

Boron: Medical Physiology, 2nd Updated Edition

Test Bank

MULTIPLE CHOICE

1. A 47-year-old woman with a longstanding history of heartburn complains of severe heartburn. You make the diagnosis of gastroesophageal reflux disease (GERD). An upper endoscopy study is positive for Barrett's esophagus. Which of the following correctly describes Barrett's esophagus?
- A. Replacement of the squamous epithelium of the esophagus with columnar epithelium
 - B. Replacement of the columnar epithelium of the esophagus with squamous epithelium
 - C. The presence of moderate-to-high grade dysplasia in the esophagus
 - D. The presence of low-to-moderate grade dysplasia in the esophagus
 - E. The presence of any stricture within the esophagus

Answer

A – Replacement of the squamous epithelium of the esophagus with columnar epithelium is correct. Barrett's esophagus appears when the squamous epithelium of the esophagus is replaced by brownish metaplastic columnar epithelium extending up from the stomach in a tongue-like or circumferential fashion. Barrett's esophagus is present in up to 10% of patients with chronic reflux and is associated with an increased risk of neoplasia.

Other choices

B – Replacement of the columnar epithelium of the esophagus with squamous epithelium is incorrect. Normal esophageal epithelium is squamous, and not columnar.

C – The presence of moderate-to-high grade dysplasia in the esophagus is incorrect. Esophageal dysplasia is thought to be premalignant, progressing from low to moderate to high grade dysplasia to carcinoma in situ, but does not describe Barrett's esophagus.

D – The presence of low-to-moderate grade dysplasia in the esophagus is incorrect. Low or moderate grade dysplasia is not associated with Barrett's esophagus.

E – The presence of any stricture within the esophagus is incorrect. Barrett's esophagus is not described by esophageal stricture.

2. A 65-year-old woman with a history of congestive heart failure, osteoarthritis, and hypertension presents with pain and tenderness, which is relieved by food or antacids. Upper endoscopy reveals a gastric ulcer. Her current medications include digoxin, metoprolol, lisinopril, aspirin, and hydrochlorothiazide. Which of her medications is most likely to have contributed to her peptic ulcer disease?
- A. Digoxin
 - B. Metoprolol
 - C. Lisinopril
 - D. Aspirin
 - E. Hydrochlorothiazide

Answer

D – Aspirin is correct. This patient is probably taking aspirin for her osteoarthritis. The risk of developing gastric ulcers is increased in all chronic nonsteroidal anti-inflammatory drug (NSAID) users. NSAIDs function as cyclo-oxygenase (COX) inhibitors, blocking prostaglandin production in the gastric mucosa. Prostaglandins are cytoprotective in the gastric mucosa preventing damage to the gastric mucosal barrier. Newer NSAIDs have been designed to reduce the risk of gastric complications of NSAID therapy.

Other choices

A – Digoxin has a variety of adverse effects, but does not predispose patients to peptic ulcer disease.

B – Metoprolol is a beta-blocker and beta blocking agents do not predispose patients to peptic ulcer disease.

C – Lisinopril is an angiotensin-converting enzyme (ACE) inhibitor and has not been linked to peptic ulcer disease.

E – Hydrochlorothiazide is a thiazide diuretic, and thiazides have not been linked to peptic ulcer disease.

3. A 45-year-old woman complains of episodic epigastric pain. She denies fevers, chills, diaphoresis, flushing, chest pain or shortness of breath. An upper endoscopy reveals severe and atypical peptic ulcer disease. Biopsy results are *Helicobacter pylori* negative and she denies taking NSAIDs. Continued workup should include serum levels of which of the following?
- A. Serotonin
 - B. Gastrin
 - C. Vasoactive intestinal peptide (VIP)
 - D. Cholecystokinin (CCK)
 - E. Histamine

Answer

B – Gastrin is correct. Severe peptic ulcer disease in the absence of predisposing factors such as NSAID use or *H. pylori* infection should raise a suspicion for Zollinger-Ellison syndrome (also known as gastrinoma). In this syndrome gastrin-secreting gut tumors lead to hypergastrinemia and gastric acid hypersecretion.

Other choices

A – Serotonin has not been implicated in peptic ulcer disease.

C – VIP is incorrect. VIPomas are associated with watery diarrhea, leading to dehydration, but VIP, however, is not associated with peptic ulcer disease.

D – CCK is incorrect. It is produced by I cells in the small intestine and increases secretion of digestive enzymes from the pancreas and bile from the gallbladder, and is not associated with peptic ulcer disease.

E – Histamine is incorrect. Although histamine is an important secretagogue for gastric acid secretion, histamine excess is also associated with vasodilation, often leading to potentially fatal hypotension.

4. A 67-year-old man presents with mild dysphagia and throat discomfort that has slowly progressed over the past 5 years. He reports waking up at night choking and regurgitating undigested food. He has been troubled by halitosis and has noticed a small protrusion in his neck over the past year. He denies weight loss or heartburn. Which of the following is most consistent with his symptoms?
- A. Achalasia
 - B. Zenker's diverticulum
 - C. Gastroesophageal reflux disease
 - D. Schatzki's ring
 - E. Esophageal cancer

Answer

B – Zenker's diverticulum is correct. Zenker's diverticulum is a protrusion of the pharyngeal mucosa resulting from a loss of elasticity of the upper esophageal sphincter. Dysphagia and regurgitation slowly progress over years in middle-aged or elderly patients. Other symptoms may include throat discomfort, coughing, halitosis, and a protrusion in the neck. Treatment consists of surgical upper esophageal myotomy, and often diverticulectomy.

Other choices

A – Achalasia is incorrect. Gradual, progressive dysphagia and regurgitation are characteristic of achalasia. No weight loss was noted in this case. Patients with achalasia experience discomfort in the substernal region, not the throat, and neck protrusions are not observed.

C – Gastroesophageal reflux disease is incorrect. Gastroesophageal reflux disease can lead to a peptic stricture within the esophagus, which could lead to dysphagia and regurgitation, but the patient's discomfort would be lower than the neck, and no neck protrusion would be seen.

D – Schatzki's ring is incorrect. Patients with Schatzki's ring, a lower esophageal ring associated with a hiatal hernia, experience dysphagia that is intermittent, not progressive.

E – Esophageal cancer is incorrect. Patients with esophageal cancer have progressive dysphagia. They also present with weight loss, which this patient did not exhibit.

5. A 56-year-old retired schoolteacher presents with progressive dysphagia, substernal pain with eating, and weight loss over the course of 1 year. He has never traveled outside the United States. Barium esophagography reveals esophageal dilation, lack of esophageal peristalsis, and a 'bird's beak' tapering of the distal esophagus. Which of the following is a likely cause of this patient's condition?
- A. Achalasia
 - B. Zenker's diverticulum
 - C. Barrett's esophagus
 - D. Chagas disease
 - E. Increased pressure of the upper esophageal sphincter

Answer

A – Achalasia is correct. Achalasia is characterized by loss of peristalsis in two-thirds of the esophagus and impaired relaxation of the lower esophageal sphincter. Barium swallow studies reveal a dilated esophagus and a tapering of the distal esophagus, classically referred to as a 'bird's beak'. The diagnosis is confirmed by esophageal manometry.

Other choices

- B – Formation of an esophageal diverticulum is incorrect. Esophageal diverticula, can present with symptoms similar to those of dysphagia, but a barium swallow study would not reveal the findings seen in this patient.
- C – Barrett's esophagus is incorrect. Barrett's esophagus involves the migration of gastric columnar epithelium into the esophagus, but does not usually lead to dysphagia or the findings seen in this patient.
- D – Chagas disease is incorrect. Chagas disease, which is caused by trypanosome infection, can lead to esophageal findings identical to those seen in achalasia, but would be unlikely in this patient, because he has never traveled to Central or South America.
- E – Increased pressure of the upper esophageal sphincter is incorrect. Increased pressure of the upper esophageal sphincter would be more likely to lead to a Zenker's diverticulum.

6. A 79-year-old woman presents to the emergency department with right lower quadrant abdominal pain of several hours' duration. She has a temperature of 101.7° C and has tenderness to palpation in the right lower quadrant of her abdomen. Abdominal computed tomography (CT) scan reveals diverticulitis of the colon. Where are diverticula most frequently found in the colon?
- A. Cecum
 - B. Ascending colon
 - C. Transverse colon
 - D. Descending colon
 - E. Sigmoid colon

Answer

E – Sigmoid colon is correct. The incidence of colonic diverticular disease increases with age, with an incidence of over 50% in patients over age 80. Most patients with diverticulosis have diverticula in the sigmoid colon, where intraluminal pressures are higher than in other colonic segments.

Other choices

- A – Diverticular disease is rarely seen in the cecum.
- B – Ascending colon is incorrect. Although diverticular disease can involve any segment of the colon, it is most commonly found in the descending colon especially the sigmoid.
- C – The transverse colon, like the ascending colon, is not frequently involved in diverticular disease.
- D – Diverticular disease in the descending colon is not uncommon, but intraluminal pressures are still higher in the sigmoid colon and diverticula are more likely to be found in the sigmoid colon than the descending colon.

7. A 30-year-old woman with severe Crohn's disease is taken to surgery for an ileal resection. What nutritional deficiency does this woman risk in the future?
- A. Folate deficiency
 - B. Niacin deficiency
 - C. Thiamine deficiency
 - D. Iron deficiency
 - E. Vitamin B₁₂ deficiency

Answer

E – Vitamin B₁₂ deficiency is correct. The vitamin B₁₂ intrinsic factor complex is absorbed in the ileum. Thus, vitamin B₁₂ deficiency can result from resection of the ileum. The most common result of vitamin B₁₂ deficiency is anemia, with severe deficiency leading to a complicated neurologic syndrome.

Other choices

A – Folate deficiency is often seen in alcoholics, who do not have sufficient dietary intake. Folate deficiency is not often observed in patients with Crohn's disease.

B – Niacin deficiency is incorrect. Niacin is a component of essential cofactors in oxidation–reduction reactions. Niacin deficiency leads to the triad of dermatitis, dementia, and diarrhea.

C – Thiamine deficiency is incorrect. Thiamine deficiency is most often associated with alcoholism, and symptoms include anorexia, muscle cramps, paresthesia and irritability.

D – Iron deficiency is incorrect. Iron is predominantly absorbed in the duodenum, not the ileum. Iron deficiency is often caused by blood loss and is associated with a microcytic anemia.

8. A 60-year-old man presents to your office with facial flushing and abdominal cramps and diarrhea. The workup reveals an elevated level of urinary 5-hydroxyindoleacetic acid (5-HIAA), and subsequently, elevated levels of 5-HIAA in a 24-hour urine collection. What is the most likely diagnosis?

A. Zollinger-Ellison syndrome

B. Cushing's syndrome

C. Malignant carcinoid syndrome

D. Vipoma

E. Glucagonoma

Answer

C – Malignant carcinoid syndrome is correct. Elevated levels of 5-HIAA on 24-hour urine collection are characteristic of carcinoid syndrome. Carcinoid tumors are the most common neuroendocrine tumors and are often malignant. Serotonin is the most important factor causing the symptoms associated with the carcinoid syndrome.

Other choices

A – Zollinger-Ellison syndrome is incorrect. Zollinger-Ellison syndrome results from gastrin-secreting neuroendocrine tumors, also known as gastrinomas. Symptoms include diarrhea, and severe peptic ulcer disease. It is not associated with facial flushing.

B – Cushing's syndrome is incorrect. Cushing's syndrome is seen in hypercortisolism, and includes central obesity, muscle wasting, thin skin, bruisability, hirsutism, purple striae, osteoporosis, poor wound healing, hyperglycemia, leukocytosis, and lymphocytopenia. In a patient with Cushing's syndrome, the diagnosis would be made by detecting an elevated serum cortisol and urinary free cortisol rather than serotonin or 5-HIAA.

D – Vipoma is incorrect. Vipoma is a neuroendocrine tumor that secretes vasoactive intestinal polypeptide (VIP), which causes intestinal glands to secrete a profuse watery diarrhea.

E – Glucagonoma is incorrect. Glucagonomas cause diarrhea, nausea and peptic ulcer disease. It is unlikely that this patient's symptoms are due to a glucagonoma.

9. A 58-year-old woman with type II diabetes mellitus was diagnosed approximately 1 year ago. Her labs show no improvement in blood glucose control over the ensuing months despite treatment. What test should you order to examine her average blood sugar levels over the past few months?
- A. Fasting blood glucose
 - B. Two-hour glucose tolerance test
 - C. Hemoglobin
 - D. Hemoglobin A_{1c}
 - E. Hemoglobin S

Answer

D – Hemoglobin A_{1c} is correct. The best test to evaluate long past blood sugar levels are serum levels of glycosylated hemoglobin, or hemoglobin A_{1c}, which reflect the past 90 days of blood sugar levels and will allow evaluation of the patient's past compliance and adequacy of her treatment.

Other choices

A – Fasting blood glucose is incorrect. Fasting blood glucose is useful for determining a baseline blood glucose level but provides no evidence of past blood sugar control.

B – Two-hour glucose tolerance test is incorrect. The glucose tolerance test is commonly administered to pregnant women of 24–28 weeks' gestation to detect the presence of gestational diabetes, but is not appropriate in this case.

C – Hemoglobin is incorrect. Hemoglobin indicates the presence or absence of anemia, but is not related to type II diabetes.

E – Hemoglobin S is incorrect. Hemoglobin S is a form of hemoglobin present in patients with sickle cell disease and is unrelated to diabetes mellitus.

10. You see a 78-year-old man in clinic for his annual physical. He reports excellent health. During your review of systems, he admits to having difficulty initiating his urine stream, nocturia, and occasionally feels as if he does not completely empty his bladder. Routine lab tests show a normal level of prostate-specific antigen (PSA). Analysis shows no hematuria or crystalluria. What related finding might you anticipate when you move on to his physical exam?
- A. Testicular atrophy
 - B. Urinary calculi (stones) blocking the urethra
 - C. Hypospadias
 - D. Irregular prostatic nodularity
 - E. Uniformly smooth prostatic enlargement

Answer

E – Uniformly smooth prostatic enlargement is correct. A normal prostate should feel firm with a smooth surface to the examiner's gloved finger. The patient clearly has a urinary outlet obstruction, probably caused by benign prostatic hypertrophy (BPH). It is not uncommon for men to develop this condition as they age, but it should not be confused with malignant processes, particularly with normal PSA levels. BPH may be treated with anti-androgens such as finasteride, herbal remedies (such as saw palmetto), or with a surgical procedure (transurethral resection of prostate [TUR]). The condition may progress to complete outlet obstruction with urinary retention and kidney failure without treatment.

Other choices

A – Testicular atrophy is incorrect. As men age there is a decrease in androgen production, sometimes resulting in some testicular atrophy. Testicular atrophy, however, would not cause any restriction of urinary flow through the urethra.

B – Urinary calculi (stones) blocking the urethra is incorrect. Renal stones can cause lower urinary obstruction and are associated with hematuria and microscopic crystals in the urine. The absence of hematuria and flank pain in this patient decrease the likelihood of this diagnosis.

C – Hypospadias is incorrect. Hypospadias is a congenital malformation of the male urinary system resulting in an abnormal opening of the urethral meatus on the ventral surface of the penis. Deficiency in 3β -hydroxysteroid dehydrogenase enzyme results in inadequate masculinization of the genitalia of genetic males.

D – Irregular prostatic nodularity is incorrect. Nodularity or irregularity of the surface of the prostate is an ominous sign, and a biopsy is usually recommended to rule out prostatic cancer. Normal PSA levels in this patient, however, reduce the suspicion of prostate cancer.

11. A 14-year-old male soccer player complains of occasional shortness of breath, particularly during practice or games. You decide to initially treat his asthma with a β_2 agonist inhaler to be used when symptoms appear. By which mechanism will this agent improve his ability to breathe?
- A. Bronchodilation via smooth muscle relaxation
 - B. A decrease of pro-inflammatory cells
 - C. Prevention of histamine release
 - D. Inhibition of leukotriene synthesis
 - E. Leukotriene-1 receptor antagonism

Answer

A – Bronchodilation via smooth muscle relaxation is correct. This patient's symptoms point to a diagnosis of exercise-induced asthma. Because his asthma only occurs when he is active and only some of the time, his disease can be classified as mild. The treatment of choice for such cases is an inhaled β -agonist, such as albuterol, which directly promotes the relaxation of airway smooth muscle, leading to bronchodilation and increased air flow.

Other choices

B – A decrease of pro-inflammatory cells is incorrect. Corticosteroids such as beclomethasone decrease the synthesis of pro-inflammatory cells (eosinophils, macrophages, and T lymphocytes) and eventually reduce the hyperresponsive airway smooth muscle's response to irritants. These agents are more useful in chronic asthma.

C – Prevention of histamine release is incorrect. Agents that prevent activation of mast cells, such as cromolyn sodium, are mast cell stabilizers that prevent bronchoconstriction when the airway is exposed to stimuli such as exercise or allergens. Such agents may be useful if the patient's symptoms are inadequately controlled by an inhaler.

D – Inhibition of leukotriene synthesis is incorrect. As leukotrienes are potent mediators of inflammation and bronchial constriction, inhibition of leukotrienes prevents or lessens the severity of asthmatic symptoms. These drugs are not intended for acute asthmatic attacks.

E – Leukotriene-1 receptor antagonism is incorrect. Inhibition of pro-asthmatic leukotrienes prevents their bronchial constrictive effects on the smooth muscle tissue of the airways. These are prophylactic drugs and are not used for acute asthma attacks.

12. A middle-aged obese man complains of increasing frequency of headaches and worsening visual acuity. Although his headache pain is usually relieved by over-the-counter pain relievers, the discomfort returns after a few hours. An ophthalmoscopic examination reveals bilateral flame hemorrhages and cotton-wool spots. What laboratory measurement would confirm the likely cause of this man's headaches and worsening sight?
- A. Serum glucose level
 - B. Hemoglobin A_{1c}
 - C. Toxicology screen including methanol
 - D. Serum vitamin A level
 - E. Blood pressure

Answer

E – Blood pressure is correct. Flame hemorrhages and cotton-wool spots indicate hypertensive retinopathy as a consequence of chronic untreated or undertreated hypertension. Treatment for the hypertension would be better than optical or neurological treatment.

Other choices

A – Serum glucose level is incorrect. Serum glucose levels indicate whether the patient is metabolizing glucose properly, but blood sugar levels are unrelated to the pathological findings of this patient.

B – Hemoglobin A_{1c} is incorrect. Hemoglobin A_{1c} represents glycosylated hemoglobin. HgbA_{1c} levels are directly associated with levels of plasma glucose and represent an excellent progress marker for diabetes mellitus. HgbA_{1c}, however, is not related to this patient's retinal findings.

C – Toxicology screen including methanol is incorrect. Methanol is used by some chronic alcoholics as an inexpensive substitute for ethanol. Blurred vision and blindness from ingestion of methanol is due to toxic changes in the nervous system and would not cause the findings described in this case.

D – Serum vitamin A level is incorrect. Vitamin A deficiency can cause diffuse, severe keratinization of the entire epithelium of the mucous membranes of the eye. The deficiency may also cause night blindness secondary to photoreceptor dysfunction, but it does not cause hemorrhages or cotton-wool spots, as described in this case.

13. Which if the following is true about voltage-gated Na⁺ channels in the axon?
- A. They remain open as long as the membrane is sufficiently hyperpolarized.
 - B. They remain open as long as the membrane is sufficiently depolarized.
 - C. They remain open for only a short period of time after the cell is sufficiently depolarized.
 - D. They belong to a family of channels that are made of five subunits.
 - E. They have about the same relative permeability ratio (P_{Na}/P_K) as ACh channels.

Answer

C – They remain open for only a short period of time after the cell is sufficiently depolarized is correct. Na⁺ channels normally reside in a closed conformation at the resting membrane

potential and their opening is a transient process determined by the kinetics of channel activation and inactivation.

Other choices

A – Remain open as long as the membrane is sufficiently hyperpolarized is incorrect. Voltage-gated Na^+ channels act to produce the initial depolarizing phase of fast action potentials.

B – Remain open as long as the membrane is sufficiently depolarized is incorrect. Prolonged cellular depolarization leads to inactivation of Na channels.

D – Belong to a family of channels that are made of five subunits is incorrect. Although there are some accessory proteins, the channel is a single polypeptide chain.

E – Have about the same relative permeability ratio ($P_{\text{Na}}/P_{\text{K}}$) as do ACh channels is incorrect. The permeability ratio of Na^+ relative to K^+ is in the range of 11–20 under physiological conditions and they are relatively impermeable to Ca^+ .

14. Lidocaine, a use-dependent blocker of voltage-gated Na^+ channels, is an effective antiarrhythmic because its blocking effect becomes greater when:
- A. The drug is repeatedly used.
 - B. Na^+ channels are activated repeatedly at a high frequency.
 - C. Na^+ channels are activated repeatedly at a low frequency.
 - D. Na^+ channels are closed.
 - E. The extracellular Na^+ concentration is high.

Answer

B – When Na^+ channels are activated repeatedly at a high frequency is correct. Lidocaine blocks activated and inactivated, but not resting channels. When the frequency of excitation is increased, Na^+ channels tend to stay in their inactivated state giving lidocaine a preferential effect on arrhythmogenic tissue.

Other choices

A – When the drug is repeatedly used is incorrect. There is apparently no benefit for repeated use of lidocaine because the Na^+ channel blocking effect does not become greater.

C – When Na^+ channels are activated repeatedly at a low frequency is incorrect. Inhibition depends on the frequency of stimulation.

D – When Na^+ channels are closed is incorrect. Lidocaine binds most effectively only after the Na^+ channel has already opened. It does not block resting Na^+ channels.

E – When the extracellular Na^+ concentration is high is incorrect. Lidocaine antiarrhythmic effects are unrelated to the extracellular Na^+ concentration.

15. In skeletal muscle during a contraction cycle:
- A. Myosin–ATP complex has a high affinity for actin.
 - B. Tropomyosin binds calcium.
 - C. The rigor complex is broken by the binding of ADP to myosin.
 - D. ATP hydrolysis provides the energy required for myosin flexure in the ‘hinge regions’.
 - E. The T tubules take up calcium via an active transport mechanism.

Answer

D – ATP hydrolysis provides the energy required for myosin flexure in the ‘hinge regions’ is correct. The hydrolysis of ATP by the myosin ATPase provides the energy for the mechanical aspects of skeletal muscle contraction.

Other choices

A – Myosin–ATP complex has a high affinity for actin is incorrect. The binding of ATP to cross-bridges causes loss of affinity for actin.

B – Tropomyosin binds calcium is incorrect. Calcium binds to troponin, causing tropomyosin to move and expose attachment sites for myosin cross-bridges.

C – The rigor complex is broken by the binding of ADP to myosin is incorrect. Rigor occurs when muscle fibers are depleted of ATP and phosphoryl creatine and would not be broken by the binding of ADP to myosin.

E – The T tubules take up calcium via an active transport mechanism is incorrect. In skeletal muscle, depolarization of the T-tubule membrane activates the sarcoplasmic reticulum via dihydropyridine receptors, which serve as triggers that unlock the release of Ca^{2+} from the sarcoplasmic reticulum.

16. An 18-year-old male complains about continuous growth, lack of facial hair, small genitalia and lack of muscle development. Laboratory values include total testosterone 125 ng/dL (normal 300–1100 ng/dL) and luteinizing hormone (LH) < 2 mIU/mL (normal 6–23 mIU/mL). A major causal factor in some cases of hypogonadism is:

- A. Increased number of follicle stimulating hormone (FSH) receptors in the testis
- B. Hypersecretion of pituitary LH and FSH as the result of increased gonadotropin-releasing hormone (GnRH)
- C. Excess secretion of testicular activin by Sertoli cells
- D. Failure of the hypothalamus to respond to testosterone
- E. Reduced secretion of GnRH

Answer

E – Reduced secretion of GnRH is correct. This patient has hypogonadotropic hypogonadism due to reduced secretion of GnRH. This is the only option that could be responsible for the hypogonadism described in this case.

Other choices

A – Increased number of FSH receptors in the testis is incorrect. An increased number of FSH receptors in the testis would stimulate spermatogenesis, but not testosterone secretion.

B – Hypersecretion of pituitary LH and FSH as the result of increased GnRH is incorrect. Hypersecretion of gonadotropins would promote normal pubertal development, not hypogonadism.

C – Excess secretion of testicular activin by Sertoli cells is incorrect. Testicular activins secreted by Sertoli cells stimulate FSH, which would not be responsible for the hypogonadism in this case.

D – Failure of the hypothalamus to respond to testosterone is incorrect. Testosterone exerts a negative feedback on the hypothalamus to reduce testosterone secretion. Lack of a hypothalamic response to testosterone would result in increased testosterone secretion, not decreased testosterone that would result in hypogonadism.

17. A 17-year-old girl comes to see an endocrinologist because of primary amenorrhea. Breast development started several years ago, and she has otherwise been well. On examination breast development and height is in the tenth percentile, but she has no pubic or axillary hair. A pelvic examination reveals a blind vagina. These findings are most consistent with which of the following?
- A. Turner's syndrome
 - B. Hypopituitarism
 - C. Androgen insensitivity
 - D. Klinefelter's syndrome
 - E. Adrenogenital syndrome

Answer

C – Androgen insensitivity is correct. Androgen insensitivity syndrome, also known as testicular feminization syndrome, is where patients are genetically and gonadally male, but phenotypically female. Testes are present and functional, producing testosterone, but due to the absence of androgen receptors, tissues do not respond to testosterone androgen effects.

Other choices

A – Turner's syndrome is incorrect. Turner's syndrome is characterized by an XO chromosomal pattern, short stature, no pubertal maturation, absent or rudimentary gonads, and other congenital abnormalities. Breast development, described in this case, is absent.

B – Hypopituitarism is incorrect. Hypopituitarism is characterized by an absence of gonadal and secondary sex characteristic development, so the feminization and breast development described in this syndrome would be absent.

D – Klinefelter's syndrome is incorrect. Klinefelter's syndrome is characterized by male genitalia, small testes, gynecomastia and infertility. Patients with this syndrome have an XXY chromosomal configuration.

E – Congenital adrenal hyperplasia is incorrect. Congenital adrenal hyperplasia is most often due to a deficiency of 21- α -hydroxylase and results in a female pseudohermaphrodite that is genetically and gonadally female, but has male secondary sex characteristics.

18. Your 55-year-old female patient suffers from osteoporosis. For treatment you decide to use an antiresorptive agent currently used for treatment of osteoporosis:
- A. Increasing parathyroid hormone (PTH) secretion
 - B. Inhibiting calcitonin release
 - C. Decreasing the remodeling space of bone
 - D. Stimulating estrogen synthesis
 - E. Blocking 1 α -hydroxylase activity

Answer

C – Decreasing the remodeling space of bone is correct. Bone is constantly resorbed and new bone being formed throughout life. Bone remodeling is a local process carried out in small areas by cells called bone remodeling units, where osteoclasts resorb bone and osteoblasts lay down new bone in the same general area. Osteoporosis is characterized by a net excess of bone resorption over bone formation by these bone remodeling units. Thus, decreasing the number of bone remodeling unit space available will result in an overall improvement of this bone disease.

Other choices

A – Increasing PTH secretion is incorrect. PTH stimulates bone resorption, which would enhance the osteoporosis already present.

B – Inhibiting calcitonin release is incorrect. Calcitonin is a hormone produced by the parafollicular cells of the thyroid gland and acts to inhibit bone resorption. By inhibiting calcitonin release you would exacerbate osteoporosis not improve it.

D – Stimulating estrogen synthesis is incorrect. Although estrogen decreases bone resorption, probably by inhibiting PTH release, the possibility of stimulating estrogen synthesis in this menopausal woman would be remote and therefore not a practical solution to her osteoporosis.

E – Blocking 1α -hydroxylase activity is incorrect. 25-hydroxy vitamin D is activated to its active form (1,25-dihydroxyvitamin D [$1,25(\text{OH})_2\text{D}$]) by 1α -hydroxylase enzyme in the kidney. Blocking 1α -hydroxylase activity would decrease the amount of vitamin D_3 available to increase calcium absorption in the intestine to improve the osteoporosis in this case.

19. Your 74-year-old male patient suffers from hyperthyroidism. Hyperthyroid individuals characteristically exhibit:

- A. Heat tolerance
- B. A low basal metabolic rate (BMR)
- C. Decreased peripheral resistance
- D. Dry, yellowish skin
- E. High plasma cholesterol levels

Answer

C – Decreased peripheral resistance is correct. In elderly patients, hyperthyroidism places a severe load on the cardiovascular system. There is a decrease in peripheral resistance as a result of cutaneous vasodilation, and an increased incidence of atrial fibrillation.

Other choices

A – Heat tolerance is incorrect. Hyperthyroid individuals exhibit heat intolerance.

B – A low BMR is incorrect. People with hyperthyroidism exhibit an elevated BMR.

D – Dry yellowish skin is incorrect. Hypothyroid individuals exhibit dry yellowish skin and tolerate cold poorly.

E – High plasma cholesterol levels is incorrect. High plasma cholesterol levels are seen more in hypothyroid than hyperthyroid individuals.

20. In an elite marathon runner, performance in a marathon race is limited by a number of factors. Among world class marathon runners, which of the following factors is considered to be critical for a high level of performance?

- A. Muscle ATP content
- B. Adequate fat stores
- C. High muscle glycogen content
- D. High muscle oxidative capacity
- E. High percentage of type II muscle fibers

Answer

D – High muscle oxidative capacity is correct. Endurance training increases muscle oxidative capacity, which reduces the ventilatory demands of exercise, thus increasing exercise capacity for a high level of performance.

Other choices

A – Muscle ATP content is incorrect. Muscle ATP serves as an immediate fuel source at the onset of exercise, but is of little use in endurance exercise.

B – Adequate fat stores is incorrect. Most energy is stored in the form of triglycerides in fat cells. The ability to use fat cells in exercise is restricted to 70% of the muscle fuel oxidation rate.

C – High muscle glycogen content is incorrect. Although glycogen is another primary store of energy, the supply is of little use until it is made available to muscle cells by glucose oxidation.

E – High percentage of type II muscle fibers is incorrect. Fast twitch or type II fibers fatigue rapidly due to the inability of type II fibers to maintain tension, and training does not increase the resistance to this high-frequency fatigue.

21. An individual has arterial hypoxemia; $\text{PaO}_2 = 50$ mmHg. Which possible cause of this hypoxemia would cause the largest elevation in arterial PCO_2 ?
- A. High altitude
 - B. Diffusion impairment
 - C. Physiological shunt
 - D. Pulmonary embolism
 - E. Hypoventilation

Answer

E – Hypoventilation is correct. Because ventilation is depressed in hypoventilation there is a significant increase in PaCO_2 and a decrease in arterial pH.

Other choices

A – High altitude is incorrect. Exposure to high altitude results in hyperventilation, reducing PaCO_2 levels not increasing them.

B – Diffusion impairment is incorrect. Diffusion impairment results in a low ventilation/perfusion ratio and low PaO_2 , but PaCO_2 is only slightly elevated because excess CO_2 can still be used by the lungs.

C – Physiological shunt is incorrect. Patients with right-to-left shunt have a low PaO_2 , but a normal or slightly elevated PaCO_2 .

D – Pulmonary embolism is incorrect. A blood clot causes an overperfusion to another part of the lung, resulting in a regionally low ventilation/perfusion ratio with low O_2 , but normal or slightly increased PaCO_2 .

22. A 26-year-old man comes to the emergency room complaining of lethargy, headache, nausea and extreme weakness. His skin has a cherry-red color. He has a normal arterial PO_2 , but a low venous PO_2 of 20 mmHg (normal is 40 mmHg). You believe this situation is caused by:
- A. Cyanide poisoning
 - B. Absolute right-to-left cardiopulmonary shunt
 - C. A right-shifted hemoglobin
 - D. Hypoventilation

E. Carbon monoxide poisoning

Answer

E – Carbon monoxide poisoning is correct. Carbon monoxide poisoning not only reduces the oxygen carrying capacity of the blood, but also shifts the oxyhemoglobin dissociation curve to the left, altering the affinity of hemoglobin for oxygen, resulting in less availability of oxygen to the tissues. At very high doses, carbon monoxide also diffuses into cells and binds to myoglobin, producing a functionally hypoxic state at the level of mitochondria despite oxygen delivery at the capillary level.

Other choices

A – Cyanide poisoning is incorrect. Cyanide inhibits cytochrome oxidase and produces hypoxia due to inhibition of tissue oxidative processes. The symptoms of the patient described do not suggest histotoxic hypoxia because the blood gas content is normal in histotoxic hypoxia.

B – Absolute right-to-left cardiopulmonary shunt is incorrect. Persons with a right-to-left shunt have chronic hypoxic hypoxia and cyanosis. The scenario described does not suggest hypoxic hypoxia because the arterial PO_2 is not reduced. Only venous PO_2 is reduced.

C – A right-shifted hemoglobin is incorrect. The oxyhemoglobin equilibrium curve is shifted to the left when carbon monoxide binds with hemoglobin. Arterial PO_2 is normal in the scenario so this choice is incorrect.

D – Hypoventilation is incorrect. Hypoventilation does not result in normal arterial PO_2 levels described in this case.

23. A 59-year-old morbidly obese female patient is diagnosed with a restrictive lung disease that causes lung compliance to be half the normal value. If tidal volume and breathing rate are normal, then:

- A. Total work of breathing is twice normal.
- B. Airway resistance is twice normal.
- C. Pleural pressure at end-inspiration is more negative than normal.
- D. Alveolar pressure at end-inspiration is positive.
- E. The functional reserve capacity (FRC) is increased.

Answer

C – Pleural pressure at end-inspiration is more negative than normal is correct. The decreased compliance reduces the amount of air that can be inhaled so pleural pressure at end inspiration will be more negative than normal in order to inhale as much air as possible.

Other choices

A – Total work of breathing is twice normal is incorrect. Because tidal volume and breathing rate are normal, the total work of breathing is not increased.

B – Airway resistance is twice normal is incorrect. Obstructive lung disease is characterized by increased resistance to air flow whereas in restrictive disease there is decreased compliance, but resistance is not increased.

D – Alveolar pressure at end-inspiration is positive is incorrect. At the end of inspiration, the pressure in the alveoli becomes equal to atmospheric pressure and flow ceases.

E – The FRC is increased is incorrect. The FRC is decreased in restrictive lung disease because of decreased lung compliance.

24. Your patient has normal function of the diaphragm but has a spinal injury that completely prevents any activity of abdominal or intercostal muscles. In this patient you expect to find that:
- A. Residual volume is smaller than normal.
 - B. Vital capacity equals total lung capacity.
 - C. Intrapleural pressure is positive during expiration.
 - D. Transpulmonary pressure is negative during expiration.
 - E. Alveolar pressure is positive during expiration.

Answer

E – Alveolar pressure is positive during expiration is correct. During expiration, inspiratory muscles relax and the thorax and lungs recoil increasing alveolar pressure causing outward air flow.

Other choices

A – Residual volume is smaller than normal is incorrect. With no activity of abdominal or intercostal muscles the residual volume will be increased compared to normal lung volumes.
B – Vital capacity equals total lung capacity is incorrect. Vital capacity is the amount of air that can be slowly exhaled after a maximal inspiration and will not equal total lung capacity, which is the amount of air in the lung at maximal inspiration.
C – Intrapleural pressure is positive during expiration is incorrect. During expiration, the lungs recoil and the intrapleural pressure is negative.
D – Transpulmonary pressure is negative during expiration is incorrect. Transpulmonary pressure equals alveolar pressure minus pleural pressure and the net difference is positive during expiration causing the lungs to deflate.

25. A sudden ascent to high altitude (e.g. atmospheric pressure half that at sea level) will, in the first several hours, cause:
- A. Hypoxic stimulation of central chemoreceptors
 - B. A decrease in the pH of the fluid surrounding the central chemoreceptors
 - C. An increase in alveolar to arterial PO_2 difference
 - D. Hypoxic stimulation of carotid body chemoreceptors
 - E. A decrease in pulmonary arterial blood pressure

Answer

D – Hypoxic stimulation of carotid body chemoreceptors is correct. At high altitude, arterial PO_2 is low because of low barometric pressure and ventilation increases due to stimulation of carotid body chemoreceptors.

Other choices

A – Hypoxic stimulation of central chemoreceptors is incorrect. The central chemoreceptors are not stimulated by decreases in PaO_2 , but are depressed by long-term decreases in O_2 supply.
B – A decrease in the pH of the fluid surrounding the central chemoreceptors is incorrect. At high altitude, hyperventilation keeps $PaCO_2$ low and there is no decrease of pH of the extracellular fluid.

C – An increase in alveolar to arterial PO_2 difference is incorrect. The low barometric pressure at high altitude decreases both alveolar and arterial PO_2 , so the difference is not increased.

E – A decrease in pulmonary arterial blood pressure is incorrect. High altitude results in constriction of pulmonary arteries, resulting in a rise in pulmonary arterial pressure not a decrease.

26. A patient presents with a urine flow (V), of 12 L/day. You find that plasma osmolality (P_{OSM}) is above normal and that plasma AVP levels are very low. Based on this information, and given the following choices, what is your best diagnosis for this patient?
- A. Hypothalamic (central) diabetes insipidus
 - B. Nephrogenic diabetes insipidus
 - C. Diabetes mellitus
 - D. Polydipsic diabetes insipidus
 - E. Diabetes macula densa

Answer

A – Hypothalamic (central) diabetes insipidus is correct. As the AVP levels are very low, this patient has a defect in the production or pituitary release of AVP, which is known as central diabetes insipidus because it is a central nervous system (CNS) disorder.

Other choices

B – Nephrogenic diabetes insipidus is incorrect. Patients with nephrogenic diabetes insipidus have normal levels of AVP and a renal defect that prevents its action.

C – Diabetes mellitus is incorrect. In early diabetes, the glomerular filtration rate (GFR) is increased and urine flow is enhanced, but plasma AVP levels are normal. In this case, AVP levels are low.

D – Polydipsic diabetes insipidus is incorrect. In cases of excessive water ingestion (polydipsia), plasma AVP levels are low, but plasma water concentration is high, resulting in low P_{OSM} .

E – Diabetes macula densa is incorrect. Macula densa cells of the juxtaglomerular apparatus sense changes in plasma volume and regulate renin release and renal sodium handling. Damage to these cells by diabetes will not affect plasma AVP levels, as seen in this case.

27. Al and Zack are twins with end-stage renal failure due to Alport syndrome. Both are on chronic dialysis and make no urine. Following dialysis, they both weigh the same and have identical serum osmolalities. On the way home from a dialysis session, they stop at Vino's for lunch. Al drinks 1 liter of pale ale and eats a pepperoni calzone (sodium content 140 mEq). Zack, the designated driver, isn't hungry but drinks 2 liters of lager. When (if) they arrive home, which of the following statements would be true?
- A. Zack's total body water is less than Al's.
 - B. Zack's serum osmolality is greater than Al's.
 - C. Zack's intracellular fluid (ICF) volume is greater than Al's.
 - D. Zack's extracellular fluid (ECF) volume is greater than Al's.
 - E. Zack's plasma sodium level is greater than Al's.

Answer

C – Zack's ICF volume is greater than Al's is correct. Because Al ingested the pepperoni containing sodium along with the ale, his ECF volume is increased and his ICF volume is decreased. Thus, Zack, who did not consume pizza, has a larger ICF volume than Al.

Other choices

A – Zack's total body water is less than Al's is incorrect. Zack drank 2 liters of lagers whereas Al drank only 1 liter. Thus, Zack's total body water is greater than Al's.

B – Zack's serum osmolality is greater than Al's is incorrect. Because Al consumed pizza as well as ale, his serum osmolality is greater than Zack's.

D – Zack's ECF volume is greater than Al's is incorrect. Because Al added a hypertonic solution to his ECF, his ECF volume is increased compared to Zack's. Thus, Zack's ECF volume is less than Al's, not greater.

E – Zack's plasma sodium level is greater than Al's is incorrect. Because Al consumed pizza containing sodium, his plasma sodium level would be greater than Zack's.

28. A 68-year-old man is brought to your emergency room in July after concerned neighbors, who had not seen him for several days, found him collapsed on his living room floor. The temperature inside the house was about 105° F. The patient was barely arousable. His body temperature is 40° C, his skin and mucus membranes are dry, and his blood pressure is low. Which of the following laboratory results would you expect to find?
- A. Elevated aldosterone level
 - B. Decreased renin level
 - C. Elevated urine Na⁺ concentration
 - D. Decreased antidiuretic hormone (ADH) levels
 - E. Low urine osmolality

Answer

A – Elevated aldosterone level is correct. In dehydration, the kidney responds by retaining sodium and the urinary sodium concentration would be low. Sodium retention would be accomplished by increasing the plasma aldosterone level.

Other choices

B – Decreased renin level is incorrect. In dehydration, the renin level would be increased because plasma volume is decreased, inhibiting renin release by the granular cells of the juxtaglomerular apparatus.

C – Elevated urine Na⁺ concentration is incorrect. As mentioned above, the kidney retains sodium so urine sodium concentration would be low, not elevated.

D – Decreased ADH level is incorrect. In this case the ADH level would be increased to retain more fluid, not decreased.

E – Low urine osmolality is incorrect. In dehydration, the urine osmolality is high and urine sodium is low, consistent with retention of both water and sodium by the kidneys.

29. A 56-year-old man presents with a 4-day history of impaired vision. On physical exam, you note a loss of vision of his left visual field in both eyes. The patient most likely has a lesion involving the:
- A. Right optic nerve
 - B. Optic chiasm

- C. Right optic tract
- D. Right temporal lobe
- E. Right parietal lobe

Answer

C – Right optic tract is correct. The patient has a lesion in the right optic tract that causes left homonymous hemianopia. Left homonymous hemianopia can arise from lesions in the right optic tract, right lateral geniculate body, right optic radiations or right occipital cortex.

Other choices

A – A lesion at the level of the right optic nerve is incorrect. A right optic nerve lesion would cause right-sided anopia. If only one eye is affected, the lesion must be prechiasmal.

B – A lesion at the optic chiasm is incorrect. Lesions affecting the chiasm disrupt crossing fibers from the nasal halves of both retinas, causing bitemporal hemianopia.

D – A lesion in the right temporal lobe is incorrect. Superior quadrantanopia results from damage to the inferior optic radiations such as Meyer's loop, a bundle of inferior optic radiations that swings forward into the temporal lobe.

E – A lesion in the right parietal lobe is incorrect. A lesion in the right parietal lobe would result in left inferior quadrantanopia.

30. A 49-year-old male presents to the emergency department with intermittent abdominal pain and nausea for the past week. He is worried that he has a duodenal ulcer. Which of the following is correct regarding duodenal ulcers?
- A. Characterized by epigastric pain that worsens with eating
 - B. Less than 20% are associated with *Helicobacter pylori* infection
 - C. Incidence is greater in smokers.
 - D. It is unrelated to consumption of nonsteroidal anti-inflammatory drugs (NSAIDs)
 - E. Peak incidence is at 60 years of age

Answer

C – Incidence is greater in smokers is correct. Factors increasing the risk of peptic ulcer disease include tobacco, use of aspirin or other NSAIDs, alcohol use and being male.

Other choices

A – Pain worsens with eating is incorrect. The pain from peptic ulcer disease generally improves with eating. Duodenal ulcers may be caused by increased gastric acid secretion or decreased mucosal protection against acid

B – Less than 20% of peptic ulcer disease is due to *H. pylori* infection is incorrect. Almost 100% of duodenal ulcers and 70% of gastric ulcers are associated with *H. pylori* infection.

D – It is unrelated to consumption of NSAIDs is incorrect. The consumption of NSAIDs is one of the major causative factors in duodenal ulcer disease.

E – Peak incidence of peptic ulcer is at 60 years of age is incorrect. Duodenal ulcers have a peak incidence at age 40, and gastric ulcers peak at age 50.