial oxygen content (choice A) should be normal; however, the oxygen content of venous blood from exercising muscle will be low during exercise because the tissues can extract greater than normal amounts of oxygen from slowly flowing blood (choice C).

General vascular resistance (choice D) is expected to be high in a patient with arteriosclerotic occlusive disease, which would provide a reason to suspect that serum lipid levels (choice E) are decreased. Elevated serum lipid levels can accelerate the progression of arteriosclerosis.
Routine immunization injection being given to her 2-year-old brother, a teenage girl suddenly feeling faint and starts hyperventilating. A nurse has her sit on the floor and gives her a paper bag. What is the rationale for this therapy?

- Higher CO2 content of the bag will correct the patient's compensated respiratory acidosis
- Higher CO2 content of the bag will correct the patient's compensated respiratory alkalosis
- Higher CO2 content of the bag will correct the patient's uncompensated respiratory acidosis
- Higher CO2 content of the bag will correct the patient's uncompensated respiratory alkalosis

A paper bag is a placebo

Answer is D. Hyperventilation can be triggered by emotional stress, and the resulting rapid breathing results in "blow off" more CO2 from the lung than usual. Since CO2 is carried in the serum principally as bicarbonate plus hydrogen ion, blowing off CO2 shifts the balance so that less bicarbonate and less hydrogen ion are present in the blood. Less hydrogen ion translates to higher blood pH, i.e., alkalosis, which in this setting is respiratory origin. It is an uncompensated respiratory alkalosis, since renal compensation takes time to occur. Re-breathing air, which is easily accomplished by breathing into a paper bag, will slow CO2 loss and quickly correct the alkalosis. The manifestations of the type of mild respiratory alkalosis (not seen in this setting) can also cause cramps, tetany, seizures, and sometimes, syncope.
A 52-year-old man is admitted to the hospital complaining of chest pain and difficulty breathing. He has a history of rheumatic valvular disease. Physical examination reveals a systolic murmur. Pressure tracings from the aorta, left ventricle, and left atrium are shown in the diagram. This patient is suffering from which of the following?

A. Aortic obstruction  
B. Aortic regurgitation  
C. Infarction of the left ventricle  
D. Mitral obstruction  
E. Rupture of the chordae tendineae

Explanation:

The correct answer is E. The patient is suffering from mitral regurgitation caused by rupture of the chordae tendineae. Mitral regurgitation is characterized by a greatly elevated left atrial pressure toward the end of systole caused by backward flow of blood from the left ventricle into the left atrium through the leaky mitral valve. The left atrial pressure is normal at the end of diastole with mitral regurgitation because blood flows unimpeded from the atrium into the ventricle when the mitral valve is open. The leak occurs during systole, and is characterized by a systolic murmur, which was noted in the patient. The chordae tendineae are tendinous cords that connect each cusp of the mitral valve to the papillary muscles in the left ventricle. When these rupture, the cusps of the mitral valve cannot be approximated during systole, which results in backward flow of blood into the left atrium. The
chordae tendineae are often damaged in rheumatic valvular disease, which increases the probability of rupture.

The aortic pressure and left ventricular pressure tracings are nearly superimposed during systole in the diagram, which eliminates the possibility of aortic obstruction (choice A) and aortic regurgitation (choice B).

The rate of rise of left ventricular pressure appears to be normal, which argues against the possibility of left ventricular infarction (choice C).

In mitral obstruction (choice D), the left atrial pressure is greater than the left ventricular pressure toward the end of diastole when blood is flowing from the left atrium into the left ventricle.

A 23-year-old woman decides to donate her left kidney to her brother, who has bilateral renal failure. Blood flow was 600 mL/min and vascular resistance was 0.16 mm Hg/mL/min in her kidney before it was removed. Which of the following would be expected to increase following the removal of her kidney?

A. Arterial blood pressure  
B. Cardiac output  
C. Pulmonary blood flow  
D. Total renal blood flow  
E. Total peripheral resistance

Explanation:

The correct answer is E. The various organs of the body are arranged in parallel, and therefore contribute a parallel resistance to the peripheral circulation. You should recall that adding resistances (R1, R2, R3...) in parallel reduces the total resistance (RT) of a circuit as follows (1/RT = 1/R1 + 1/R2 + 1/R3...) so that removing a parallel resistance (R1, R2, or R3) increases the total resistance (RT). For this reason, the total peripheral resistance increases when a kidney is removed. Another way to think about the problem is the following: each kidney provides a pathway for blood to flow from the aorta to the vena cava. When a kidney is removed, there is one less pathway through which blood can flow from the aorta to the vena cava, which means that the resistance to blood flow from the aorta to the vena cava (i.e., the total peripheral resistance) must be increased. Similar logic can be applied to any organ of the body.
Removing a kidney should have not have a lasting effect on arterial pressure (choice A), assuming that the remaining kidney functions normally.

The cardiac output (choice B) decreases when a kidney is removed.

The pulmonary blood flow (choice C), which is equal to the cardiac output of the right heart, should decrease when a kidney is removed.

The total renal blood flow (choice D) will decrease when a kidney is removed.

A 27-year-old woman is giving birth. During the birth, the placental membranes tear and amniotic fluid is expressed into a lacerated cervical vein. Which of the following is the woman most likely to experience immediately following this event?

A. Hemiplegia

B. Placental abruption

C. Renal failure

D. Respiratory distress

E. Splinter hemorrhages

Explanation:

The correct answer is D. Respiratory distress immediately follows amniotic fluid embolism as the emboli consisting of squamous cells, lanugo, and mucus deposit in the pulmonary microcirculation, producing numerous tiny pulmonary infarcts. The dramatic respiratory distress may also reflect the action of prostaglandins and other bioactive compounds present in high concentrations in the amniotic fluid embolus.

Hemiplegia (choice A) would reflect an ischemic injury to one hemisphere of the cerebrum or the brainstem. A venous embolus would not produce such an insult.

Placental abruption (choice B) is partial, premature separation of the placental disc from the endometrium. Although abruption may occur in this setting, it is not a result of an amniotic fluid embolism.
There are numerous causes of renal failure (choice C); the most likely ones in the peripartum interval include eclampsia, hypovolemic shock, and ascending infections. Amniotic fluid embolism would be expected to produce severe dyspnea well before shock and renal failure might arise.

Splinter hemorrhages (choice E) are small hemorrhages seen on toes and fingers due to a shower of microemboli arising in the arterial circulation. Amniotic fluid emboli arise in the veins and deposit in the lungs.

In a normal individual, a tube with a transducer at its tip is swallowed and passed an unknown distance down the esophagus. Between swallows it records a pressure of 25 mm Hg. A small amount of water is swallowed. Within 2 seconds, the pressure falls to 5 mm Hg, where it remains until returning to its resting pressure 6 seconds later. In a patient with achalasia, the transducer is advanced to the same location. Between swallows, it records a pressure of 30 mm Hg. After swallowing, the pressure fails to decrease at all. In which of the following sites is the transducer most likely located?

A. Esophageal body distal to the diaphragm
B. Esophageal body proximal to the diaphragm
C. Lower esophageal sphincter
D. Pharynx
E. Upper esophageal sphincter

Explanation:
The correct answer is C. Achalasia is an acquired esophageal motility disorder that is characterized by loss of enteric inhibitory neurons. The lower esophageal sphincter may exhibit increased tone in between swallows and fail to relax normally with a swallow. Peristalsis in the esophageal body is also abnormal. A swallow may not induce any peristalsis in the esophageal body or may produce simultaneous contractions along its entire length.

The esophageal body distal to the diaphragm (choice A) is relaxed in between swallows. The intraesophageal pressure at this point reflects the intra-abdominal pressure, which is slightly positive (5 mm Hg). During inspiration, the pressure inside the distal esophagus rises along with the intra-abdominal pressure; during expiration this pressure falls. The pressure in the esophageal body proximal to the diaphragm (choice B) reflects the intrathoracic pressure. It is slightly negative at the end of inspiration and slightly positive at the end.
of expiration.

Since the mouth and pharynx are open to the atmosphere, in between swallows, the pressure within the pharynx (choice D) is atmospheric (0 mm Hg). The pressure rises abruptly to a maximum of 100 mm Hg at the start of a swallow and returns to baseline within 0.5 seconds.

At rest, the pressure in the upper esophageal sphincter (choice E) can be as high as 60 mm Hg. It is maintained by the normal elasticity of the sphincteric structures, and by active contraction of the cricopharyngeal muscle, which composes most of the sphincter. Shortly after the pharyngeal muscles contract during a swallow, the upper esophageal sphincter relaxes as the tonic neural input to the cricopharyngeal muscle (skeletal muscle) is inhibited as part of the swallowing program. Function of this sphincter is unaffected by achalasia.

A 69-year-old man with Alzheimer disease and a 10-year history of type 2 diabetes is brought to a family practice clinic by his daughter. The patient is unable to give a clear account of how carefully he controls his blood glucose. Which of the following laboratory parameters could be used to assess glycemic control over the past 3-6 months?

A. Blood glucose

B. Blood insulin levels

C. Blood ketones

D. Glycosylated hemoglobin

E. Urinary glucose

Explanation:

The correct answer is D. The amount of glycosylated hemoglobin (HbA1c) is directly related to the level of glucose in the blood. Since HbA1c is a stable product, its concentration reflects glucose levels over the past 3-6 months. HbA1c forms as a result of nonenzymatic glycosylation, a fundamental biochemical abnormality that accounts for most of the histopathologic alterations in diabetes mellitus. At first, glucose forms reversible glycosylation products with proteins by formation of Schiff bases. Rearrangement of Schiff bases leads to more stable, but still reversible, Amadori products and subsequently to irreversible advanced glycosylation end products (AGE), of which HbA1c is an example. Blood ketones, blood glucose, urinary glucose, and blood
insulin do not reflect long-standing metabolic abnormalities of diabetes mellitus and cannot be used to assess long-term glycemic control.

Blood glucose (choice A) is elevated in both type 1 and type 2 diabetes mellitus. Hyperglycemia is the diagnostic feature of diabetes mellitus and leads to glycosuria (choice E) when blood glucose exceeds 160-180 mg/dL.

Blood insulin (choice B) is decreased in untreated type 1 diabetes and normal or even slightly increased in type 2 diabetes.

Blood ketones (choice C) (acetoacetic acid and β-hydroxybutyric acid) are synthesized from free fatty acids in response to severe insulin deficiency. Accumulation of ketone bodies in the blood is a crucial pathogenetic factor in ketoacidosis, which occurs exclusively in type 1 diabetics.

A high school basketball player passes out in the middle of a game. He is rushed to the emergency room, where he regains consciousness. He claims that just before he fainted, he had difficulty breathing and experienced palpitations. On physical exam, he has a bifid apical impulse and a coarse systolic murmur at the left sternal border. The echocardiogram reveals ventricular hypertrophy with asymmetric septal thickening. Which of the following would increase the intensity of his heart murmur?

A. Elevating his legs
B. Increasing sympathetic tone
C. Performing the Valsalva maneuver
D. Squatting

Explanation:
The correct answer is C. This patient has hypertrophic cardiomyopathy—the most common cause of sudden cardiac death in young patients. It usually causes problems during exertion. Clues to the diagnosis include: dyspnea, palpitations, bifid apical impulse, coarse systolic murmur at the left sternal border, and ventricular hypertrophy with asymmetric septal thickening on echocardiogram. Left ventricular outflow obstruction typically plays an important role in the pathophysiology of this condition. Maneuvers that decrease preload, such as the Valsalva maneuver, will accentuate the heart murmur because they result in less ventricular filling, contributing to greater outflow obstruction.
Elevating his legs (choice A), increasing sympathetic tone (choice B), and squatting (choice D) would all increase venous return and would therefore diminish the murmur.

Deficiency in which of the following usually predisposes to thrombosis rather than bleeding?

A. Factor V
B. Factor VIII
C. Factor IX
D. Factor X
E. Factor XII

Explanation:

The correct answer is E. Factor XII is unusual among coagulation factors in that its deficiency is associated with thrombosis rather than hemorrhage. The mechanism appears to be a deficient activation of fibrinolysis, and both thrombophlebitis and myocardial infarction have occurred in severely affected patients. The condition is inherited in an autosomal recessive manner. Many patients with mild-to-moderate factor XII deficiency are never detected; others are identified when a routine preoperative clotting screen demonstrates a greatly prolonged partial thromboplastin time. Deficiency of each of the other factors (choices A, B, C, and D) is associated with hemorrhage.

In attempting to introduce a catheter into the right internal jugular vein, a resident inadvertently damages the cervical sympathetic trunk in a patient. Which of the following findings is most likely to be seen in this patient as a result of the injury?

A. Constriction of the right pupil
B. Dilation of the right pupil
C. Inability to abduct the right eye

D. Inability to close the right eye

E. Paralysis of the platysma muscle on the right side

Explanation:

The correct answer is A. The right sympathetic trunk lies posterior to the right internal jugular vein, and may be injured in this procedure. Preganglionic sympathetic nerve fibers will be damaged. These nerve fibers synapse in the superior cervical ganglion on postganglionic sympathetic neurons that innervate structures in the head. The dilator pupillae muscle (smooth muscle of the iris that dilates the pupil) is sympathetically innervated; paralysis of this muscle due to interruption of its innervation results in constriction of the pupil (miosis).

Dilation of the pupil (choice B) would result from paralysis of the sphincter pupillae muscle (smooth muscle of the iris that constricts the pupil). This muscle is parasympathetically innervated and would not be affected by this injury.

An inability to abduct the eye (choice C) would result from paralysis of the lateral rectus muscle, an extraocular muscle that is innervated by the abducens nerve. It would not be affected by this injury.

An inability to close the eye (choice D) would result from paralysis of the orbicularis oculi muscle, a skeletal muscle of the face. This muscle is innervated by the facial nerve and would not be affected by this injury.

The platysma muscle (choice E) is a skeletal muscle in the superficial fascia of the neck. It is innervated by the facial nerve and would not be affected by this injury.

A 33-year-old woman develops a reducible mass of the groin that is inferolateral to the pubic tubercle and medial to the femoral vein. Which of the following is the most likely diagnosis?

A. Direct inguinal hernia

B. Femoral hernia

C. Incisional hernia

D. Indirect inguinal hernia
E. Umbilical hernia

Explanation:

The correct answer is B. The patient has a femoral hernia. This hernia forms by passage of a loop of bowel into the saphenous opening of the fascia lata and then through the cribiform fascia, to bulge anteriorly under the skin over the saphenous opening. Femoral hernias are much more common in women than in men. The major risk of this type (and most other types) of hernia is strangulation of the herniated small intestine, which may result in death of the involved tissue with significant risk of subsequent life-threatening peritonitis and sepsis.

A direct inguinal hernia (choice A) represents intestinal structures passing through a gap in the abdominal wall between transversus abdominis and the internal oblique muscles; these structures do not pass through the deep ring.

An incisional hernia (choice C) occurs where a surgical incision has weakened the abdominal wall.

An indirect inguinal hernia (choice D) represents extrusion of abdominal contents through the deep ring, through the inguinal canal, to emerge at the superficial inguinal ring. During physical examination, the hernia can sometimes be reduced by the patient lying on his/her back; if the physician applies pressure to the site of the deep ring, reherniation will temporarily be prevented, verifying the diagnosis of indirect inguinal hernia.

An umbilical hernia (choice E) represents a slight herniation of the midgut at the site of insertion of the umbilical cord.

A 58-year-old man with fainting spells and exercise intolerance is found to have a bicuspid aortic valve with marked aortic stenosis. Which of the following physical findings would be prominent in this patient?

A. Diastolic murmur

B. Heave at left parasternal border

C. Loud S2 heart sound

D. Loud S3 heart sound

E. Weak peripheral pulse
Explanation:

The correct answer is E. Flow across the aortic valve is very slow and turbulent in aortic stenosis. Consequently, aortic pressure rises slowly, and peripheral pulses are of low amplitude. The flow murmur across the aortic valve is heard during systole.

Diastolic murmurs (choice A) are a consequence of turbulence during ventricular filling, such as in mitral stenosis or aortic incompetence. Classically, aortic stenosis is associated with a midsystolic murmur.

Heaves are due to ventricular hypertrophy, and a left parasternal heave (choice B) indicates right ventricular hypertrophy. Aortic stenosis produces left ventricular hypertrophy, and thus a sustained apical heave is felt.

The S2 heart sound (choice C) is produced when the aortic valve snaps shut. S2 is soft in aortic stenosis because of the decreased arterial pressures and the intrinsically poor mobility of the aortic valve.

The S3 heart sound (choice D) is associated with rapid ventricular filling, and may occur either in mitral incompetence or congestive heart failure. No extra heart sound is heard in aortic stenosis.

The diagram above shows maximum expiratory flow-volume (MEFV) curves from a typical healthy individual (solid curve) and from a 62-year-old carpenter who complains of shortness of breath (dashed curve). The carpenter most likely suffers from which of the following disorders?

A. Asbestosis

B. Emphysema
C. Pleural effusion

D. Pneumothorax

E. Silicosis

Explanation:

The correct answer is B. In obstructive lung disease such as emphysema, the MEFV curve begins and ends at abnormally high lung volumes, and the flow rates are lower than normal at any given lung volume. Note on the diagram that the patient's total lung capacity is 7 liters and the residual volume is 3.5 liters (dashed curve). The curve may also have a scooped out appearance as shown on the diagram. Note that absolute lung volumes cannot be determined from a MEFV curve alone. An additional method is used to measure residual volume, then the curves can be placed appropriately on the abscissa.

Lung volumes are expected to be lower than normal in asbestosis (choice A), pleural effusion (choice C), pneumothorax (choice D), silicosis (choice E), and other types of restrictive lung diseases.

A 3-month-old infant develops cyanosis limited to the lower part of the body. Which of the following anomalies would most likely account for this peculiar clinical presentation?

A. Aortic coarctation, adult form

B. Aortic coarctation, infantile form

C. Isolated patent ductus arteriosus (PDA)

D. Pulmonary stenosis

E. Tetralogy of Fallot

Explanation:
The correct answer is B. There are two forms of aortic coarctation, infantile and adult. This infant manifests the characteristic signs of the infantile form of aortic coarctation, which is associated with patent ductus arteriosus (PDA). The stenotic segment is localized proximal to a PDA. Since blood pressure drops distal to the PDA, blood will shunt from the pulmonary artery to the aorta through the PDA. Thus, cyanosis develops in the lower part of the body only.

The adult form of aortic coarctation (choice A), in contrast, is not associated with PDA. This is more common than the infantile form and leads to hypertension proximal to the stenosis (ie, in the head and upper limbs) and hypotension in the lower half of the body. There is no cyanosis.

Isolated PDA (choice C), if large enough, will allow significant left-to-right shunting, resulting in pulmonary overload, secondary pulmonary hypertension, and right ventricular hypertrophy (chronic cor pulmonale). Persistence of PDA is promoted by prostaglandin E, whereas inhibitors of prostaglandin synthesis (indomethacin or other NSAIDs) facilitate closure of the ductus.

Pulmonary stenosis (choice D) is an infrequent form of congenital heart disease that presents with chronic cor pulmonale because of increased resistance to blood flow in the pulmonary artery. Right-sided heart failure develops without cyanosis.

Tetralogy of Fallot (choice E) is one of the most frequent types of congenital heart disease in general, and the most frequent cause of cyanotic congenital heart disease. Its features include subpulmonary stenosis, ventricular septal defect, an overriding aorta, and right ventricular hypertrophy. If the degree of subpulmonary stenosis is severe, right-to-left shunting ensues and cyanosis is produced. In this case, cyanosis involves the entire body, not the lower half only.

A 1-year-old child with frequent pulmonary infections has signs of mild congestive heart failure. On physical examination, he is found to have a harsh systolic murmur with no diastolic murmur. Cardiac catheterization shows increased oxygen saturation in the right ventricle. Two-dimensional echocardiography would most likely reveal

A. aortic insufficiency

B. mitral stenosis

C. a patent ductus arteriosus

D. a patent foramen ovale

E. a ventricular septal defect
Explanation:

The correct answer is E. A child with a harsh systolic murmur, no diastolic murmur, and an increased oxygen saturation in the right ventricle most likely has a ventricular septal defect (VSD). VSDs are congenital and are commonly located near the membranous interventricular septum. Hemodynamic consequences include the development of left-to-right shunts (the magnitude of the shunt being proportional to the size of the defect), which may result in equalization of systolic pressures in the two ventricles. Cardiac catheterization allows for direct visualization and measurement of the shunt and reveals increased oxygen saturation in the right ventricle. Clinically, VSD is associated with a harsh, holosystolic murmur heard more readily if there is a residual pressure gradient between the two sides.

Aortic insufficiency (choice A) and mitral stenosis (choice B) do not generate left-to-right shunts and will not produce increased oxygen saturation in the right ventricle.

A patent ductus arteriosus (choice C) can initially cause left-to-right shunting, but eventually, as pulmonary vascular resistance increases, a right-to-left shunt may occur. Therefore, cardiac catheterization will fail to show increased oxygen saturation in the right ventricle. The murmur of a patent ductus arteriosus is not holosystolic but a continuous "machinery" murmur; it is readily distinguishable from a VSD murmur.

A patent foramen ovale (choice D) should not be confused with an atrial septal defect, which could account for the increased oxygen saturation on the right side but could not account for the systolic murmur. A patent foramen ovale refers to a residual slitlike opening between the atria that is patent to a probe but is not of hemodynamic significance. In contrast, an atrial septal defect is a much larger opening.

An injection of lipopolysaccharide (LPS) into the vascular system will rapidly produce myocardial dysfunction, hypotension, disseminated intravascular coagulation, and coma. This sequence of events most closely mimics what type of shock?

A. Anaphylactic

B. Cardiogenic

C. Hypovolemic
D. Neurogenic

E. Septic

Explanation:

The correct answer is E. Septic shock is a complex, multisystem organ failure that can be produced either by LPS (which is present in the cell wall of all gram-negative bacteria) or certain toxins released by gram-positive bacteria and fungi. LPS binds to a serum protein and stimulates CD14 receptors on endothelial cells and circulating inflammatory cells, eliciting a broad range of end-organ responses.

Anaphylactic shock (choice A) is brought about by an exaggerated Type I hypersensitivity reaction mediated by IgE antibodies bound to mast cells and basophils. The resulting degranulation produces massive histamine and adenosine release, which produces constriction of the bronchi and pulmonary circulation.

Cardiogenic shock (choice B) reflects the inability of the heart to maintain arterial pressure sufficiently to perfuse the systemic vasculature. Cardiogenic shock is intrinsic to the heart and usually a consequence of ischemia, arrhythmia, or obstruction.

Hypovolemic shock (choice C) occurs when blood volume decreases to a point at which it is inadequate to maintain arterial pressure in the vital organs. Hypovolemic shock is due to hemorrhage, fluid loss from burns, or severe diarrhea and vomiting.

Neurogenic shock (choice D) is an unusual form of shock that occurs in catastrophic nervous system injuries that cause diffuse vasodilation and hypotension.

A 60-year-old nursing home patient is transferred to the hospital in respiratory distress. Portable chest x-ray demonstrates a heavy shadowing of the right middle and right lower lobes. Gram's stain of sputum shows large numbers of lancet-shaped, gram-positive diplococci. Arterial blood gases reveal a P02 of 50 mm Hg. Which of the following mechanisms most likely accounts for this patient's hypoxia?

A. Decreased surface area of alveolar capillary membranes

B. Decrease of P02 in inspired air

C. Hypoventilation of central origin
D. Hypoventilation of peripheral origin

E. Inequalities of ventilation and perfusion

Explanation:

The correct answer is E. The patient has lobar pneumococcal pneumonia of the right middle and right lower lobes. Respiratory distress in lobar pneumonia is predominately due to inequalities of ventilation and perfusion, since the dilated vessels of the involved lobes transmit a higher-than-usual percentage of the blood passing through the lungs at the same time that the alveolar fluid prevents normal ventilation of the affected areas. Inequalities of ventilation and perfusion also can contribute to hypoxemia in chronic obstructive pulmonary disease, atelectasis, pulmonary infarction, tumors, and granulomatous diseases.

Decreased surface area of alveolar capillary membranes (choice A) is seen following lung resection and in diseases such as emphysema.

Decrease of P02 in inspired air (choice B) is seen at high altitude and during artificial ventilation if the fractional O2 content setting is incorrect.

Hypoventilation of central origin (choice C) is seen with morphine and barbiturate overdose.

Hypoventilation of peripheral origin (choice D) is seen with acute poliomyelitis, chest trauma, suffocation, drowning, phrenic nerve paralysis, and Pickwickian syndrome.

Over a 3-month period, a 12-year-old girl develops weight loss despite eating large amounts of food. Careful questioning by the clinician reveals that the child is now drinking soft drinks "all the time." Which of the following serum chemistry studies will most likely be diagnostic of this child's condition?

A. Blood urea nitrogen (BUN)

B. Serum bicarbonate

C. Serum calcium

D. Serum glucose
E. Serum sodium

Explanation:

The correct answer is D. While it is commonly known that diabetes mellitus is associated with polyuria and polydipsia, many do not realize it also associated with weight loss despite increased eating. In our extremely weight- and food-conscious society, this phenomenon may be much more striking to the patient and his family than a change in the amount of fluid intake. The lesson learned is that a child who develops weight loss despite increased food intake deserves a blood glucose test.

A 42-year-old male presents with complaints of recurrent headaches. He also admits to impotence and loss of libido that has gradually worsened during the past year. Visual field examination reveals a bitemporal hemianopsia. Laboratory examination reveals an increase in serum prolactin, while serum luteinizing hormone (LH) and testosterone are decreased. Which of the following is the most likely diagnosis?

A. Craniopharyngioma
B. Idiopathic panhypopituitarism
C. Isolated LH deficiency
D. Pituitary infarction
E. Prolactinoma

Explanation:

The correct answer is E. Hyperprolactinemia is the most common hypothalamic-pituitary disorder. A tumor in the pituitary (prolactinoma) that secretes excessive prolactin is the most common functional pituitary tumor. The increase in serum prolactin suppresses the normal GnRH-gonadotropin-gonadal steroid axis. Hypogonadism, manifested as amenorrhea in females or loss of libido and/or impotence in males, is a prominent symptom. Blood levels of sex steroids are usually decreased. Although not present in this patient, galactorrhea may occur due to the action of prolactin on the mammary gland. Since the anterior pituitary is located just below the optic chiasm, space-filling tumors that compress this structure may produce visual field defects.

Craniopharyngioma (choice A) can also produce hyperprolactinemia. If this tumor impinges on the pituitary stalk
and interferes with hypophyseal portal blood flow, the decrease in delivery of dopamine to the anterior pituitary can result in increased prolactin secretion. However, craniopharyngioma is more common in children and adolescents than in adults. Only 20% of craniopharyngiomas are diagnosed after age 40.

Idiopathic panhypopituitarism (choice B) would manifest with decreases in all anterior pituitary hormones, including prolactin.

Isolated LH deficiency (choice C) could explain the loss of libido and decreased plasma levels of LH and testosterone. However, it could not explain the increase in prolactin.

Pituitary infarction (choice D), which can occur in women who hemorrhage excessively during parturition (Sheehan's syndrome), leads to varying degrees of hypopituitarism. If the infarction produced significant necrosis in pituitary lactotrophs, blood levels of prolactin would be low rather than high.

A 47-year-old male enters the hospital emergency room after severing a major artery during a farm accident. It is estimated that the patient lost about 800 mL of blood. His blood pressure is 95/65 mm Hg. A decrease in which of the following would be expected in response to hemorrhage in this man?

A. Heart rate
B. Plasma renin activity
C. Sympathetic nerve activity
D. Total peripheral resistance
E. Vagal nerve activity

Explanation:

The correct answer is E. The decrease in blood pressure caused by hemorrhage activates the baroreceptor reflex, which tends to increase sympathetic nerve activity (compare with choice C) and decrease parasympathetic (vagal) nerve activity. The fact that the patient has lost 800 mL of blood and yet his blood pressure has decreased only slightly may be attributed to the following compensatory responses: baroreceptor reflex, chemoreceptor reflex, epinephrine and norepinephrine released from the adrenal medulla, formation of angiotensin II, formation of vasopressin, and the shift of fluid from the tissues into the capillaries.
The increase in heart rate (choice A) that occurs during hemorrhage can be attributed to decreased vagal tone and increased sympathetic nerve activity.

Plasma renin activity (choice B) is increased during hemorrhage. Activation of the renin-angiotensin system during hemorrhage plays an important role in maintaining blood pressure. Angiotensin II increases blood pressure acutely by constricting arterioles throughout the body, and chronically by decreasing the renal excretion of both salt and water.

The increase in sympathetic nerve activity constricts blood vessels throughout the body, which causes the total peripheral resistance (choice D) to increase.

The diagram above shows spirographic tracings of forced expirations from two different individuals. Trace X was obtained from a person with healthy lungs. Which of the following conditions is most likely represented by trace Y?

A. Asbestosis
B. Emphysema
C. Pleural effusion
D. Pneumothorax
E. Silicosis

Explanation:

The correct answer is B. A forced expiration is the simplest test of lung function. The individual breathes in as much air as the lungs can hold and then expels the air as rapidly and as forcefully as possible. The forced vital capacity (FVC) is the vital capacity measured with a forced expiration (3 L for patient Y). The forced expiratory volume in one second (FEV1) is the amount of air that can be expelled from the lungs during the first second of a forced
expiration (1.5 L for patient Y). The FEV1/FVC ratio has diagnostic value for differentiating between normal, obstructive, and restrictive patterns of a forced expiration. FEV1/FVC is a function of airway resistance. Airway resistance is often increased in emphysematous lungs, which causes FEV1/FVC to decrease (note that FEV1/FVC is 50% in patient Y and 80% in the healthy individual represented by trace X).

FVC is also decreased in restrictive lung diseases such as asbestosis (choice A) and silicosis (choice E) with a normal or slightly increased FEV1/FVC ratio.

Although FVC is decreased in pleural effusion (choice C) and pneumothorax (choice D), the airway resistance is usually not affected greatly so that FEV1/FVC may be normal.

An elderly woman in a nursing home has a fainting spell and is taken to the doctor. Physical examination reveals a resting blood pressure of 130/60 mm Hg and a heart rate of 40 beats per minute. Which of the following is the most likely diagnosis?

A. Aortic valve obstruction  
B. Cardiac tamponade  
C. Complete heart block  
D. Heart failure  
E. Mitral valve obstruction

Explanation:

The correct answer is C. In complete (third degree) heart block the ventricles beat independently of SA node activity and P waves become completely dissociated from QRS-T complexes. The rate of the ventricular beat is usually 30 to 45 per minute. Because resting cardiac output (CO) is normal and because CO = stroke volume x heart rate, the stroke volume is increased in complete heart block. When the stroke volume increases, a greater amount of blood must be accommodated in the arterial tree with each heartbeat, which causes a greater rise and fall in pressure during systole and diastole. Note that the pulse pressure is 70 mm Hg in this patient (normal pulse pressure is 30 to 50 mm Hg).

The pulse pressure is decreased in aortic valve obstruction (choice A), cardiac tamponade (choice B), heart failure (choice D), and mitral valve obstruction (choice E).
A 2-year old child's height is 3 standard deviations below the mean for his chronological age. Growth velocity is below the fifth percentile for his chronological age. The child's father is 6' 2" and his mother is 5' 5". Laboratory data show that plasma growth hormone (GH) is increased compared to normal. Plasma levels of IGF-1 are decreased. Growth hormone binding protein (GHBP) in the blood is undetectable. Which of the following most likely explains these findings?

A. Constitutional short stature

B. Genetic short stature

C. Growth hormone deficiency due to decreased GRH

D. Growth hormone deficiency due to dysplasia of the pituitary

E. Laron dwarfism

Explanation:

The correct answer is E. Laron dwarfism is due to a congenital absence of growth hormone receptors. Growth hormone binding protein (GHBP), which circulates in the blood, is identical to the extracellular portion of the growth hormone receptor. Plasma levels of GHBP are directly related to tissue expression of the growth hormone receptor. The absence of GHBP in the blood of this child confirms the absence of tissue growth hormone receptor. In Laron dwarfism, plasma concentrations of IGF-1 are low because there is no growth hormone receptor on hepatocytes, which secrete most of the blood-borne IGF-1 in response to growth hormone. Plasma growth hormone concentration is increased because of loss of negative feedback effects of growth hormone on the hypothalamus to increase the release of somatostatin into the hypophyseal portal blood. In addition, the negative feedback effects of IGF-1 at the hypothalamus and pituitary are diminished because of the low blood levels of this growth factor.

With constitutional short stature (choice A), growth hormone is not decreased. Rather, this disorder is considered a delay in the normal velocity of growth. Other family members often have a similar decrease in growth rate. The pubertal growth spurt is also delayed. Adult height is usually normal to low-normal.

Genetic short stature (choice B) is unlikely in this child because neither of the parents is short.

Dwarfing also occurs with growth hormone deficiency due to either hypothalamic (choice C) or pituitary (choice
D) dysfunction. However, both of these defects would be characterized by decreased plasma growth hormone concentration and decreased IGF-1 concentration.

A 32-year-old female with gradually worsening dyspnea and fatigue, anginal chest pain, and two documented episodes of pulmonary thromboemboli over the last year receives a heart-lung transplant. Her native heart shows massive right ventricular hypertrophy. The lungs show numerous thromboemboli, and the vasculature shows marked medial smooth muscle hypertrophy, web-like endothelial proliferations filling several arterioles, and atherosclerotic plaques on the main pulmonary arteries. With which of the following diagnoses are these findings most consistent?

A. Adult respiratory distress syndrome

B. Atopic asthma

C. Goodpasture's disease

D. Pulmonary hypertension

E. Sarcoidosis

Explanation:

The correct answer is D. Normally, the pulmonary circulation is a low-pressure system, eliciting very little endothelial or medial response. Conversely, pulmonary hypertension leads to medial hypertrophy, arterial fibrosis, and marked narrowing of the arterial lumina, predisposing to arterial thrombosis. Tufts of endothelial proliferations (producing so-called plexogenic pulmonary arteriopathy) is prominent in primary pulmonary hypertension.

Adult respiratory distress syndrome (ARDS; choice A) is a clinical term for rapid onset of respiratory insufficiency secondary to diffuse alveolar damage. The lungs show alveoli filled with proteinaceous debris and desquamated alveolar lining cells and alveolar septae lined by hyaline membranes. The heart and pulmonary vasculature show no specific changes in ARDS.

Atopic asthma (choice B) is characterized by chronic airway inflammation and bronchial hyperresponsiveness. No cardiovascular changes are found in atopic asthma; instead there are copious mucus plugs, numerous bronchial neutrophils and eosinophils, thickening of the bronchial basement membrane, and hypertrophy of bronchial smooth muscle and submucous glands.
Goodpasture's disease (choice C) is a necrotizing and hemorrhagic pneumonitis accompanied by rapidly progressive glomerulonephritis. The lungs would be filled with fresh hemorrhage and hemosiderin-laden macrophages.

Sarcoidosis (choice E) is an interstitial pneumonitis that produces non-caseating giant cell granulomas. It typically produces nodules in the lungs and hilar lymph nodes; arterial and cardiac involvement by sarcoidosis is very uncommon.

A 68-year-old man sustains a myocardial infarct resulting from thrombotic occlusion at the origin of the left circumflex artery. Cardiac catheterization demonstrates that the patient has a left dominant coronary circulation. Which of the following areas of the heart have most likely suffered ischemic necrosis?

A. Apex of left ventricle and anterior portion of septum
B. Lateral left ventricular wall and posterior portion of the septum
C. Lateral wall of the left ventricle only
D. Posterior portion of the septum only
E. Right ventricular wall

Explanation:

The correct answer is B. A right dominant coronary circulation is present when the posterior descending branch originates from the right coronary artery (80% of individuals). On the contrary, the posterior descending artery originates from the left circumflex artery in a left dominant circulation (20% of individuals). The posterior descending branch gives blood to the posterior half of the interventricular septum. Occlusion of the left circumflex artery in a left dominant circulation will therefore lead to ischemic necrosis in the left ventricular wall and the posterior interventricular septum.

The apex of the left ventricle (choice A) is dependent on the anterior descending branch; thus, occlusion of the left circumflex does not affect this portion of the left ventricle.

Infarction of the lateral (free) wall alone (choice C) will result from occlusion of the circumflex in a right dominant circulation.
An isolated infarct of the posterior interventricular septum (choice D) arises from occlusion of the posterior descending branch.

Isolated infarcts of the right ventricular wall (choice E) are very rare and would be caused by occlusion of branches of the right coronary artery.

A 32-year-old woman develops hyperthyroidism every time she gets pregnant. Serum T4 levels markedly increase during the first 10 weeks of the pregnancy and then decline and are only moderately increased during the remainder of the pregnancy. When she is not pregnant, her thyroid hormone status is completely normal. This condition can best be explained by a mutation in the

A. T3 receptor, rendering it responsive to progesterone
B. T3 receptor, rendering it responsive to estriol
C. TSH receptor, rendering it responsive to human chorionic gonadotropin
D. TRH receptor, rendering it responsive to human chorionic somatomammotropin
E. TSH receptor, rendering it responsive to human chorionic somatomammotropin

Explanation:

The correct answer is C. The key to answering this question is knowing the plasma concentration profile across the 40 weeks of pregnancy for each of the hormones mentioned. Plasma concentration of human chorionic gonadotropin (hCG) doubles every 2 days during the first ten weeks of pregnancy and then declines to a level that is one tenth of the peak for the remainder of the pregnancy. hCG is in the same hormone family as TSH, FSH, and LH. These are all glycoprotein hormones with identical α subunits but different β subunits. Hence, there is a similarity in receptors for these hormones as well. A mutation in the TSH receptor that also made it responsive to hCG would result in increased thyroid hormone secretion during pregnancy due to the increased circulating hCG. Under non-pregnant conditions, thyroid hormone secretion would be normal. This mutation was actually found in a woman who had experienced several early miscarriages. When she was treated for hyperthyroidism with propylthiouracil during her pregnancy, her child was carried to full term.

Plasma concentrations of progesterone and estrogen increase throughout pregnancy. By 40 weeks, the progesterone concentration may be 200 times greater than pre-pregnancy levels. Estradiol and estrone
increase by about 50 fold, while estriol increases about 1000 fold. While the T3, estrogen, and progesterone receptors all originate from the same superfamily, it is unlikely that the woman's pregnancy-associated hyperthyroidism is due to an action of progesterone or estrogen on the T3 receptor (choices A and B). If this were the case, plasma levels of thyroid hormone would be expected to rise throughout pregnancy with highest concentration occurring just prior to birth. Furthermore, in the non-pregnant state, increases in estrogen during the follicular phase and increases in progesterone during the luteal phase would produce problems in thyroid hormone secretion. This patient had normal thyroid status when not pregnant.

Human chorionic somatomammotropin (hCS) increases throughout pregnancy. It is related to the anterior pituitary hormones prolactin and growth hormone. A mutation in either the TRH receptor (choice D) or the TSH receptor (choice E) would be unlikely to be responsive to hCS because this hormone is unrelated to either TRH or TSH. Furthermore, if such a mutation could occur, it would produce maximal thyroid hormone concentration near the end of the pregnancy (not at 10 weeks).

A 40-year-old man with polyuria has a urine osmolality of 50 mOsm. Despite drinking a large amount of water, his serum osmolarity is 316 mOsm. Upon administration of vasopressin, serum osmolarity decreases to 285 mOsm and urine osmolarity increases to 350 mOsm. What is the most likely diagnosis?

A. Nephrogenic diabetes insipidus
B. Primary diabetes insipidus
C. Psychogenic polydipsia
D. Severe water deprivation

Explanation:

The correct answer is B. Primary (central) diabetes insipidus can occur as a result of disruption of the pituitary stalk. In such cases, vasopressin (ADH) is not released from the hypothalamus and the kidney is not able to conserve water. This man has a low urine osmolarity and an elevated serum osmolarity. Normally, increases in serum osmolarity should trigger vasopressin release, which would act to increase the permeability of the collecting ducts to water. The fact that his kidneys respond to the administration of exogenous vasopressin suggests that he has a deficiency in ADH production (in contrast to a peripheral resistance to ADH, as is seen in nephrogenic diabetes insipidus).

Nephrogenic diabetes insipidus (choice A) reflects peripheral resistance to vasopressin. In such cases, the
urine osmolarity would not respond to administration of vasopressin. Serum vasopressin levels are probably already elevated in this sort of patient.

Psychogenic polydipsia (choice C) will show decreases in both serum and urine osmolarity. Vasopressin will be suppressed, and if the patient is water deprived, the serum osmolarity will gradually increase to normal.

In water deprivation (choice D), both urine and serum osmolarity are elevated. ADH is also elevated.

Many patients with cirrhosis, particularly alcoholic cirrhosis, develop gynecomastia, testicular atrophy, and impotence. Which of the following is thought to be the underlying mechanism producing these changes?

A. Both decreased testosterone secretion and decreased extraction of androstenedione

B. Decreased hepatic extraction of androstenedione

C. Increased estrogen secretion by Leydig cells

D. Increased estrogen secretion by Sertoli cells

E. Testosterone deficiency alone

Explanation:

The correct answer is A. The secondary sexual changes seen in alcoholic cirrhosis appear to be due to both decreased testicular secretion of testosterone and decreased hepatic extraction of the androgen, androstenedione. Thus, androstenedione is available for extrasplanchnic aromatization (occurring mostly in peripheral adipose tissue) to form compounds with estrogentic activity.

Choices B and E do not fully explain the secondary sexual changes.

While tumors of Leydig and/or Sertoli cells may excrete both androgens and estrogens, the normal Leydig (choice C) and Sertoli cells (choice D) do not usually secrete estrogens.

A 45-year-old male presents to the physician with muscle cramps, perioral numbness, and irritability over the past 3 to 4 months. Lab results reveal hypocalcemia, normal albumin level, and hyperphosphatemia. Parathyroid
hormone level is decreased. Alkaline phosphatase level is normal. Which of the following is most likely causing this clinical scenario?

A. Bone metastases

B. Hashimoto's thyroiditis

C. Hypervitaminosis D

D. Hypomagnesemia

E. Previous subtotal thyroidectomy

Explanation:

The correct answer is E. This patient is experiencing symptoms of hypocalcemia secondary to diminished parathyroid hormone (PTH) secretion. This must always be considered in a patient who undergoes total or subtotal thyroidectomy because the parathyroids are nestled in the tissue surrounding the thyroid gland. Surgical attempts to leave portions of the parathyroids intact are sometimes unsuccessful. Other causes of decreased PTH include neck irradiation, autoimmune phenomena (polyglandular autoimmune syndromes), dysembryogenesis (as in DiGeorge's syndrome), or as a result of heavy metal damage (Wilson's disease, hemosiderosis, hemochromatosis).

Bone metastases (choice A) would cause hypercalcemia, as a result of osteolysis.

Hashimoto's thyroiditis (choice B) is the most common cause of hypothyroidism and results in decreased thyroid hormone and elevated TSH levels. Serum calcium and PTH should be normal.

Hypervitaminosis D (choice C) would cause hypercalcemia.

Hypomagnesemia (choice D) may cause a functional hypoparathyroidism because magnesium is needed for PTH activity in tissue. However, in such a case, actual PTH levels would not be decreased.

A 10-year-old boy is admitted to a university hospital with a full thickness burn over 40% of his body surface area. He develops a Pseudomonas infection over the burned areas of his body. The boy is treated with intravenous antibiotics but continues to show positive cultures. He becomes septic and develops fulminant pulmonary edema. A Swan-Ganz flow-directed catheter placed into the pulmonary artery indicates that the pulmonary artery and pulmonary wedge pressures are both normal. An increase in which of the following is the
most likely cause of his pulmonary edema?

A. Interstitial colloid osmotic pressure

B. Interstitial hydrostatic pressure

C. Lymph flow

D. Microvascular hydrostatic pressure

E. Microvascular permeability

Explanation:

The correct answer is E. A major problem in patients with sepsis is a generalized increase in vascular permeability, which causes widespread edema. The increase in pulmonary microvascular permeability allows excess amounts of fluid and protein to leak into the interstitium of the lung, and from there into the alveoli.

Pulmonary edema caused by increased microvascular permeability is characterized by an increase in interstitial fluid protein concentration, which causes interstitial colloid osmotic pressure (choice A) to increase as well. Although the increased interstitial colloid osmotic pressure promotes the development of edema, the ultimate cause of the protein leakage into the interstitium is the high permeability of the microvasculature.

The interstitial fluid hydrostatic pressure (choice B) is increased during pulmonary edema, which tends to decrease the amount of fluid extravasation from the vasculature.

Lymph flow (choice C) increases greatly as a consequence of edema; were it not for this increase in lymph flow, even greater amounts of fluid would collect in the lungs.

The development of pulmonary edema during sepsis is often exacerbated by concomitant increases in pulmonary microvascular pressure (choice D); however, pulmonary artery pressure and wedge pressure were both normal in the patient, suggesting that increased microvascular pressure did not contribute significantly to the development of edema. The pulmonary wedge pressure provides an estimate of left atrial pressure, and the pulmonary microvascular pressure is estimated as the average of the pulmonary artery pressure and the pulmonary wedge pressure.
A 35-year-old woman is evaluated for a long history of easy bruising. The peripheral smear shows only a few, large, young platelets, while other cell lines are normal. Marrow studies show increased megakaryocytes. Which of the following is the most likely diagnosis?

A. Idiopathic thrombocytopenic purpura

B. Microangiopathic hemolytic anemia

C. Thrombasthenia

D. Thrombotic thrombocytopenic purpura

E. Von Willebrand's disease

Explanation:

The correct answer is A. This clinical scenario is most consistent with idiopathic thrombocytopenic purpura, which is an immune-mediated destruction of platelets by the spleen. The peripheral smear and marrow show the features described.

Idiopathic thrombocytopenic purpura is distinguished from microangiopathic hemolytic anemia (choice B) and thrombotic thrombocytopenic purpura (choice D) by the absence of fragmented red cells.

In both thrombasthenia (choice C) and von Willebrand's disease (choice E), the platelet count will be normal, although platelet function is impaired.

At 25 weeks of pregnancy, an unidentified infection greatly compromises the viability of a developing fetus. The level of which of the following hormones in the mother's blood is most likely to be affected?

A. Estriol

B. Free thyroxine

C. Human chorionic gonadotropin

D. Human chorionic somatomammotropin
E. Progesterone

Explanation:

The correct answer is A. Plasma levels of maternal estrogens during pregnancy are dependent on a functioning fetus. The fetal adrenal cortex and liver produce the weak androgens, DHEA-S and 16-OH DHEA-S, which are carried to the placenta by the fetal circulation. The placenta then desulfates the androgens and aromatizes them to estrogens (16-OH DHEA-S, estriol) prior to delivery to the maternal circulation. Estradiol and estrone increase approximately 50 fold during pregnancy, but estriol increases about 1000 fold. When estriol is assayed daily, a significant drop may be a sensitive early indicator of fetal jeopardy.

Total serum thyroxine concentration may be increased in pregnancy due to an increase in circulating TBG resulting from increased estrogen. However, free thyroxine (choice B) remains within the normal range because of feedback regulatory loops. The decline in estrogen with fetal compromise may gradually decrease serum thyroxine, but the free thyroxine will remain unchanged.

Human chorionic gonadotropin (choice C) and human chorionic somatomammotropin (choice D) are both secreted by syncytiotrophoblasts of the placenta. As long as placental function is intact, blood levels of these two hormones should not change with fetal compromise.

Placental secretion of progesterone (choice E) during pregnancy is also independent of any fetal contribution. The placenta relies on maternal cholesterol for progesterone production. Fetal death has no immediate influence on progesterone production by the placenta.
A work diagram showing changes in left ventricular volume and pressure during one cardiac cycle is shown above for a normal heart (diagram A) and following aortic valvular disease (diagram B). Diagram B shows which of the following compared to diagram A?

A. Decreased work for a greater stroke volume
B. Decreased work for a lower stroke volume
C. Decreased work for the same stroke volume
D. Increased work for a greater stroke volume
E. Increased work for a lower stroke volume
F. Increased work for the same stroke volume

Explanation:

The correct answer is F. The area enclosed by the volume-pressure diagram of the left ventricle is equal to the stroke work output of the heart during its cardiac cycle. The stroke work output is therefore lower for the heart depicted by diagram A compared to the heart with valvular damage depicted by diagram B; this fact eliminates choices A-C. Diagram B shows a volume-pressure diagram from a heart in which the aortic valve is stenosed. In aortic stenosis, blood is ejected from the left ventricle through a smaller-than-normal opening. Because the resistance to ejection of blood is high, the left ventricular pressure can sometimes increase to over 300 mm Hg with normal systolic pressure in the aorta. Note in this patient that the left ventricular peak systolic pressure has increased to about 190 mm Hg.

The stroke volume is equal to the difference between the amount of blood in the ventricle prior to systole (end diastolic volume) and the amount of blood in the ventricle at the end of systole (end systolic volume). Note on Diagram A that the end diastolic volume is 125 mL and the end systolic volume is 50 mL; the stroke volume is thus 75 mL. Diagram B shows that the end diastolic volume and end systolic volume have both increased by similar amounts so that the stroke volume is still equal to 75 mL after aortic stenosis; this fact eliminates choices D and E.
The diagram above shows maximum expiratory flow-volume (MEFV) curves from a typical healthy individual (solid curve) and from a patient with compromised pulmonary function (dashed curve). Which of the following conditions is most likely represented by the dashed curve?

A. Asthma
B. Bronchospasm
C. Emphysema
D. Interstitial fibrosis
E. Old age

Explanation:

The correct answer is D. The maximum expiratory flow-volume (MEFV) curve is often used as a diagnostic tool for identifying obstructive and restrictive lung diseases. In restrictive lung diseases such as interstitial fibrosis, the MEFV curve begins and ends at abnormally low lung volumes, and the flow rates are often higher than normal at any given lung volume. Note on the diagram that the total lung capacity is ~3.2 liters and the residual volume is ~0.8 liters in the patient (dashed curve). The residual volume cannot be determined from a MEFV curve alone, so must be measured using a different technique before the curves can be placed appropriately on the abscissa.

Lung volumes would expected to be higher than normal in asthma (choice A), bronchospasm (choice B), emphysema (choice C), old age (choice E), and other conditions involving narrowing of the airways or reduced radial traction of the airways, allowing them to close more easily.

A 45-year-old asymptomatic woman is undergoing a routine physical examination. Urine is collected for reagent strip dipstick analysis as part of the biochemical screens. The reagent strip is positive for glucose when dipped in urine. This suggests that her blood glucose is as high or higher than which of the following values?

A. 50 mg/dL
B. 100 mg/dL
C. 200 mg/dL
A 42-year-old female presents with a recent onset of fatigue, malaise, constipation, and a 12-pound weight gain. On examination, her thyroid is firm and enlarged. What laboratory test is most likely to confirm the expected diagnosis?

A. Antithyroid antibodies
B. Serum thyroid-stimulating hormone (TSH) measurement
C. Serum thyroxine (T4) measurement
D. Serum triiodothyronine (T3) measurement
E. T3 resin uptake

Explanation:

The correct answer is B. The patient's presentation is consistent with hypothyroidism. Serum thyroid-stimulating hormone (TSH) measurement (choice B) is most likely to confirm the empiric diagnosis. TSH levels usually rise above normal before serum thyroxine (T4; choice C) and serum triiodothyronine (T3; choice D) levels do, even in mild cases of hypothyroidism. Therefore, TSH measurement would be the most accurate test to determine the presence of hypothyroidism regardless of the severity.

A high titer of antithyroid antibodies (choice A) is characteristic of chronic thyroiditis, which is the most common
cause of hypothyroidism. However, detection of these antibodies would not indicate if hypothyroidism was present.

T3 resin uptake (choice E) measurement is not an accurate test of thyroid function; it is primarily used to exclude various abnormalities in the thyroid-hormone binding proteins.

A 14-year-old female is evaluated for delayed puberty and short stature. Her height is 3 standard deviations below the mean for her age. She exhibits a webbed neck, low-set ears, fish-like mouth, and ptosis. Biopsy of her ovary reveals the presence of fibrous stroma arranged in whorls. Chromosomal analysis shows a 45,XO karyotype. Which of the following laboratory findings would be most likely in this individual?

A. Decreased plasma growth hormone

B. Decreased plasma thyroid hormone

C. Increased plasma follicle stimulating hormone

D. Increased plasma inhibin

E. Increased plasma estrogen

Explanation:

The correct answer is C. The 45,XO karyotype results in Turner's syndrome, which is characterized by ovarian dysgenesis and a variety of somatic abnormalities including micrognathia, a fish-like mouth, a shield chest, low-set ears, ptosis, and a webbed neck. Other findings can include coarctation of the aorta, hypertension, and renal abnormalities. Short stature is invariably present; the cause is not known because plasma levels of growth hormone (choice A) and thyroid hormone (choice B) are typically not decreased. Clinical studies have shown, however, that injections of human growth hormone can increase the final height. The ovaries are usually streak-like and exhibit only fibrous stroma. The ovarian dysgenesis leads to decreased secretion of estrogen (not increased, choice E) and inhibin (not increased, choice D) and persistent infantilism. Plasma levels of FSH are markedly increased due to the lack of feedback inhibition by ovarian secretions. FSH levels are high during infancy and again after 9-10 years of age. Combination estrogen and progesterone replacement therapy can induce the development of secondary sex characteristics and menses.
A one-month-old infant is taken to the pediatrician because of dyspnea, difficulty feeding, and poor weight gain. Physical examination reveals tachypnea and a weak femoral pulse compared to the radial pulse. Pressure recordings from a catheter placed into the thoracic aorta and then advanced into the abdominal aorta are shown in the figure above. Which of the following is the most likely diagnosis?

A. Aortic valve obstruction

B. Cardiac tamponade

C. Coarctation of aorta

D. Complete heart block

E. Heart failure

Explanation:

The correct answer is C. The pressure tracings from the thoracic and abdominal aorta are characteristic of a coarctation of the aorta. The coarctation (constriction) obstructs blood flow in the aorta because of the increase in resistance at the site of the constriction. More than 95% of coarctations occur just distal to the left subclavian artery,
in the region of the ductus arteriosus. Thus the constriction usually occurs at a point beyond the arterial branches to
the head and arms, but proximal to the kidneys. Collateral vessels in the body wall carry much of the blood flow to the
lower body. The arterial pressure in the upper body is usually about 50% higher than the pressure in the lower body.
The lower-than-normal pressure at the level of the kidneys causes renal retention of salt and water, similar to that
which occurs when an individual has one kidney removed. Within a few days, the blood pressure at the level of the
kidneys becomes almost normal as hypertension develops in the upper body.

Neither aortic valve obstruction (choice A), cardiac tamponade (choice B), complete heart block (choice D), nor heart
failure (choice E) cause a difference in blood pressure between the thoracic and abdominal aorta.

A 42-year old man claims to have gained 60 pounds over the past year. Physical examination reveals a 280
pound, 5' 11" male with central obesity. There is also fat accumulation on the back producing a "buffalo hump." There are prominent vertical purple striae on the abdomen. Fasting blood glucose is in the high normal range. Plasma levels of ACTH and cortisol are both increased compared to normal. An overnight high-dose dexamethasone test produces 75% suppression of cortisol levels. This patient most likely has

A. Addison's disease
B. an ectopic ACTH-secreting tumor
C. Conn's syndrome
D. Cushing's disease
E. primary hypercortisolism

Explanation:
The correct answer is D. This patient presents with "Cushingoid" signs and symptoms due to hypercortisolism. While the acute effect of cortisol is to produce lipolysis, patients with chronically increased cortisol levels develop a characteristic central obesity and buffalo hump. The extremities are often thinned. The mechanism for the redistribution of body fat is not known, but may involve an interaction between cortisol and insulin. The weight gain with hypercortisolism usually results from increased appetite. Cortisol excess causes protein catabolism, which leads to poor wound healing, decreased connective tissue, and fragile blood vessels. The combination of thin skin and fragile blood vessels leads to abdominal stretch marks (striae) that are characteristically purple in color. Because of increased gluconeogenesis and decreased peripheral insulin sensitivity, blood glucose may be increased. Some patients with cortisol excess have overt secondary diabetes
mellitus. If the hypercortisolism is due to a functional tumor in the adrenal cortex (primary hypercortisolism, choice E), plasma concentration of ACTH should be low because of negative feedback suppression. The patient described in the question has increased cortisol and increased ACTH. This could result from either a functional ACTH-secreting tumor in the pituitary (Cushing's disease) or an ectopic tumor (such as a small cell carcinoma of the lung, choice B). One way to distinguish between these two possibilities is to administer high doses of the potent synthetic glucocorticoid, dexamethasone. High-dose dexamethasone should suppress ACTH secretion from the pituitary by at least 50%; secretion from an ectopic tumor typically is not suppressed by dexamethasone.

Addison's disease (choice A) is primary adrenal insufficiency, and while plasma ACTH is increased (producing hyperpigmentation), plasma cortisol and aldosterone are both decreased (not increased) compared to normal.

Conn's syndrome (choice C) results from hypersecretion of aldosterone by the adrenal cortex. Some of the clinical manifestations overlap with Cushing's disease: for example, both may exhibit hypertension. In the case of Conn's syndrome, this is due to excessive renal sodium and water reabsorption due to increased aldosterone levels. In Cushing's disease, it is due in part to the mineralocorticoid-like effects of high plasma cortisol.

A 62-year-old woman complains to her physician that she is chronically tired. She has lost several pounds in the past few months without a change in her diet. Blood tests indicate she has severe anemia (Hb < 7 g/dL). Further testing shows the presence of blood products in her stool and a large malignant tumor in her ascending colon. Which of the following is likely to be decreased in this woman?

A. Arterial O2 content
B. Arterial O2 saturation
C. Arterial PO2
D. Cardiac output
E. Heart rate
F. Stroke volume

Explanation:

The correct answer is A. A decrease in the hemoglobin concentration of the blood causes a proportional
decrease in the oxygen carrying capacity of the blood. Each gram of hemoglobin can normally carry a total of 1.34 g oxygen. Thus, each 100 mL of arterial blood can normally carry about 20 mL oxygen at a normal hemoglobin concentration of 15 g/dL blood. With a hemoglobin concentration of 7 g/100 mL, each 100 mL of blood can carry only 9.4 mL oxygen. The oxygen saturation of hemoglobin in the arterial blood (choice B) and the arterial PO2 (choice C) are virtually unaffected by the hemoglobin concentration of the blood.

The reduced oxygen-carrying capacity of the severely anemic patient is associated with a compensatory increase in cardiac output during resting conditions, and especially during exercise. The elevation in cardiac output helps to maintain oxygen delivery to the tissues at an adequate level. The increase in cardiac output (choice D) is caused by an increase in heart rate (choice E) and stroke volume (choice F).

Careful testing of the visual fields in a patient complaining of difficulty reading demonstrates a central scotoma involving one visual field. This defect is most likely due to a lesion involving which of the following structures?

A. Macula
B. Optic chiasm
C. Optic radiations in the parietal lobe
D. Optic radiations in the temporal lobe
E. Optic tract

Explanation:

The correct answer is A. The probable location of lesions producing visual defects is a favorite USMLE topic (and is also well worth knowing if you have occasion to work up such a patient). Here is a list that may help you sort through these problems:

Central scotoma ~ macula
Ipsilateral blindness ~ optic nerve
Bitemporal hemianopia ~ optic chiasm (choice B)
Homonymous hemianopia ~ optic tract (choice E)
Upper homonymous quadrantanopia ~ temporal optic radiations (choice D)
Lower homonymous quadrantanopia ~ parietal optic radiations (choice C)
Also, cortical lesions produce defects similar to those of the optic radiations, but may spare the macula.

A 26-year-old pregnant migrant worker sustains a placental abruption, and is admitted to the intensive care unit. While in the unit, she begins bleeding from multiple sites, including her venipuncture sites and oral mucous membranes. Which of the following studies would be most valuable in assessing this patient's condition?

A. Partial thromboplastin time, kininogen, and factor VIII levels
B. Platelet count, fibrinogen levels, and fibrin degradation products
C. Platelet count, thrombin time, and prekallikrein levels
D. Prothrombin time and factor VIII levels
E. Thrombin time, fibrinogen levels, and factor VIII levels

Explanation:
The correct answer is B. Disseminated intravascular coagulation (DIC) is characterized by consumption of both platelets and clotting factors. The best tests to order are platelet count (which will be markedly decreased), serum fibrinogen level (which will be low), and fibrin degradation products (which will be high).

Prothrombin time (PT) measures factors I (fibrinogen), II, V, VII, and X. Partial thromboplastin time (PTT) measures prekallikrein, high-molecular weight kininogen, and factors I, II, V, VIII, IX, X, and XI. Both PT and PTT are relatively non-specific. Thrombin time (TT) is a more specific measure of fibrinogen and would potentially be a useful test in this setting. However, specific measurement of factor VIII, kininogen, or prekallikrein levels would not be rational in evaluating DIC.

A 62-year-old man has a 25-year history of alcoholism and liver disease. He visits his physician complaining of pain and swelling of his legs. A decrease in which of the following is the most likely cause of the peripheral
edema?

A. Capillary hydrostatic pressure

B. Interstitial colloid osmotic pressure

C. Interstitial hydrostatic pressure

D. Plasma colloid osmotic pressure

E. Precapillary arteriolar resistance

Explanation:

The correct answer is D. The plasma colloid osmotic pressure is often low in alcoholics with chronic liver disease (cirrhosis). The diseased liver cannot produce adequate amounts of albumin, which leads to a decrease in the concentration of albumin in the plasma, i.e., hypoalbuminemia. Because about 75% of the plasma colloid osmotic pressure can be attributed to the presence of albumin in the plasma, the decrease in plasma albumin concentration that occurs in the latter stages of cirrhosis often leads to peripheral edema. Cirrhosis also causes excess fluid to accumulate in the peritoneal cavity as ascites. In the case of ascites, the edema results not only from hypoalbuminemia, but also from portal vein obstruction (which increases capillary hydrostatic pressure) as well as the obstruction of lymphatic drainage of the liver. In fact, ascites is observed more often than peripheral edema in liver disease.

A decrease in capillary hydrostatic pressure (choice A) would tend to decrease fluid loss from the capillaries, and thereby oppose the development of edema.

A decrease in the colloid osmotic pressure of the interstitial fluid (choice B) would decrease fluid loss from the capillaries, thereby opposing the development of edema.

A decrease in interstitial hydrostatic pressure (choice C) would tend to increase fluid loss from the capillaries, but this cannot be considered a primary cause of edema because the interstitial hydrostatic pressure actually increases when a tissue becomes edematous.

A decrease in precapillary arteriolar resistance (choice E), which means arteriolar dilation, would increase capillary hydrostatic pressure and tend to cause edema. However, decreased precapillary arteriolar resistance in the peripheral vasculature is not associated with cirrhosis.
An increase in which of the following best explains the mechanism by which the cardiac output increases in severe anemia?

A. Arteriolar diameter
B. Blood viscosity
C. Peripheral vascular resistance
D. Splanchnic blood flow
E. Tissue oxygen tension

Explanation:

The correct answer is A. In severe anemia, diminished transport of oxygen in the blood leads to hypoxia in the tissues. The hypoxia (compare to choice E) causes small arteries and arterioles to dilate, which allows greater-than-normal amounts of blood to return to the heart. In severe anemia, the viscosity of blood (choice B) may decrease by 50% or more because blood viscosity depends largely on the concentration of red blood cells. This decrease in viscosity lowers the resistance to blood flow in the peripheral tissues (i.e., decreases peripheral vascular resistance, choice C) allowing even greater amounts of blood to return to the heart.

Blood is often shunted away from the splanchnic vascular bed (choice D) in anemia, which can cause gastrointestinal problems.

A 52-year-old female complains of sudden visual abnormalities. Her history reveals a 30 pack-year history of smoking, hypertension, and hypercholesterolemia. A head CT shows a lesion in the right occipital lobe and an angiogram reveals an embolic stroke of the right posterior cerebral artery. What type of visual deficit is she most likely experiencing?

A. Bitemporal hemianopia
B. Central scotoma
C. Left homonymous hemianopia
D. Left superior quadrantanopia

E. Right homonymous hemianopia

F. Right superior quadrantanopia

G. Total left eye blindness

H. Total right eye blindness

Explanation:

The correct answer is C. The posterior cerebral arteries supply the cortical surfaces of the occipital and medial temporal lobes. Damage to one occipital lobe (e.g., by trauma or by ischemia/infarction due to stroke) usually produces a contralateral homonymous hemianopia. Occlusion of the right posterior cerebral artery would therefore result in a left homonymous hemianopia—blindness in the left half of the visual field in both eyes. In addition, involvement of the medial temporal lobe might give rise to peduncular hallucinosis—visual illusions or elementary (unformed) hallucinations. Bilateral lesions would cause "cortical" blindness, which does not affect the pupillary reflexes.

Bitemporal hemianopia (choice A) is a loss of vision in the temporal quadrants of the visual field. (It is also termed heteronymous hemianopia). This occurs in lesions of the optic chiasm, which may occur with pituitary tumors.

Central scotoma (choice B) is a loss of vision in the center of the visual field, with preservation of the peripheral fields. It is associated with optic neuritis, a common complication of multiple sclerosis.

Superior quadrantanopia (choices D and F) is caused by lesions in the upper portion of the contralateral temporal lobe.

Right homonymous hemianopia (choice E) would result from left posterior cerebral artery occlusion.

Total blindness in one eye (choices G and H) occurs when its optic nerve is severed.

A 55-year-old man presents to the emergency room with crushing substernal pain and left shoulder pain of 2 hours duration. The pain is not relieved by sublingual nitroglycerin, and the electrocardiogram shows ST elevation in several leads. Aspirin and streptokinase therapy are initiated, and the patient is admitted to the
intensive care unit. The next morning, serum cardiac enzymes are elevated to 4 times the upper limit of normal, and the electrocardiographic changes are still present. Which of the following is the most likely diagnosis?

A. Prinzmetal's angina
B. Stable angina
C. Subendocardial infarction
D. Transmural infarction
E. Unstable angina

Explanation:

The correct answer is D. The elevated serum cardiac enzymes indicate that a myocardial infarction has occurred. The setting (patient brought in from community with typical myocardial pain) and limitation of ST elevation to a few leads are typical of transmural infarction due to occlusion of a coronary artery. In contrast, hospitalized, severely hypotensive patients typically undergo the more generalized subendocardial infarction.

Prinzmetal's angina (choice A) would not cause a marked rise in serum enzymes.

Stable angina (choice B) would not cause a marked rise in serum enzymes.

Subendocardial infarction (choice C) usually occurs in the setting of shock and affects most EKG leads.

Unstable angina (choice E) may be accompanied by enzyme elevations up to 2 times the upper limit of normal.

A patient with systemic lupus erythematosus very much wants to become pregnant. What should her physician tell her regarding pregnancy in lupus patients?

A. There is no increased risk to the baby.
B. There may be an increase in cardiovascular malformations
C. There may be an increase in nervous system malformations.
D. There may be an increase in renal malformations

E. There may be an increase in spontaneous abortions and prematurity.

Explanation:

The correct answer is E. Systemic lupus erythematosus (SLE) predominantly affects younger women, and so the question of lupus and pregnancy may arise frequently in clinical practice. Patients with SLE have an increased incidence of spontaneous abortion, fetal death in utero, and prematurity. The mother may experience an exacerbation in the activity of her disease in the third trimester or peripartum period, and it may be difficult to distinguish between active SLE and preeclampsia. Therapy of pregnant patients with SLE is problematic, and the generalist should consult the literature or a specialist when such a patient is encountered.

Congenital malformations (choices B, C, and D) are not a complication of pregnancies in patients with SLE.

During a routine office check-up, a 50-year-old woman is found to have increased serum levels of calcium. She has no specific complaints, although when asked, the patient admits to feeling weak recently and has experienced an increased incidence of constipation. Additional testing shows that serum phosphate is below normal and urinary cAMP levels are increased. Which of the following is the most likely diagnosis?

A. A calcitonin-secreting tumor

B. Primary hyperparathyroidism

C. Primary hypoparathyroidism

D. Pseudohypoparathyroidism

E. Vitamin D deficiency

Explanation:

The correct answer is B. Primary hyperparathyroidism is often asymptomatic and is only incidentally discovered during routine blood work, however, there may be vague complaints of fatigue or weakness and constipation. These neuromuscular manifestations are due to the hypercalcemia which can "hyperstabilize" excitable tissue.
membranes and reduce normal responsiveness. The incidence of primary hyperparathyroidism increases greatly after age 50, and it is more common in women than men. The hypercalcemia is due to the excess plasma concentration of parathyroid hormone (PTH). In primary hyperparathyroidism, 80% of the cases are due to a single adenoma in a parathyroid gland that secretes excessive PTH. In the other 20% of cases, the hypersecretion of PTH is due to hyperplasia in multiple parathyroid glands. The increased PTH also causes renal excretion of phosphate, producing hypophosphatemia. PTH acts by increasing cAMP formation in target tissues. The cAMP formed in renal tubules can diffuse into the lumen and be measured in the urine.

Tumors that secrete calcitonin (choice A) include medullary carcinoma of the thyroid and occasionally, small and large cell carcinomas of the lung. Despite the high blood concentration of calcitonin, serum calcium and phosphate are rarely abnormal.

Primary hypoparathyroidism (choice C), which is due to decreased secretion of PTH, is associated with hypocalcemia and hyperphosphatemia. Furthermore, urinary cAMP concentration would be decreased. The low calcium in extracellular fluid "destabilizes" excitable tissue membranes and can lead to spontaneous action potentials that produce tetany.

Pseudohypoparathyroidism (choice D) is a rare genetic disorder that results in hypocalcemia and hyperphosphatemia due to end organ unresponsiveness to PTH.

With vitamin D deficiency (choice E), serum calcium is decreased due to diminished absorption from the diet. PTH secretion is increased to compensate, resulting in bone demineralization (osteomalacia).

A 20-year-old woman presents to the emergency room in labor. She has had no prenatal care. The patient is noted to be very restless, with fever, profuse sweating, marked tachycardia, and a marked tremor. Over the next hour, she develops delirium, nausea, vomiting and abdominal pain between contractions. This potentially fatal condition is most likely related to which of the following thyroid diseases?

A. De Quervain's thyroiditis

B. Follicular carcinoma

C. Graves' disease

D. Hashimoto's thyroiditis

E. Papillary carcinoma
The correct answer is C. The patient is experiencing a thyrotoxic crisis, which occurs most commonly in patients with untreated or inadequately treated Graves' disease. The onset is typically abrupt and may be precipitated by stressors that can include infection, trauma, radio-iodine treatment, and childbirth. The condition, if unrecognized, may progress to congestive cardiac failure, pulmonary edema, and death.

De Quervain's thyroiditis (choice A), also known as subacute granulomatous thyroiditis, can produce transient hyperthyroidism, but does not usually produce a thyrotoxic crisis.

Both follicular (choice B) and papillary (choice E) carcinomas of the thyroid gland are usually non-secretory and consequently do not produce hyperthyroidism.

Hashimoto's thyroiditis (choice D) is an autoimmune thyroiditis that may transiently produce hyperthyroidism before producing hypothyroidism, but thyrotoxic crisis is not usually a feature.

A 47-year-old alcoholic presents with acute upper left abdominal pain with pain on palpation. The pain is referred to his back. Lab results reveal a low serum calcium level. His hypocalcemia probably reflects which of the following?

A. Caseous necrosis

B. Coagulative necrosis

C. Enzymatic fat necrosis

D. Gangrenous necrosis

E. Liquefactive necrosis

The correct answer is C. The patient most likely has acute pancreatitis, which is commonly caused by either alcoholism or impaction of a small gallstone in the common bile duct. Acute pancreatitis causes the release of many digestive enzyme precursors, which are then converted to the active form in the damaged tissues. These enzymes degrade the adipose tissue around the pancreatic lobules, producing enzymatic fat necrosis. As part
of this process, many free fatty acids are produced that can bind as soaps with extracellular calcium in chemical equilibrium with serum calcium. This will often cause a significant decrease in serum calcium levels.

Caseous necrosis (choice A) is seen in granulomata produced by infection with M. tuberculosis.

Coagulative necrosis (choice B) preserves the outlines of cells in affected tissue. This common type of necrosis is seen in the heart following an infarct.

Gangrenous necrosis (choice D) is massive necrosis associated with loss of vascular supply, and is generally accompanied by bacterial infection.

Liquefactive necrosis (choice E) results in liquefaction of tissues due to the release of lysosomal enzymes. Cellular outlines are not preserved. This type of necrosis characterizes bacterial infections and CNS infarcts.

A 54-year-old man develops sustained, severe chest pain. He takes several antacid tablets without significant relief. Finally he tells his wife, who demands that he go to the emergency room. At the hospital, he is diagnosed with a myocardial infarction, and is admitted and stabilized, then released several days later. Three weeks after the myocardial infarction, the man develops steady, burning chest pain. He returns to the emergency room, where a friction rub is heard on auscultation. Which of the following is the most probable underlying cause of this complication?

A. Autoimmune phenomenon
B. Bacterial infection
C. Chlamydial infection
D. Fungal infection
E. Viral infection

Explanation:

The correct answer is A. The patient has Dressler's syndrome, which is thought to be an autoimmune phenomenon resulting in fibrinous pericarditis with fever and pleuropericardial chest pain several weeks after a myocardial infarction.
Bacterial (choice B), fungal (choice D), and viral (choice E) infections can cause pericarditis, but would not be suspected in the setting of myocardial infarction.

Chlamydia (choice C) are not a usual cause of pericarditis.

A baby, who was apparently normal at birth, develops persistent regurgitation and vomiting in the second and third weeks of life. No fever is present and hematologic studies and blood chemistries are normal. Which of the following therapies is most likely to be effective in this case?

A. Antacids
B. Barium enema
C. Gastric resection
D. Oral antibiotics
E. Pyloromyotomy

Explanation:

The correct answer is E. The baby probably has congenital hypertrophic pyloric stenosis, which usually presents at several weeks of age. Partial surgical incision through the pylorus (pyloromyotomy) is usually curative.

Antacids (choice A) are beneficial in esophageal reflux and peptic ulcer disease.

Barium enema (choice B) can reverse intussusception in a child, but would not be therapeutic in this case.

Gastric resection (choice C) is not indicated, since the much less invasive procedure of pyloromyotomy is actually more effective.

Oral antibiotics (choice D) are not indicated, since this is not an infectious process.

A 65-year-old woman with a long-standing disease has bone marrow fibrosis and increased bone remodeling, with
bone resorption exceeding bone formation. She has a history of passing calcium-oxalate kidney stones. Which of the following lab result profiles would be expected in the serum of this patient?

<table>
<thead>
<tr>
<th>Calcium</th>
<th>Phosphate</th>
<th>PTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. decreased</td>
<td>decreased</td>
<td>increased</td>
</tr>
<tr>
<td>B. decreased</td>
<td>increased</td>
<td>decreased</td>
</tr>
<tr>
<td>C. decreased</td>
<td>increased</td>
<td>increased</td>
</tr>
<tr>
<td>D. increased</td>
<td>decreased</td>
<td>increased</td>
</tr>
<tr>
<td>E. increased</td>
<td>increased</td>
<td>increased</td>
</tr>
</tbody>
</table>

Explanation:

The correct answer is D. This is one of those questions for which having a good idea of what you are looking for before exploring the answer choices will certainly save you valuable time. The answers all look alike and you could have been easily confused if you were not confident of the answer before approaching the choices.

This patient has long-standing hyperparathyroidism (elevated PTH), which predisposes to the development of osteitis fibrosa, her bone disease. PTH acts initially on osteocytes of bone tissue (osteocytic osteolysis) and subsequently on osteoclasts (osteoclastic resorption) to resorb calcium from bone matrix and make it available to the circulation. This increases plasma calcium levels. PTH also causes decreased phosphate reabsorption in the proximal renal tubule, yielding hypophosphatemia. Hypercalciuria is another sequela of excess PTH production,
which predisposes the patient to the formation of calcium oxalate stones.

Choices A and E correspond to neither hyper- nor hypoparathyroid states.

Choice B is the profile of hypoparathyroidism. You should have quickly eliminated this choice since the PTH was decreased and you were looking for a profile consistent with HYPERparathyroidism.

Choice C is the profile of secondary hyperparathyroidism. This occurs when there is parathyroid overproduction due to a nonparathyroid cause. By far, the most common cause is chronic renal failure. In such cases, there is decreased calcium absorption since the kidneys are involved in the conversion of 25(OH)D3 to the active form 1,25(OH)D3. The decreased calcium ion level stimulates the parathyroid, leading to elevated PTH levels. Hyperphosphatemia results from diminished renal synthesis of 1,25 dihydroxyvitamin D3, creating further calcium-phosphate imbalance and enhanced PTH production.

A 68-year-old woman visits her physician complaining of labored breathing and swelling in her lower extremities. Physical examination is consistent with a diagnosis of congestive heart failure. An increase in which of the following is the most likely explanation for the swelling in her legs?

A. Interstitial colloid osmotic pressure
B. Lymph flow
C. Plasma colloid osmotic pressure
D. Right atrial pressure
E. Stroke volume

Explanation:

The correct answer is D. The patient described has peripheral edema in her lower extremities secondary to congestive heart failure. Congestive heart failure typically develops when the heart becomes damaged (usually as a result of myocardial infarction) and the cardiac output cannot be maintained at a normal level. A low cardiac output has profound effects on the kidneys, causing salt and water retention. If the heart is not damaged too badly, the increase in blood volume caused by the fluid retention can increase venous return sufficiently to totally compensate for the diminished pumping capacity of the heart. The increase in venous return causes the right atrial pressure to rise, which elevates venous pressure throughout the body. This
increase in venous pressure can cause excessive fluid loss from the microcirculation and the development of peripheral edema. The labored breathing experienced by the patient is indicative of mild pulmonary edema caused by increased pressure in the pulmonary microvasculature.

The increase in fluid loss from the microcirculation would be expected to literally wash protein molecules out of the interstitial compartment and thereby decrease the interstitial colloid osmotic pressure (choice A), and increase the flow of lymph (choice B) from the tissue as a consequence rather than a cause of the edema.

Increased plasma colloid osmotic pressure (choice C) would tend to decrease the development of edema. Also, fluid retention by the kidneys tends to dilute the plasma and thus decrease the plasma colloid osmotic pressure.

Stroke volume (choice E) has no direct role in the formation of peripheral edema.

A 55-year-old man walks into clinic, breathing heavily and complaining of dyspnea and constant fatigue. On physical examination, the physician observes a "barrel chest" (expanded, with increased anteroposterior diameter) and hypertrophy of the accessory respiratory muscles. No cyanosis is evident. The man states that he has been smoking two packs of cigarettes/day for 30 years. Occasionally, he develops episodes of nonproductive cough, each lasting a few days, but he denies asthma attacks. Blood gas analysis shows minimal hypoxemia and normal CO2. Respiratory volumes are characterized by reduced forced expiratory volume/second (FEV1), markedly increased residual volume, and increased total lung capacity. Which of the following underlying pathogenetic mechanisms is most likely responsible for this patient's condition?

A. Airway obstruction
B. Bronchospasm
C. Chest wall deformity
D. Interstitial infiltration
E. Loss of elastic recoil

Explanation:

The correct answer is E. This patient is the classic pink puffer with chronic obstructive pulmonary disease (COPD). COPD is an umbrella term that refers to overlapping clinical conditions resulting from a combination of
emphysema, asthma, bronchiectasis, and chronic bronchitis. If emphysema is predominant, patients with COPD have severe dyspnea (puffers), scanty sputum production, and nearly normal O2 arterial pressure, and thus no cyanosis (pink). Loss of elastic recoil is characteristic of emphysema, which is due to destruction of alveolar walls and enlargement of airspaces distal to terminal bronchioles. Destruction of the pulmonary elastic fibers brings about increased resistance to airflow, which is reflected by an increased FEV1. The lungs become overexpanded; while total pulmonary capacity increases, the functioning lung parenchyma decreases.

Airway obstruction (choice A) is prevalent in patients who have COPD with predominant chronic bronchitis, ie, blue bloaters. Decreased PaO2 manifests with cyanosis (blue), and bronchitis causes abundant sputum production. Pulmonary hypertension and right ventricular overload produce peripheral edema (bloaters). The patient in this case does not fit this description.

Bronchospasm (choice B) is associated with asthma, a frequent component of COPD. Attacks of asthma are due to spasm of bronchiolar smooth muscles, resulting in increased resistance to expiration. The clinical history clearly rules out bronchospasm as the fundamental mechanism of this patient's condition.

Chest wall deformity (choice C), such as severe kyphoscoliosis and obesity, and interstitial infiltration (choice D), usually due to interstitial fibrosis, are responsible for restrictive pulmonary disease. Restrictive pulmonary disease leads to decreased lung compliance and reduction in all respiratory volumes. The barrel-chest deformity of this patient is a consequence, not a cause, of the underlying pathologic change, ie, overexpansion of lungs.

A Guatemalan child with a history of meconium ileus is brought to a clinic because of a chronic cough. The mother notes a history of respiratory tract infections and bulky, foul-smelling stools. After assessment of the respiratory tract illness, the physician should also look for signs of

A. cystinuria

B. hypoglycemia

C. iron deficiency anemia

D. sphingomyelin accumulation

E. vitamin A deficiency

Explanation:
The correct answer is E. The child is likely suffering from cystic fibrosis. In this disorder, an abnormality of chloride channels causes all exocrine secretions to be much thicker, and more viscous than normal. Pancreatic secretion of digestive enzymes is often severely impaired, with consequent steatorrhea and deficiency of fat-soluble vitamins, including vitamin A.

Cystinuria (choice A) is a relatively common disorder in which a defective transporter for dibasic amino acids (cystine, ornithine, lysine, arginine; COLA) leads to saturation of the urine with cystine, which is not very soluble in urine, and precipitates out to form stones.

Hypoglycemia (choice B) is not a prominent feature of children with cystic fibrosis who are on a normal diet. Hyperglycemia may occur late in the course of the disease.

Iron deficiency anemia (choice C) is not found with any regularity in children with cystic fibrosis.

Sphingomyelin accumulation (choice D) is generally associated with deficiency of sphingomyelinase, as seen in Niemann-Pick disease.

A 25-year-old male gets into a brawl outside a bar. During the altercation, someone pulls out a gun and shoots him in the head. The bullet enters the man's temple and severs his right optic nerve completely. He is quickly transported to a nearby emergency room and an emergency physician tests his pupillary response by shining a light in the right eye. What will the physician most likely find?

A. No pupillary constriction in the right eye, and no pupillary constriction in the left eye

B. No pupillary constriction in the right eye, but pupillary constriction in the left eye

C. Pupillary constriction followed by pupillary dilatation in both eyes

D. Pupillary constriction in the right eye, and no pupillary constriction in the left eye

E. Pupillary constriction in both eyes

F. Pupillary dilatation in both eyes

Explanation:
The correct answer is A. This person is blind in the right eye. The afferent limb of the pupillary light reflex is carried by the optic nerve (CN II), and the efferent limb is via the oculomotor nerve (CN III), which carries parasympathetic fibers from the Edinger-Westphal nucleus. Thus, shining a light in the affected eye will not elicit any pupillary response. On the other hand, shining the light in the left eye will result in simultaneous constriction of both pupils (assuming an intact right CN III), since the left optic nerve is intact.

The circulatory system of a 48-year-old woman who is training for a triathlon is at point B on the figure above during strenuous exercise. Her circulatory system normally operates at point A. She has a sudden occlusion of her right coronary artery during the exercise, which is followed immediately by ventricular fibrillation. Which of the following results would reflect the changes in her right atrial pressure expected within one minute of fibrillation?

A. Decreases by 18 mm Hg
B. Decreases by 10 mm Hg
C. Decreases by 2 mm Hg
D. Does not change
E. Increases by 2 mm Hg
F. Increases by 10 mm Hg

G. Increases by 18 mm Hg

Explanation:

The correct answer is G. When the heart is stopped suddenly by ventricular fibrillation or any other means, the flow of blood in the circulation ceases within about one minute. Within the first several seconds, blood flows mainly from the high pressure arterial system into the venous system until the pressures everywhere in the circulation become equal. This equilibrated pressure is called the "mean circulatory filling pressure," which for all practical purposes is roughly equivalent to the "mean systemic filling pressure (MSFP)." The MSFP is thus a measure of the "tightness" with which the circulatory system is filled with blood. The greater the system is filled (i.e., when MSFP is increased), the easier it is for blood to flow into the heart, which tends to increase venous return and cardiac output.

The MSFP is the point at which the venous return curves intersect the X-axis. Thus, MSFP is normally about +7 mm Hg in this woman, and it increased to +20 mm Hg during the exercise. Because the right atrial pressure (RAP) was 2 mm Hg during the exercise, fibrillation of the heart should cause the RAP to increase by 18 mm Hg to achieve the MSFP of +20 mm Hg shown on the figure.

Which of the following would be expected in a woman with isolated ACTH-deficiency?

A. Decreased pubic and axillary hair

B. Decreased serum sodium concentration

C. Hyperpigmentation

D. Increased serum cortisol

E. Increased serum potassium

Explanation:

The correct answer is A. Isolated ACTH-deficiency is a pituitary disorder characterized by decreased secretion
of ACTH, but not of the other hormones of the anterior pituitary. Because of the decreased drive to the inner two zones of the adrenal cortex, the secretion of adrenal androgens is decreased. Since pubic and axillary hair in females is dependent on adrenal androgens, ACTH deficiency would lead to a decrease in both. Like primary adrenal insufficiency, isolated ACTH-deficiency would lead to low serum levels of cortisol (not increased, choice D). However, unlike primary adrenal insufficiency, serum levels of aldosterone are usually unchanged with isolated ACTH deficiency. This is because ACTH is not a long-term regulator of aldosterone secretion (angiotensin II and potassium are the main long-term regulators). Since aldosterone is unchanged, serum sodium (choice B) and serum potassium (choice E) are normal. Hyperpigmentation (choice C) is associated with increased, not decreased, serum levels of ACTH.

A 57-year-old female with renal insufficiency has been on dialysis for thirteen years, but has failed to make her last two appointments. She presents to the emergency room in obvious distress with a blood pressure of 85/40 and jugular venous distension. Cardiac auscultation reveals no murmurs, thrills, or heaves. Her heart rate is rapid, at 108 beats/min, and the peripheral pulses are thready. Pulsus paradoxus is present, but Kussmaul's sign is absent. Echocardiography reveals the presence of a small heart. Which of the following is the most likely diagnosis?

A. Cardiac tamponade
B. Constrictive pericarditis
C. Congestive heart failure
D. Myocardial infarct
E. Restrictive cardiomyopathy

Explanation:

The correct answer is A. The woman is experiencing cardiac tamponade. This disorder occurs most commonly in the context of neoplastic disease, idiopathic pericarditis, and uremia, but may also result from bleeding into the pericardial space after cardiac surgery, trauma, or ventricular rupture. The classic signs of cardiac tamponade consist of 1) decreased arterial pressure, 2) increased systemic venous pressure, and 3) a small, quiet heart. The presenting symptoms include hypotension, tachypnea, tachycardia, and increased jugular venous pressure. Kussmaul's sign (a rise in the systemic venous pressure upon inspiration) is typically absent. Pulsus paradoxus (a fall of more than 10 mm Hg in the systolic pressure with inspiration) is characteristic. If catheterization is performed, the x-descent (but not the y-descent) of the jugular venous pulse is usually
prominent. Pericardiocentesis may be life-saving.

In constrictive pericarditis (choice B), Kussmaul's sign would likely be present, pulsus paradoxus is usually absent, and a pericardial knock might be appreciated.

Slowly developing cardiac tamponade can present with dyspnea, orthopnea, hepatic engorgement, and jugular venous hypertension, resembling the classic symptoms of congestive heart failure (choice C). However, a pulsus paradoxus and a small heart argue against the diagnosis of congestive heart failure in this case.

A myocardial infarct (choice D) could lead to cardiac tamponade if ventricular rupture (nearly always fatal) occurs, but would otherwise not likely be associated with the classical signs and symptoms of cardiac tamponade. A predominant inferoposterior infarct, affecting the right ventricle, can produce symptoms similar to tamponade, but Kussmaul's sign would likely be present, and the y-descent prominent upon catheterization. The electrocardiogram would also help distinguish the two (electrical alternans and lowered voltage would be present in tamponade).

In restrictive cardiomyopathy (choice E), pulsus paradoxus would be rare, and the right ventricle would likely be normal-sized.

A 40-year-old man presents to his physician with complaints of chest pain. The pain is paroxysmal, substernal, and occurs while at rest. An electrocardiogram performed in the doctor's office shows ST segment elevations. Which of the following is the most likely cause of the man's pain?

A. Heartburn
B. Hypertension
C. Severe atherosclerotic narrowing of coronary arteries
D. Thromboembolism of coronary arteries
E. Vasospasm of atherosclerotic vessels

Explanation:

The correct answer is E. The condition described is Prinzmetal's variant angina (paroxysmal vasospasm), which characteristically occurs at rest. It is a consequence of vasospasm of vessels that have a moderate amount of
Atherosclerosis. ST segment elevation indicates myocardial ischemia; the paroxysmal nature of the pain suggests vasospasm, as does the occurrence of the pain at rest. Prinzmetal's angina tends to occur in younger patients than does typical angina pectoris. Confirmation of the diagnosis rests on the angiographic detection of vasospasm, occurring spontaneously or following such provocative maneuvers as intravenous ergonovine, intracoronary acetylcholine, or hyperventilation.

The pain of acid reflux (heartburn; choice A) is typically a deep, burning pain in the thorax without ST segment changes on the electrocardiogram.

Hypertension (choice B), in the absence of myocardial ischemia, is unlikely to produce the signs and symptoms noted.

Severe atherosclerotic narrowing of coronary arteries (choice C) can produce angina, but ST segment depression, rather than elevation, is typically produced. Generally, this type of pain does not occur at rest.

Thromboembolism of coronary arteries (choice D) might produce myocardial ischemia, but it would not typically have the paroxysmal nature described in the question. Also, the pain would not occur predominantly at rest, and in the absence of a myocardial infarct, ST segment elevation usually would not be seen.

The maximum expiratory flow-volume (MEFV) curves shown in the diagram above are from a typical healthy individual (solid curve) and from a patient with pulmonary disease (dashed curve). Which of the following is increased in the patient?

A. Airway diameter

B. Maximum expiratory flow rate

C. Radial traction of airways
D. Total lung capacity

E. Vital capacity

Explanation:

The correct answer is D. The dashed curve is typical of obstructive lung diseases such as emphysema. The patient breathes at higher-than-normal lung volumes, as reflected by the leftward shift of the dashed MEFV curve shown in the diagram. Note that the total lung capacity (TLC) is 7 liters and the residual volume (RV) is about 3.5 liters in the patient (dashed curve). The vital capacity (choice E), which is the difference between TLC and RV is reduced to 3.5 liters with obstructive disease, compared to a normal value of 5 liters (solid curve). (You should know that absolute lung volumes cannot be determined from a MEFV test alone. An additional method is needed to measure residual volume. However, the diagram above states that lung volumes are absolute, indicating correct placement of the curves on the abscissa.)

The maximum expiratory flow rate (choice B) is reduced at any given lung volume in the patient with obstructive disease (dashed curve) because the airway diameter (choice A) is reduced. One factor that can lead to decreased airway diameter in emphysematous lungs is the decrease in radial traction of the airways (choice C) which occurs when lung elasticity is reduced.

Which of the following would be expected to be decreased in a patient with chronic hypertension secondary to renal artery stenosis?

A. Atrial natriuretic peptide levels

B. Blood urea nitrogen (BUN) levels

C. Glomerular filtration rate in response to captopril

D. Net acid excretion

E. Potassium secretion

Explanation:
The correct answer is C. Renal artery stenosis can decrease the renal perfusion pressure sufficiently to increase renin secretion significantly, which increases angiotensin II (AII), which, in turn, increases aldosterone. Chronic hypertension due to renal artery stenosis is the result of elevated levels of AII and aldosterone. Aldosterone increases retention of sodium from the collecting duct, and water follows; AII increases reabsorption of sodium from the proximal tubule, and water follows. AII is also a vasoconstrictor, increasing peripheral vascular resistance. Vasoconstriction of the renal vasculature decreases renal plasma flow, which would be expected to decrease glomerular filtration rate proportionately. AII, however, preferentially vasoconstricts the efferent arteriole in the nephron, maintaining a reasonable glomerular filtration rate even with the reduced renal plasma flow. Captopril (an angiotensin-converting enzyme inhibitor) inhibits the conversion of angiotensin I to AII. The captopril-mediated decrease of AII will actually decrease glomerular filtration in the kidney with renal artery stenosis, because decreasing efferent constriction causes the glomerular capillary pressure to fall.

Atrial natriuretic peptide (choice A) levels would be expected to increase with increased water and sodium retention due to renal artery stenosis.

BUN (choice B) would be expected to increase or stay the same with renal artery stenosis, depending on the extent of AII-mediated efferent arteriole vasoconstriction.

Metabolic alkalosis, due to the increased net acid secretion (compare with choice D) from hyperaldosteronism, is typical in renal artery stenosis.

Potassium secretion would increase, rather than decrease (choice E), due to the effects of excessive aldosterone secondary to renal artery stenosis.

A patient with signs and symptoms consistent with hypothyroidism exhibits a decrease in both serum TSH and serum T4. Injection of TRH fails to produce the expected increase in TSH. Which of the following is the most likely cause of the patient's hypothyroidism?

A. Hashimoto's thyroiditis

B. Iodine deficiency

C. Secondary hypothyroidism

D. Tertiary hypothyroidism

E. T4 receptor insensitivity
Explanation:

The correct answer is C. A decrease in both serum T4 and TSH could result from either a pituitary defect or a hypothalamic defect. In the case of the hypothalamic defect (tertiary hypothyroidism), decreased secretion of TRH leads to decreased TSH secretion and, hence, decreased T4 secretion. In secondary hypothyroidism, a decrease in TSH secretion due to a pituitary defect is responsible for the decreased T4. The TRH stimulation test can be used to distinguish between these two possibilities. Failure of TSH to increase after injection of TRH indicates a pituitary defect.

Hashimoto's thyroiditis (choice A) is an autoimmune disease that leads to primary hypothyroidism (low serum T4) and increased serum TSH. The autoantibodies ultimately lead to thyroid failure and decreased secretion of thyroid hormones. The decrease in negative feedback at the hypothalamus and pituitary leads to increased secretion of TSH.

Iodine deficiency (choice B) can lead to hypothyroidism due to inadequate iodine for thyroid hormone production. As in primary hypothyroidism, plasma levels of TSH are increased due to loss of negative feedback.

A normal to prolonged increase in TSH after injection of TRH indicates a hypothalamic defect, or tertiary hypothyroidism (choice D).

T4 receptor insensitivity (choice E) also presents with signs and symptoms of hypothyroidism. However, the negative feedback effects of T4 at the hypothalamus and pituitary, which are also mediated by thyroid hormone receptors, would be reduced and lead to increased TSH and T4 in the blood.

A 49-year-old man is found to have a blood pressure exceeding 165/100 mm Hg. Various antihypertensive medications have been prescribed to the man over the years, but during each of his periodic admissions to the hospital for alcohol detoxification, his blood pressure continues to be elevated. The man admits that he spends what little money he has on alcoholic beverages rather than on blood pressure medications. Which of the following is most likely to be increased in the skeletal muscles of this man during resting conditions?

A. Arteriolar density

B. Capillary density

C. Arteriolar wall-to-lumen ratio

D. Capillary wall-to-lumen ratio
E. Total cross-sectional area of arterioles

F. Total cross-sectional area of capillaries

Explanation:

The correct answer is C. Untreated hypertension leads to hypertrophy of arteries and arterioles. The wall-to-lumen ratio increases as the walls of the blood vessels thicken. It is not entirely clear why arteries and arterioles hypertrophy in hypertensive patients; however, the vessel walls are subjected to extra amounts of stretch at the higher luminal pressures which may stimulate smooth muscle cell growth. Thus, the thickened walls of arteries and arterioles in hypertensive patients is an adaption to the hypertension rather than a cause of the hypertension. The increase in blood pressure that occurs during normal exercise can cause the walls of arteries to thicken (and thus the wall-to-lumen ratio to increase) when the exercise is frequent, even though the normal resting blood pressure is not necessarily elevated in individuals who exercise regularly. ["Wall to lumen ratio" refers to the ratio of wall thickness to lumen radius, or to the ratio of the two cross-sectional areas.]

Arteriolar density (choice A) and capillary density (choice B) are thought to be decreased in hypertensive individuals.

The capillaries lack smooth muscle cells in their walls, so the wall-to-lumen ratio of capillaries does not change (choice D).

Because the density of capillaries and arterioles decreases in hypertensive individuals, the total cross-sectional areas of the capillaries (choice F) and arterioles (choice E) are also decreased.

A 57-year-old woman has severe arteriosclerosis that decreases the luminal diameter of her right renal artery by about 50%. Which of the following is most likely increased in this patient?

A. Afferent arteriolar resistance

B. Glomerular filtration rate

C. Glomerular hydrostatic pressure
D. Interlobar artery pressure

E. Secretion of renin

Explanation:

The correct answer is E. The decrease in renal artery diameter causes a reduction in arterial pressure within the kidney, which results in an initial decrease in glomerular hydrostatic pressure (choice C) and glomerular filtration rate (choice B). The fall in glomerular filtration rate decreases the amount of sodium chloride that is delivered to the macula densa; in turn, the juxtaglomerular cells secrete renin and angiotensin II is formed. The angiotensin then mainly constricts the efferent arterioles, which increases glomerular hydrostatic pressure and glomerular filtration rate. This macula densa feedback mechanism also attempts to return glomerular hydrostatic pressure (and therefore glomerular filtration rate) to a normal level by decreasing afferent arteriolar resistance (choice A).

An obstruction of the renal artery would decrease blood pressure in the interlobar arteries (choice D).

Q 2

The figure above illustrates an aortic pressure pulse contour from a normal individual and one obtained from a patient. The patient is most likely suffering from which of the following?
A. Aortic regurgitation

B. Aortic stenosis

C. Arteriosclerosis

D. Mitral regurgitation

E. Patent ductus arteriosus

Explanation:

The correct answer is C. This patient has arteriosclerosis, which is commonly referred to as hardening of the arteries. When the distensibility of the arterial system decreases, the rise and fall in pressure during systole and diastole are proportionately increased. Note in the figure that the normal pulse pressure is about 40 mg Hg (systolic pressure of 120 mg Hg - diastolic pressure of 80 mg Hg). The pulse pressure has increased to about 80 mg Hg in the patient with arteriosclerosis (systolic pressure of 160 mg Hg - diastolic pressure of 80 mg Hg).

In aortic regurgitation (choice A), the aortic valve does not close properly, so that blood flows backward through the valve during diastole. The aortic pressure thus falls greatly during diastole before the next heartbeat.

In aortic stenosis (choice B), the pulse pressure is greatly diminished because of decreased blood flow through the stenotic valve.

The aortic pressure pulse contour is usually not affected by mitral regurgitation (choice D) because this is a problem internal to the heart.

In patent ductus arteriosus (choice E), a large portion of the blood pumped by the heart flows through the ductus into the pulmonary artery, which allows the diastolic pressure to fall to very low levels before the next heartbeat.

A patient presents with a blood pressure of 165/95 mm Hg, and complaints of tiredness and muscle weakness. A blood workup reveals that plasma sodium is slightly increased and plasma potassium is significantly decreased
compared to normal. Hematocrit is also low. Plasma renin activity is markedly decreased, and serum aldosterone is increased. Which of the following is the most likely diagnosis?

A. Addison's disease
B. Conn's syndrome
C. Cushing's syndrome
D. 21-Hydroxylase deficiency
E. Pheochromocytoma

Explanation:

The correct answer is B. Conn's syndrome, or primary hyperaldosteronism, results from an adrenal tumor that secretes excessive aldosterone. The increased mineralocorticoid effects of aldosterone lead to renal sodium and water retention (which explains the hypertension) and increased renal potassium excretion (hypokalemia). The volume expansion also explains the decrease in hematocrit. The increased blood volume, increased blood pressure, and hypernatremia will all tend to suppress renin secretion in an attempt to compensate for the increased aldosterone.

Addison's disease (choice A), or primary adrenal insufficiency, is characterized by low plasma concentration of aldosterone, hyponatremia, hypotension, and hyperkalemia.

In Cushing's syndrome (choice C), blood pressure may be increased because of crossover mineralocorticoid activity of the increased plasma cortisol. Furthermore, cortisol makes blood vessels more responsive to catecholamines, which could increase peripheral resistance. The combination of increased blood pressure and hypokalemia would, if anything, tend to suppress secretion of aldosterone.

21-Hydroxylase deficiency (choice D) is likely to produce hypotension. In the salt-wasting variant of this disorder, the plasma concentration of aldosterone is decreased and hyponatremia and hyperkalemia result.
Pheochromocytoma (choice E) is another endocrine cause of hypertension. The increased plasma concentration of catecholamines can cause increased cardiac output and increased peripheral resistance. Plasma renin activity may be increased because of increased beta receptor activation on juxtaglomerular cells. This could produce increased aldosterone secretion and subsequent salt retention.

A 70-year-old woman presents to her physician prior to beginning chemotherapy for newly diagnosed small cell lung carcinoma. Her examination is notable for obesity, blood pressure of 180/110, facial hair, abdominal striae, and an acneiform rash on her chest and back. Laboratory values are normal except for a serum glucose of 250. Her chest x-ray shows a right perihilar mass and severe diffuse osteoporosis. Which of the following accounts for her physical exam, lab, and x-ray findings?

A. Adrenal gland destruction by metastases

B. Anterior pituitary gland disruption by metastases

C. Ectopic production of ACTH

D. Ectopic production of gastrin

E. Ectopic production of PTH

Explanation:

The correct answer is C. This woman has all the classic findings of Cushing's syndrome: obesity, hypertension, hirsutism, acne, striae, glucose intolerance, and osteoporosis. Cushing's syndrome may be caused by an excess production of cortisol by bilateral adrenal hyperplasia or an adrenal neoplasm; by excess production of ACTH by a pituitary adenoma; or by ectopic production of ACTH by a tumor, most commonly a small cell lung carcinoma (major clue in the question stem!).
Destruction of the adrenal glands bilaterally (choice A) or of the anterior pituitary by metastases (choice B) would cause a deficiency of cortisol and ACTH, respectively, and would lead to a syndrome of cortisol deficiency with orthostatic hypotension, malaise, nausea, and weight loss.

Ectopic production of gastrin (choice D), as seen in Zollinger-Ellison syndrome, causes severe refractory peptic ulcer disease.

Ectopic production of PTH (choice E), which can be seen in squamous cell lung carcinoma, would result in hypercalcemia.

A 23-year-old graduate student comes to the emergency room complaining of sudden onset of shortness of breath while walking home from the library. He denies any significant medical history and infrequently uses an inhaler when his asthma "acts up." He appears to be in moderate distress and is breathing at a rate of 28/min.

On physical examination he is afebrile and his breath sounds are normal on the right and decreased on the left. Percussion of the left chest is hyperresonant. An anterior-posterior chest radiograph of this patient would likely show which of the following?

A. An infiltrate in the left lower lobe

B. A radiolucency along the left chest wall

C. A wedge-shaped opacity in the left lung field

D. Fluid along the left costophrenic angle

E. Hyperinflation of both lung fields

Explanation:
The correct answer is B. This patient has suffered a spontaneous pneumothorax—an accumulation of air within the pleural space often resulting in collapse of the lung. Pneumothoraces are not uncommon. They are often caused by trauma but may also be secondary to other lung pathology (i.e., tuberculosis, malignancy, emphysema, pulmonary infarction, etc.). In this case, a pneumothorax has spontaneously arisen, most likely from rupture of a bulla in the upper lung lobe. Spontaneous pneumothoraces occur most often in young men (during the second or third decade) with a tall, slender body habitus. Symptoms include pain and difficulty breathing. Diagnosis should be suspected anytime there is absent or decreased breath sounds in an area that is hyperresonant to percussion. A chest x-ray will show a radiolucency (dark area). In a large pneumothorax with complete lung collapse, this area of radiolucency will be throughout the entire lung field, but in a small pneumothorax it can be a long, narrow area corresponding to the space between the chest wall and the partially collapsed lung.

A lobar infiltrate (choice A) could signify a lobar pneumonia, unlikely in this patient, since he is afebrile and because of the sudden nature of the symptoms.

A wedge-shaped opacity (choice C) can sometimes be seen after a pulmonary infarction from an embolus.

Fluid in the left lung field (choice D) would correlate with a pleural effusion (decreased breath sounds, hyporesonance).

Hyperinflation of the lung fields (choice E) usually accompanies an obstructive disorder, such as asthma (during an attack) or emphysema.

A 45-year-old woman with AIDS and disseminated histoplasmosis complains of profound weakness, easy fatigability, anorexia, weight loss, and diarrhea. Laboratory investigation reveals a serum sodium of 132 mEq/L, a serum potassium of 5.8 mEq/L and pH of 7.58. Skin hyperpigmentation is seen on physical examination. Which of the following is the most likely diagnosis?

A. Conn syndrome

B. Cushing syndrome

C. Primary adrenocortical insufficiency
D. Secondary adrenocortical insufficiency

E. Waterhouse-Friderichsen syndrome

Explanation:

The correct answer is C. The available evidence indicates that this patient has adrenal insufficiency due to diminished aldosterone production. The primary form of adrenocortical insufficiency (AKA Addison disease) results from any condition that destroys the adrenal cortex. Clinical manifestations of hypoaldosteronemia appear when 90% of the adrenal cortex is destroyed. The most frequent form is due to an autoimmune process (autoimmune adrenalitis). The remaining cases are secondary to infections (such as tuberculosis or fungal infections) or metastatic disease involving both adrenals. Secondary adrenocortical insufficiency (choice D) differs from the primary form for two reasons: 1) it is caused by disorders affecting the pituitary gland or hypothalamus and leading to reduced ACTH production, and 2) it is not associated with skin hyperpigmentation. Skin hyperpigmentation results from increased production of ACTH precursor (which stimulates melanocytes), present in Addison disease but obviously lacking in secondary adrenocortical insufficiency.

Conn syndrome (choice A) refers to primary hyperaldosteronism resulting from an aldosterone-producing adenoma of the adrenal gland. Hyperaldosteronism manifests with hypernatremia, hypokalemia, and hypertension.

Cushing syndrome (choice B) is due to increased levels of glucocorticoids, whether exogenous (therapeutic administration) or endogenous (e.g., adrenal adenoma and ectopic production of ACTH by a neoplasm). It manifests with hypertension, truncal obesity, osteoporosis, skin fragility, hypertension, and hyperglycemia.

Waterhouse-Friderichsen syndrome (choice E) is an acute, catastrophic form of primary adrenocortical insufficiency caused by bilateral adrenal hemorrhage. The most frequent cause is a severe infection such as Neisseria meningitidis sepsis. Children are more vulnerable to this complication.
A 48-year-old man presents to his physician with complaints of dizziness and fatigue. Physical examination reveals a blood pressure of 130/50 mm Hg and a heart rate of 100 beats per minute. On examination, the physician notes a large scar on the patient's abdomen. The man states that he was severely injured in an automobile accident several years ago, and required abdominal surgery at that time. Which of the following is the most likely diagnosis?

A. Arteriovenous fistula

B. Cardiac tamponade

C. Heart failure

D. Hypovolemia

E. Shock

Explanation:

The correct answer is A. The patient has an acquired arteriovenous fistula, probably caused by previous abdominal surgery. The decrease in peripheral resistance associated with an arteriovenous fistula causes an increase in cardiac output when the fistula is large (which usually requires involvement of a major artery such as the aorta, subclavian artery, femoral artery, common carotid artery, or iliac artery). The increase in cardiac output caused by the fistula is roughly equal to the blood flow through the fistula. The increase in cardiac output is associated with increases in both heart rate and stroke volume. The diastolic blood pressure falls because blood can rapidly exit the arterial system through the fistula, but mean blood pressure is maintained relatively constant because the normal long-term blood pressure regulating mechanisms (e.g., renal body fluid feedback mechanism) still operate normally. The decrease in diastolic pressure with a normal or slightly increased systolic pressure causes the arterial pulse pressure to increase in arteriovenous fistula (note that pulse pressure is 80 mm Hg in this problem; normal is ~40 mm Hg).

The pulse pressure is decreased in cardiac tamponade (choice B), heart failure (choice C), hypovolemia (choice D), and shock (choice E).
Which of the following characteristics is typical of type 1, but not type 2 diabetes?

A. Adult onset
B. Nearly complete twin concordance
C. Increased serum insulin levels
D. Ketoacidosis
E. Obesity

Explanation:

The correct answer is D. Type 1 diabetes (DM 1), previously known as juvenile onset or insulin-dependent diabetes, is due to low insulin production as a consequence of autoimmune destruction of pancreatic beta cells. Severe insulin deficiency causes marked increases in the use of fats as a source of energy. Ketones, acetoacetate and beta-hydroxybutyrate are produced in excess, and diabetic ketoacidosis may develop with potentially dire consequences. Type 2 diabetes (DM 2) is a consequence of insulin resistance by the tissues, despite very high levels of serum insulin, initially (insulin levels typically fall as the disease progresses). Ketoacidosis is highly unusual in DM 2, since insulin is present.

In DM 1 there is usually complete loss of beta cells by puberty; thus insulin dependence begins in childhood. DM 2 has an adult age of onset (choice A).

There is approximately 50% twin concordance in DM 1, suggesting that environmental factors must also play a "triggering role" in DM 1. The twin concordance rate is much higher in DM 2 (~90%) (choice B).
Insulin levels are nearly zero in DM 1. Conversely, DM 2 is a disease of insulin resistance, and is usually associated with increased insulin levels (choice C).

Body weight has no bearing on the pathogenesis of DM 1, whereas DM 2 occurs predominantly in the obese (choice E).

Which of the following Starling force changes is the primary cause of the edema seen in patients with nephrotic syndrome?

A. Decreased capillary hydrostatic pressure (Pc)
B. Decreased capillary oncotic pressure (πc)
C. Decreased interstitial hydrostatic pressure (Pi)
D. Decreased interstitial oncotic pressure (πi)
E. Increased capillary hydrostatic pressure (Pc)
F. Increased capillary oncotic pressure (πc)
G. Increased interstitial hydrostatic pressure (Pi)
H. Increased interstitial oncotic pressure (πi)

Explanation:

The correct answer is B. This question illustrates an important strategy: knowing what you're looking for before you consider the answer choices. If you thought about the answer before considering the choices, this question was very straightforward and simple. If, on the other hand, you considered each answer choice in turn, you no
doubt got pretty confused and wasted a lot of precious test time.

The first thing to remember is that nephrotic syndrome is defined as proteinuria (over 3.5 gm/day) with concurrent hypoalbuminemia and hyperlipidemia. The loss of protein in the urine results in a decreased oncotic pressure in the vascular space (decreased \( \pi_c \)). This decrease in capillary oncotic pressure promotes movement of fluid into the interstitium and the development of edema. This is also the cause of edema in patients with liver disease.

Decreased interstitial oncotic pressure (\( \pi_i \); choice D) would actually promote the movement of fluid into the vasculature; it would not lead to edema. The same thing would occur with decreased capillary hydrostatic forces (\( P_c \); choice A).

While decreased interstitial hydrostatic pressure (\( P_i \); choice C) would lead to edema, it is not the mechanism of action in nephrotic syndrome.

While increased capillary hydrostatic pressure (choice E) does lead to edema, it is not the mechanism at work in nephrotic syndrome. It is, however, the mechanism of edema in the setting of congestive heart failure (increased capillary hydrostatic pressure due to inefficient pumping of the heart, leading to pooling) and in glomerulonephritis (increased intravascular volume due to inefficient excretion by the kidney).

Increased capillary oncotic pressure (choice F) would not lead to edema.

Increased interstitial hydrostatic pressure (choice G) would not lead to edema.

Increased interstitial oncotic pressure (choice H) would cause edema, but not in the setting of nephrotic syndrome. Instead, this is the mechanism of edema (typically localized) in the setting of burns and inflammation (increased capillary permeability allows protein to leak into interstitium and increase oncotic pressure).

A 19-year-old male is rushed to the emergency room after being shot in the chest. He has lost a great deal of blood and appears very pale. His skin is cool and clammy, and his mental status altered. On exam he is tachycardic, tachypneic, and the jugular veins are collapsed. Urinary output is minimal. Which of the following is most consistent with the patient's condition?
Preload
Cardiac output
Vascular resistance
Mixed venous oxygen

A. Increased
   Increased
   Increased
   Decreased

B. Increased
   Decreased
   Decreased
   Increased

C. Decreased
   Decreased
   Increased
   Decreased

D. Decreased
   Decreased
   Decreased
   Increased

E. Decreased
   Decreased
   Decreased
   Decreased
Explanation:

The correct answer is C. The case depicts a classic picture of hypovolemic shock due to hemorrhage. When blood volume is low, less blood fills the ventricles during diastole, corresponding to reduced preload. Consequently, cardiac output is decreased because of the diminished stroke volume. Vascular resistance is increased in order to compensate for volume loss. Mixed venous oxygen levels are reduced because of the increased tissue demand of oxygen and the loss of hemoglobin.

The remaining choices are inconsistent with hemorrhagic shock.

A 45-year-old woman is evaluated for congestive heart failure. In addition to a dilated cardiomyopathy, she displays multiple signs and symptoms including slow speech and intellectual function, fatigue, lethargy, cold intolerance, listlessness, thickened facial features, periorbital edema, dry and coarse skin, and peripheral edema. Serum studies demonstrate a T4 of 1.2 µg/dL and a TSH of 23 µU/mL. Which of the following diagnoses is supported by these data?

A. Cretinism

B. Graves disease

C. Hashimoto's thyroiditis

D. Myxedema

E. Subacute granulomatous thyroiditis

Explanation:

The correct answer is D. The diagnosis of myxedema, due to long-standing (e.g., often several years duration) hypothyroidism in adults, is warranted. The clinical manifestations are those listed in the question stem.
Myxedema can result from the many causes of hypothyroidism: Hashimoto's thyroiditis, idiopathic primary hypothyroidism, iodine deficiency, drugs, pituitary lesions, hypothalamic lesions, and damage to the thyroid by surgery or radiation. It is not warranted at this stage in the patient's evaluation to assign a specific cause for the myxedema, as the appropriate work-up has not yet been done.

Cretinism (choice A) is caused by hypothyroidism in infancy.

Graves disease (choice B) usually produces hyperthyroidism.

Hashimoto's thyroiditis (choice C) is an important cause of hypothyroidism, but this diagnosis would require a biopsy demonstrating infiltration with lymphocytes, macrophages and plasma cells, often associated with germinal center formation.

Subacute granulomatous thyroiditis (choice E) usually causes hyperthyroidism but can cause transient hypothyroidism; this specific diagnosis would necessitate a biopsy demonstrating disruption of thyroid follicles, a neutrophilic infiltrate, cellular aggregates, and multinucleated giant cells.

A 52-year-old male is brought into the emergency room by his wife because he has been complaining of a severe headache. Physical exam reveals ptosis of the right eyelid with the right eye facing down and out. There is a fixed and dilated right pupil with an inability to accommodate. Subarachnoid blood appears on noncontrast CT scan. Magnetic resonance angiography (MRA) would be expected to reveal an aneurysm of which of the following vessels?

A. Anterior cerebral artery

B. Anterior choroidal artery

C. Anterior communicating artery

D. Middle cerebral artery

E. Ophthalmic artery
F. Posterior communicating artery

G. Posterior inferior cerebellar artery

Explanation:

The correct answer is F. Aneurysm of the posterior communicating artery is the second most common aneurysm of the circle of Willis (anterior communicating artery is most common) and can result in third cranial nerve palsy (paralysis). The oculomotor nerve (CN III) innervates the levator palpebrae muscle. CN III paralysis would therefore result in ptosis (drooping of the upper eyelid). CN III also innervates all of the extraocular muscles, except for the superior oblique (CN IV) and the lateral rectus muscles (CN VI). Thus, CN III palsy would result in unopposed action of the superior oblique and lateral rectus muscles, causing the affected eye to look down and out. CN III also supplies parasympathetic innervation to the sphincter muscle of the iris (which constricts the pupil) and to the ciliary muscle. Interruption of this pathway leads to a dilated and fixed pupil and to paralysis of accommodation.

Note that this question teaches you about another Boards-favorite pathology: subarachnoid hemorrhage (SAH). (In this case, it was due to rupture of a posterior communicating artery aneurysm). A classic clue to the diagnosis is a patient presenting with "the worst headache of their life." When you are presented a case of sudden severe headache, SAH should rank highly on your differential diagnosis list.

The anterior cerebral artery (choice A) supplies the medial surface of the cerebral hemisphere, from the frontal pole to the parieto-occipital sulcus. Occlusion may produce hypesthesia and paresis of the contralateral lower extremity.

The anterior choroidal artery (choice B) arises from the internal carotid artery and is not part of the circle of Willis. It perfuses the lateral ventricular choroid plexus, the hippocampus, parts of the globus pallidus and posterior limb of the internal capsule.

The anterior communicating artery (choice C) connects the two anterior cerebral arteries. It is the most common site of aneurysm in the circle of Willis and may cause aphasia, abulia (impaired initiative), and hemiparesis.
The middle cerebral artery (choice D) supplies the lateral convexity of the cerebral hemisphere, including Broca's and Wernicke's speech areas and the face and arm areas of the motor and sensory cortices. It also gives rise to the lateral striate arteries, which supply the internal capsule, caudate, putamen, and globus pallidus. The middle cerebral artery is the most common site of stroke.

The ophthalmic artery (choice E) enters the orbit with the optic nerve (CN II) and gives rise to the central artery of the retina. Occlusion results in blindness.

The posterior inferior cerebellar artery (choice G) supplies the dorsolateral medulla and the inferior surface of the cerebellar vermis. Occlusion may result in Wallenberg's syndrome: cerebellar ataxia, hypotonia, loss of pain and temperature sensation of the ipsilateral face, absence of corneal reflex ipsilaterally, contralateral loss of pain and temperature sensation in the limbs and trunk, nystagmus, ipsilateral Horner's syndrome, dysphagia, and dysphonia.

A patient who immigrated from a mountainous area of Asia complains of fatigue, weight gain, constipation, and cold intolerance. Physical examination demonstrates a diffuse mass in the anterior aspect of the neck. Dietary deficiency of which of the following nutrients is most likely to have contributed to the patient's problem?

A. Copper

B. Iodine

C. Iron

D. Selenium

E. Zinc

Explanation:
The correct answer is B. Endemic goiter, such as in this patient, is due to dietary iodine deficiency. This disorder is common world-wide in mountainous areas (where fish are not available), although the use of iodized salt in the United States has limited its prevalence here. Frank symptoms of hypothyroidism may or may not be present, possibly because of the increased synthesis of the more potent triiodothyronine (T3) at the expense of thyroxine (T4).

Copper deficiency (choice A) can cause anemia, neutropenia, hypotonia, psychomotor retardation, osteoporosis, depigmentation of hair, and glucose intolerance.

Iron deficiency (choice C) can cause anemia, cognitive dysfunction, impaired immunity, impaired thermoregulation, and reduced levels of physical activity.

Selenium deficiency (choice D) can cause congestive cardiomyopathy and skeletal muscle degeneration.

Zinc deficiency (choice E) causes rash, growth retardation, and impairments of immunity, wound healing, mentation, sexual function, and night vision.

A patient has an insulin-secreting tumor that is localized to the tail of the pancreas. Which of the following would most likely be an associated finding during fasting?

A. Glycosylated hemoglobin level is increased

B. Plasma concentration of C peptide is decreased

C. Plasma concentration of glucagon is decreased

D. Plasma concentration of glucose is increased

E. Plasma concentration of proinsulin is increased
The correct answer is E. Hypersecretion of insulin by a pancreatic β cell tumor is a major cause of fasting hypoglycemia (plasma glucose is not increased, choice D). Symptoms are related to neuroglycopenia and could include recurrent central nervous system dysfunction during fasting or exercise. While proinsulin only makes up approximately 20% of plasma immunoreactive insulin in normal individuals, in patients with an insulinoma it contributes 30-90% of the immunoreactive insulin. Hence, plasma levels of proinsulin are increased. The increased secretion of insulin by the tumor will also lead to an increase in C peptide secretion (not decreased, choice B) since β cells secrete insulin and C peptide on a one-to-one molar ratio. Given the prolonged hypoglycemia, the amount of glycosylated hemoglobin may also be decreased, although this is not a universal finding. Certainly, an increase in glycosylated hemoglobin would not be expected (choice A). Glucagon secretion is increased by hypoglycemia and its plasma level in a patient with an insulinoma would be expected to be increased compared to normal (not decreased, choice C).

A genotypic male (XY) is born with feminized external genitalia. The testes are retained within the abdominal cavity and the internal reproductive tracts exhibit the normal male phenotype. Which of the following could account for this abnormal development?

A. Complete androgen resistance
B. 5α-reductase deficiency
C. 17α-hydroxylase deficiency
D. Sertoli-only syndrome
E. Testicular dysgenesis

Explanation:
The correct answer is B. In utero differentiation of the Wolffian ducts into the normal male phenotypic internal reproductive tract requires testosterone, but not dihydrotestosterone. On the other hand, differentiation of the indifferent external genital slit into the penis, prostate, and scrotum does require dihydrotestosterone. A congenital absence of 5α-reductase in these tissues will result in feminization. If left untreated, the affected individuals are generally phenotypic females until puberty, at which time, increased amounts of testosterone results in virilization ("penis-at-twelve" syndrome). If discovered early, a male gender assignment can be supported with administration of dihydrotestosterone to increase penis size. If discovered after infancy, a female gender assignment can be supported with estrogen substitution therapy and prophylactic orchiectomy.

With complete androgen resistance (choice A), the external genitalia are feminized, but neither the male-type nor the female-type internal tracts develop. In the absence of the androgen receptor, the Wolffian ducts will degenerate. The Müllerian ducts will also degenerate because of the normal effect of testicular Müllerian regression factor.

With 17α-hydroxylase deficiency (choice C), the testes cannot synthesize testosterone, resulting in feminization of the external genitalia and degeneration of the Wolffian ducts. Normal secretion of Müllerian regression factor should also cause the degeneration of the Müllerian ducts. Because of the excessive secretion of deoxycorticosterone by the adrenal cortex, these individuals are usually hypertensive.

The Sertoli-only syndrome (choice D) refers to the situation in which only the Sertoli cells of the seminiferous tubules are present (germinal cell aplasia). Spermatogenesis is absent in these individuals, who also show increased plasma levels of FSH due to decreased Sertoli cell secretion of inhibin. They may exhibit both male-type and female-type internal tracts due to the absence of Müllerian regression factor. The Leydig cells, however, have normal function and result in normal secretion of testosterone, so that both male-type internal tracts and external genitalia develop.

Testicular dysgenesis (choice E) results in poor in utero development of the testes with concomitantly decreased secretion of testosterone and Müllerian regression factor. The Wolffian duct structures may degenerate and the external genitalia may be feminized. Female-type internal tracts may develop because of the decreased secretion of Müllerian regression factor.

A 60-year-old man is admitted to the hospital because of shortness of breath. The man's ankles have 4+ edema
and his blood pressure is 75/50 mm Hg. Initial chemistry studies show serum urea nitrogen (BUN) 36 mg/dL and serum creatinine 1.0 mg/dL. A chest x-ray shows cardiac enlargement and perihilar infiltrates. Which of the following most likely accounts for the patient's BUN and creatinine levels?

A. Decreased renal perfusion  
B. Distal urinary tract obstruction  
C. Increased synthesis of urea  
D. Renal glomerular disease  
E. Renal tubulointerstitial disease

Explanation:

The correct answer is A. The patient's ankle edema, shortness of breath, and relatively low blood pressure suggest the possibility of congestive heart failure, which is confirmed by the cardiac enlargement and perihilar infiltrates seen on chest x-ray. The serum urea nitrogen is elevated while serum creatinine is normal, suggesting a prerenal cause for the azotemia. Congestive heart failure with its resulting decreased blood pressure is a known, common cause of decreased renal perfusion leading to prerenal azotemia.

Postrenal causes of azotemia are typically due to urinary tract obstruction distal to the kidney (choice B), and usually cause a rise in both urea and creatinine, with the rise in urea being larger than that in creatinine.

Increased synthesis of urea (choice C) is seen in severe burns and prolonged high fever.

Renal glomerular disease (choice D) severe enough to cause acute or chronic renal failure will cause urea and creatinine to rise together.

Renal tubulointerstitial disease (choice E) severe enough to cause renal failure will cause both urea and creatinine to rise; the creatinine may rise out of proportion to the urea, particularly in acute tubular necrosis.
A 64-year-old man has a myocardial infarction, and is hospitalized. He is seen by a cardiologist, who orders echocardiographic studies, which demonstrate a portion of the apex of the left ventricle that bulges outward during systole and inward during diastole. This finding is most likely related to disease involving which of the following structures?

A. Aortic valve
B. Circumflex artery
C. Left anterior descending artery
D. Mitral valve
E. Tricuspid valve

Explanation:

The correct answer is C. The motion described is called "paradoxical movement" and occurs when a portion of the ventricular wall is infarcted and can no longer contract during systole. The site of infarction described is in the distribution of the left anterior descending artery.

Valvular disease, including that of the aortic valve (choice A), mitral valve (choice D), or tricuspid valve (choice E) will not cause localized paradoxical movement.

The circumflex artery (choice B) supplies the superior part of the posterior wall of the heart, anastomosing there with the right coronary artery.
A 43-year-old man with diabetes insipidus, severe polydipsia, and polyuria is admitted to the hospital for surgical repair of an inguinal hernia. After surgery, he exhibits fever and psychic disturbances. His plasma sodium concentration is 175 mEq/L.

Diagrams A-E show the relative osmolarity (Y-axis) and volume (X-axis) of the intracellular and extracellular fluid compartments during normal conditions (solid line) and following various disturbances in the body fluids (shaded area, dashed line). Which of the following diagrams most accurately depicts this man's condition after surgery?

A.

B.

C.

D.

E.

Explanation:

The correct answer is D. Diagram D shows a disturbance in body fluid balance referred to as "hypertonic contraction," which is characteristic of loss of hypotonic fluid from the body. Loss of hypotonic fluid decreases total body water and increases body fluid osmolarity, as indicated in this diagram. Normal function of the thirst center ensures that polyuria (excessive urine output) closely matches polydipsia (excessive water intake) so that dehydration does not occur. However, when adequate replenishment of water loss by excretion is interfered with (i.e., during surgical procedures), dehydration may become severe, causing fever, psychic disturbances, and even death. The plasma sodium concentration of 175 mEq/L in this patient is a clear indication that he is dehydrated and that serum osmolarity is elevated (extracellular osmolarity can be approximated as 2 times the plasma sodium concentration, which is 350 mOsm/L).

Choice A (isotonic contraction) can be caused by loss of isotonic fluid, eg, acute diarrhea.
Choice B (hypertonic expansion) can be caused by excessive intake of sodium chloride without allowing water to be drunk.

Choice C (hypotonic contraction) is characteristic of sodium chloride loss from the body, eg, secondary to lack of aldosterone.

Choice E (hypotonic expansion) can be caused by retention of water by the kidneys, eg, inappropriate secretion of antidiuretic hormone.

A 56-year-old man visits his physician with complaints of complete exhaustion after mowing the lawn in his small front yard. He also complains of dizziness, irritability, difficulty sleeping, and loss of libido. On physical examination, the man's skin, conjunctiva, and oral mucosa are pale. A blood test indicates the man's hemoglobin is 7 g/dL. Which of the following findings is also likely to be present in this man?

A. Bradycardia
B. Cyanosis
C. Low stroke volume
D. Warm hands
E. Wide pulse pressure

Explanation:

The correct answer is E. The normal blood hemoglobin concentration is about 15-16 g/dL for a man and about 13-14 g/dL for a woman. A patient is considered to be severely anemic when the hemoglobin concentration falls below 7.5 g/dL. In severely anemic patients, the resting cardiac output is significantly increased with an
increase in both heart rate and stroke volume (choice C). The increase in stroke volume causes a widening of the pulse pressure, because when a greater amount of blood is ejected during each systole, the blood pressure rises and falls to a greater extent.

Bradycardia (choice A) is said to occur when the heart rate falls below 60 BPM. Severely anemic patients exhibit tachycardia, which is defined as a heart rate greater than 100 BPM.

Cyanosis (choice B) refers to a bluish color of the skin and mucous membranes that results from the presence of deoxygenated hemoglobin in the blood vessels, especially the capillaries. Cyanosis does not occur in severely anemic patients despite widespread hypoxia in the tissues because 5 grams of deoxygenated hemoglobin must be present in each 100 mL of blood to produce overt cyanosis. In other words, the hemoglobin concentration is too low for a severely anemic patient to become cyanotic.

The hands of anemic patients are often cold (choice D) because of decreased blood flow to the skin.

Q 5

The diagram above shows spirographic tracings of forced expirations from two different individuals. Trace X was obtained from a person with healthy lungs. Which of the following is most likely represented by trace Y?
A. Asthma

B. Bronchospasm

C. Emphysema

D. Interstitial fibrosis

E. Old age

Explanation:

The correct answer is D. A forced expiration is the simplest test of lung function. The individual breathes in as much air as the lungs can hold and then expels the air as rapidly and as far as possible. The forced vital capacity (FVC) is the vital capacity measured with a forced expiration (FVC = 3 L for patient Y). The forced expiratory volume in one second (FEV1) is the amount of air that can be expelled from the lungs during the first second of a forced expiration (FEV1 = 2.7 L for patient Y). The FEV1/FVC ratio has diagnostic value for differentiating between normal, obstructive, and restrictive patterns of a forced expiration. The FEV1/FVC ratio for the healthy individual (X) is 4 L/5 L = 80% and the FEV1/FVC for patient Y is 2.7/3.0 = 90%.

FEV1/FVC is a function of airway resistance. Increases in airway resistance associated with asthma (choice A), bronchospasm (choice B), emphysema (choice C), and old age (choice E) tend to decrease the FEV1/FVC ratio below its typical normal value of 80%. FEV1/FVC is often increased with interstitial fibrosis because of increased radial traction of the airways, i.e., the airways are held open to a greater extent at any given lung volume, reducing their resistance to air flow. The increase in elastic recoil also makes it difficult to breathe deeply, which decreases FVC. This combination of decreased FVC along with normal or slightly increased FEV1/FVC is characteristic of fibrotic lung disease.

A heroin addict is found unconscious in an alley with an empty syringe beside him. When his blood gases are checked, which of the following would be expected?
A. Metabolic acidosis

B. Metabolic alkalosis

C. Normal pH balance

D. Respiratory acidosis

E. Respiratory alkalosis

Explanation:

The correct answer is D. Opioids, such as heroin, depress respiration centrally by reducing the responsiveness of brainstem respiratory centers to CO2. The resulting hypoventilation leads to CO2 retention because of the inability of the patient to "blow off" the CO2. This increases the production of carbonic acid (H2CO3) by carbonic anhydrase present in red blood cells (which converts CO2 to carbonic acid). Dissociation of carbonic acid to bicarbonate (HCO3−) and protons produces a respiratory acidosis.

Metabolic acidosis (choice A) is caused by a primary decrease in HCO3−, which can occur after tissue hypoxia (which increases levels of lactic acid) or in uncontrolled diabetes mellitus.

Metabolic alkalosis (choice B) is caused by an increase in HCO3−, which can occur subsequent to ingestion of alkali or a loss of gastric acid (vomiting).

Normal pH balance (choice C) might be anticipated if the respiratory acidosis persists, allowing time for the kidneys to compensate for the altered pH by conserving HCO3−. However, renal compensation takes several days (this patient suffered from an acute heroin overdose), and is rarely complete.

Respiratory alkalosis (choice E) is caused by a decrease in PCO2, which can occur with hyperventilation.
A 73-year-old man is stabbed in the chest with a large butcher's knife which lacerates the outer layers of his aorta. He is released from the hospital after recovery and appears to be doing well. A few weeks later, the man shows up at the hospital confused and feeling dizzy. His blood pressure is 78/28 mm Hg and his heart rate is 94 BPM. His circulatory system is operating at point B on the figure above; point A is the normal operating point. Which of the following mostly likely accounts for his new equilibrium at point B?

A. Arteriovenous fistula

B. Exercise

C. Heart failure

D. Narcotic overdose

E. Severe hemorrhage

Explanation:

The correct answer is A. A penetrating wound of the aorta has resulted in the formation of an aneurysm. The aneurysm has eroded into the vena cava, creating a large arteriovenous fistula. The blood pressure has decreased greatly as arterial blood gushes into the venous system through the large fistula. The venous return
curve is shifted to the right and rotated upward (dashed line), causing the cardiac output to increase from a normal value of 5 L/min to over 12 L/min. This upward rotation of the venous return curve is caused by the large decrease in resistance to venous return that occurs when blood flows directly from the aorta into the vena cava, bypassing the resistance vessels of the microcirculation. The mean systemic filling pressure (MSFP) is the point at which a venous return curve intersects the X-axis. Note that the presence of the fistula has increased the MSFP from its normal value of about +7 mm Hg to about +9 mm Hg. This increase in MSFP is caused by sympathetic nerve reflexes initiated by the decrease in blood pressure. The MSFP would be expected to increase further within a few days as renal retention of salt and water increase blood volume.

Exercise (choice B) causes a rightward shift of the venous return curve. However, exercise also increases cardiac performance, raising the cardiac output curve to a higher level. Exercise does not decrease blood pressure.

In heart failure (choice C) the cardiac output curve (cardiac function curve) is shifted downward because of decreased myocardial contractility. Cardiac output does not increase.

A narcotic overdose (choice D) is expected to depress the myocardium, causing the cardiac output curve to shift downward. Cardiac output does not increase.

Hemorrhage (choice E) causes a reduction in blood volume, which decreases MSFP and thus shifts the venous return curve to the left. Also, the cardiac output curve is shifted downward when hemorrhagic shock decreases myocardial contractility.

A 68-year-old female who recently had a cholecystectomy develops a fever of 103°F and has persistent drainage from her biliary catheter. She is given cephalothin and gentamicin for 10 days. Her serum creatinine level increases to 7.6 mg/dL. Her urine output is 1.3 L/day and has not diminished over the past few days. There is no history of hypotension and her vital signs are normal. Renal ultrasonography shows no evidence of obstruction. The most likely etiology of the patient's condition is

A. acute glomerulonephritis

B. acute renal failure secondary to cephalothin
C. gentamicin nephrotoxicity

D. renal artery occlusion

E. sepsis

Explanation:

The correct answer is C. A small percentage of patients (5% to 10%) develop a nonoliguric form of acute renal failure when treated with aminoglycosides such as gentamicin. Gentamicin can accumulate in the kidney to produce a delayed form of acute renal failure resulting in an elevation of the serum creatinine level. The nonoliguric form of renal failure, seen in this patient, is the typical presentation for gentamicin nephrotoxicity.

Acute glomerulonephritis (choice A) is typically associated with hypertension and the appearance of an active urinary sediment containing casts and red blood cells.

Cephalothin (choice B) is a first-generation cephalosporin commonly used in the treatment of severe infection of the genitourinary tract, gastrointestinal tract, and respiratory tract, as well as skin infections. This antibiotic can produce an acute interstitial nephritis; however, the patient's presentation is consistent with gentamicin nephrotoxicity. Interstitial nephritis is commonly associated with the development of acute renal failure, fever, rash, and eosinophilia.

Renal artery occlusion (choice D) is commonly caused by thrombosis or embolism. The clinical features of acute renal artery occlusion are hematuria, flank pain, fever, nausea, elevated LDH, elevated SGOT and acute renal failure.

Since the patient has normal vital signs and no history of hypotension, a diagnosis of sepsis (choice E) is unlikely.

A woman in the 2nd trimester of her pregnancy is concerned because her baby, which was previously quite
active, has not been moving much lately. An ultrasound shows that the fetal heart is no longer beating. Which of the following hormones of pregnancy is most likely to be significantly decreased compared to normal in this woman's blood?

A. Estriol

B. Human chorionic gonadotropin

C. Human chorionic somatomammotropin

D. Progesterone

E. Prolactin

Explanation:

The correct answer is A. Maternal blood levels of estriol, a weak estrogen, are dependent on a viable fetus. The fetal adrenal cortex and liver produce the weak androgen, 16-OH dehydroepiandrosterone sulfate (16-OH DHEA-S). The 16-OH DHEA-S is carried by the fetal circulation to the placenta, where it is desulfated and aromatized to estriol prior to secretion into the maternal circulation. While maternal blood levels of estradiol and estrone increase by 50-fold during pregnancy, maternal blood levels of estriol increase 1000-fold. Rising maternal blood levels of estriol is the best indicator of fetal well-being. A significant drop in maternal estriol may indicate fetal jeopardy.

Human chorionic gonadotropin (hCG, choice B) is secreted by syncytiotrophoblast cells and is not dependent on a viable fetus. Human chorionic gonadotropin (hCG) is in the same hormone family as TSH, FSH, and LH. It has an alpha subunit that is identical to the alpha subunits of these pituitary hormones (although the glycosylation may differ) and a beta subunit similar to that of LH. The maternal blood or urinary level of hCG is used to confirm the presence of pregnancy. Its function is to "rescue" the corpus luteum and maintain the pregnancy until the placenta can produce sufficient estrogen and progesterone.

Human chorionic somatomammotropin (hCS; choice C) is secreted by syncytiotrophoblast cells and is not
dependent on the presence of a viable fetus. It is also known as human placental lactogen, and is in the same hormone family as growth hormone and prolactin. Its function in pregnancy is not completely understood, but it may serve to reduce maternal glucose utilization and allow for "shunting" of glucose to the fetus.

Maternal progesterone (choice D) is dependent on a viable placenta, but is not dependent on a fetal contribution. The precursor for placental secretion of progesterone is maternal (not fetal) cholesterol.

Prolactin (choice E) levels steadily rise during pregnancy. This contributes to the final development of a mature mammary gland. It is secreted by the anterior pituitary and does not require a fetal contribution.

A 25-year-old man presents with headache, dizziness, and claudication. Blood pressure measurements reveal hypertension in the upper limbs and hypotension in the lower limbs. Which of the following additional findings would be most likely in this case?

A. Aortic valvular stenosis

B. Notching of inferior margins of ribs

C. Patent ductus arteriosus

D. Pulmonary valvular stenosis

E. Vasculitis involving the aortic arch

Explanation:

The correct answer is B. The adult form of aortic coarctation is caused by stenosis in the aortic arch just distal to the left subclavian artery. This leads to hypertension proximal to, and hypotension distal to, the stenotic segment. Hypertension in the upper part of the body manifests with headache, dizziness, and other neurologic symptoms. Hypotension in the lower part of the body results in signs and symptoms of ischemia, most often
claudication, i.e., recurrent pain due to ischemia of leg muscles. In addition, collateral arteries between the 
precoarctation and postcoarctation aorta (eg, the intercostal and internal mammary arteries) enlarge and 
establish communication between aortic segments proximal and distal to stenosis. Enlarged intercostal arteries 
produce notching of the inferior margins of the ribs, which can be detected on x-ray and is diagnostic of this 
condition. Remember that the infantile form of aortic coarctation is associated with patent ductus arteriosus, 
whereas the adult form is not.

Aortic valvular stenosis (choice A) at this age would most likely be caused by a congenitally malformed valve, 
usually a valve with two cusps or a single cusp. Aortic stenosis manifests with systolic hypotension, recurrent 
syncope, and hypertrophy/dilatation of the left ventricle. Low systolic pressure is present in the entire body.

The isolated form of patent ductus arteriosus (choice C) leads to shunting of blood from the aorta 
(high-pressure vessel) to the pulmonary artery (low-pressure vessel). Eventually, chronic cor pulmonale 
develops with resultant right-sided heart failure.

Pulmonary valvular stenosis (choice D) is a rare form of congenital heart disease that leads to chronic cor 
pulmonale and heart failure.

Vasculitis involving the aortic arch (choice E) is found in Takayasu arteritis, in which chronic inflammatory 
changes develop in the aortic arch and its branches (brachiocephalic trunk, left common carotid, and left 
subclavian arteries). This condition causes stenosis of these arteries; therefore, there will be signs and 
symptoms of ischemia to the upper part of the body. Since the radial pulses are very weak or absent, this 
disorder is also known as pulseless disease.

A 38-year-old woman comes to the emergency room complaining of severe, right-sided abdominal pain, fever, 
and chills for the past several hours. She has a history of gallstones and her family doctor recommended a 
cholecystectomy after a similar episode several months ago. Upon examination, she has a temperature of 
102.7°F (39.3°C), is tender in the right upper quadrant, and is visibly jaundiced. Her white blood count is 
18,000/mm3 . In which of the following locations is a gallstone most likely lodged in this patient?

A. Common bile duct
B. Cystic duct

C. Fundus of gallbladder

D. Proximal duodenum

E. Terminal ileum

Explanation:

The correct answer is A. The patient is probably suffering from choledocholithiasis, a condition in which a gallstone becomes lodged in the common bile duct. She is displaying "Charcot's triad" (fever, jaundice, and right upper quadrant pain), which is indicative of cholangitis (infection of the biliary tree proximal to an obstruction such as a gallstone or malignancy). Gallstones are very common, occurring in as many as 15-20% of the general population. The most common type of stone contains cholesterol, which precipitates from supersaturated bile within the gallbladder. Some risk factors for cholesterol stones are increasing age, rapid weight loss, oral contraceptive use, and either disease of or resection of the terminal ileum (the site at which bile salts are reabsorbed). Pigmented gallstones made of calcium bilirubinate are less common and occur in patients with hemolytic disorders and certain types of biliary tract infections.

The key point in this case is the fact that the patient is jaundiced, eliminating all choices other than a stone in the common bile duct. Stones within the cystic duct (choice B) or gallbladder (choice C) do not cause jaundice.

A stone within the small intestine (choices D and E) could cause jaundice only if it were very large and physically obstructing the biliary tree from within the intestinal lumen, which would be very unlikely.
The volume-pressure curves shown above (TLC = total lung capacity) were obtained from a normal subject and from a patient. Which of the following conditions best accounts for the differences observed in the patient?

A. Asthma

B. Bronchospasm

C. Emphysema

D. Interstitial fibrosis

E. Old age

Explanation:

The correct answer is D. Compliance is the change in lung volume for a given change in pressure. Interstitial fibrosis decreases pulmonary compliance. The volume-pressure curve indicates the patient has a lower-than-normal pulmonary compliance, i.e., the lung is "stiffer" than normal. The elastic recoil of the lung is increased when fibrous material is deposited in the interstitium and alveolar walls, reducing the distensibility (compliance) of the lung. Note that the pressure-volume curve is often reported as a percentage of the total lung capacity (TLC) rather than the absolute lung volume. Expressing lung volume in this manner reduces variability between patients caused by differences in body size.

Asthma (choice A), as well as other conditions in which bronchospasm (choice B) is prominent, causes the apparent pulmonary compliance to increase, i.e., increases the slope of the volume-pressure relationship.

The elastic recoil of the lungs is decreased in emphysema (choice C) and old age (choice E), which increases the distensibility (compliance) of the lungs.
The volume-pressure curves shown above were obtained from a normal subject and a patient. Which of the following abnormalities is most likely in this patient?

A. Adult respiratory distress syndrome
B. Asbestosis
C. Emphysema
D. Pulmonary edema
E. Sarcoidosis

Explanation:

The correct answer is C. Histological examination of the emphysematous lung shows loss of alveolar walls with destruction of associated capillary beds. This loss of lung tissue reduces the elastic recoil of the lung and increases the pulmonary compliance, i.e., increases the distensibility of the lungs. [Recall that compliance = volume/pressure.]
Note that the volume-pressure curve of the patient is displaced to the left and has a steeper slope compared to normal. The increase in compliance associated with emphysema is not reversible.

Adult respiratory distress syndrome (choice A), asbestosis (choice B), and sarcoidosis (choice E) all cause decreased pulmonary compliance.

Pulmonary edema (choice D), e.g., from congestive heart failure or valvular disease, decreases pulmonary compliance.

A 26-year-old man is admitted through the emergency department to the hospital for a heroin overdose. His heart rate is 45 beats/min, and his blood pressure is 75/40 mm Hg. Which of the following best depicts the results from an arterial blood sample?

<table>
<thead>
<tr>
<th>pH</th>
<th>PaCO2 (mm Hg)</th>
<th>HCO3- (mEq/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>7.22</td>
<td>66</td>
</tr>
<tr>
<td>B</td>
<td>7.34</td>
<td>29</td>
</tr>
<tr>
<td>C</td>
<td>7.40</td>
<td>40</td>
</tr>
<tr>
<td>D</td>
<td>7.47</td>
<td></td>
</tr>
</tbody>
</table>
Explanation:

The correct answer is A. This man has a respiratory acidosis. Overdose with drugs that suppress ventilation (e.g., heroin, morphine, barbiturates, methaqualone, and "sleeping pills") often causes hypercapnia. In patients with an intact renal response, the respiratory acidosis causes a compensatory rise in plasma HCO3-, which lessens the fall in pH. However, the renal response requires several days to develop fully. The plasma HCO3- of 26 mEq/L (normal: 22-28 mEq/L) for this man is typical of acute respiratory acidosis with little or no renal compensation.

Choice B reflects metabolic acidosis.

Choice C is normal.

Choice D reflects respiratory alkalosis.

Choice E reflects metabolic alkalosis.

A 65-year-old man presents with a productive cough and difficulty breathing. His sputum culture is positive for encapsulated gram-positive cocci, which are often seen in pairs. The patient's dyspnea is primarily due to which of the following mechanisms?

   A. Inadequate perfusion
B. Inadequate ventilation

C. Increased airway resistance

D. Increased lung compliance

E. Poor oxygen diffusion

Explanation:

The correct answer is E. The patient has pneumococcal pneumonia. In many bacterial pneumonias, alveoli in large areas of the lungs fill with viscous fluid containing proteinaceous debris and many neutrophils. This filling limits the rate at which oxygen can diffuse into the capillary bed, and in many filled alveoli, may even completely block oxygen diffusion into the bloodstream.

Inadequate ventilation (choice B) is not initially as important as poor diffusion.

Changes in perfusion (choice A), airway resistance (choice C), and lung compliance (choice D) usually play lesser roles, although a perfusion/ventilation mismatch may also develop as blood is shunted through poorly ventilated lung tissue.

A 13-year-old boy is brought to the emergency room by ambulance after collapsing while playing at his school. The teacher states that while playing tag, the boy had difficulty breathing, became tired, and fell to the ground without losing consciousness. While trying to catch his breath, he made high-pitched inspiratory noises. On arrival at the hospital, the boy appears lethargic and in moderate respiratory distress, with a respiratory rate of 30 per minute. Physical examination of the chest reveals decreased breath sounds in all lung fields with coarse rhonchi and wheezes throughout. An arterial blood gas on 50% oxygen is as follows: pH = 7.34 PCO2 = 45 PO2 = 55 Bicarbonate = 14 Which of the following sets of pulmonary function test results would most likely be obtained in this patient?

A. High FVC, high FEV-1, high TLC

B. High FVC, high FEV-1, low TLC

C. Low FVC, high FEV-1, low TLC
D. Low FVC, low FEV-1, high TLC

E. Low FVC, low FEV-1, low TLC

Explanation:

The correct answer is D. This patient is having an acute asthma attack. Asthma is an obstructive lung disease primarily affecting air movement out of the lungs (exhalation). The airways (especially the large bronchioles) are hypersensitive to irritating stimuli, such as allergens and smoke. Local mast cell histamine release causes mucous secretion and smooth muscle contraction leading to bronchoconstriction. Certain allergic "triggers" (cats, pollen, hay, etc.) can precipitate attacks. Symptoms include coughing, difficulty breathing, and wheezing. Physical examination of the lungs often reveals wheezes and coarse lung sounds, although in severe cases one may hear only decreased breath sounds and no wheezes due to very poor air flow. On pulmonary function tests asthmatics show an obstructive pattern. Both the FEV-1 (maximum volume exhaled in one second) and the FVC (maximum volume of air that can be exhaled in one breath) are decreased. The hallmark of obstructive lung disease, however, is a decreased FEV-1/FVC ratio. The total lung capacity (TLC) is often increased in acute asthma attacks as patients tend to hyperinflate to obtain more oxygen while being unable to exhale efficiently. Thus, this patient has a low FEV-1, a low FVC, and a high TLC.

A patient complains of excessive thirst and urination. Laboratory tests show that serum osmolarity is 310 mOsm/L and urine osmolarity is 90 mOsm/L. Plasma glucose is normal. Water deprivation (12 hours) fails to increase urine osmolarity. Subsequent injection of vasopressin also fails to increase urine osmolarity. Which of the following is the most likely diagnosis?

A. Diabetes mellitus

B. Nephrogenic diabetes insipidus

C. Neurogenic diabetes insipidus

D. Primary hyperparathyroidism

E. Primary polydipsia

Explanation:
The correct answer is B. Nephrogenic diabetes insipidus results in excessive excretion of free water in the urine because of an inability of the kidney to respond to vasopressin (antidiuretic hormone). It can occur in association with certain renal diseases that prevent the normal formation of the medullary concentration gradient. In this case, the kidney is unable to produce a concentrated urine. Congenital nephrogenic diabetes insipidus could be due to a defect in the renal V2 receptor, Gs protein, or other steps in the normal formation of cyclic AMP. Plasma levels of vasopressin are usually increased because of the hyperosmolarity of the serum. Water deprivation will fail to increase urine osmolarity in both neurogenic and nephrogenic diabetes insipidus. However, subsequent injection of vasopressin will concentrate the urine in the case of neurogenic diabetes insipidus (choice C), but not in nephrogenic diabetes insipidus. Certain drugs (e.g., lithium) can also produce similar symptoms.

Diabetes mellitus (choice A) causes polyuria because of an osmotic diuresis due to glucosuria. This sort of diuresis does not involve the loss of much free water and the urine osmolarity tends toward that of the plasma (not 90 mOsm/L, as in the patient above). Furthermore, plasma glucose is normal in this patient, making diabetes mellitus unlikely.

Some patients with primary hyperparathyroidism (choice D) complain of increased urination. This is due to an osmotic diuresis, produced in this case by hypercalciuria. When serum levels of calcium exceed 12 mg/dL, the kidney's ability to reabsorb filtered calcium is overwhelmed and hypercalciuria ensues.

Primary polydipsia (choice E) is a psychological disorder characterized by excessive water drinking. It too produces polyuria, but the excretion of free water is appropriate. These patients typically present with decreased serum osmolarity (due to the dilutional effect of the ingested water). Furthermore, water deprivation should produce a concentrated urine. It is helpful to remember that the water deprivation test can distinguish between primary polydipsia and diabetes insipidus, but it cannot distinguish between neurogenic and nephrogenic diabetes insipidus.
A patient complains of heat intolerance, fine tremors in his hands, and palpitations. Laboratory data reveal that serum T4 is increased compared to normal. The results of a radioactive iodine uptake test (RAIU) are shown above. Which of the following best explains these findings?

A. Graves' disease

B. Surreptitious ingestion of thyroxine to lose weight

C. Thyroid hormone receptor insensitivity

D. Toxic adenoma

E. TSH-secreting tumor in the pituitary

Explanation:

The correct answer is B. Ingestion of exogenous thyroxine (sometimes called factitious thyrotoxicosis) could explain the patient's symptoms related to hyperthyroidism, and could explain the increase in serum T4. The decrease in radioactive iodine uptake is due to decreased serum TSH resulting from the negative feedback effects of the excess T4. Note that hyperthyroidism is not always associated with increased radioactive iodine uptake.

Both Graves' disease (choice A), which is characterized by increased production of thyroid-stimulating immunoglobulins, and a TSH-secreting tumor in the pituitary (choice D), would produce signs and symptoms of hyperthyroidism, but would be associated with increased radioactive iodine uptake. Overactivation of the TSH receptor in the thyroid gland in both cases would increase the iodine trapping mechanism in the follicle cells.

Thyroid hormone receptor insensitivity (choice C) would produce signs and symptoms consistent with hypothyroidism (cold intolerance, lethargy, bradycardia, etc.). Furthermore, the negative feedback effects of thyroid hormone in the hypothalamus and pituitary would be diminished (since this is also a receptor-mediated event) and serum levels of TSH would be increased, producing an increase in radioactive iodine uptake. Note that hypothyroidism is not always associated with decreased radioactive iodine uptake.

With toxic adenoma (choice E), the thyroid gland autonomously secretes excessive thyroid hormone; increased iodine uptake would be needed to support this overproduction. The increased serum levels of thyroid hormone inhibit TSH secretion from the anterior pituitary and the thyroid tissue undergoes atrophy.

A 15-year-old white male presents with a hemarthrosis of the right knee joint and a recent history of protracted
bleeding from cuts or scrapes. He has no family history of bleeding disorders. The patient also notes a long history of chronic abdominal discomfort and diarrhea, which has been worse for the last 6 months, occasionally accompanied by fever. Physical examination reveals a patient at the 5th percentile for both height and weight; an actively bleeding rectal fissure is also noted. Both prothrombin time and the partial thromboplasatin time are prolonged. Laboratory evaluation of the blood is likely to reveal low levels of

A. factor VIII

B. factor IX

C. factors II, VII, IX, and X

D. factors II, V, VII, IX, and X

E. von Willebrand's factor

Explanation:

The correct answer is C. Low levels of factors II, VII, IX, and X are seen in vitamin K deficiency, leading to prolonged prothrombin time (PT) and partial thromboplastin time (APTT). Vitamin K deficiency is occasionally severe enough in obstructive jaundice, pancreatic disease, or small bowel disease to cause a bleeding diathesis. This patient has evidence of small bowel disease and a history that is suggestive of Crohn's disease (chronic abdominal discomfort, diarrhea and fever). Crohn's disease is also characterized by rectal fissures, growth retardation and malabsorption. Crohn's disease causes malabsorption of fat-soluble vitamins (A,D,E,K) by several mechanisms. It most often involves the terminal ileum, which is responsible for the recycling of bile acids necessary for the transport and proper absorption of lipids. Small intestinal Crohn's disease itself can cause malabsorption by reducing the surface area available for absorption of nutrients. Finally, Crohn's disease can cause the development of fistulae, which can lead to exclusion of loops of bowel, also reducing available absorptive surface area.

Factor VIII deficiency (choice A) is the cause of hemophilia A. This answer is incorrect because hemophilia A is characterized by an elevated APTT, but a normal prothrombin time, since only factor VIII is involved. Although hemophilia A can cause GI hemorrhage and pain, a six month crisis with abdominal discomfort as the only symptom would be extremely rare. Also, hemophilia would likely be characterized by black tarry stools rather than diarrhea. Hemophilia A is inherited as an X-linked recessive; thus affected individuals are usually male, while females are carriers.

Low levels of factor IX (choice B) is the cause of Christmas disease. Like hemophilia A, factor IX deficiency is characterized by prolonged APTT and normal prothrombin time. Specific coagulation factor assays distinguish
these two diseases, as they are otherwise identical in both presentation and inheritance.

Low levels of factors II, V, VII, IX, and X (choice D) could be characteristic of liver disease, but in such a case both prothrombin time and APTT would be elevated. Note that in liver disease, all other factors (except for Factor VII) would also be low.

Low levels of von Willebrand's factor (choice E) cause a prolonged or normal APTT, a normal prothrombin time, and a prolonged bleeding time. Von Willebrand's disease is inherited in an autosomal dominant pattern with incomplete penetrance.

A 50-year-old man is brought to the emergency room with substernal chest pain. An electrocardiogram is performed, which demonstrates ST segment elevation and T wave inversion. Several hours later the patient develops an arrhythmia. The electrocardiogram shows random electrical activity without recognizable QRS complexes. Which of the following descriptions best describes this arrhythmia?

A. Accelerated idioventricular rhythm

B. Accelerated junctional rhythm

C. Premature ventricular contraction

D. Ventricular fibrillation

E. Ventricular tachycardia

Explanation:

The correct answer is D. The rhythm described is that of ventricular fibrillation, which is a feared complication of myocardial infarction that must be corrected immediately (CPR, defibrillation, IV and intracardiac drugs including epinephrine, lidocaine, or procainamide) if the patient is to survive.

In an accelerated idioventricular rhythm (choice A), a normal latent pacemaker in the ventricles depolarizes at a regular, accelerated rate of 50 to 100/min, each time producing unusually shaped (but similar to each other) QRS complexes. P waves related to the complexes are not seen.

In an accelerated junctional rhythm (choice B), the P waves are typically inverted and may precede, follow, or be hidden within regular QRS complexes that occur at a rate of 60 to 150/min.
In a premature ventricular contraction (choice C), an ectopic ventricular pacemaker inserts an ectopic beat (typically with a wide and bizarre QRS complex) before the next sinus beat occurs.

In ventricular tachycardia (choice E), wide and bizarre, but recognizable, QRS complexes occur at an accelerated rate.

A 62-year-old female is brought to the emergency room by her husband with complaints of shortness of breath. Which of the following physical findings would be the most reliable indicator that she is experiencing heart failure?

A. A third heart sound (S3)

B. A fourth heart sound (S4)

C. Ascites

D. Orthopnea

E. Pulmonary rales

Explanation:

The correct answer is A. A third heart sound (S3) is a low-pitched sound occurring at the termination of rapid filling. In patients over 40 years of age, the appearance of a third heart sound strongly suggests congestive heart failure. It also occurs in patients with atrioventricular valve incompetence and can be a normal finding in some young athletes.

A fourth heart sound (S4; choice B) can be a normal finding in some older patients who do not have congestive heart failure.

Ascites (choice C) can also occur in patients with renal, hepatic, or local conditions not associated with cardiac factors.

Both orthopnea (choice D) and pulmonary rales (choice E) often occur secondary to heart failure, however, they both are associated with noncardiac disorders as well.
An unrestrained driver sustains a blunt chest injury in an automobile accident, and is taken to the emergency room. The emergency room physician wants to determine if the heart was bruised when he collided with the steering wheel. The levels of which of the following creatine kinase isoenzymes or combinations of creatine kinase isoenzymes would be most useful for this determination?

A. BB isoenzyme
B. MB isoenzyme of creatine kinase
C. MM isoenzyme of creatine kinase
D. Total creatine kinase and the MB isoenzyme
E. Total creatine kinase and the MM isoenzyme

Explanation:

The correct answer is D. The MB isoenzyme of creatine kinase is associated with heart damage; the MM isoenzyme is associated with muscle damage; and the BB isoenzyme is associated with brain damage. Actually, most tissues contain a mix of creatine kinase isoenzymes, but one species often predominates. In the case of myocardial infarction not occurring in the setting of trauma, either total creatine kinase, or, preferentially, the MB isoenzyme can be used for monitoring. However, in a complex setting such as in this case, where there is known skeletal muscle damage secondary to trauma, the ratio of the MB isoenzyme to total creatine kinase is most informative.

An emphysema patient is breathing quickly and shallowly. A friend tells the patient that he is breathing too fast, and suggests the patient instead breathe deeply and slowly. The patient complies, then begins to turn blue. What happened?

A. The decreased compliance of the alveoli collapses them
B. The decreased compliance of the large airways collapses them
C. The increased compliance of the alveoli collapses them
D. The increased compliance of the large airways collapses them

E. Changes in compliance play no role in the observed pathophysiology

Explanation:

The correct answer is D. In emphysema, the compliance of both the lung parenchyma and the weakened bronchi is markedly increased. This change in compliance can create the paradoxical situation that forced expiration may compress the larger airways (dynamic compression), trapping air in the alveoli, rather than allowing air exchange. Thus, the best breathing strategy for these patients is taking short, rapid breaths that do not cause collapse of airways.

Changes in alveolar compliance (choices A and C) are not implicated in this phenomenon.

Decreased compliance of the large airways (choice B) would make dynamic compression less likely to occur.

Choice E is incorrect, as changes in airway compliance are fundamental to the observed pathophysiology.

A 45-year-old male complains of gradual weight gain over the past several years. His fingers have enlarged so much that he can no longer wear his wedding ring. He sweats more than usual, and in particular, his hands are constantly sweaty. He has also noticed a gradual coarsening of his facial features. An MRI reveals the presence of a 1.5-cm tumor in the anterior pituitary. Which of the following endocrine abnormalities is likely to be present?

A. Decreased plasma growth hormone concentration

B. Decreased plasma IGF-1 concentration

C. Decreased plasma insulin concentration

D. Impaired glucose tolerance

E. Increased suppression of growth hormone secretion with oral glucose

Explanation:
The correct answer is D. The patient probably has acromegaly due to a growth hormone-secreting adenoma in the anterior pituitary. Hypersecretion of growth hormone in an adult will not cause an increase in stature, since the epiphyses of long bones have already fused. However, overgrowth of bone in the face and skull produces the characteristic protruding jaw and forehead observed in this disorder. Soft tissue proliferation leads to a coarsening of facial features. The hands and feet are particularly affected, producing large and thickened spade-like fingers and toes. Excessive growth hormone decreases the sensitivity of peripheral tissues to insulin ("anti-insulin" effect). This tends to raise blood glucose and produce a compensatory hyperinsulinemia (not decreased plasma insulin, choice C) that functions to limit the hyperglycemia. Approximately 50% of patients with acromegaly show impaired glucose tolerance.

Plasma levels of growth hormone (choice A) and IGF-1 (choice B) are both increased in acromegaly.

Administration of oral glucose does not suppress growth hormone in acromegaly as it does in normal individuals (choice E).

A 43-year-old woman is found to have a blood pressure of 200/140 during a routine examination for a life insurance policy. Further examination reveals retinal hemorrhages and the electrocardiogram (ECG) shows left axis deviation. Which of the following is most likely to be decreased in this woman?

A. Arteriolar density

B. Arteriolar wall thickness

C. Arteriolar wall-to-lumen ratio

D. Capillary wall-to-lumen ratio

E. Total peripheral resistance

Explanation:

The correct answer is A. This woman has malignant hypertension. The hypertension has caused left ventricular hypertrophy and it is likely that hypertrophy of arteries and arterioles has occurred as well. Another consequence of long-term hypertension is arteriolar rarefaction, i.e., dissolution and loss of arterioles. Although the mechanism of arteriolar rarefaction is poorly understood, it is believed to result from long-term over-perfusion of the tissues. Organs and tissues in which the vasculature has primarily a nutritive function (e.g., brain, heart, skeletal muscle) regulate their blood flow in accordance with the metabolic needs of the
A 1-week-old infant has a coarctation of the aorta just distal to the subclavian arteries. The blood pressure distal to the constriction is 50% lower than normal. Which of the following is increased in this infant?

A. Blood flow in the lower body
B. Glomerular filtration rate
C. Plasma levels of angiotensin II
D. Renal excretion of sodium
E. Renal excretion of water

Explanation:

The correct answer is C. The aorta is constricted at a point beyond the arterial branches to the head and arms but proximal to the kidneys. Collateral vessels in the body wall carry much of the blood flow to the lower body, and the arterial pressure in the lower body is about 50% lower compared to the pressure in the upper body. The lower-than-normal pressure at the level of the kidneys causes renin to be secreted and angiotensin to be formed. The angiotensin causes salt and water retention so that within a few days to weeks the arterial pressure in the lower body (at the level of the kidneys) increases to normal, but in doing so, the blood pressure in the upper body has increased to hypertensive levels. The kidneys are no longer ischemic when the blood pressure has increased; therefore, renin secretion decreases and the formation of angiotensin returns to
normal levels.

Blood flow in the lower body (choice A) is lower than normal at this early stage of aortic coarctation. However, blood flow can be normal above and below the constriction if the body is able to compensate fully.

The decrease in blood pressure at the level of the kidneys causes the glomerular filtration rate (choice B) to decrease.

Increase plasma levels of angiotensin II causes salt and water retention; thus, salt and water excretion (choices D and E) are decreased.

Which of the following would be present in a patient with a small-cell carcinoma of the lung that autonomously secretes vasopressin?

A. Blood volume contraction
B. Decreased plasma atrial natriuretic peptide
C. Hypernatremia
D. Inappropriately concentrated urine
E. Increased thirst

Explanation:

The correct answer is D. A tumor that ectopically secretes vasopressin can produce a disorder called the syndrome of inappropriate antidiuretic hormone (SIADH). A hallmark of this disorder is excessive renal retention of free water with resultant hypervolemia, not blood volume contraction (choice A), and dilutional hyponatremia, not hypernatremia (choice C). The volume expansion leads to increased (not decreased, choice B) secretion of atrial natriuretic peptide (ANP) by atrial myocytes. The increased ANP is one of the factors that causes the kidney to increase sodium excretion and produce an inappropriately concentrated urine. Urine is typically hypertonic to plasma in this disorder. The volume expansion also tends to suppress renin secretion, and the resultant decrease in serum aldosterone may also contribute to the increased renal sodium excretion. The dilutional hypotonicity would inhibit (not stimulate, choice E) hypothalamic thirst mechanisms.

During a routine pediatric examination, a 12-year-old boy is noted to be in growth arrest. The child is obese, and multiple small bruises are observed on his arms and legs. The patient has difficulty rising from a crouching
Measurement of blood pressure demonstrates hypertension when compared to age-based standards. This patient most likely has which of the following?

A. Diabetes mellitus

B. Grave's disease

C. Hypothyroidism

D. Parathyroid adenoma

E. Pituitary microadenoma

Explanation:

The correct answer is E. The child has features of Cushing's syndrome, which can be caused by excess ACTH (due to pituitary adenoma or ectopic ACTH production) or can occur independently of ACTH production (due to adrenal adenoma, adrenal carcinoma, alcohol, or exogenous steroids). The presentation of Cushing's syndrome, as classically stressed to medical students, includes truncal obesity, moon facies, and "buffalo hump." However, these features cannot always be clearly distinguished from ordinary obesity, particularly in unusual populations such as children. It is consequently of great help to be aware of other features that may suggest the diagnosis. Children with Cushing's syndrome almost inevitably have growth arrest, which may, as in this patient, be the initial diagnostic clue that more than simple obesity is present. Some children also show precocious puberty, secondary to androgen excess. Features present in both children and adults that are particularly helpful in discriminating Cushing's syndrome from obesity include easy bruising and a mild proximal myopathy that can be demonstrated by asking the patient to rise from a crouching position. Hypertension is another prominent feature, which tends to be more common in Cushing's than in obese patients. A predisposition to infections can be another helpful clue. Other features that can be present (usually in adult cases) include psychiatric abnormalities (most commonly depression and lethargy); osteoporotic vertebral collapse leading to lost height (in long-standing Cushing's syndrome); red-purple striae of the abdomen or thighs; plethoric appearance secondary to skin thinning; and sometimes, skin pigmentation in ectopic ACTH syndrome and with some pituitary tumors. Once Cushing's syndrome is suspected, it can be investigated with a variety of endocrine techniques (urinary free cortisol, dexamethasone suppression tests, plasma ACTH, etc.) and can be treated surgically if an adrenal or pituitary tumor is found.

A 50-year-old female with chronic dysphagia undergoes an upper endoscopy that reveals massive dilation of the
distal esophagus. The esophagus is kinked and tortuous and partly filled with undigested foods. What is the most likely diagnosis for this patient?

A. Achalasia

B. Barrett's esophagus

C. Hiatal hernia

D. Plummer-Vinson syndrome

E. Zenker's diverticulum

Explanation:

The correct answer is A. Achalasia (from the Greek "unrelaxed") is a disease of ganglion cells in the esophageal myenteric plexus causing a failure of relaxation in the lower esophageal (cardiac) sphincter. The cause of achalasia is usually not determined. The peristaltic waves in the esophagus stop before the sphincter, and the food collects in the esophagus, which becomes dilated and elongated.

Barrett's esophagus (choice B) is metaplastic replacement of the squamous esophageal epithelium with columnar epithelium. Barrett's esophagus is an important risk factor for esophageal adenocarcinoma.

Hiatal hernia (choice C) is a protrusion of the stomach into the thorax via the diaphragmatic hiatus, at the lower esophageal sphincter. Although hiatal hernia can produce gastroesophageal reflux, the esophagus does not become distended and food passes normally into the stomach.

Plummer-Vinson syndrome (choice D) is a constellation of physical findings associated with severe iron-deficiency anemia. Plummer-Vinson syndrome includes koilonychia, atrophic glossitis, and dysphagia due to atrophy of the pharyngeal mucosa and mucosal webs in the upper esophagus.

Zenker's diverticulum (choice E) is an oropharyngeal diverticulum occurring at the junction of the pharynx and esophagus. Zenker's diverticula occur because of wall weakness in the esophagus at this location, and may produce dysphagia.

A patient presents with a blood pressure of 165/95, and complains of tiredness and muscle weakness. A blood
work-up reveals that plasma sodium is slightly increased and plasma potassium is significantly decreased compared to normal. Hematocrit is also low. Plasma renin activity is markedly decreased, and plasma aldosterone is increased. Which of the following is the most likely diagnosis?

A. Addison's disease

B. Conn's syndrome

C. Cushing's syndrome

D. 21-hydroxylase deficiency

E. Pheochromocytoma

Explanation:

The correct answer is B. Conn's syndrome is hyperaldosteronism due to a hypersecreting adrenal adenoma. Conn's syndrome is one of several endocrine causes of hypertension. The hypertension is due to volume expansion secondary to increased renal sodium and water retention. The excessive aldosterone also causes increased renal excretion of potassium leading to hypokalemia, which can explain the tiredness and muscle weakness. The decreased hematocrit is also consistent with blood volume expansion. The increase in blood volume, blood pressure, and plasma sodium all contribute to the suppression of renin secretion.

Addison's disease (choice A) is primary adrenal insufficiency and is characterized by decreased secretion of both cortisol and aldosterone. It is accompanied by hyponatremia and hyperkalemia.

Patients with Cushing's syndrome (choice C) can also be hypertensive. This may be, in part, to an increased permissive action of cortisol on catecholamine-mediated vascular tone. In addition, cortisol in high levels can have significant mineralocorticoid activity, and can produce sodium retention and potassium loss. The hypertension, sodium retention, and hypervolemia tend to suppress renin secretion and may decrease aldosterone secretion. Cushing's syndrome is also characterized by a redistribution of body fat, producing central obesity and a buffalo hump with the extremities being thinned.

21-hydroxylase deficiency (choice D) is a salt-wasting form of congenital adrenal hyperplasia. With severe deficiency of this enzyme, the zona glomerulosa secretes decreased amounts of aldosterone, which explains the salt wasting.

Pheochromocytoma (choice E) is another endocrine cause of hypertension. It is due to a catecholamine-secreting tumor. The hypertension is due to excessive vasoconstriction and increased cardiac
A patient reports periodic bouts of light-headedness and confusion. Blood tests (fasting) show that blood glucose is 45 mg/dL. Plasma insulin is found to be markedly elevated, but plasma C-peptide is undetectable. Which of the following could explain these findings?

A. Dumping syndrome

B. Factitious hypoglycemia

C. Growth hormone deficiency

D. Insulinoma

E. Pheochromocytoma

Explanation:

The correct answer is B. Factitious hypoglycemia, or self-induced hypoglycemia, is a psychological disorder that results from surreptitious self-injection with insulin. It is most commonly seen in healthcare professionals or in diabetic patients or their relatives. The key to diagnosing this disorder is that injectable insulin preparations do not contain any C-peptide. Hence, the injected insulin (which explains the increased plasma insulin concentration) produces hypoglycemia. The hypoglycemia then suppresses beta-cell secretion of endogenous insulin and C-peptide.

Dumping syndrome (choice A) can produce a non-fasting hypoglycemia. This is a reactive hypoglycemia produced by excessive secretion of insulin after rapid discharge of ingested carbohydrate into the small intestine in patients with previous gastrectomy. The excessive insulin secretion may be due to overstimulation of parasympathetic reflexes or to increased secretion of insulinotropic gut peptides. The increase in insulin secretion would be accompanied by an increase in C-peptide secretion.

Patients with growth hormone deficiency (choice C) can also experience hypoglycemic episodes, especially when fasting. Growth hormone has an anti-insulin action, and when this hormone is deficient, the ability of insulin to induce hypoglycemia is increased. Growth hormone deficiency could not explain the increase in plasma insulin and decrease in plasma C-peptide.

Insulinoma (choice D) also produces fasting hypoglycemia due to uncontrolled secretion of insulin by a beta cell
tumor. However, in this case, plasma insulin and C-peptide will both be increased, since the two polypeptides are secreted by beta cells in a one-to-one molar ratio.

Pheochromocytoma (choice E) results from a catecholamine-secreting tumor. If anything, blood glucose is increased in this disorder. The excess catecholamines stimulate glycogenolysis and also suppress insulin secretion.

Q17

During a clinical research trial, two subjects are instructed to breathe in as much air as they can and then expel the air as rapidly and as far as possible. The figure above shows a forced expiration for a healthy individual (A) and a patient with pulmonary disease (B). What is the respective FEV1/FVC ratio (expressed as a percent) of the healthy individual and the patient?

A. 20% and 50%
B. 50% and 80%
C. 80% and 20%
D. 80% and 50%
E. Cannot be determined

Explanation:
The correct answer is D. The forced vital capacity (FVC) is the vital capacity measured with a forced expiration (which may be less than that measured without straining). The forced expiratory volume in one second (FEV1) is the amount of air that can be expelled from the lungs during the first second of a forced expiration. The FEV1/FVC ratio has diagnostic value for differentiating between normal, obstructive, and restrictive patterns of a forced expiration.

The FEV1/FVC for the normal individual (trace A) is 4 L/5 L = 80% and 1.5 L/3.0 L = 50% for the patient (trace B), as determined from the diagram. Trace B is an example of a trace obtained from a patient with chronic obstructive pulmonary disease. Notice that the rate of expiration is slower and the total volume exhaled is reduced. This is typical of obstructive disease. Patients with restrictive disease also have a reduced FVC, but exhale a large percentage of it in the first second, increasing their FEV1/FVC ratio.

A 27-year-old African-American male visits his primary care physician because of recent onset of "yellowness in the white of his eyes." His recent history is significant for a "chest cold" for which he is taking trimethoprim-sulfamethoxazole; he is also taking fluoxetine for depression. On exam, the sclera are icteric and the mucosa beneath the tongue appears yellow. No hepatosplenomegaly is present. Laboratory studies are as follows:

The most likely cause of this patient's jaundice is

A. acute infectious hepatitis
B. cholestatic liver disease
C. drug reaction from fluoxetine
D. drug reaction from trimethoprim-sulfamethoxazole

Explanation:
The correct answer is D. This man has G6PD deficiency (as do 10% of African-American males). G6PD serves to protect the RBC from oxidative damage by maintaining high intracellular levels of NADPH. People of Mediterranean descent can also have G6PD deficiency, but to a much greater degree. Therefore, hemolytic episodes in this population are more severe (and can be fatal) as compared to those of the African-American type, which are usually mild and self-limited. Common oxidative stressors that initiate hemolysis are drug reactions (especially sulfa drugs), febrile illnesses, and fava bean ingestion.

Acute infectious hepatitis (choice A) would more likely present with abdominal pain, hepatomegaly, and high elevations of AST and ALT (often into the 1000s).

Cholestatic liver disease (choice B) more often presents with elevation of alkaline phosphatase along with mild AST and ALT elevations. This patient has elevated unconjugated bilirubin levels, as in hemolytic disorders. Both hepatocellular (hepatitis) and cholestatic liver disease cause more conjugated (as opposed to unconjugated) hyperbilirubinemia.

Fluoxetine's (a selective serotonin reuptake inhibitor; choice C) most common side effects are anxiety, agitation, and insomnia.

A 45-year-old man develops a severe headache and visual field defects. CT scan demonstrates a 5 cm mass involving the optic chiasm and sella turcica. The mass is resected via a transsphenoidal approach. Post-operatively, there is concern about possible anterior pituitary insufficiency. Which of the following pairs of hormones are most important to replace immediately, before life-threatening symptoms develop?

A. Estrogens and mineralocorticoids
B. Glucocorticoids and thyroid hormones
C. Growth hormone and luteinizing hormone
D. Prolactin and glucocorticoids
E. Testosterone and follicle stimulating hormone

Explanation:

The correct answer is B. The most dangerous hormonal deficiencies involve glucocorticoids and thyroid hormone. It has consequently become customary to "cover" patients for these potential deficiencies immediately
after any event (including surgery and possible pituitary apoplexy) in which function of the anterior pituitary may be lost. If it turns out that the function was not lost, these hormones can be discontinued later.

Deficiency of vasopressin produces decreased mineralocorticoid release (choice A), and clinically recognizable diabetes insipidus (high urinary output with inability to concentrate urine), but replacement is usually not begun unless symptoms become apparent.

Gonadal steroids (not LH and FSH) are given eventually, but they are not urgently required (choices A, C, and E).

Growth hormone (choice C) replacement is usually only given to children.

Prolactin (choice D) does not usually require replacement in cases of pituitary insufficiency.

A 48-year-old man complaining of chest pain is brought to the emergency room. Physical examination followed by echocardiography demonstrates aortic stenosis. His coronary blood flow is increased. Which of the following is the most likely explanation for the increased coronary blood flow in this individual?

A. Decreased left ventricular oxygen consumption

B. Decreased left ventricular pressure

C. Decreased left ventricular work

D. Increased cardiac tissue adenosine concentration

E. Increased cardiac tissue oxygen concentration

Explanation:

The correct answer is D. Blood flow through the coronary circulation is regulated almost entirely by the metabolic requirements of the cardiac muscle. When the oxygen consumption of the heart increases, a larger than normal proportion of the adenosine triphosphate (ATP) in the heart muscle cells degrades to adenosine. The adenosine then dilates the coronary blood vessels, increasing oxygen delivery to an adequate level. In this way, the coronary blood flow increases in direct proportion to the oxygen consumption of the heart.

In aortic stenosis, the left ventricular pressure (choice B) becomes excessively high because the resistance of
the aortic valve orifice is higher than normal. This increase in left ventricular pressure increases the work load on the left ventricle (choice C) because the heart now pumps blood with an elevated left ventricular pressure. The increased work load on the heart requires a greater consumption of oxygen (choice A). Under these conditions of increased cardiac work and increased oxygen consumption, one expects the cardiac tissue oxygen concentration (choice E) to be lower than normal.

A 4-year-old girl is brought to her pediatrician for a check up. The child's skin is slightly jaundiced and she has mild splenomegaly. Her hemoglobin and hematocrit are reduced. Her mean corpuscular volume is 90 µm³ and her reticulocyte count is 7%. A Coombs test is performed and is negative. A hemoglobin electrophoresis shows an abnormal component, constituting less than 25% of the total. A blood smear shows inclusion bodies within the RBCs. Which of the following is the most likely diagnosis?

A. Beta thalassemia
B. Heinz body anemia
C. Hereditary spherocytosis
D. Pernicious anemia
E. Sickle cell anemia

Explanation:

The correct answer is B. Heinz body anemia is an autosomal dominant disease that causes an abnormal hemoglobin variant. The mutant hemoglobin precipitates within the RBC, forming an inclusion, or Heinz body. The RBC is then either phagocytosed or removed by the spleen. Patients present with hemolytic anemia, jaundice, splenomegaly, and dark colored urine. The MCV is normal and the electrophoresis usually reveals the abnormal component as a small percentage of the total. The reticulocyte count is increased as the body tries to make new blood to compensate. If the Coombs test were positive, this would indicate that the problem was extra-corpuscular.

Beta thalassemia (choice A), an inherited defect in or absence of the beta chain of hemoglobin, causes a microcytic, rather than a normocytic anemia. It results in red cells containing excess alpha globin chains which form insoluble aggregates, leading to hemolysis. The presenting symptoms are anemia, jaundice, splenomegaly, hepatomegaly, and certain developmental abnormalities depending on the subtype of the disease.
Hereditary spherocytosis (choice C) can cause a normocytic anemia with an increased reticulocyte count, but the hemoglobin electrophoresis would be normal in these patients. Jaundice and splenomegaly are often present. The disease is caused by an autosomal dominant defect in the erythrocyte membrane spectrin molecule that makes the cell less pliable and more easily destroyed.

Pernicious anemia (choice D) causes a megaloblastic anemia, ruled out in this patient by the normal MCV. It presents in children less than 10 years old (juvenile form) or in adults in the 6th decade. It is caused by lack of intrinsic factor from the gastric mucosa, causing a lack of vitamin B12 uptake in the terminal ileum. Patients present with pallor, slight jaundice, tachycardia, a smooth red tongue, diarrhea, and possibly CNS symptoms.

Sickle cell anemia (choice E) causes a microcytic, rather than normocytic anemia. It is a hereditary disorder characterized by a substitution of valine for glutamic acid in the beta hemoglobin chain. With hypoxemia the cell changes to a sickle shape. Patients present with pain, jaundice, splenomegaly, and anemia.

A 34-year-old female is brought to the emergency room with severe muscle cramps and carpopedal spasms. The patient was noted to be extremely irritable and was complaining of tingling around the mouth and in the hands and feet. A few hours later, laboratory examination reveals sodium 140 mEq/L, potassium 4.2 mEq/L, chloride 101 mEq/L, calcium 6.4 mg/dL, phosphate 5.1 mg/dL, magnesium 2.4 (normal 1.8-3.8 mg/dL) and alkaline phosphatase 67 U/L. A CT scan of the head shows basal ganglia calcifications. Prolonged QT intervals and T wave abnormalities are noted on electrocardiogram. The history is pertinent for a thyroidectomy two months prior to admission. Which of the following conclusions is most consistent with these data?

A. An increase in dietary vitamin D is warranted
B. Hepatocytes have a low 25-hydroxylase activity
C. Intestinal cells are underexpressing calcium transporter genes
D. Isolated cells from the kidney have high 1-hydroxylase activity
E. The levels of 1,25-dihydroxy vitamin D are normal

Explanation:

The correct answer is C. The patient presents with the classic symptoms of acute hypocalcemia secondary to hypoparathyroidism, itself the result of overzealous thyroid removal by the surgeon causing damage to the
nearby parathyroid glands. Other classic findings would have been Trousseau's sign (carpal spasm after application of a blood pressure cuff) and the Chvostek's sign (facial muscle contraction on tapping in front of the ear). Serum calcium is low and serum phosphate is high, with normal alkaline phosphatase. The magnesium is normal, ruling it out as a cause of the tetany (and also indirectly ruling out chronic alcoholism or renal losses as causes). The calcifications seen on CT scan are a sign of overmineralization due to an unfavorable \[\text{calcium} \times \text{phosphate}\] product. Acute treatment with calcium gluconate and, if possible, 1,25-dihydroxy vitamin D3 (cholecalciferol) is necessary.

Hypocalcemia normally triggers parathyroid hormone (PTH) release from the parathyroid glands. PTH can increase bone resorption by stimulating osteoclastic activity and can promote calcium reabsorption at the level of the kidney distal tubule (to the expense of phosphate), but has no direct effect on intestinal absorption of calcium and phosphate, which are under vitamin D control. However, PTH is required to activate 1-hydroxylase in the kidney, the rate-limiting step in metabolism of Vitamin D3 to its active metabolite, 1,25-dihydroxy-D3. This metabolite helps to raise serum calcium by increasing proximal intestinal absorption of calcium. The lack of 1,25-dihydroxy-D3 would be expected to prevent expression of these calcium transporters. The active metabolite works in concert with PTH to increase osteoclastic activity, promote calcium reabsorption in the kidney, oppose the phosphate losses, and most uniquely, promote calcium and phosphate intestinal absorption.

An increase in dietary vitamin D (choice A) would not be helpful at this time, particularly since the lack of PTH would preclude the activation of the precursor vitamin to the dihydroyxylated metabolite. Rather oral calcium would be eventually needed on a chronic basis.

Hepatocytes would not have a low 25-hydroxylase activity (choice B) for two reasons: PTH has no effect on this first hydroxylation step and, more generally, it is not a controlled enzymatic reaction.

Isolated cells from the kidney do not have high 1-hydroxylase activity (choice D) since PTH is no longer present to activate this step.

The levels of 1,25-dihydroxy vitamin D (choice E) would be found to be abnormally low.

A 36-year-old female cash register attendant visits her physician complaining about the large, "lumpy" surface veins in her legs. Her blood pressure is 125/88 mm Hg and she has a heart rate of 78/min. She is 5 feet 3 inches tall and weighs 125 lbs. As a part of her weight loss program, she has been jogging 2 miles each day for the past 2 months. Which of the following is most likely to aggravate this patient's varicose veins?

A. Chronically high venous pressure in her legs

B. Excessive jogging on a hard surface
C. Hypertension

D. Obesity

E. Tachycardia

Explanation:

The correct answer is A. Varicose veins are dilated, tortuous, superficial veins with incompetent valves. They develop with age in men, and occur in association with puberty, pregnancy, and the onset of menopause in women. Although the etiology is unclear, varicose veins can be aggravated by increased venous pressure in the legs. Each time the muscles tighten around a vein, the blood is squeezed out of the vein and pushed toward the heart. Were it not for the valves in veins, the hydrostatic pressure effect of the column of blood from the heart to the feet would cause the pressure in the feet to be about +90 mm Hg. If a person stands perfectly still (e.g., at a cash register), the venous pump does not work, and the pressure in the veins of the legs can increase greatly. Venous pressure may also be increased chronically during pregnancy because the fetus compresses the large veins in the abdomen. When the veins have been overstretched for long periods of time, the valves may not close properly, allowing venous pressure to rise further. A vicious cycle develops in which a further increase in venous pressure causes further damage to the valves, leading to a further increase in venous pressure and greater dilatation of the vein.

Venous pressure in the legs is kept low during any type of leg exercise (choice B), as discussed above.

The woman is not hypertensive (choice C), and hypertension is usually not associated with a significant increase in venous pressure unless the right heart begins to fail.

Only very severe obesity (choice D) might be expected to compress the veins in the abdomen sufficiently to increase venous pressure in the legs.

Tachycardia (choice E) has no effect on varicose veins, and a heart rate of 78/min does not qualify as tachycardia.

An unconscious patient with sepsis in the intensive care unit undergoes a 2-hour period of severe hypotension. Blood chemistries taken during the following 48 hours show rising creatine kinase MB fraction (CK-MB), peaking at 5 times the upper limit of normal. ECG findings are equivocal, with some degree of flat S-T segment depression over several leads. Which of the following is the most likely diagnosis?
A. Prinzmetal angina

B. Stable angina

C. Subendocardial infarction

D. Transmural infarction

E. Unstable angina

Explanation:

The correct answer is C. The high serum CK-MB indicates that the patient has sustained an infarction rather than angina. Subendocardial, rather than transmural, infarction is most likely in the setting of known, prolonged severe hypotension, and the equivocal nature of the ECG findings confirms this diagnosis. Subendocardial infarction occurs in settings of generalized poor perfusion complicated by increased demand or transient vasospasm. Subendocardial muscle tissue is especially vulnerable because it is farthest from the arterial supply.

In Prinzmetal angina (choice A) and stable angina (choice B), the CK-MB would not be expected to increase significantly.

Transmural infarction (choice D) is not specifically expected in the setting of shock. It produces characteristic ECG changes that are usually localized (unless a very large infarct has occurred) to a few leads.

In unstable angina (choice E), an increase in cardiac enzymes may be seen, but is usually less than 2 times the upper limit of normal.

A 7-month-old child with failure to thrive is found to have a hemoglobin of 4.4 g/dL. The peripheral smear shows very small red cells with marked pallor. It is determined that the child has very low levels of hemoglobin A, with elevated fractions of hemoglobin A2 and hemoglobin F. Which of the following underlying mechanisms is most likely related to the observed findings?

A. Amino acid substitution on &beta; globin

B. Antibody against fetal blood cells
C. Cytoskeletal protein defect

D. Insufficient production of β globin

E. Iron deficiency

Explanation:

The correct answer is D. This child most likely has β+ thalassemia, an autosomal recessive disease that, in the homozygous state, produces defects in the transcription, processing, or translation of β globin mRNA. The predominant hemoglobin switches from HbF (α2γ2) to HbA (α2β2) at about 6 months of age, at which point these children become markedly anemic because of their inability to synthesize the β globin chain. The anemia of β thalassemia is microcytic and hypochromic with anisocytosis.

Amino acid substitutions in β globin (choice A) lead to hemoglobinopathies, of which sickle cell anemia is the archetype. Homozygotes with these hemoglobin variants do not produce any HbA, but rather mutant types, such as HbS, HbC and HbM.

Antibodies against fetal blood cells (choice B) are generally produced by a mother who has been sensitized to fetal blood antigens by transfusion or a previous pregnancy. Such immune-mediated hemolysis leads to intrauterine anemia and hydrops fetalis.

Cytoskeletal protein defects (choice C), such as spectrin deficiency causing hereditary spherocytosis, produce anemia and jaundice that are apparent at birth. The RBCs contain the normal types of hemoglobin.

Iron deficiency anemia (choice E) is due to inadequate iron stores for the production of the heme iron in hemoglobin. Although iron deficiency anemia is not uncommon in infants because human breast milk has only small amounts of iron, the resultant microcytic anemia is not associated with abnormal types of hemoglobin.
The maximum expiratory flow-volume (MEFV) curves shown in the diagram above are from a typical healthy individual (solid curve) and from a patient with pulmonary disease (dashed curve). Which of the following is increased in the patient?

A. Pulmonary compliance
B. Radial traction of airways
C. Residual volume
D. Total lung capacity
E. Vital capacity

Explanation:

The correct answer is B. Because the airways are tethered to the lung parenchyma, radial traction of the airways decreases when lung volume decreases, causing the airway diameter to decrease with each decrease in lung volume. The dashed curve is typical of a patient with restrictive lung disease such as interstitial fibrosis. The airways are tethered more strongly to the lung parenchyma in interstitial fibrosis (and the overall elasticity of the lung is increased), which causes the airways to be held open to a greater extent at each lung volume (i.e., radial traction is greater). This increase in radial traction and subsequent increase in airway diameter causes the maximum expiratory flow rate to be higher at any given lung volume, as shown by the dashed curve in the diagram. The increase in fibrous material in the lung causes the pulmonary compliance (choice A) to decrease.

The MEFV curve in restrictive lung disease (dashed curve) begins and ends at abnormally low lung volumes, and the flow rates are often higher than normal at a given lung volume. Note that the total lung capacity (TLC, choice D) is ~3.2 liters and the residual volume (RV, choice C) is ~0.8 liters in the patient (dashed curve). The vital capacity (choice E), which is the difference between TLC and RV thus is reduced to ~2.4 liters in the patient, compared to a value of 5 liters in the healthy individual (solid curve). Note that absolute lung volumes cannot be determined from a MEFV test alone. An additional method is needed to measure residual volume. However, the diagram above states that lung volumes are absolute, indicating correct placement of the curves on the abscissa.

A 27-year-old female complains that she is constantly thirsty and has to urinate every two hours. Her plasma osmolality is 295 mOsm/kg H2O, and her urine osmolality is 100 mOsm/kg H2O. Her urine is negative for glucose. As part of a diagnostic workup, the patient is deprived of fluids for three hours. Her urine osmolality remains 100 mOsm/kg H2O. One hour after injection of arginine vasopressin (AVP), her urine osmolality becomes 400
mOsm/kg H2O. Which of the following is the most likely diagnosis?

A. Diabetes mellitus

B. Nephrogenic diabetes insipidus

C. Neurogenic diabetes insipidus

D. Primary polydipsia

E. SIADH (syndrome of inappropriate ADH)

Explanation:

The correct answer is C. This question tests a very intuitive concept. Once you learn how ADH works and where it acts, you'll never be stumped by this type of question again. ADH (antidiuretic hormone, vasopressin) is normally released from the posterior pituitary in response to hypovolemia and increased osmotic pressure. It acts on the collecting duct of the nephron, increasing its permeability to water. This concentrates the urine and conserves water. Diabetes insipidus (DI) is a condition in which ADH function is absent.

Two forms of DI exist: neurogenic and nephrogenic. Neurogenic DI (choice C) is due to the absence of ADH secretion by the posterior pituitary; thus, serum ADH levels are always low, even in states of serious volume depletion. Nephrogenic DI (choice B) is due to complete or partial resistance to ADH; therefore even though ADH levels may be high, the hormone has no effect on renal water regulation.

You are told in the question that the patient failed to concentrate her urine on a water deprivation test. This immediately suggests DI. (Normally, when an individual is deprived of fluids for 3 hours, her kidneys respond by concentrating the urine and conserving water). Your task then becomes determining which type of DI the patient has. This is achieved by evaluating the results of the arginine vasopressin (AVP) suppression test. Patients with neurogenic DI readily respond to AVP by producing more concentrated urine. Patients with nephrogenic DI do not concentrate urine in response to AVP because of continued renal resistance.

Although thirst is a common symptom of diabetes mellitus (choice A), the absence of glucosuria argues against this diagnosis.

Primary polydipsia (choice D) usually occurs in patients taking antipsychotic drugs (e.g., phenothiazines) that cause dry mouth, promoting the sensation of thirst. As a result, these patients drink large quantities of water. They excrete dilute urine, and eventually may dilute their serum as well, to the point of electrolyte imbalance. But upon water deprivation, these patients will concentrate their urine normally.
SIADH (syndrome of inappropriate diuretic hormone) (choice E) occurs when there is oversecretion of ADH, for example by a small cell carcinoma of the lung or other ADH-producing neoplasm. One would expect test results opposite to those in this patient. In contrast to DI, the diagnosis of SIADH is usually made with a water-load test.

Thyroid function tests performed on serum from a 33-year-old woman reveal increased TSH, decreased total T4, decreased free T4, and decreased T3 uptake. Which of the following clinical features would be most likely to be seen in this patient?

A. Diarrhea  
B. Heat intolerance  
C. Hyperactivity  
D. Palpitations  
E. Weight gain

Explanation:

The correct answer is E. The laboratory studies are typical for primary hypothyroidism, in which the thyroid fails to produce adequate T4 despite appropriate TSH signals from the pituitary gland. Clinical features of hypothyroidism include weight gain, cold intolerance, hypoactivity, fatigue, lethargy, decreased appetite, constipation, weakness, decreased reflexes, facial and periorbital myxedema, dry and cool skin, and brittle hair.

In contrast, diarrhea (choice A), heat intolerance (choice B), hyperactivity (choice C), and palpitations (choice D) are features of hyperthyroidism.

A 59-year-old male complains of headache and decreasing visual ability. History reveals that the patient has also "outgrown" his pants and shirts within the past year. The patient exhibits a marked overbite. Which of the following is the best method to diagnose this patient?

A. Measurement of GH and IGF-1 levels before and after administrating glucose
B. Measurement of resting ACTH levels

C. Measurement of resting prolactin levels

D. Measuring the patient's height and comparing it to last year's value

E. Measuring the patient's shoe size and comparing it to last year's value

Explanation:

The correct answer is A. Acromegaly is a disease most commonly stemming from the onset of a pituitary adenoma. Acromegalic persons secrete excessively high levels of growth hormone and insulin growth factor-1 from pituitary gland tissue. These hormones are not suppressed by glucose, as they would be in a nonacromegalic patient.

Measurement of resting ACTH levels (choice B) may be indicated in a person with Cushing's syndrome.

Measurement of resting prolactin levels (choice C) would be indicated in a person suspected of having a prolactinoma.

Measurement of height (choice D) in a 59-year-old patient would not be indicated. Acromegaly, or excess growth hormone, in individuals who have already experienced closure of bone growth centers results in a broadening of the skeletal bones, not a lengthening. Lengthening of skeletal bones occurs in gigantism, before the closure of bone growth centers.

Measuring a patient's shoe size and comparing it to last year's size (choice E), while indicative of a broadening of skeletal bones, is not a clinically used standard for the diagnosis of acromegaly.

A 65-year old man, who underwent neck surgery to remove a cancerous lesion two days previously, complains of thigh and calf cramps and tingling around the lips. Laboratory data show that serum calcium is 8 mg/dL and serum phosphate is 5.5 mg/dL. Which of the following is the most likely explanation for these findings?

A. Primary hypoparathyroidism

B. Pseudohypoparathyroidism
C. Pseudopseudohypoparathyroidism

D. Renal failure

E. Vitamin D deficiency

Explanation:

The correct answer is A. Surgical hypoparathyroidism is the most common cause of primary hypoparathyroidism. Exploration of the anterior neck during thyroidectomy, parathyroidectomy, or removal of neck lesions can all compromise parathyroid gland function. Often, the problem occurs because the blood supply to the parathyroid glands is interrupted during the surgery. The decrease in plasma parathyroid hormone leads to hypocalcemia and hyperphosphatemia. The decreased serum calcium is due to decreased absorption of dietary calcium (because vitamin D activation is decreased) and decreased movement of calcium from bone to extracellular fluid. Low serum calcium can lead to tetany and paresthesias because of destabilization of excitable tissue membranes. Tetany is most often observed when there is a rapid decrease in serum calcium, such as that occurring with surgical hypoparathyroidism. The increased serum phosphate is due to decreased renal excretion.

Pseudohypoparathyroidism (choice B) is a rare genetic defect in which the target tissues are insensitive to parathyroid hormone. In one form of this disease, the expression of the Gs heterotrimeric protein is decreased by half. Because parathyroid hormone is less effective, serum calcium decreases and serum phosphate increases. Pseudohypoparathyroidism is also accompanied by developmental defects, including mental retardation, short stature, and missing metatarsal and/or metacarpal bones.

Pseudopseudohypoparathyroidism (choice C) is also a rare genetic defect in which the same developmental abnormalities as pseudohypoparathyroidism occur, but there is no abnormality in serum calcium, serum phosphate, or parathyroid hormone.

In renal failure (choice D), hyperphosphatemia occurs because of decreased renal excretion. This can lead to hypocalcemia as the equilibrium between serum phosphate and serum calcium is pushed toward hydroxyapatite. Furthermore, dietary absorption of calcium is decreased because vitamin D activation is decreased by hyperphosphatemia, even before there is significant decrease in renal 1-alpha-hydroxylase activity. The low serum calcium produces a compensatory increase in parathyroid hormone with subsequent bone demineralization (renal osteodystrophy).

With vitamin D deficiency (choice E), serum calcium and phosphate are both typically decreased. The calcium is low because of decreased dietary absorption. The phosphate is low (not high) because of decreased dietary absorption, and because the secondary increase in parathyroid hormone secretion (due to the hypocalcemia) increases renal excretion of phosphate.
A 45-year-old woman presents with a 10-pound weight gain over the past six months. She states that she has also been tired lately and has had problems with her memory. Examination reveals a blood pressure of 90/60 mm Hg, a heart rate of 55 BPM, and a temperature of 35 degrees C. Her reflexes are sluggish. The thyroid is enlarged but nontender on palpation. Serum T4 is 5.5 μg/dL and serum TSH is 8 μU/mL. Antimicrosomal antibodies are present. Which of the following is the most likely diagnosis?

A. Graves' disease
B. Hashimoto's thyroiditis
C. Secondary hypothyroidism
D. Tertiary hypothyroidism
E. Toxic adenoma

Explanation:

The correct answer is B. Hashimoto's thyroiditis is an autoimmune disorder in which antibodies directed against various thyroid components (e.g., thyroid peroxidase) are inappropriately produced. These antibodies are commonly called "microsomal" antibodies because thyroid peroxidase appears in the microsomal fraction of follicular cells. Other potential antibodies include anti-thyroglobulin antibodies and thyroid receptor-inhibiting antibodies. The autoimmune reaction results in lymphocytic infiltration of the thyroid gland potentially destroying the normal thyroid architecture. Early in the disease, serum T4 may remain within the low-normal range because the increased TSH (due to loss of negative feedback inhibition by T4) can cause thyroid enlargement, helping to maintain adequate hormone secretion. However, as the disease progresses, thyroid gland failure results in frank hypothyroidism.

Graves' disease (choice A) is also an autoimmune disorder. However, in this case, the antibodies (thyroid stimulating immunoglobulins) are TSH receptor-stimulating antibodies. This results in excessive thyroid hormone secretion and hyperthyroid (not hypothyroid) symptoms. Serum levels of TSH are usually undetectable because of feedback suppression by the elevated T4.

Secondary hypothyroidism (choice C) occurs because of decreased TSH secretion by the anterior pituitary. The increased serum TSH in this patient rules out secondary hypothyroidism. Tertiary hypothyroidism (choice D), which is due to decreased TRH secretion by the hypothalamus, also results in decreased (not increased) serum TSH.
Toxic adenoma (choice E) can produce a nodular goiter, but is associated with excessive T4 secretion and hyperthyroidism. Serum TSH levels are suppressed due to the negative feedback effects of the T4 at the pituitary and hypothalamus.

A 30-year-old woman is involved in an automobile accident. The woman, who was not wearing a seat belt, hits her chest against the steering wheel. When she is brought by ambulance to the emergency room, she is noted to be cyanotic. Her blood pressure is within normal limits and her heart rate is fast but regular. Her respirations are rapid and very shallow. She receives no medications in the ambulance. Chest x-ray demonstrates multiple broken ribs, but no pleural effusion or obvious lung disease. Which of the following mechanisms would most likely account for this patient's hypoxemia?

A. Decreased capacity for pulmonary diffusion
B. Decreased surface area of alveolar capillary membranes
C. Hypoventilation of central origin
D. Hypoventilation of peripheral origin
E. Inequalities of ventilation and perfusion

Explanation:

The correct answer is D. Rib fractures are very painful (it hurts to breathe deeply) and can compromise the normal chest morphology (the chest can't change shape normally), both of which can impair ventilation at the peripheral level. Ventilation is the term used for the mechanical part of breathing: the air goes in and the air goes out. Other causes of hypoventilation of peripheral origin include phrenic nerve paralysis, suffocation, submersion, poliomyelitis, tetanus, and the Pickwickian syndrome.

Decreased diffusion capacity (choice A) can occur when the blood-gas barrier is thickened (e.g., diffuse interstitial fibrosis, sarcoidosis, asbestosis, hyaline membrane disease), when the surface area of the blood-gas barrier is reduced (e.g., pneumonectomy, emphysema), or when less hemoglobin is available to pick up the oxygen (e.g., anemia, pulmonary embolism).

Decreased surface area of alveolar capillary membranes (choice B) occurs after lung resection or in disease (e.g., emphysema).
Hypoventilation of central origin (choice C) involves the central respiratory center of the brain, and is most commonly seen in morphine or barbiturate overdose.

Inequalities of ventilation and perfusion (choice E) are common in chronic obstructive lung disease (both emphysema and chronic bronchitis), asthma, bronchiectasis, pneumonia, and granulomatous diseases.

Which of the following is thought to be a major contributor to the cachexia often experienced by patients with advanced cancer?

A. Clathrin
B. Histamine
C. Interferon
D. Interleukin 2
E. Tumor necrosis factor

Explanation:

The correct answer is E. Weight loss of more than 5% of body weight is considered a very adverse prognostic feature in cancer since it usually indicates the presence of widespread disease. (Uncommonly, a relatively small primary lesion that has not yet metastasized can cause cachexia.) Both tumor necrosis factor (TNF) and interleukin 1-beta have been implicated in the production of cachexia with weight loss, loss of appetite, and alteration in taste. Large tumor burdens may additionally alter protein and energy balance, often with negative nitrogen balance. Therapy, in whatever form (surgery, radiation, chemotherapy), may also contribute to cachexia late in the course secondary to effects on the digestive system.

Clathrin (choice A) is a protein that helps to form pinocytotic vesicles.

Histamine (choice B) is released by mast cells and basophils and contributes to allergic responses.

Interferon (choice C) is important in the body's response to viral infection.

Interleukin 1-beta, not 2 (choice D), is produced by activated monocytes and macrophages and has been
implicated in cachexia. Interleukin 2 is released by helper T cells and augments B-cell growth as well as antibody production.

An 59-year-old woman with a 15-year-history of type 2 diabetes mellitus develops urinary incontinence. Which of the following is a consequence of diabetes that would be most likely to cause this symptom?

A. Autonomic neuropathy
B. Bladder prolapse
C. Glomerulosclerosis
D. Normal pressure hydrocephalus
E. Toxic myopathy

Explanation:

The correct answer is A. Diabetic neuropathy is a poorly understood phenomenon characterized by damage to Schwann cells and axons in the spinal cord and especially, the peripheral nerves. The peripheral neuropathy is symmetrical and favors the lower extremities. Autonomic neuropathy is most likely to produce sexual, bowel or bladder dysfunction.

Bladder prolapse (choice B) is a common cause of urinary incontinence in older women with weakened pelvic floor musculature due to the effects of aging and prior pregnancies.

Glomerulosclerosis (choice C), a very frequent complication of diabetes mellitus, leads to proteinuria and renal failure, but does not predispose an individual to urinary incontinence.

Normal pressure hydrocephalus (choice D) is a slowly progressive, nonobstructive hydrocephalus that characteristically occurs in the elderly and produces incontinence, gait disturbance and cognitive changes. Its cause is not known, but it is not a direct consequence of diabetes.

Toxic myopathies (choice E) represent direct chemical damage to skeletal muscle due to recognized chemical toxins. Examples include thyrotoxicosis, and alcohol- and drug-related myopathies. There is no identified myopathy associated with diabetes mellitus.
A 57-year-old female is found unconscious on her kitchen floor after having suffered a myocardial infarction. She has pulmonary edema and distended jugular and peripheral veins. A midsystolic gallop is heard upon chest auscultation. EKG shows prominent Q waves in leads II, III, and aVF. Which of the following is most consistent with the patient's condition?

Preload
Cardiac output
PAWP
CVP
Vascular resistance
Mixed venous oxygen

A. Increased
   Decreased
   Decreased
   Increased
   Increased
   Decreased

B. Increased
   Increased
   Decreased
   Decreased
   Decreased
   Increased

C. Increased
   Decreased
   Increased
   Increased
   Increased
   Decreased

D. Increased
   Increased
   Increased
   Increased
Explanation:

The correct answer is C. This case depicts the classic picture of cardiogenic shock. This typically occurs after ischemic myocardial injury, acute valve dysfunction associated with endocarditis, blunt chest trauma, acute myocarditis, or end-stage cardiomyopathy. Left ventricular function is compromised, therefore cardiac output is diminished. Preload is increased because blood from the right side of the heart and pulmonary circulation is pumped into an already filled left ventricle (this explains the S3 and S4 sounds that presented as a midsystolic gallop). Pulmonary artery wedge pressure, measured with a Swan-Ganz catheter, reveals left atrial pressure as well as left ventricular end-diastolic pressure and is elevated in heart failure. Left ventricular failure causes increased left atrial pressure, which results in increased hydrostatic pressure in pulmonary vasculature. Once hydrostatic pressure is higher than oncotic pressure, fluid from the circulation leaks into the alveolar spaces, causing pulmonary edema and dyspnea. Eventually, the right ventricle can no longer pump blood against the increased pulmonary pressure and fails. This causes a backup of blood, which results in increased central venous pressure. Systemic vascular resistance is increased in an attempt to compensate for the diminished cardiac output. Mixed venous oxygen levels are reduced because of increased tissue demand for oxygen.
A patient complains of daily burning epigastric pain of 4-months duration. He states that he is sometimes awakened at night by coughing spells and a burning in his throat. He has also been having diarrhea. Basal acid output, using a nasogastric tube, is measured to be 15 meq/hr (normal < 5 meq/hr). An antral biopsy is negative for H. pylori. Fasting serum gastrin is measured at 1,000 pg/mL (normal <150 pg/mL). Which of the following is the most likely explanation for these symptoms?

A. Type A chronic gastritis
B. Routine duodenal ulcer
C. Routine gastric ulcer
D. Vipoma
E. Zollinger-Ellison syndrome

Explanation:

The correct answer is E. Zollinger-Ellison syndrome results from hypersecretion of gastric acid due to a gastrin-secreting neoplasm (gastrinoma). The esophageal symptoms, epigastric pain, and duodenal ulcers are all due to excessive acid secretion. Diarrhea occurs in about half of Zollinger-Ellison patients. It is partly due to the excess gastric secretions delivered to the intestines, and partly due to maldigestion because the low pH in the duodenal lumen creates a poor environment for function of pancreatic enzymes. Furthermore, the low duodenal pH can damage the intestinal mucosa and flatten the villi, leading to malabsorption.

Type A chronic gastritis (choice A) is another cause of increased circulating gastrin. In this case, the autoimmune destruction of the acid-secreting mucosa leads to achlorhydria. A major factor that normally suppresses acid secretion by the parietal cells is the low pH of gastric juice. With achlorhydria, the pH of the juice rises and gastrin secretion increases (it can be as high as in Zollinger-Ellison syndrome). However, with chronic gastritis the basal secretion of acid would be decreased, not increased. Furthermore, duodenal ulcer is unlikely.

Most often the plasma concentration of gastrin is not significantly increased with routine duodenal ulcer (choice B), however it can be increased in about 10% of the patients with this disorder. Provocative testing using secretin infusion will markedly increase gastrin secretion from a gastrinoma, but have little effect with benign duodenal ulcer. H. pylori is present in virtually 100% of duodenal ulcers and multiple ulcers are less common than in Zollinger-Ellison syndrome.
The endoscopic examination failed to provide evidence of a gastric ulcer (choice C). Furthermore, the incidence of H. pylori infection is very high with gastric ulcer. Patients with gastric ulcer often exhibit decreased basal acid secretion and the ulcer is usually due to breakdown of the gastric mucosal barrier.

A vasoactive intestinal peptide-secreting tumor (VIPoma) (choice D) produces a watery diarrhea because of excessive cAMP-dependent secretion of chloride and water by intestinal cells in the crypts of Lieberkühn. However, the symptoms of dyspepsia, presence of duodenal ulcers, and hypersecretion of acid and gastrin are not present. In fact, the excessive vasoactive intestinal peptide usually suppresses gastric acid secretion.

A 54-year-old man complains of weakness and vague bone pain a year after resection of a significant portion of his ileum. A bone X-ray reveals the presence of multiple pseudofractures characteristic of osteomalacia. Which of the following data sets depicts the most likely relationship among serum concentrations of calcium, 25-OH vitamin D, and phosphate in this patient?

<table>
<thead>
<tr>
<th>Calcium</th>
<th>25-OH Vit D</th>
<th>Phosphate</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Increased</td>
<td>Increased</td>
<td>Increased</td>
</tr>
<tr>
<td>B. Increased</td>
<td>Increased</td>
<td>Decreased</td>
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<tr>
<td>C. Increased</td>
<td>Decreased</td>
<td>Decreased</td>
</tr>
<tr>
<td>D. Increased</td>
<td>Decreased</td>
<td>Increased</td>
</tr>
<tr>
<td>E. Decreased</td>
<td>Decreased</td>
<td></td>
</tr>
</tbody>
</table>
The correct answer is E. Surgical resection of a significant portion of the ileum decreases the ability to absorb bile salts into the enterohepatic circulation. The gradual loss of bile salts in the stool can result in poor absorption of fats and fat-soluble vitamins (such as vitamin D). The vitamin D deficiency would be manifested as decreased plasma concentration of 25-OH vitamin D. Vitamin D deficiency reduces the ability of the small intestine to absorb calcium and phosphate from the diet. The resulting hypocalcemia produces a compensatory increase in PTH secretion. The secondary hyperparathyroidism causes bone demineralization (osteomalacia) in an attempt to restore serum calcium levels. Serum phosphate is low in vitamin D deficiency partly because of decreased dietary absorption by the gut, and partly because the increased PTH causes increased urinary excretion of phosphate.

A patient who has never traveled outside of the United States complains of crampy abdominal pain, diarrhea, fatigue, and weight loss over the past 12 months. Each day, she passes 4-5 loose, malodorous stools that float in the toilet. Fecal fat content is increased. A biopsy of duodenal mucosa reveals loss of villi and intraepithelial lymphocytic infiltration; smooth muscle layers appear normal. Which of the following is the most likely diagnosis?

A. Celiac sprue

B. Irritable bowel syndrome

C. Lactose intolerance

D. Scleroderma
E. Tropical sprue

Explanation:

The correct answer is A. Celiac sprue, or gluten-sensitive enteropathy, results from destruction of the intestinal epithelium by antibodies against the gliadin component of gluten (from wheat, oats, barley, and rye). It results in flattening of the villi of the small intestine, beginning in the duodenum and gradually involving more distal parts of the small intestine. Enterocytes also show lymphocytic infiltration suggestive of an immune reaction. The loss of surface area for digestion and absorption results in a generalized malabsorption with malnutrition and weight loss. The absorption of iron and folic acid is usually diminished as well. Steatorrhea (fat in the stool) contributes to diarrhea because of an action of colonic bacteria to produce metabolites of the undigested fat that stimulate electrolyte and water secretion. Removal of gluten from the diet will allow the villi to regenerate and restore normal absorptive function.

Irritable bowel syndrome (choice B) is characterized by alternating bouts of constipation and diarrhea. The cause is unknown and there are typically no abnormal tests or physical abnormalities. It is thought to be a motility disorder.

Lactose intolerance (choice C) results in flatulence, bloating, and diarrhea due to lactase deficiency and diminished digestion of lactose. The undigested disaccharide remains in the lumen of the small intestine and draws water, creating an osmotic diarrhea. The villus structure of the intestinal epithelium is not flattened as it is in celiac sprue. Steatorrhea is not a problem since this is only a carbohydrate malabsorption problem.

Scleroderma (choice D) is a disease that is characterized by excessive deposition of collagen in tissues such as smooth muscle. In the small intestine, motility is decreased as the smooth muscle is replaced by the fibrous material. In the absence of normal motility, bacterial overgrowth of the intestinal mucosa can occur and produce a generalized malabsorption. An intestinal biopsy would show increased fibrosis.

Tropical sprue (choice E) also produces a flattening of the intestinal villi, but not as completely as in celiac sprue; generalized malabsorption also occurs. This disorder is thought to be caused by toxins secreted by certain bacteria that are present in the tropics. The fact that the patient has not been out of the United States makes tropical sprue highly unlikely.

A 43-year-old woman with jaundice undergoes endoscopic retrograde cholangiopancreatography. Multiple common bile duct stones are imaged and the injected contrast material is retained within a dilated common bile duct proximal to the stones. Which of the following findings would be consistent with this case of jaundice?

A. Excessive hemolysis
B. Increased pigmentation of the stool
C. Increased urinary urobilinogen
D. Tea-colored urine
E. Unconjugated hyperbilirubinemia

Explanation:

The correct answer is D. The results of the retrograde cholangiopancreatography indicate the presence of an obstruction in the common bile duct. This would lead to an obstructive jaundice. The liver's ability to take up, conjugate, and secrete bilirubin is not impaired. However, the conjugated bilirubin would "back up" and regurgitate into the circulation, producing a conjugated hyperbilirubinemia (not unconjugated hyperbilirubinemia, choice E). Since conjugated bilirubin is water soluble, it can be filtered by the kidney and show up in the urine. The excessive filtration of conjugated bilirubin can produce a darkening of the urine (tea-colored).

Excessive hemolysis (choice A) produces an unconjugated hyperbilirubinemia because the ability of the liver to take up the increased bilirubin from heme metabolism is exceeded.

An obstruction of the common bile duct would prevent the delivery of bile to the duodenum. As a consequence, the pigmentation of the stool would be diminished (not increased, choice B).

Urinary urobilinogen is a reflection of circulating urobilinogen. Urobilinogen enters the blood as part of the enterohepatic circulation. Bilirubin secreted in the bile is ordinarily metabolized by gut bacteria to urobilinogen. Most urobilinogen remains in the gut, and after further metabolism, provides the pigmentation to the stool. However, some of the urobilinogen is absorbed by the ileum and enters the enterohepatic circulation. Some of this absorbed urobilinogen ends up in the urine. With an obstruction of the common bile duct, less urobilinogen will reach the small intestine, and hence, less will enter the hepatic portal vein. Therefore, urinary urobilinogen will be decreased (not increased, choice C).

A 24-year-old woman is involved in an automobile accident, sustaining a closed head injury and blunt abdominal trauma. She is admitted to the hospital and treated, then released fifteen days later. On the day she is released, her serum sodium is 147 mEq/L, her serum potassium 4.2 mEq/L, and her fasting serum glucose is 80 mg/dL. Her serum osmolality is 290 mOsmol/kg and her urine osmolality is 85 mOsmol/kg. Water deprivation (12 hours)
fails to increase urine osmolarity. Measurement of which of the following would best differentiate nephrogenic
diabetes insipidus from neurogenic diabetes insipidus in this individual?

A. Creatinine in a 24-hour urine collection

B. Plasma osmolality after angiotensin II administration

C. Serum renin after infusion of hypotonic saline

D. Serum sodium after infusion of hypertonic saline

E. Urine osmolality after vasopressin administration

Explanation:
The correct answer is E. Diabetes insipidus is characterized by the excretion of abnormally large volumes of
dilute urine (polyuria) with a commensurate increase in fluid intake (polydipsia). There are two types,
neurogenic and nephrogenic. The most common type is neurogenic diabetes insipidus, which is due to
inadequate secretion of antidiuretic hormone (ADH), or vasopressin. In the absence of ADH, a brisk diuresis (up
to 1000 mL/hr) results; the osmolality of the urine may be as low as 50 mOsmol/kg. This patient has neurogenic
(central) diabetes insipidus; many patients with this condition have a history of head trauma, brain tumors, or
brain infections that damage the hypothalamus or neurohypophysis. Nephrogenic diabetes insipidus, which
presents in much the same way, can be seen in association with certain renal diseases. Congenital
nephrogenic diabetes insipidus can be due to a defect in the renal V2 vasopressin receptor, Gs protein, or
other steps in the formation of cyclic AMP. Plasma levels of vasopressin are usually increased, because of the
hyperosmolarity of the serum. Water deprivation will fail to increase urine osmolarity in both neurogenic and
nephrogenic diabetes insipidus. However, because V2 receptors are functional in neurogenic diabetes
insipidus, administration of exogenous ADH will still concentrate the urine, whereas this would be ineffective in
nephrogenic diabetes insipidus.

Measurement of creatinine (choice A) in a 24-hour urine collection, coupled with plasma creatinine values and
the urine flow rate, can be used to approximate glomerular filtration rate.

Measurement of plasma osmolality after angiotensin II administration (choice B) would not help distinguish
nephrogenic from neurogenic diabetes insipidus. Plasma osmolality would rise in either case.

Renin secretion would be inhibited by infusion of hypotonic saline (choice C) in both neurogenic and
nephrogenic diabetes.
Serum sodium (choice D) would rise with infusion of hypertonic saline in either type of diabetes insipidus.

A 29-year-old female comes to her physician's office complaining of headaches, fatigue, and weakness over the past several months. Physical exam is significant for pallor, tachycardia, dizziness on standing up, and koilonychia (spooning of the nails). Laboratory studies show:

Hemoglobin: 10.2 g/dl

Hematocrit: 30.8%

Serum Fe: 24 µg/dl

Serum ferritin: 30 ng/ml

Total Fe binding capacity: 713 mg/dl

A peripheral blood smear would likely show

A. macrocytosis with hypersegmented neutrophils

B. microcytosis with basophilic stippling

C. microcytosis with hypochromia

D. numerous schistocytes

Explanation:

The correct answer is C. This is a classic description of Fe deficiency anemia (up to 20% of adult women are Fe deficient!). Fe deficiency anemia is very common in menstruating women, and is associated with the signs and symptoms described (fatigue, weakness, pallor). It can also be associated with epithelial changes such as brittle nails and atrophic tongue. The typical laboratory values are those described along with a decreased reticulocyte count. On peripheral blood smear, the RBCs are small (microcytic) and pale in color (hypochromic, due to low Hb levels from inadequate Fe stores).

Vitamin B12/folate deficiency would give you macrocytosis with hypersegmented neutrophils (choice A).
Lead poisoning would give you microcytosis with basophilic stippling (choice B).

Schistocytes (choice D) are RBC fragments seen when the cells are destroyed by shearing forces in the vascular system, such as those present in prosthetic heart valves and microangiopathic hemolytic anemias.

A patient who recently underwent a gastrectomy procedure complains of nausea, diarrhea, sweating, palpitations, and flushing soon after eating a meal. This patient should be instructed to

A. eat less frequent, larger meals that are high in carbohydrates
B. eat less frequent, smaller meals that are high in fat
C. eat more frequent, larger meals that are high in protein
D. eat more frequent, smaller meals that are high in carbohydrates
E. eat more frequent, smaller meals that are high in fat

Explanation:

The correct answer is E. The postgastrectomy symptoms described above are collectively called the dumping syndrome. Because all or part of the stomach is removed, an ingested meal will be delivered to the small intestine more quickly than normal. The large increase in tonicity in the small intestine causes an osmotic fluid shift from the extracellular fluid (plasma) into the lumen of the gut. The increased distention of the small intestine increases motility through reflex mechanisms and causes diarrhea. The blood volume contraction and concomitant release of vasoactive substances such as bradykinin and/or vasoactive intestinal peptide can create hypotension and reflex tachycardia. Patients should be instructed to eat more frequent, smaller meals to reduce the osmotic and/or carbohydrate load that is delivered to the small intestine. Furthermore, since fats are the slowest to be absorbed, a diet that is higher in fat will also reduce the problem of rapid absorption.

A patient is brought to a physician because of multiple episodes of "fainting." Cardiovascular evaluation proves negative, but the clinician suspects that a medical condition exists and orders an EEG, which demonstrates an abnormal spiking pattern. Which of the following types of seizure did this patient most likely experience?
A. Absence

B. Atonic

C. Myoclonic

D. Tonic

E. Tonic-clonic

Explanation:

The correct answer is B. All of the forms of seizure listed in the choices are generalized seizures. The type of seizure that would most closely resemble a fainting spell is the atonic, or "drop," seizure. In this form of seizure, the patient suddenly loses muscle tone and falls to the floor.

Absence seizures (choice A), also known as petit mal seizures, are characterized by blank stares and an absence of any change in position. They are more commonly seen in childhood.

Myoclonic seizures (choice C) are characterized by quick, repetitive jerks.

Tonic seizures (choice D) are characterized by stiffening of the muscles.

Tonic-clonic seizures (choice E), also known as grand mal seizures, are characterized by alternating stiffening and movement.

A 50-year old male is brought to the emergency room in a coma. His wife had not noticed any problems preceding this incident, however, the man had been complaining about having to urinate at night over the past few months. Body temperature is 98.6 degrees F. Blood drawn in the emergency room shows the following: Plasma glucose = 1200 mg/dL, serum osmolarity = 380 mosm/L, ketone bodies = negative, and PCO2 = 40 mm Hg. Which of the following is the most likely cause of the coma?

A. Diabetic ketoacidosis

B. Hyperosmolar nonketotic coma

C. Insulin overdose
D. Myxedema

E. Sulfonylurea overdose

Explanation:

The correct answer is B. Both diabetic ketoacidosis (choice A) and hyperosmolar nonketotic coma present with hyperglycemia and increased serum osmolarity. In both cases, the hyperosmolarity is due to fluid loss because of the osmotic diuresis produced by the excess filtered glucose. However, the onset of hyperosmolar nonketotic coma is slow, as blood glucose gradually increases due to insulin resistance. Diabetic ketoacidosis has an acute onset of 1-2 days because of insulin deficiency. Since hyperosmolar nonketotic coma, by definition, is not associated with ketosis, it is not accompanied by metabolic acidosis. Hence, respiration is not stimulated (as it is in diabetic ketoacidosis) and PCO2 remains within the normal range. Ketoacidosis is absent in insulin resistance, primarily because even small amounts of effective insulin are able to prevent lipolysis. Without sufficient free fatty acids, the liver is unable to produce ketone bodies.

Insulin overdose (choice C) or sulfonylurea overdose (choice E) can both produce hypoglycemic coma. Insulin overdose is the most common cause of coma in the insulin-treated diabetic patient. It may be partly due to poor sympathetic response to hypoglycemia in diabetics. The oral hypoglycemic agents are more prone to produce hypoglycemia in older patients with renal or hepatic dysfunction.

Myxedema coma (choice D) is the end stage of untreated hypothyroidism. These patients also tend to have hypoglycemia due to decreased glucose absorption by the small intestine. The lack of thyroid hormone reduces the normal drive for respiration. Hence, these patients have depressed ventilation, hypercapnia, and hypoxia. Inappropriate secretion of vasopressin may occur and produce a dilutional hyponatremia. Body temperature is usually markedly decreased.

What role do the lungs play in the pathogenesis of systemic hypertension?

A. The alveolar capillaries contain aldosterone

B. The alveolar capillaries contain angiotensin-converting enzyme (ACE)

C. The alveolar capillaries contain antidiuretic hormone (ADH)

D. The type II pneumocytes contain aldosterone
E. The type II pneumocytes contain angiotensin-converting enzyme (ACE)

F. The type II pneumocytes contain antidiuretic hormone (ADH)

Explanation:

The correct answer is B. Renin is a renal protease that cleaves angiotensinogen (secreted into the plasma by the liver) to form angiotensin I. Angiotensin I is cleaved by angiotensin-converting enzyme (found in very high concentrations in the endothelial cells of the pulmonary capillary bed) to form angiotensin II. Angiotensin II triggers release of aldosterone from the adrenal cortex. Aldosterone increases Na⁺ resorption from the cortical collecting duct of the kidney, thereby tending to increase blood pressure. Under normal circumstances, angiotensin-converting enzyme is present in large amounts and is not rate-limiting in this process; however, it does provide an effective point at which the pathway can be interrupted (e.g., by ACE inhibitors such as captopril and enalapril).

Aldosterone (choices A and D) is produced in the adrenal cortex.

ADH (choices C and F) is secreted by the posterior pituitary.

Angiotensin-converting enzyme is present in the endothelial cells of the alveolar capillary bed, not in the type II pneumocytes (choice E).

A 65-year-old male visits his family practitioner for a yearly examination. Measurement of his blood pressure reveals a systolic pressure of 190 mm Hg and a diastolic pressure of 100 mm Hg. His heart rate is 74/min and pulse pressure is 90 mm Hg. A decrease in which of the following is the most likely explanation for the high pulse pressure?

A. Arterial compliance
B. Cardiac output
C. Myocardial contractility
D. Stroke volume
E. Total peripheral resistance

Explanation:

The correct answer is A. A decrease in arterial compliance indicates that the arterial wall is stiffer (i.e., less distensible). When the compliance of the arterial system decreases, the rise in arterial pressure becomes greater for a given stroke volume pumped into the arteries. In the normal young adult, the systolic blood pressure is about 120 mm Hg and the diastolic blood pressure is about 80 mm Hg. Because the pulse pressure is the difference between the systolic and diastolic blood pressures, the normal pulse pressure is about 40 mm Hg in a healthy young adult. However, in older adults the pulse pressure sometimes increases as much as two
times normal because the arteries become hardened by arteriosclerosis.

The cardiac output (choice B) itself has no direct effect on the pulse pressure; however, if a decrease in cardiac output is associated with a decrease in stroke volume, the pulse pressure would be expected to decrease.

A decrease in myocardial contractility (choice C) would be expected to decrease stroke volume, and therefore cause the pulse pressure to decrease.

A decrease in stroke volume (choice D) causes the pulse pressure to decrease because a smaller amount of blood enters the arterial system with each heartbeat, and the rise and fall of pressure during systole and diastole is decreased.

A decrease in total peripheral resistance (choice E), i.e., vasodilation, does not have a significant effect on the pulse pressure of the major arteries under normal conditions.

A 54-year-old male is seen in clinic with complaints of palpitations and light-headedness. Physical examination is remarkable for a heart rate of greater than 200 beats per minute and a blood pressure of 75/40 mm Hg. What adjustments have probably occurred in the cardiac cycle?

A. Diastolic time has decreased and systolic time has increased
B. Diastolic time has decreased but systolic time has decreased more
C. Systolic time has decreased and diastolic time has increased
D. Systolic time has decreased but diastolic time has decreased more
E. Systolic time has decreased but diastolic time has not changed

Explanation:
The correct answer is D. Under normal conditions, one-third of the cardiac cycle is spent in systole and two-thirds spent in diastole. As heart rate increases dramatically, the time spent in diastole falls precipitously but the time spent in systole falls only slightly.

A large increase in heart rate must produce a decrease in both diastole and systole (compare with choice A).

The major change with increased heart rate is in diastole, not systole (compare with choice B).

Heart rate cannot increase if diastolic time increases (choice C).

An increase in heart rate must be accompanied by a decrease in diastolic time (compare with choice E).

In a tissue capillary, the interstitial hydrostatic pressure is 2 mm Hg, the capillary hydrostatic pressure is 25 mm Hg and the interstitial oncotic pressure is 7 mm Hg. If the net driving force across the capillary wall is 3 mm Hg favoring filtration, what is the capillary oncotic pressure?

A. 21 mm Hg
B. 23 mm Hg
C. 24 mm Hg
D. 25 mm Hg
E. 27 mm Hg

Explanation:
The correct answer is E. The net driving force for fluid across a capillary wall is calculated by the following:

\[
\text{driving force} = (\text{hydrostatic}_c - \text{hydrostatic}_i) - (\text{oncotic}_c - \text{oncotic}_i)
\]

where:

\[
\text{hydrostatic}_i = \text{interstitial hydrostatic pressure}
\]

\[
\text{hydrostatic}_c = \text{capillary hydrostatic pressure}
\]

\[
\text{oncotic}_i = \text{interstitial oncotic pressure}
\]

\[
\text{oncotic}_c = \text{capillary oncotic pressure}
\]

Substituting the values in the question stem: \(3 = (25 - 2) - (x - 7)\). Simplifying, \(3 = 23 - x + 7\), therefore \(x = 27\).

Q 4

Blood is flowing through the circuit shown above. The inflow pressure is 100 mm Hg and the outflow pressure is 10 mm Hg. The resistance of each of the five branches is 5 mm Hg/mL/min. What is the flow across the circuit?

A. 3.6 mL/min
B. 45 mL/min
C. 90 mL/min
D. 135 mL/min
E. 180 mL/min

Explanation:
The correct answer is C. Because the various resistances (R1-R5) are arranged in parallel, the total resistance of the circuit (RT) is calculated using the following formula: 1/RT = 1/R1 + 1/R2 + 1/R3 + 1/R4 + 1/R5. Therefore, the resistance of the circuit is 1/RT = 1/5 + 1/5 + 1/5 + 1/5 + 1/5 = 1 mm Hg/mL/min. Because flow = \( \Delta \) pressure/resistance, the total flow through the circuit is \((100 - 10) \text{ mm Hg})/1 \text{ mm Hg/mL/min} = 90 \text{ mL/min.} \) Note from the equation that the total resistance (RT) decreases when additional resistances are added in parallel to the circuit. Conversely, the total resistance increases when parallel resistances are removed. Because the various organs of the body are arranged in parallel, the total peripheral resistance increases when an organ is removed.

Q 5

A work diagram showing changes in left ventricular volume and pressure during one cardiac cycle is shown in the figure above. Which of the following values is the diastolic blood pressure?

A. 0 mm Hg
B. 5 mm Hg
C. 80 mm Hg
D. 110 mm Hg
E. 125 mm Hg

Explanation:

The correct answer is C. The volume-pressure diagram is from a normal heart. The aortic valve opens at point B, which marks the beginning of the period of ejection. The pressure at this point is equal to the diastolic blood pressure, which is about 80 mm Hg on the diagram. Point D corresponds to the incisura or dicrotic notch on the pressure pulse contour, which signals closure of the aortic valve. Point D is commonly mistaken to be the diastolic pressure; you may wish to consult a diagram which shows simultaneous pressures in the aorta and left ventricle along with the various heart sounds. Point C corresponds to the peak systolic pressure in the left ventricle and is usually 2 or 3 mm Hg higher than the peak systolic pressure in the aorta. Point E marks the end of the period of isovolumetric relaxation. The mitral valve opens at point E and the ventricle begins to fill with blood.

A balloon-tipped catheter is placed into a small branch of the pulmonary artery in a patient. The lumen of the catheter opens distal to the balloon. The pressure measured from the catheter with the balloon deflated is 25/8 mm Hg. When the balloon is inflated, the pressure is 7 mm Hg and non-pulsatile. Which of the following pressures is being approximated when the balloon is inflated?
A. Left atrial pressure

B. Left ventricular end diastolic pressure

C. Left ventricular peak systolic pressure

D. Pulmonary artery pressure

E. Right atrial pressure

**Explanation:**

The correct answer is A. When the balloon is deflated, the catheter simply measures the pulmonary artery pressure (choice D), which is pulsatile with systolic/diastolic values of 25/8 mm Hg. When the balloon is inflated, the catheter is "wedged" in a small branch of the pulmonary artery and the pressure that is measured is called the "pulmonary wedge pressure." Because inflation of the balloon obstructs all blood flow in the artery branch, the blood vessels distal to the point of obstruction also have no flow. One can think of these distal vessels as physical extensions of the catheter, as they allow blood pressure to be measured on the other side of the pulmonary circulation, i.e., in the left atrium. The pulmonary wedge pressure is usually a few mm Hg higher compared to the left atrial pressure, but the general opinion is that pulmonary wedge pressure is a reflection of events in the left atrium. It is usually not feasible to measure left atrial pressure directly in the normal human being because it is difficult to pass a catheter retrograde through the aorta and left ventricle. Therefore, the pulmonary wedge pressure provides an important clinical estimate of left atrial pressure. Be aware that pulmonary wedge pressure may also be called pulmonary capillary wedge pressure, pulmonary arterial wedge pressure, or simply wedge pressure.

In many instances, the pulmonary wedge pressure can provide a reasonable estimate of left ventricular end diastolic pressure (choice B). However, a notable exception is during mitral stenosis, in which the pressure in the left atrium (and therefore, the pulmonary wedge pressure) is much higher than the left ventricular end diastolic pressure because of the high resistance to blood flow through the stenosed valve.

The left ventricular peak systolic pressure (choice C) occurs when the mitral valve is closed, making it impossible to be approximated using a catheter in the pulmonary artery.

The right atrial pressure (choice E) cannot be measured or approximated from a catheter in the pulmonary artery.
The vascular systems of five organs are arranged as shown in the drawing above. The vascular resistance of each organ is the same and the total resistance of the entire circuit is 0.05 mm Hg/mL/min. Which of the following values is the total resistance of the entire circuit if one of the organs was removed?

A. 0.0625 mm Hg/mL/min  
B. 0.0725 mL/min/mm Hg  
C. 0.04 mm Hg/mL/min  
D. 0.03 mm Hg/mL/min  
E. 0.01 mm Hg/mL/min

Explanation:

The correct answer is A. This problem is relatively simple if you know that removing a parallel resistance from a circuit increases the total resistance of that circuit. Because the total resistance with all five organs in the circuit is 0.05 mm Hg/mL/min, removing an organ would produce a total resistance greater than 0.05 mm Hg/mL/min. Choice B can be rejected because the units are incorrect, and choices C, D, and E can be eliminated because the values of resistance are lower than the total resistance prior to removal of the organ.

The problem is more difficult when a mathematical solution is required. The equation for parallel resistances is the following:

Because the total resistance (RT) is 0.05 mm Hg/mL/min, \( \frac{1}{0.05} = 20 = \frac{1}{RT} + \frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3} + \frac{1}{R4} + \frac{1}{R5} \). Therefore, each individual resistance must equal 0.25 mm Hg/mL/min since \( \frac{1}{0.25} = 4 \) and \( 4 \times 5 = 20 \). Removing one of the resistances therefore yields the following: \( \frac{1}{RT} = \frac{1}{0.25} + \frac{1}{0.25} + \frac{1}{0.25} + \frac{1}{0.25} = 16 \). Thus, \( RT = \frac{1}{16} = 0.625 \) mm Hg/mL/min.

Q8

A volume-pressure diagram of the left ventricle during one cardiac cycle of a normal heart is shown above. Which point on the diagram corresponds to the second heart sound?

A. Point A  
B. Point B
C. Point C
D. Point D
E. Point E
F. Point F
G. Point G
H. Point H

Explanation:

The correct answer is E. The various points on the volume-pressure diagram correspond to specific events of the cardiac cycle as follows:

Choice A: Marks the beginning of systole. The mitral valve closes and S1 can be heard. The end diastolic pressure (5 mm Hg) and end diastolic volume (125 mL) can be determined on the Y-axis and X-axis from this point.

Choice B: This is the period of isovolumic contraction. Left ventricular pressure increases rapidly, but left ventricular volume remains constant. All heart valves are closed.

Choice C: The aortic valve opens, which marks the beginning of the period of ejection. The pressure at this point is equal to the diastolic blood pressure, which is about 80 mm Hg on the diagram.

Choice D: This is the period of ejection. The pressure at the apex of the curve is the peak systolic pressure of the left ventricle.

Choice E: Marks the beginning of diastole. The aortic valve closes and S2 can be heard. The end systolic volume (50 mL) can be read from the X-axis at this point.

Choice F: The is the period of isovolumic relaxation. Left ventricular pressure is falling rapidly, but left ventricular volume remains constant. All heart valves are closed.

Choice G: The mitral valve opens and the period of filling begins.

Choice H: This is the period of filling.

A patient complaining of chest pain with exercise is evaluated by cardiac catheterization. The left anterior descending (LAD) branch of the coronary artery is visualized but the contrast angiography is poor. A Doppler-tipped catheter is inserted and the blood velocity is observed to increase transiently from 10 cm/sec to 70 cm/sec and then decrease back to 10 cm/sec as the probe passes a particular location in the artery. What was the cause of these changes in velocity measurements?

A. A coronary artery aneurysm with a cross-sectional area 1/7th the size of the native artery
B. A coronary artery aneurysm with a cross-sectional area 7 times greater than the native artery
C. A coronary artery obstruction with a cross-sectional area 1/7th of the size of the native artery
D. A coronary artery obstruction with a cross-sectional area 7 times greater than the native artery
**Explanation:**

The correct answer is C. Velocity has increased 7-fold, indicating a decrease in cross-sectional area by a factor of 7. This would be caused by an obstruction, not an aneurysm.

Choice A is incorrect, because a coronary artery aneurysm would produce an increase in cross-sectional area rather than a decrease.

Flow has increased 7-fold, indicating a decrease in vessel diameter, thus choices B and D are incorrect.

Which of the following vascular structures contains the largest proportion of the total blood volume in a normal individual?

A. Aorta and large arteries
B. Arterioles
C. Capillaries
D. Chambers of the heart
E. Pulmonary vasculature
F. Vena cavae
G. Venules and veins

**Explanation:**

The correct answer is G. The total blood volume of the body is about 5000 mL. The systemic veins contain about 64% of this volume or about 3200 mL. The vena cavae (choice F) contain a small fraction of the total venous volume. No other segment of the circulation comes close to the amount of blood contained by the systemic veins: the pulmonary vasculature (choice E) contains about 450 mL; the chambers of the heart (choice D) contain about 350 mL; the aorta and large arteries (choice A) together contain about 650 mL; and the arterioles and capillaries (choices B and C) together contain about 350 mL. Although the capillaries contain less than 7% of the total blood volume, they have a very large surface area which facilitates diffusion exchange of nutrients and metabolites between the blood and tissue spaces.

A healthy, 25-year-old female medical student has an exercise stress test at a local health club. Which of the following is most likely to occur in this woman's skeletal muscles during exercise?

A. Decreased blood flow
B. Decreased metabolite concentrations
C. Increased arteriolar diameter
D. Increased oxygen concentration
E. Increased vascular resistance

**Explanation:**

The correct answer is C. Blood flow can increase as much as 20-fold in exercising skeletal muscle, which is a greater increase than in any other tissue in the body. This tremendous increase in blood flow results almost
entirely from the actions of local vasodilator substances on the muscle arterioles. During exercise, the muscles use oxygen more rapidly than it can be delivered by the blood, which decreases the oxygen concentration (choice D) in the tissues. The oxygen deficiency causes vasodilator metabolites (choice B) such as adenosine, carbon dioxide, lactic acid, and others to accumulate in the tissues. The vasodilator metabolites acting on the arterioles lead to a reduction in vascular resistance (choice E) and an increase in blood flow (choice A).

Q12

The figure above shows four phases of coronary blood flow in the left coronary artery during one complete cardiac cycle. During which of the four phases indicated on the figure does the coronary circulation deliver the most oxygen to the left ventricle?

A. Phase 1
B. Phase 2
C. Phase 3
D. Phase 4

Explanation:

The correct answer is A. Oxygen delivery to the left ventricle is equal to the oxygen content of the arterial blood entering the heart multiplied by the coronary blood flow. Because the oxygen content of blood entering the delivery to the left ventricle is low in the left coronary artery occurs. Phase 2 (choice B) corresponds to period of ejection, and phase 4 use 4 has a peak blood flow similar to during phase 4 is relatively low because
A work diagram showing changes in left ventricular volume and pressure during one cardiac cycle is depicted above. To which of the following phases of the cardiac cycle does the portion of the graph labeled number 3 correspond?

A. Isometric contraction  
B. Isometric relaxation  
C. Isotonic contraction  
D. Isotonic relaxation

Explanation:

The correct answer is A. During each cardiac cycle, the walls of the ventricle undergo isometric contraction and relaxation as well as isotonic contraction and relaxation. Muscle contraction and relaxation is considered to be isometric when the muscle length does not change, and isotonic when the muscle length does change with a constant tension on the muscle. Phase 3 corresponds to a period of isometric contraction, referred to as the period of isovolumetric or isovolumic contraction. The ventricle is contracting and the pressure is rising, but the volume of the ventricle remains constant, thus muscle length is relatively constant. The aortic valve opens when ventricular pressure exceeds about 80 mm Hg, allowing blood to eject from the heart, which begins a phase of isotonic contraction (phase 2, choice C). This phase is called the period of ejection. Phase 1 begins when the ventricle relaxes and the aortic valve closes (period of isovolumetric or isovolumic relaxation). Phase 1 is a period of isotonic relaxation (choice B), referred to as the period of isovolummic or isovolumetric relaxation. The ventricle relaxes and the pressure falls during phase 1, but the volume of the ventricle remains constant, thus muscle length is relatively constant. Phase 4 begins when the mitral valve opens. This is a period of isotonic relaxation (choice D) in which the relaxed ventricle fills with blood; it is called the period of filling.

Q14

The vascular systems of five organs are arranged as shown in the drawing above. The arterial inflow pressures and venous outflow pressures are the same for all organs. What is the total resistance of the entire circuit if the resistance of each of the five organs is 0.25 mm Hg/mL/min?

A. 0.01 mm Hg/mL/min
B. 0.02 mm Hg/mL/min
C. 0.05 mm Hg/mL/min
D. 1.25 mm Hg/mL/min
E. 20.0 mm Hg/mL/min

Explanation:
The correct answer is C. Because the five organs are arranged in parallel, the total resistance of the circuit (RT) is calculated as follows: \( \frac{1}{RT} = \frac{1}{0.25} + \frac{1}{0.25} + \frac{1}{0.25} + \frac{1}{0.25} + \frac{1}{0.25} = 20 \) mm Hg/mL/min. Therefore, \( RT = \frac{1}{20} = 0.05 \) mm Hg/mL/min. The various organs of the body are arranged in parallel and therefore contribute a parallel resistance to the peripheral circulation. You should recall that adding resistances (R1, R2, R3...) in parallel reduces the total resistance (RT) of a circuit because of the manner in which parallel resistances are added, i.e., \( \frac{1}{RT} = \frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3} \). Note also from the equation that removing a parallel resistance (R1, R2, or R3) increases the total resistance (RT).

A 78-year-old woman has a mean arterial pressure of 120 mm Hg and a heart rate of 60/min. She has a stroke volume of 50 mL, cardiac output of 3000 mL/min, and a right atrial pressure of 0 mm Hg. What is the total peripheral resistance (in mm Hg/mL/min) in this woman?

A. 0.01
B. 0.02
C. 0.04
D. 0.08
E. 0.10

Explanation:
The correct answer is C. Total peripheral resistance (TPR) is equal to the pressure gradient across the circulation (mean arterial pressure - right atrial pressure) divided by the cardiac output. Thus, \( TPR = \frac{120}{3000} = 0.04 \) mm Hg/mL/min. The “ABC rule” is useful in remembering the relation between pressure (P), flow (Q), and resistance (R) because \( P = QR \) (note the alphabetical order). Note also that knowledge of heart rate and stroke volume are not required to solve this problem because cardiac output is provided.

```
100
80
60
40
20

Blood Flow (% Control)

40 80 120 160 200

PO2 (mm Hg)
```

to the pressure gradient across the cardiac output. Thus, \( TPR = \frac{120}{3000} \) the relation between pressure (P), flow (Q), output is provided.
A research physiologist is studying the effects of hypoxia on vascular resistance. An anesthetized animal is ventilated with varying partial pressures of oxygen and the venous outflow from different organs is measured using Doppler technology. The graph depicted above most likely represents data obtained from the

A. brain  
B. kidney  
C. liver  
D. lungs  
E. spleen  

Explanation:

The correct answer is D. The graph indicates that blood flow decreases with hypoxia. Only the lungs exhibit vasoconstriction in response to hypoxia (pulmonary hypoxic vasoconstriction). This is an adaptive mechanism that causes blood to shunt away from regions of the lung which are poorly ventilated (e.g., because of airway obstruction) to areas which are better ventilated. In other organs, vasodilation generally occurs in response to hypoxia.

During normal diastole, which of the following is most important in preventing over-distension of the ventricles?

A. Adjacent lungs  
B. Aortic valve  
C. Diaphragm  
D. Fibrous pericardium  
E. Mitral valve  

Explanation:

The correct answer is D. The fibrous pericardium, which surrounds the heart, does not simply separate the heart from other chest structures, but has the important physiologic role of limiting the distension of the heart during diastole. This helps keep the (normal) heart functioning in a useful part of Starling's curve. In congestive heart failure, the slow enlargement of the heart also enlarges the fibrous pericardium, and this protective function may be lost.

The lungs (choice A) and diaphragm (choice C) do not usually significantly limit cardiac expansion during diastole.

Shutting and opening of the aortic (choice B) and mitral valves (choice E) are mechanical events that occur secondary to the changes in muscle tone in the cardiac chambers.

During cardiac examination of a newborn infant, a murmur is detected, and the diagnosis of patent ductus arteriosus is made. Which of the following best describes the direction of blood flow through the patent ductus arteriosus in this infant?
A. From aorta to left pulmonary artery
B. From aorta to left pulmonary vein
C. From aorta to right pulmonary artery
D. From left pulmonary artery to aorta
E. From right pulmonary artery to aorta

Explanation:
The correct answer is A. The ductus arteriosus connects the left pulmonary artery to the aortic arch. It is derived from the left sixth aortic arch. During prenatal life, the pressure gradient causes blood to flow from the left pulmonary artery to the aorta. However, after birth, the pressure gradient reverses, and if the ductus arteriosus remains patent, the flow is from the aorta to the left pulmonary artery.

The ductus arteriosus does not connect to the pulmonary veins or the right pulmonary artery (choices B, C, and E).

The flow through the ductus arteriosus is from the left pulmonary artery to the aorta (choice D) prior to birth, but reverses after birth.

<table>
<thead>
<tr>
<th>Type of blood vessel</th>
<th>Fall in blood pressure (mm Hg) (% of total peripheral resistance)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aorta and large arteries</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Small arteries</td>
<td>10-20</td>
</tr>
<tr>
<td>Arterioles</td>
<td>50</td>
</tr>
<tr>
<td>Capillaries</td>
<td>25</td>
</tr>
<tr>
<td>Venules and small veins</td>
<td>9</td>
</tr>
<tr>
<td>Vena cave</td>
<td>&lt;1</td>
</tr>
</tbody>
</table>

The table above shows the fall in blood pressure that occurs for the various types of blood vessels as blood flows from the aorta (100 mm Hg) to the right atrium (0 mm Hg). Which of the following types of blood vessel is likely to have the highest ratio of wall cross-sectional area to lumen cross-sectional area?

A. Aorta and large arteries
B. Small arteries
C. Arterioles
D. Capillaries
E. Venules and small veins
F. Vena cavae
Explanation:

The correct answer is C. The table shows that the greatest fall in blood pressure (50 mm Hg) occurs in the arterioles, which indicates that the arterioles account for about 50% of the total peripheral resistance. The structural characteristics of arterioles are consistent with their function as control valves that regulate blood flow to the capillary networks of the body. Thus, arterioles are thick-walled vessels with the highest ratio of wall cross-sectional area to lumen cross-sectional area. This does not mean that arterioles have thicker walls compared to arteries. It simply means that the walls of arterioles are relatively thick compared to their overall size (diameter). The wall-to-lumen ratio of arteries, which includes the aorta (choice A) as well as large (choice A) and small arteries (choice B), is less than that of arterioles but greater than that of venules and veins (choices E and F). The capillaries (choice D) lack smooth muscle cells in their walls, which makes wall-to-lumen ratio measurements much less meaningful.

A healthy 22-year-old female medical student has an exercise stress test at a local health club. Which of the following is most likely to decrease in her skeletal muscles during exercise?

A. Arteriolar resistance
B. Carbon dioxide concentration
C. Lactic acid concentration
D. Sympathetic nervous activity
E. Vascular conductance

Explanation:

The correct answer is A. The increase in muscle blood flow that occurs during exercise is caused by dilation of the arterioles (i.e., decreased arteriolar resistance). In normal skeletal muscles, the blood flow can increase as much as 20-fold during strenuous exercise. Most of this increase in blood flow can be attributed to the dilatory actions of metabolic factors (e.g., adenosine, lactic acid, carbon dioxide) produced by the exercising muscles.

Exercise causes the concentration of carbon dioxide (choice B) and lactic acid (choice C) to increase in the muscles.

Mass discharge of the sympathetic nervous system (choice D) occurs throughout the body during exercise, causing arterioles to constrict in most tissues. The arterioles in the exercising muscles, however, are strongly dilated by vasodilator substances released from the muscles.

A decrease in vascular conductance (choice E) occurs when the vasculature is constricted. Resistance and conductance are inversely related, so that a decrease in arteriolar resistance is associated with an increase in arteriolar conductance.

During surgical removal of an invasive glioma from the skull base, cranial nerves IX and X are accidentally cut bilaterally. What would be the immediate change in the patient's hemodynamic condition?

A. Bradycardia with hypertension
B. Bradycardia with hypotension
C. Sinus arrhythmia with hypotension
D. Tachycardia with hypertension
E. Tachycardia with hypotension

Explanation:

The correct answer is D. The glossopharyngeal nerve (CN IX) and the vagus nerve (CN X) carry afferent information to the medulla from the carotid sinus and aortic arch baroreceptors, respectively. The firing rate of these neurons increases with increasing blood pressure. Therefore, severing these nerves sends the medulla a false signal that the patient has suddenly lost all blood pressure. This elicits a baroreceptor reflex, resulting in an increase in sympathetic outflow and leading to tachycardia and hypertension.

After an accident at work resulting in severe hemorrhage, a machinist is rushed to the emergency room. Which of the following sets of autonomic responses would be predicted in this patient?

<table>
<thead>
<tr>
<th>Heart rate</th>
<th>Bowel sounds</th>
<th>Pupil diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Decreased</td>
<td>Decreased</td>
<td>Constricted</td>
</tr>
<tr>
<td>B. Decreased</td>
<td>Decreased</td>
<td>Dilated</td>
</tr>
<tr>
<td>C. Decreased</td>
<td>Increased</td>
<td>Constricted</td>
</tr>
<tr>
<td>D. Decreased</td>
<td>Increased</td>
<td>Dilated</td>
</tr>
<tr>
<td>E. Increased</td>
<td>Decreased</td>
<td>Constricted</td>
</tr>
<tr>
<td>F. Increased</td>
<td>Decreased</td>
<td>Dilated</td>
</tr>
<tr>
<td>G. Increased</td>
<td>Increased</td>
<td>Constricted</td>
</tr>
<tr>
<td>H. Increased</td>
<td>Increased</td>
<td>Dilated</td>
</tr>
</tbody>
</table>

Explanation:

The correct answer is F. This is simply a question about baroreceptor reflexes. The reflex response that would be anticipated after a decrease in blood pressure (e.g., after a hemorrhage) would be an increase in sympathetic outflow and a decrease in parasympathetic outflow. As a result, heart rate would increase, gastrointestinal motility...
would decrease, and the pupils would dilate.

The table below shows the pressure gradient, radius, and viscosity of blood in various vessels of the same length. Which vessel has the highest flow?

<table>
<thead>
<tr>
<th>Vessel</th>
<th>Pressure gradient</th>
<th>Radius</th>
<th>Viscosity</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. A</td>
<td>100</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>B. B</td>
<td>50</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>C. C</td>
<td>25</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>D. D</td>
<td>10</td>
<td>6</td>
<td>1</td>
</tr>
</tbody>
</table>

Explanation:

The correct answer is D. Recall that flow = pressure gradient/resistance. Also recall that resistance (R) is inversely proportional to the fourth power of the radius (R \(\alpha\) 1/ radius^4) and proportional to the first power of the blood viscosity (R \(\alpha\) viscosity). The problem can be confusing because the vessels with the highest pressure gradient and radius also have the highest viscosity. However, the discerning student will note that the 6-fold increase in radius will cause a 1296-fold increase in flow, and that the range of pressure and viscosity given in the table will have a relatively minor effect on flow as compared to the effect of vessel radius.

In which segment of the systemic circulation does the greatest decrease in blood pressure occur?

A. Aorta and large arteries  
B. Arterioles  
C. Capillaries  
D. Small arteries  
E. Vena cavae and large veins  
F. Venules and small veins
Explanation:

The correct answer is B. As blood flows through the systemic circulation the mean pressure of the blood decreases from about 100 mm Hg in the aorta to about 0 mm Hg in the right atrium. The mean blood pressure is about the same in all portions of the aorta (choice A) and it only falls by a few mm Hg in the large arteries (choice A). The blood pressure decreases by 10 to 20 mm Hg in the small arteries (choice D) so that blood entering the arterioles has a pressure averaging about 80 to 90 mm Hg. By the time the blood has reached the ends of the arterioles (choice B) the pressure has fallen to about 35 mm Hg. The pressure falls another 25 mm Hg as it flows through the capillary network (choice C), so that blood entering the venules has a pressure of about 10 mm Hg. The blood pressure falls by about 10 mm Hg as it flows along the venous system (choices E and F) to the right atrium.

The fall in blood pressure (from 100 to 0 mm Hg) along the various types of blood vessels in the circulation is summarized in the table. The table also shows the relative resistance (expressed as % of total peripheral resistance) to blood flow in the various segments of the circulation.

<table>
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</tr>
<tr>
<td>Vena cave</td>
<td>&lt;1</td>
</tr>
</tbody>
</table>

A 60-year-old male with heart disease is brought to the emergency room. Cardiovascular evaluation reveals a resting O2 consumption of 200 mL/min, a peripheral arterial O2 content of 0.20 mL O2/ml of blood, and a mixed venous O2 content of 0.15 mL O2/mL of blood. What is his cardiac output?

A. 2.5 L/min  
B. 4.0 L/min  
C. 10.0 L/min  
D. 25.0 L/min  
E. 100.0 L/min

Explanation:

The correct answer is B. Cardiac output can be measured by way of O2 consumption using the Fick principle:

\[ \text{CO} = \frac{\text{O2 Consumption}}{\text{O2 arterial} - \text{O2 Venous}} \]

In this case, oxygen consumption was 200 mL/min, [O2] arterial was 0.20 mL O2/mL of blood, and [O2] venous was 0.15 mL O2/mL of blood:

\[ \text{C.O} = \frac{200 \text{ml/ min}}{0.20 - 0.15} \]
Choice A corresponds to a very low cardiac output, as average cardiac output is taken to be approximately 5 L/min.

Choices C, D, and E are illogical since the heart is virtually incapable of pumping so much blood in 1 minute, especially in a patient with heart disease.

A cardiovascular physiologist performs an experiment on an animal subject to study heart rate and blood pressure changes with nerve stimulation. He selectively stimulates the afferent portions of the glossopharyngeal and vagus nerves. Which of the following outcomes would most likely occur after this manipulation?

A. Bradycardia with hypertension
B. Bradycardia with hypotension
C. Sinus arrhythmia with hypotension
D. Tachycardia with hypertension
E. Tachycardia with hypotension

Explanation:

The correct answer is B. The glossopharyngeal nerve (CN IX) and the vagus nerve (CN X) carry afferent information to the medulla from the carotid sinus and aortic arch baroreceptors, respectively. The firing rate of these neurons increases with increasing blood pressure. Therefore, by artificially increasing the firing rate of these nerves, the medulla receives a false signal that indicates that the blood pressure is too high. This elicits a baroreceptor reflex, resulting in a decrease in sympathetic outflow and an increase in parasympathetic outflow, which leads to bradycardia and hypotension.

A researcher is carrying out an experiment on an anesthetized animal to study the cardiovascular and neural responses to various types of stimuli. His experimental setup allows him to measure blood pressure and monitor the electrocardiogram. He carefully isolates the afferent nerves from the carotid sinus and aortic arch and implants microelectrodes to record nerve activity. After taking baseline measurements, he massages the right carotid artery for 60 seconds. Which of the following data sets would best correspond to his experimental findings during the carotid massage?

A.
B.
C.
D.
E.
F.

Explanation:
The correct answer is B. This is actually a straightforward question. The fastest way to approach this question is to predict the physiological responses that would occur as a result of a carotid massage and identify the appropriate graph, rather than spending the time to read all of the graphs.

During a carotid massage, the carotid sinus baroreceptors sense the increase in pressure. This leads to an increase in afferent traffic (firing rate) in the glossopharyngeal nerve. A signal indicating high blood pressure travels to the nucleus of the solitary tract (NTS) in the medulla, and a baroreceptor reflex occurs. The animal is "tricked" into thinking it has high blood pressure, so it decreases sympathetic outflow and increases parasympathetic outflow, leading to decreases in blood pressure and heart rate. Meanwhile, the aortic arch baroreceptors, which are innervated by the vagus nerve, correctly sense that the blood pressure has decreased. This decreases afferent traffic along the vagus nerve to the brain stem.

If you simply knew that a carotid massage leads to a decrease in blood pressure and heart rate, you could immediately narrow your choices to A and B. Knowledge of baroreceptor physiology allows you to distinguish between A and B.

Respiratory rate
  15
Blood pressure
  120/80 mm Hg
Cardiac output
  5 L
Heart rate
  50

A 25-year-old man is participating in a clinical study to determine the cardiovascular response to physical exercise. Basal measurements are shown above. What is his stroke volume during resting conditions (in mL/min)?

A. 50
B. 75
C. 100
D. 125
E. 150

Explanation:

The correct answer is C. The cardiac output (CO) is equal to the volume of blood ejected from the heart during each systole (i.e., the stroke volume; SV) multiplied by the number of times the heart beats each minute (heart rate; HR). In other words, CO = SV x HR. Therefore, SV = CO/HR, and since CO = 5000 mL/min, and HR = 50/min, SV = 5000/50 = 100 mL.

A healthy 28-year-old woman stands up from a supine position. Which of the following cardiovascular changes is most likely to occur?

A. Decreased myocardial contractility
B. Decreased total peripheral resistance
C. Dilation of large veins
D. Increased heart rate
E. Increased renal blood flow

Explanation:
The correct answer is D. The baroreceptor mechanism is important for maintaining arterial pressure when a person sits or stands from a lying position. When a person suddenly stands, the blood pressure in the brain and upper body tends to fall, which initiates a strong sympathetic discharge throughout the body aimed at returning blood pressure to normal. Increasing sympathetic stimulation to the heart causes an increase in heart rate, conduction velocity, and myocardial contractility (compare with choice A). The sympathetic stimulation also causes constriction of nearly all the arterioles in the body, which greatly increases the total peripheral resistance (compare with choice B). Sympathetic stimulation of the renal vasculature leads to a decrease in renal blood flow (compare with choice E). Constriction of large veins (compare with choice C) increases venous return to the heart, causing the heart to pump increased amounts of blood.

A medical student is studying the fluid exchange in skeletal muscle capillaries in a laboratory animal. He determines that fluid is being forced out of a capillary with a net filtration pressure of 8 mm Hg, and obtains the following laboratory values:
- Capillary hydrostatic pressure = 24 mm Hg,
- Capillary colloid osmotic pressure = 17 mm Hg,
- Interstitial hydrostatic pressure = 7 mm Hg.

What is the interstitial osmotic pressure?

A. –9 mm Hg
B. –8 mm Hg
C. –6 mm Hg
D. 6 mm Hg
E. 8 mm Hg
F. 9 mm Hg

Explanation:
The correct answer is E. To calculate the direction and driving force for fluid movement use the Starling equation [net filtration pressure = (Pc− Pi) − (πc−πi)]. The net pressure in this case is positive because fluid is being forced out of the capillary.

\[ \text{Pc} = \text{capillary hydrostatic pressure} = 24, \ \&\pi;\text{c} = \text{capillary colloid osmotic pressure} = 17 \ \text{and} \ \Pi = \text{hydrostatic osmotic pressure} = 7. \] Substituting these values into the equation and solving for \&\pi;i, we get:

\[ 8 \ \text{mm Hg} = (24 \ &\text{minus}; 7) \ &\text{minus}; (17 \ &\text{minus}; \&\pi;i) \ \text{mm Hg} \]

\[ \&\pi;i = 8 \ \text{mm Hg} \]

A 56-year old woman has a mean systemic blood pressure of 100 mm Hg and a resting cardiac output of 4 L/min.
What is the total peripheral resistance of this woman?

A. 0.025 mL/min/mm Hg
B. 0.025 mm Hg/mL/min
C. 40 mL/min/mm Hg
D. 40 mm Hg/min/mL
E. 4000 mm Hg x L/min

Explanation:
The correct answer is B. Total peripheral resistance (TPR) is equal to the pressure gradient across the circulation (mean arterial pressure - right atrial pressure) divided by the cardiac output. Right atrial pressure is assumed to equal 0 mm Hg. Thus, TPR = 100/4000 = 0.025 mm Hg/mL/min. The "ABC rule" is useful in remembering the relation between pressure (P), flow (Q), and resistance (R) because P=QR (in alphabetical order). Note that choices A, C, D, and E can be eliminated quickly because in each case the units are incorrect.

During an experimental procedure, a cardiovascular researcher prepares his anesthetized animal subject for blood pressure and electrocardiogram monitoring. He then isolates and electrically stimulates glossopharyngeal afferent fibers that supply the carotid sinus. Which of the following changes would most likely occur in this subject?

A. Hypertension with bradycardia
B. Hypertension with tachycardia
C. Hypotension with bradycardia
D. Hypotension with tachycardia
E. No changes in blood pressure or heart rate

Explanation:
The correct answer is C. The glossopharyngeal nerve (CN IX) and the vagus nerve (CN X) carry afferent information to the medulla from the carotid sinus and aortic arch baroreceptors, respectively. The firing rate of these neurons increases with increasing blood pressure. Therefore, stimulation of the glossopharyngeal nerve sends the medulla a false signal that the animal has suddenly had an increase in blood pressure. This elicits a baroreceptor reflex resulting in a decrease in sympathetic outflow and an increase in parasympathetic outflow, leading to hypotension and bradycardia.

In which type of blood vessel is the mean linear velocity of a red blood cell the lowest?

A. Aorta and large arteries
B. Arterioles
C. Capillaries
D. Small arteries

E. Vena cavae and large veins

F. Venules and small veins

Explanation:

The correct answer is C. The same volume of blood flows through each of the different types of blood vessels each minute. Because the capillaries have the largest cross-sectional area (averaging 2500-5000 cm²), and because the velocity of blood flow is inversely related to cross-sectional area, it is clear that the mean linear velocity of a red blood cell is lowest in the capillaries. Under resting conditions, the mean linear velocity of a red blood cell in the capillaries is 0.3-0.6 mm/sec, whereas, the velocity in the aorta (choice A) is about 200 mm/sec. This low velocity of red blood cells in the capillary network allows plenty of time for oxygen to diffuse to the tissues.

The velocity of blood flow is ranked from highest to lowest as follows: aorta (choice A) > vena cavae (choice E) > large veins (choice E) > small arteries (choice D) > arterioles (choice B) > small veins (choice F) > venules (choice F) > capillaries. This ranking assumes the vena cavae have a larger cross-sectional area than the aorta; however, when the vena cavae are partially collapsed (which occurs often) they have a lower cross-sectional area and a higher velocity of blood flow compared to the aorta.