

**KAPLAN[®]
medical**

NBDE^{*} Part I

Explanations to Reprints

Test Packet 1-H

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Anatomic Sciences

- The correct answer is D.** The ductus arteriosus is a bypass of the fetal lungs and consists of a connection between the fetal aorta and pulmonary artery. It shunts blood from the nonfunctioning fetal lungs. This connection closes and becomes the ligamentum arteriosum after birth. The hepatic veins (**choice B**) take blood from the liver to the vena cava in both adult and fetus. The ligamentum teres (**choice C**) is the remnant of the left umbilical vein, so the vein does not exist after birth but the ligamentum teres does. Fossa ovalis (**choice A**) is a depression in the right atrial wall, near the position of the foramen ovale (a fetal heart structure) but different from it. Crista terminalis (**choice E**) is an area in the right atrium marking the line connecting the primitive sinus venosus and the atrium proper. It persists in the adult.
- The correct answer is E.** A microvillus can be part of a villus of the small intestine. In addition, microvilli exist in lymphocytes, hepatic cells, taste buds, and other cells and organs. They are extensions of epithelial cells, making up a brush border. They are composed of actin microfilaments. The 9 + 2 arrangement of microtubules (**choice A**) is found in cilia, and flagella. Nine triplets of microtubules (**choice B**) are found in centrioles. Microvilli are not composed of either intermediate (**choice C**) or vimentin (**choice D**) filaments.
- The correct answer is A.** The anatomic sciences section generally includes several questions from histology, embryology, and basic cell biology (like this one). The rough endoplasmic reticulum is ER lined with ribosomes and is generally involved in production of proteins for export outside of the cell. Translation takes place on the ribosomes, then the proteins enter the ER and travel to the Golgi apparatus (**choice E**) for further processing and packaging. They then travel to the cell membrane. Membrane-bound vesicles (**choice B**) may include vacuoles or lysosomes but not ribosomes, which are not membrane-bound. Sarcoplasmic reticulum (**choice C**) is specialized endoplasmic reticulum in muscle cells, used for storing calcium ions. Mitochondria (**choice D**) produce energy in the form of ATP, and are the site of oxidative respiration.
- The correct answer is E.** The thyroid gland is the first endocrine gland to appear during development. It appears during week 4 of prenatal development as a median diverticulum in the floor of the pharynx between the first and second pharyngeal pouches. It soon elongates caudally as a thyroid diverticulum whose tip expands and bifurcates into a bilobed gland with a narrow isthmus. It remains connected to its original site by a narrow thyroglossal duct until week 7, when it reaches its final location at the level of the second and third tracheal cartilages. After this time the duct usually regresses, with its original point of origin into the pharynx marked by the foramen cecum, a small, pitlike depression on the dorsal surface of the mature tongue.

Tongue development begins from the tuberculum impar (**choice B**) on the floor of the primitive pharynx. The lingual swellings on each side of the tuberculum impar merge with each other and then overgrow and encompass the disappearing tuberculum impar to form the

anterior two thirds, or body. The copula (**choice A**) is formed from the fusion of mainly the third, and parts of the fourth, branchial arches. The copula gradually overgrows the second branchial arches, or hyoid arches, to form the posterior one-third, or base.

The overgrown copula then merges with the anterior swellings of the first branchial arches during week 8, which is superficially demarcated by the sulcus terminalis (**choice C**) in the mature tongue, an inverted V-shaped groove marking the border between the body and its base on the dorsal surface of the tongue.

The second pharyngeal pouch forms the wall of the pharynx at the level of the palatine tonsil(s) (**choice D**).

5. **The correct answer is E.** The sternocleidomastoid (SCM) muscle divides each side of the neck diagonally into anterior and posterior cervical triangles. The digastric muscle further divides the anterior triangle of the neck into three smaller triangles: 1) the submandibular, or digastric, triangle (**choices B and C**), bounded above by the lower border of the body of the mandible and a line drawn from its angle to the SCM, below by the posterior belly of the digastric and the stylohyoid muscle, and in front by the anterior belly of the digastric; 2) the carotid triangle, bounded above by the posterior belly of the digastric and stylohyoid, behind by the SCM, and below by the omohyoid muscle; and 3) the suprahyoid or submental triangle, bounded laterally by the anterior belly of the digastric, medially by the middle line of the neck from the hyoid bone to the symphysis menti, and inferiorly by the body of the hyoid bone.

The inferior carotid, or muscular, triangle (**choice D**) is bounded in front by the median line of the neck from the hyoid bone to the sternum; behind, by the anterior margin of the SCM; and above, by the superior belly of the omohyoid.

The occipital triangle of the posterior cervical triangle is bounded in front, by the SCM; behind, by the trapezius muscle; and below, by the omohyoid. The subclavian triangle of the posterior cervical triangle is bounded above by the inferior belly of the omohyoid and below, by the clavicle; its base is formed by the posterior border of the SCM. There is no superclavicular triangle (**choice A**).

6. **The correct answer is D.** The two concepts involved are which lobe and which side. The pathway taken by pain sensation from the teeth would be from tooth receptors to the appropriate cranial nerve branch (maxillary or mandibular of CN V). This neuron would synapse in the spinal cord with a neuron traveling upward toward the thalamus. The third neuron would take the information to the postcentral gyrus of the parietal lobe. The sensory neurons usually decussate (switch right/left sides) as they ascend to the thalamus. Therefore, left side pain will be sensed in the right parietal lobe.
7. **The correct answer is D.** The first part of the small intestine is the duodenum and is located between the stomach and the ileum. After foods combine with stomach acid they descend into the duodenum, where they mix with bile from the gallbladder and digestive juices from the pancreas. The submucosal glands, or Brunner's glands, make an alkaline material that acts along with bile and pancreatic juice to neutralize the very acidic chyme entering the duodenum through the pylorus. If this were not done, the epithelium would soon be eroded by the chyme and an ulceration would result. Along the length of the duodenum, the pH of chyme goes from 1 or 2 to 7 or 8. The submucosal glands also secrete the hormone urogastrone, which inhibits gastric acid production and stimulates the division of epithelial stem cells along the digestive tract.

The duodenum is closest to the stomach. The stomach is divided into five parts: a cardiac part, the fundus (**choice E**), the body, the pyloric part, and the pylorus. The fundus is a

rounded vault to the left and superior to the cardiac orifice. The fundus is the most superior part of the stomach and is related to the left dome of the diaphragm. It is separated from the cardiac part by the cardiac notch, or incisure.

The jejunum (**choice B**) and ileum of the small intestine continue the digestive processes, with surface area increased by plica circulares (circular folds) carrying villi. Each villus has a capillary and a lacteal (lymphatic capillary). Absorption of digested foodstuff is via these to the rich venous and capillary drainage of the gut.

The large intestine, or colon (**choice A**), resorbs water and then eliminates drier residues as feces. Regions recognized are the ascending colon (from the appendix in the right groin up to a flexure at the liver), transverse colon (liver to spleen), descending colon (spleen to left groin), then sigmoid (S-shaped) colon back to the midline and anus.

The appendix (**choice C**) is attached to the first part of the large intestine (ascending). The appendix has no known function in humans. Evidence suggests that our evolutionary ancestors used their appendixes to digest tough food, such as tree bark. A blockage in the opening where the appendix attaches to the large intestine can lead to inflammation of the appendix, known as appendicitis. This can cause acute pain, fever, nausea, vomiting, and loss of appetite, but can easily be cured by removing the appendix.

8. **The correct answer is D.** The copula is formed from the fusion of mesenchyme of *mainly* the third (and parts of the fourth) branchial arch(es). The copula gradually overgrows the second branchial arch(es) (**choice C**) to form the posterior one-third, or base, of the tongue.

Tongue development begins as the tuberculum impar. Later, two lateral lingual swellings develop on each side of the tuberculum impar. All these anterior swellings are from the growth of mesenchyme of the first branchial arch(es) (**choice B**). The two fused swellings then overgrow and encompass the disappearing tuberculum impar to form the anterior two-thirds, or body.

Even further posterior to the copula is the epiglottic swelling that develops from the mesenchyme of the fourth branchial arch(es) (**choice E**) and marks the development of the posteriormost region of the tongue and the future epiglottis. As the tongue develops still further, the copula, after overgrowing the second branchial arches, merges with the anterior swellings of the first branchial arches during week 8.

The intrinsic muscles of the tongue are believed to originate from the mesoderm of the occipital somites (**choice A**), not from the branchial arches. Primitive muscle cells from these somites migrate into the developing tongue, taking their motor nerve supply from the hypoglossal nerve, or cranial nerve XII.

This explains how the single structure of the tongue is innervated by various cranial nerves. This is due to the fact that the tongue develops from the first four pairs of branchial arches (each with its own cranial nerve) and the occipital somites. The first pharyngeal arches contain the maxillary and mandibular divisions of the trigeminal nerve, or cranial nerve V, supplying general sensation to the anterior two-thirds of the tongue body. The second arches contain the facial nerve, or cranial nerve VII, supplying taste to the anterior two-thirds of the tongue body. The third arches contain the glossopharyngeal nerve, or cranial nerve IX, supplying taste and general sensation to the tongue base (the posterior one-third). The fourth arches contain the superior laryngeal and palatal branches of the vagus nerve, or cranial nerve XII, which is involved with the taste sensation of the epiglottis.

9. **The correct answer is B.** The path of the facial nerve is very complex. The facial nerve passes through the base of the skull in transit from the brain to the muscles of facial expression. After leaving the brain, the facial nerve enters the temporal bone through the internal auditory canal, then winds around the three middle ear bones, in back of the eardrum, and then

through the mastoid. After the facial nerve leaves the mastoid, it passes through the parotid gland and divides into many branches that supply the various facial muscles.

The facial nerve is cranial nerve VII and is responsible for innervation of all of the muscles of facial expression (including eye and lip movement), as well as the sensation of taste for the anterior two-thirds (or body) of the tongue. The facial nerve also carries some parasympathetic fibers to the salivary glands. A facial motor test is done to check for normal innervation levels. We can identify that during surgery the facial nerve was damaged on the mastoid area because the facial nerve runs through this area and now, as a result of the damage, the patient is unable to close his eye or mouth on that side.

The cranial nerves are composed of 12 pairs of nerves that emanate from the nervous tissue of the brain. To reach their targets they must ultimately exit/enter the cranium through openings in the skull. Hence, their name (“cranial”) is derived from their association with the cranium. The function of the cranial nerves is, for the most part, similar to the spinal nerves (i.e., the nerves that are associated with the spinal cord).

The trigeminal nerve (**choice C**) is cranial nerve V and is responsible for all sensation from the face and mouth; it also carries motor fibers to the muscles of mastication. If normal, there is no tremor, involuntary chewing, trismus, or tightly clenched teeth, with normal sensation over the area and no paralysis.

The glossopharyngeal nerve (**choice E**) is cranial nerve IX and is responsible for the normal gag reflex; it is also sensory for pain, touch, and temperature of the mucosa of pharynx, fauces, and palatine tonsil, as well as taste sensation for the posterior third of the tongue (the base) and motor to the pharynx. If normal, the patient can say “ah,” the gag reflex is intact, and the soft palate and uvula hang equally on each side of the pharynx. If damaged, the gag reflex may be lost.

The vagus nerve (**choice A**), or cranial nerve X, is also involved in the gag reflex and placement of the soft palate and uvula through innervation of the pharynx, so the test is the same as for the glossopharyngeal. It is also an important component of the autonomic nervous system so it controls heart rate, intestinal movement, and gastric acid secretion.

The hypoglossal nerve (**choice D**), or cranial nerve XII, is responsible for the motor innervation of the tongue. Its loss would affect speech and the patient would not be able to protrude the tongue.

10. **The correct answer is C.** Sertoli cells form the lining of the seminiferous tubules and are attached to each other through a set of junctional complexes that restrict the flow of most materials between the blood and testis. The significance of the barrier is unclear, but it may help maintain the specialized environment needed for spermatogenesis. Leydig cells (**choice D**) secrete steroid hormones, especially testosterone. Spermatogonia (**choice A**) are sperm-forming cells, early in the process, and are still diploid (2N). Spermatocytes (**choice B**) are future sperm (spermatozoa) and are at a later stage, and undergo meiosis to form monoploid (N) cells. Myoepithelial cells (**choice E**) are epithelial cells with contractile abilities, usually found in salivary glands.
11. **The correct answer is A.** The nerves of the temporomandibular joint (TMJ) are derived from the auriculotemporal nerve (as well as masseteric branches) of the mandibular nerve, or V3, that serves the lower face and is a branch of the trigeminal nerve, or cranial nerve V. It also carries postganglionic parasympathetic nerve fibers to the parotid salivary gland. It is important to note that these parasympathetic fibers arise from the lesser petrosal branch of the glossopharyngeal nerve, or cranial nerve IX, joining the auriculotemporal nerve only after relaying in the otic ganglion near the foramen ovale. There is also communication of the auriculotemporal nerve with the facial nerve, or cranial nerve VIII,

near the ear, giving sensation to the skin over the parotid region. The nerve courses deep to the lateral pterygoid muscle and neck of the mandible, then splits to encircle the middle meningeal artery and finally join the posterior trunk of V3.

Another branch of the mandibular nerve is the inferior alveolar nerve (**choice E**) that serves the mandibular teeth and its associated tissues (not the facial periodontium of the molars). The superior alveolar (**choice D**) may refer to either the posterior, middle, or anterior branches off the maxillary nerve, or V2. These nerves serve the maxillary teeth (from posterior to anterior) and associated facial tissues.

The greater auricular nerve (**choice B**) is the largest of the ascending branches off the small occipital nerve. It arises from the second and third cervical nerves, winds around the posterior border of the sternocleidomastoid, and after perforating the deep fascia, ascends upon that muscle beneath the platysma to the parotid gland, where it divides into an anterior and a posterior branch. The anterior branch is distributed to the skin of the face over the parotid gland and communicates in the substance of the gland with the facial nerve, but is not related to the TMJ.

The temporal branches of the facial nerve (**choice C**), or cranial nerve V, supply muscles of facial expression and work with branches of the ophthalmic nerve but not the TMJ.

12. **The correct answer is D.** The nerves of the temporomandibular joint, including its capsule, are derived from the auriculotemporal and masseteric branches of the mandibular nerve, or V3, which serve the lower face and are a branch of the trigeminal nerve, or cranial nerve V.

Another branch of the mandibular nerve is the inferior alveolar nerve (**choice E**) that serves the mandibular teeth (not the facial periodontium of the molars).

The facial nerve (**choice A**), or cranial nerve VII, consists of a motor and a sensory part. The motor part supplies somatic motor fibers to the muscles of the face, such as the superficial buccal nerve (**choice B**), scalp, and auricle, and the following muscles: buccinator, platysma, stapedius, stylohyoid, and posterior belly of the digastric. It also contains some sympathetic motor fibers that constitute the vasodilator nerves of the submandibular and sublingual glands and are conveyed through the chorda tympani nerve.

Other main branches off the trigeminal nerve are maxillary, or V2 (**choice C**), which serve the upper face.

13. **The correct answer is A.** Pulpal anesthesia of the mandibular teeth occurs when the inferior alveolar (IA) nerve is anesthetized. During an IA block, the tip of the needle enters and must remain in the pterygomandibular space (or triangle) that contains the IA nerve. It must not enter the parotid gland, which is deep and posterior to this space, or temporary facial paralysis may occur because the gland contains the facial nerve, or cranial nerve VII. The parotid space encloses the parotid gland and its associated lymph nodes as well as the facial nerve and great vessels traversing it. Contacting the medial surface of the ramus during the block assures that the needle tip is in the correct place before the injection is given. Successful IA block depends on the needle tip being close to the inferior alveolar foramen.
14. **The correct answer is C.** The seminiferous tubules are tubes in the testes of the male that conduct seminal fluid of a male after spermatogenesis. The walls of the seminiferous tubules consist of diploid spermatogonia, stem cells that are the precursors of sperm that divide by mitosis to produce more spermatogonia or differentiate into spermatocytes. Meiosis of each spermatocyte produces four haploid spermatids. This process takes more than 3 weeks to complete. The spermatids then differentiate into sperm, losing most of their cytoplasm in the process. Thus, meiosis is the type of cell division by which germ cells (eggs from ovary and sperm from the testes) are produced.

The seminiferous tubules empty into ducts that lead to a structure called the ductus epididymis (**choice A**). The sperm pass from the epididymis into the vas deferens, which carries sperm from the testes to the urethra, the tube that leads out of the body and also carries urine. In the kidney, the uriniferous tubules (**choice B**) have two parts: the nephron, which filters blood and forms urine by reabsorption and secretion; and the collecting tubule, which concentrates urine and conveys it to the calyx.

Egg formation takes place in the ovaries, from the germinal epithelium of the ovary (**choice E**). In contrast to males, the female's initial steps in egg production occur by mitosis before birth. Hundreds of these diploid cells develop into primary oocytes, begin the first steps of the first meiotic division (meiosis I), and then stop. No further development occurs until years later, when the girl becomes sexually mature. Then the oocytes recommence their development, usually one at a time and once a month. The primary oocyte grows much larger and completes the meiosis I, forming a large secondary oocyte and a small polar body that receives little more than one set of chromosomes. Which chromosomes end up in the egg and which in the polar body is entirely a matter of chance. In humans, the first polar body does not go on to meiosis II but the secondary oocyte does proceed as far as metaphase of meiosis II and then stops.

Only if fertilization occurs will meiosis II ever be completed. Entry of the sperm restarts the cell cycle. During fertilization, meiosis II occurs in the ovum. The result of this process is the joining of the ovum's chromosomes with those of the sperm's. This joining of chromosomes from both biological parents forms a new individual with "shuffled" chromosomes. To allow this formation of a new individual, the joined sperm and ovum have the proper number of chromosomes (diploid number of 46). If both of these cells, sperm and ovum, carried the full complement of chromosomes, fertilization would result in a zygote with two times the proper number, resulting in severe congenital malformations and prenatal death. This situation of excess chromosomes is avoided with meiosis because during their development in the gonads, this process enables the ovum and sperm to reduce by one-half the normal number of chromosomes (to a haploid number of 23). Thus, the zygote has received half its chromosomes from the female and half from the male, with the resultant genetic material a reflection of both biological parents.

Cell division, or mitosis, is a complex process that occurs in the stratum germinativum (SG) (**choice D**) of the epidermis or epithelium of the skin. During mitosis, the genetic material must be duplicated so that the two daughter cells are identical to the parent cell and split up other components of the cell. Cell division is divided into four phases: prophase, metaphase, anaphase, and telophase. The SG provides the germinal cells necessary for the regeneration of the layers of the epidermis. These germinal cells are separated from the dermis by a thin layer of basement membrane. After a mitotic division, a newly formed cell will undergo a progressive maturation (called "keratinization") as it migrates to the surface.

15. **The correct answer is E.** Various structures and functions of cranial nerve (CN) V (trigeminal) include the trigeminal ganglion (**choice B**), near the cavernous sinus, which sends out the maxillary, mandibular, and ophthalmic nerves. The mesencephalic nucleus receives information about proprioception from the muscles of mastication, TMJ joint, and periodontal ligament. The main sensory nucleus of CN V (**choice D**) lies near the motor nucleus and receives tactile sensation. The spinal nucleus of CN V (**choice C**) receives pain and thermal sensation. Nucleus ambiguus (**choice A**) is located in the pons and sends fibers to CN IX, X, and XI.
16. **The correct answer is D.** The muscles of the soft palate include the palatoglossal (palatoglossus), palatopharyngeus, levator veli palatini, tensor veli palatini, and the muscle of the uvula (or musculus uvulae). When the muscles of the soft palate are relaxed, the

soft palate extends posteriorly over the anterior oropharynx. The combined actions of several of the muscles of the soft palate move the soft palate superiorly and posteriorly to contact the posterior pharyngeal wall that is being moved anteriorly. This movement of both the soft palate and pharyngeal wall brings a separation between the nasopharynx and oral cavity during swallowing to prevent food from entering the nasal cavity while eating.

In addition to either elevating the hyoid bone or depressing the mandible, the mylohyoid muscle (**choice A**), an anterior suprahyoid muscle, also forms the floor of the mouth and helps elevate the tongue. The styloglossus muscle (**choice B**), an extrinsic tongue muscle, retracts the tongue, moving it superiorly and posteriorly. The stylopharyngeus muscle (**choice C**) is a paired longitudinal muscle of the pharynx that elevates the pharynx, simultaneously widening it. The inferior pharyngeal constrictor (**choice E**) is part of the pharyngeal constrictor muscles that raise the pharynx and larynx and help drive food inferiorly into the esophagus during swallowing. The tensor tympani (**choice C**) is a small muscle in the middle ear that tenses to protect the eardrum.

17. **The correct answer is C.** Even though the lymph nodes usually assist in fighting the disease process, the lymph nodes can become involved in the spread of a cancer from the region they filter. The spread of a cancer from the original, or primary, site of the tumor to another, or secondary, site is called metastasis. Primary nodes are the initial secondary site in which the cancer will metastasize from the tumor. Many times, if the cancer is caught early enough at the primary tumor site or even in the initial secondary site of the primary lymph nodes, surgery to remove the tumor as well as the primary nodes may successfully stop metastasis. If not caught early or stopped by the primary nodes, the cancer will spread to secondary nodes and metastasis will continue to progress. If the cancer is in the angle of the mouth (or labial commissure), it will involve the submandibular nodes, either as primary or secondary nodes.

The submandibular lymph nodes are located at the inferior border of the ramus of the mandible, just superficial to the submandibular salivary gland, and within the submandibular fascial space. The submandibular nodes drain the cheeks, upper lip, body of the tongue, anterior portion of the hard palate, and all the teeth and associated tissues except the mandibular incisors and maxillary third molars.

These nodes may be secondary nodes for the submental nodes (**choice B**) and facial regions. The submental lymph nodes are located inferior to the chin in the submental fascial space. The submental nodes are also just superficial to the mylohyoid muscle, near the midline between the mandible's symphysis and the hyoid bone. The submental nodes drain both sides of the chin, lower lip, floor of the mouth, apex of the tongue, and the mandibular incisors and associated tissues. The submental nodes then empty into the submandibular nodes or directly into the deep cervical nodes.

Lymphatics from both the sublingual (or lingual, **choice A**) and submandibular salivary glands also drain into the submandibular nodes. The submandibular nodes then empty into the superior deep cervical nodes (**choice E**).

The anterior jugular lymph nodes, or superficial anterior cervical lymph nodes (**choice D**), are located on each side of the neck along the length of the anterior jugular vein, anterior to the sternocleidomastoid muscle, to drain the infrahyoid region of the neck. The anterior jugular nodes then empty into the inferior deep cervical nodes.

18. **The correct answer is E.** Sympathetic innervation involves a two-neuron pathway. The pre-ganglionic neuron has a cell body in the intermediolateral horns of the thoracic vertebrae. This neuron synapses in a ganglion of the sympathetic chain, lateral to the spinal cord. These ganglia contain the cell bodies of the postganglionic neuron. The postganglionic

neuron will innervate the structure involved. The ganglia of the sympathetic chain are sometimes called paravertebral ganglia. The superior cervical ganglion is a specific sympathetic ganglion supplying innervation to various parts of the head and neck. It contains postganglionic fibers. The cervicothoracic ganglion (stellate) also contains postganglionic fibers. Grey rami communicantes are postganglionic fibers traveling from thoracic sympathetic ganglia to the ventral ramus of spinal nerves.

19. **The correct answer is B.** The thoracic duct runs from the cisterna chyli (between the aorta and azygos vein on the bodies of the first two lumbar vertebrae) through the aortic opening of the diaphragm to the posterior mediastinum, along the vertebral column, behind the esophagus, and through the superior mediastinum. It arches over the apex of the pleura, descends across the left subclavian artery, and enters the junction of the left internal jugular and subclavian veins. It is found posterior and medial to the phrenic nerve and posterior to the trachea.

20. **The correct answer is B.** The subclavian vein, a continuation of the axillary vein, extends from the outer border of the first rib to the sternal end of the clavicle, where it unites with the internal jugular to form the brachiocephalic, or innominate, vein. These veins are two large trunks, placed one on either side of the root of the neck.

The right brachiocephalic vein begins behind the sternal end of the clavicle and, passing almost vertically downward, joins with the left innominate vein just below the cartilage of the first rib, close to the right border of the sternum, to form the superior vena cava (**choice A**). The left brachiocephalic vein begins behind the sternal end of the clavicle and runs obliquely downward and to the right behind the upper half of the manubrium sterni to the sternal end of the first right costal cartilage, where it unites with the right brachiocephalic vein to form the superior vena cava.

The cephalic vein is a branch of the axillary vein (**choice D**), close to its terminal end. The azygos vein (**choice E**) begins opposite the first or second lumbar vertebra, by a branch, the ascending lumbar; sometimes by a branch from the right renal vein; or from the inferior vena cava.

The bronchial veins return the blood from the larger bronchi and from the structures at the roots of the lungs; the right side opens into the azygos vein, near its termination; the left side, into the highest left intercostal, or the accessory hemiazygos vein. A considerable quantity of the blood that is carried to the lungs through the bronchial arteries is returned to the left side of the heart through the pulmonary veins (**choice C**).

21. **The correct answer is C.** As in all connective tissues, the fibroblasts are the largest group of cells in the pulp. The pulp is the innermost tissue of the tooth. Fibroblasts are cells of mesodermal origin that make the structural fibers and ground substance of connective tissues.

The odontoblasts (**choice E**) are the second largest group of cells in the pulp, yet only their cell bodies are located in the pulp. The odontoblasts are located only along the outer pulpal wall and can form secondary dentin. In addition to fibroblasts and odontoblasts, the pulp contains undifferentiated mesenchymal cells. These cells are a rich resource for the dentin-pulp complex because they can transform into fibroblasts and odontoblasts if either cell population is lowered after injury.

The pulp also contains white blood cells, such as the macrophages (**choice D**), in its tissue and vascular supply. Mononuclear phagocytes arise from hematopoietic stem cells in the bone marrow. After passing through the monoblast and promonocyte states of the monocyte stage, they enter the blood, circulating for about 40 hours. They then enter the tissues

and increase in size, phagocytic activity, and lysosomal enzyme content, and become macrophages. Normally, the levels of these vascular cells are low, unless the cells are ready to be triggered if there is an inflammatory or immune reaction.

Adipocyte (**choice A**), or fat, cells are found only in adipose tissue and are specialized for the storage of fat. Mast cells (**choice B**) are also found in connective tissue during a response to injury or inflammation, contain numerous basophilic granules, and release substances such as heparin and histamine.

22. **The correct answer is D.** Foramen/foramina are short, windowlike openings in bone. The foramen spinosum serves as a passage for the middle meningeal vessels, both artery and vein, as well as the recurrent branch from the mandibular nerve into the cranial vault.

The foramen ovale (**choice A**) transmits the mandibular nerve, the accessory meningeal artery, and the lesser superficial petrosal nerve. The foramen lacerum (**choice B**) is normally filled up by a layer of fibrocartilage in its lower part; its upper and inner parts transmit the internal carotid artery surrounded by a plexus of sympathetic nerves. Most anatomy sources state that no structures pass completely through the foramen lacerum. The nerve of the pterygoid canal and a meningeal branch from the ascending pharyngeal artery pierce the layer of fibrocartilage. The foramen rotundum (**choice C**) serves as a passage for the maxillary nerve.

The superior orbital fissure (**choice E**) transmits to the orbital cavity the oculomotor, the trochlear, the ophthalmic division of the trigeminal, and the abducent nerves, some filaments from the cavernous plexus of the sympathetic, and the orbital branch of the middle meningeal artery; and from the orbital cavity a recurrent branch from the lacrimal artery to the dura mater, and the ophthalmic veins.

23. **The correct answer is B.** The peritoneum is a serous membrane lining the peritoneal cavity and abdominal organs. Organs within it are considered peritoneal and include the digestive organs (stomach and intestines). The spleen is in contact with the stomach and left kidney but is contained within the peritoneum. Kidneys are behind the peritoneum and are known as retroperitoneal. They are located against the dorsal body wall. They are also separated from abdominal organs by a layer of renal fascia.

24. **The correct answer is D.** The lateral borders of the posterior nasal apertures are formed on each side by the pterygoid process of the sphenoid bone. Each pterygoid process consists of a medial pterygoid and lateral pterygoid plate (**choice E**). At the inferior portion of the medial plate of the pterygoid process is a thin, curved process (the hamulus) around which the tendon of the tensor veli palatini muscle turns. So the hamulus is an extension of the medial pterygoid plate.

The ethmoid bone (**choice A**) is a single midline cranial bone that articulates with the frontal, sphenoid, lacrimal, and maxillary bones and adjoins the vomer at its inferior and posterior border.

On the posterior aspect of the body of the maxillae is a rounded, roughened elevation, the maxillary tuberosity (**choice C**), just posterior to the most distal molar of the maxillary dentition. The palatine bones (**choice B**) are paired bones of the skull and serve as a link between the maxillae and the sphenoid bone with which they articulate, as well as each other.

25. **The correct answer is C.** The esophagus is divided into zones on the basis of muscle type. The most anterior (upper) one-third section is composed of voluntary (skeletal) muscle, which aids in initiating swallowing. Slightly below this level, in the middle third, voluntary and smooth fibers mix. The lower one-third of the esophagus is all smooth (involuntary) muscle. Once swallowing is initiated it cannot be stopped, inasmuch as smooth-muscle peristalsis continues to the stomach.

26. **The correct answer is E.** The connective tissue proper in the skin is termed dermis and is found deep to the epidermis. It is a dense, irregular, collagenous connective tissue. Its components—cells, fibers, and vessels—are in an irregular arrangement.

In contrast, tendons, aponeuroses, and ligaments are a type of dense regular collagenous connective tissue (**choice D**) that has a regular arrangement of strong parallel collagen fibers with few cells.

Specialized connective tissue includes adipose, elastic, or reticular tissue. Adipose connective tissue (**choice A**) is a fatty tissue that is found beneath the skin, around organs and various joints, and in portions of the oral cavity. Elastic (modified) connective tissue (**choice B**) has mostly elastic fibers that combine strength with elasticity, such as in the tissues of the vocal cords. Reticular connective tissue (**choice C**) is a delicate network of interwoven reticular fibers that form a supportive framework for blood cells.

27. **The correct answer is B.** The azygos vein enters the thorax through the aortic opening in the diaphragm, ascends the posterior mediastinum, and loops over the root of the right lung and enters the superior vena cava. The hemiazygos vein joins the azygos at a level below the arch. In the thorax, the vagus nerve descends posterior to the azygos arch. At this point, the right phrenic nerve is located along the superior vena cava, anterior to the vagus. The right lymphatic duct is located anterior and superior to the area of the azygos arch. The greater splanchnic nerve is located in the lower thorax and abdomen.
28. **The correct answer is B.** A portal (hepatic) triad consists of three structures entering the liver before branching right and left. They include the hepatic artery, bringing oxygenated blood to the liver; the hepatic portal vein, bringing blood from the intestines for processing; and the bile duct, carrying bile to the gallbladder. Central veins are located within liver lobules, metabolic processing areas in the liver parenchyma. Bile canaliculi are microscopic structures delivering newly formed bile from hepatocytes.
29. **The correct answer is A.** Although the mechanism for tooth eruption is not yet clear, it is believed that cells and fibers from the developing periodontal ligament help push the developing tooth cervically. The other theories listed either are partly responsible or were once (but are no longer) believed to be the main forces.
30. **The correct answer is B.** A ligament is a band of fibrous tissue connecting bones. There are three paired ligaments associated with the temporomandibular joint (TMJ). The TMJ ligament is located on the lateral side of each joint and forms a reinforcement of the capsule of the TMJ. This ligament prevents the excessive retraction or posterior movement of the mandibular condyles, moving backward of the mandible, a situation that might lead to problems with the TMJ.

The sphenomandibular ligament (**choice D**) is only associated with but not a part of the TMJ. It is located on the medial side of the mandible, some distance from the joint. This ligament runs from the angular spine of the sphenoid bone to the lingula of the mandibular foramen. It is a vestige of the embryonic lower jaw, Meckel's cartilage. It becomes accentuated and taut when the mandible is protruded. The other TMJ ligament is the stylomandibular ligament, a variable ligament that is formed from a thickened cervical fascia in the area. This ligament runs from the styloid process of the temporal bone to the angle of the mandible. This ligament also becomes taut when the mandible is protruded.

The pterygomandibular fold covers the deeper pterygomandibular raphe (**choice A**). On each side, the pterygomandibular raphe passes between the tip of the hamulus of the pterygoid bone and the internal surface of the mandible at a point just posterosuperior to the posterior limit of the mylohyoid ridge. It is formed by the union of the tendinous ends of

the superior constrictor of the pharynx and buccinator. As the mandible moves relative to the hamulus, the length of the raphe is passively increased. This fold is also accentuated as the patient's mouth opens wider.

The anterior cruciate ligament (**choice C**) is one of the four stabilizing ligaments of the knee. It prevents abnormal anterior displacement and rotation of the lower leg with respect to the thigh.

There is no submandibular ligament (**choice E**).

31. **The correct answer is E.** It is believed that dental pain originates as fluid changes in dentinal tubules, then affecting nerve endings in the pulp. Note that there is no nervous tissue proper in the dentin. The periodontal ligament (**choice D**) is not the source of dental pain fibers; dental pain fibers are found in the pulp. Odontoblastic processes (**choice B**) are involved in the pain process but are not pain receptors. Meissner's corpuscles (**choice C**) are not found in the tooth but are found in skin, primarily in the hands and feet.

32. **The correct answer is E.** The temporomandibular joint (TMJ) involves the articulation of the temporal bone and the mandible on each side of the head. The articulating area on the temporal bone of the joint is located on the bone's inferior aspect. This articulating area includes the bone's articular eminence and the articular fossa. The mandible articulates with each temporal bone at the heads of the condyle of the mandible with their articulating surface of the condyle. The TMJ articulating surfaces are covered by dense fibrous connective tissue, and in older patients, dense fibrous connective tissue with chondroblasts.

Neither fat (**choice A**) nor hyaline cartilage (**choice C**) is present on the articulating surfaces, nor is there direct bone (**choice B**). The inner layer of the joint capsule is a synovial membrane (**choice D**) consisting of a thin connective tissue that contains nerves and blood vessels. Articular surfaces are not covered by synovial membrane. The blood vessels in the synovial membrane produce synovial fluid.

33. **The correct answer is D.** The hyoid bone is suspended in the neck and forms the larynx and the base of the tongue. Thus, many muscles attach to the hyoid bone but it has no direct bony attachments. These hyoid muscles, suprahyoid and infrahyoid, assist in the actions of mastication and swallowing and show attachment to the temporal bone, mandible (part of **choice C**), clavicle (also part of **choice C**), and posterior surface of the sternum, at the level of the first rib but not the first rib itself (also part of **choice C**). The hyoid bone does connect with the tongue and its muscles. The styloid process projects downward and forward from the undersurface of the temporal bone, and is involved in the attachments of the hyoid muscles. Note that choice D can quickly be identified as correct because the three attachments referred to are the geniohyoid muscle, stylohyoid ligament, and hyoglossus muscle.

The hyoid muscles are cervical muscles, as are those of the tongue, soft palate (**choice A**), and pharynx. The cricoid cartilage (part of **choice B**) forms the lower and posterior parts of the wall of the larynx, and pharyngeal constrictor muscles originate from it and not any tongue or hyoid muscles. The epiglottis (part of **choice B**) is the flap of cartilage lying behind the tongue and in front of the entrance to the larynx. The hyoid bone is not connected to the palatine bone (part of **choice A**).

34. **The correct answer is A.** The pterygoid plexus of veins is a collection of small anastomosing vessels located around the pterygoid muscles and surrounding the maxillary artery on each side of the face in the infratemporal fossa. The pterygoid plexus drains the veins from the deep portions of the face and then drains into the maxillary vein. The pterygoid plexus protects the maxillary artery from being compressed during mastication.

By either filling or emptying, the plexus can accommodate changes in volume of the infratemporal fossa that occur when the mandible moves.

This plexus anastomoses with both the facial vein (**choice C**) and retromandibular vein. The angular artery (**choice B**) is the termination of the facial artery and supplies the tissues along the side of the nose. The occipital vein (**choice D**) begins in a plexus at the back part of the vertex of the skull. The anterior jugular vein (**choice E**) begins below the chin, communicating with veins in the area, and descends near the midline, within the superficial fascia, receiving branches from the superficial cervical structures.

35. **The correct answer is C.** Biceps brachii has two major functions: flexing the elbow joint and supinating the forearm. It “puts in the corkscrew and pulls out the cork.” Brachialis (**choice B**) is the main flexor of the elbow joint. Coracobrachialis (**choice E**) and brachioradialis (**choice D**) also flex the elbow. Supinator (**choice A**) also supinates the forearm but is considered weaker than the biceps brachii.
36. **The correct answer is B.** Diploic veins are located within the marrow spaces of the bone tissue of the skull. Carotid vessels (**choice A**) are arteries, not veins, and supply the head and brain but are not located within skull bone. Meningeal arteries (**choice C**) are found in the meninges, lining the bone of the skull but not within. They are located in the dura mater and periosteum. Likewise, subarachnoid veins (**choice E**) are within the lining, below the arachnoid layer but not within bone.
37. **The correct answer is C.** Normal gag reflex is a response to tactile stimulation of the posterior pharynx. The signal transmitted to the reflex center in the medulla results in pharyngeal wall contraction. The gag reflex needs to be tested only in patients with suspected brain-stem pathology, impaired consciousness, or impaired swallowing. Cranial nerve IX is the glossopharyngeal nerve. It is responsible for the normal gag reflex, and is sensory for pain, touch, and temperature of the mucosa of pharynx, fauces, and palatine tonsil, as well as taste sensation for the posterior third of the tongue and motor to pharynx. If normal, the patient can say “ah,” the gag reflex is intact, and the soft palate and uvula hang equally on each side of the pharynx. Cranial nerve X, or the vagus nerve, may also be involved in the gag reflex and placement of these tissues. If either or both cranial nerves are damaged, the gag reflex may be lost.
- Cranial nerve V (**choice A**) is the trigeminal nerve; it is responsible for all sensation from the face and mouth and also carries motor fibers to the muscles of mastication. Cranial nerve VII (**choice B**) is the facial nerve and is responsible for innervation of all of the muscles of facial expression as well as the sensation of taste for the anterior two-thirds of the tongue. The facial nerve also carries some parasympathetic fibers to the salivary glands. A facial motor test is done to check for normal innervation levels. Cranial nerve XII (**choice D**), or the hypoglossal nerve, is responsible for the motor innervation of the tongue; its loss would affect speech and cause an inability to protrude the tongue.
38. **The correct answer is E.** Principal (chief) cells and oxyphil cells are the two major cell types of the parathyroid. Chief cells produce PTH (parathyroid hormone), known for increasing osteoclastic activity, raising serum calcium, and lowering serum phosphorous. These cells have highly developed protein-making machinery. Oxyphil cells have lower levels of ER and Golgi apparatus but higher numbers of mitochondria.
39. **The correct answer is D.** The articular disc of the temporomandibular joint, or meniscus of the joint, is located between the temporal bone and condyle of the mandible on each side. The disc is not of uniform thickness but has four well defined ellipsoidal bands or zones: the anterior, intermediate, and posterior bands, and the bilaminar region. The anterior band (**choice A**) is moderately thick but narrow anteroposteriorly. The intermediate

band (**choice C**) is the thinnest and narrowest. The posterior band (**choice B**) is the thickest of the bands and is widest anteroposteriorly.

Continuous with the posterior band is the bilaminar region, consisting of an upper stratum attached to the posterior wall of the glenoid fossa and squamotympanic fissure and a lower stratum that is attached to the back of the condylar cartilage. The disc blends with the capsule at these points. This bilaminar area of attachment of the disc to the capsule is one of the places where nerves and blood vessels enter the joint.

40. **The correct answer is B.** The lymph nodes, spleen, and thymus all contain lymphocytes. T lymphocytes become specialized in the thymus, while lymphocytes in lymph nodes are formed from germinal centers, and lymph nodes in the spleen form both lymphocytes and monocytes. Both the spleen and lymph nodes filter (blood in spleen and lymph in lymph node) through a reticular network, but the thymus does not. Both lymph nodes and the thymus have a cortex and a medulla, but the spleen does not. The lymph node has an afferent and efferent lymph supply, whereas the spleen has an afferent and efferent blood supply.
41. **The correct answer is B.** Hyaline cartilage is the most common cartilage type and can be found on the ends of bones, in tracheal rings, in the larynx, and in the ventral ends of ribs. Fibrocartilage is less common and contains fibers in its matrix, as well as typical cartilage ground substance. It is found in intervertebral disks. Elastic cartilage contains elastic fibers, as well as ground substance, and is found in the ear and epiglottis. Calcified cartilage is usually a stage in endochondral bone formation. Cartilage forms, grows, calcifies, and is replaced by bone.
42. **The correct answer is D.** The outer ear includes the auricle (the part of the ear attached to the side of the head) and the external auditory meatus, the entrance into the ear from the outside. The middle ear contains the tympanic cavity, with the three ossicles (ear bones) hammer, anvil, and stirrup (malleus, incus, stapes). Also, in the middle ear is the eardrum (tympanic membrane). The inner ear contains the bony labyrinth, including the vestibule, semicircular canals, cochlea, utricle, saccule, and spiral organ.
43. **The correct answer is E.** The mental nerve emerges from the mental foramen on the anterior-lateral surface of the mandible, usually between the apices of the first and second mandibular premolars, from its earlier merging with the incisive nerve to form the inferior alveolar nerve in the mandibular canal. Thus, the mental nerve is a branch of the mandibular nerve, V3 from the trigeminal nerve (or cranial nerve V).

Behind the medial end of the superior orbital fissure is the foramen rotundum (**choice D**) for the passage of the maxillary nerve, or V2. Below and lateral to the anterior nasal aperture are the anterior surfaces of the maxillae, each perforated near the lower margin of the orbit by the infraorbital foramen (**choice B**) for the passage of the infraorbital nerve, a branch of the maxillary nerve.

At the junction of the facial bone's medial and intermediate thirds is a notch (sometimes converted into a foramen), the supraorbital foramen (**choice A**) or notch, which transmits the supraorbital nerve. The supraorbital nerve is a branch of the frontal nerve, which is a branch of the ophthalmic nerve, or cranial nerve VI.

Emerging from the tympanic part of the occipital bone is the styloid process, and at the base of this process is the stylo mastoid foramen (**choice C**) for the exit of the facial nerve, or cranial nerve VII.

44. **The correct answer is A.** Bringing the lower jaw forward involves the protrusion of the mandible. This is accomplished by bilateral contraction of the lateral pterygoid muscles, muscles of mastication.

Bilateral contraction of the posterior portion of the temporalis muscles (**choice D**), muscles of mastication, will bring retraction of the mandible, moving the lower jaw backward. Bilateral contraction of the masseter, temporalis, and medial pterygoid muscles (all muscles of mastication) will bring elevation and retraction of the mandible, closing the jaws.

The digastric (**choice B**) is a suprahyoid muscle that has two separate bellies, the anterior and posterior. The anterior belly is part of the anterior suprahyoid muscle group, and the posterior belly is part of the posterior suprahyoid muscle group. There are two actions associated with mastication, resulting from the contraction of the suprahyoid muscles. One action of both the anterior and posterior suprahyoid muscles is to cause the elevation of the hyoid bone and larynx if the mandible is stabilized by contraction of the muscles of mastication. This action occurs during swallowing. The other action associated with mastication is from only the contraction of the anterior suprahyoid muscles, which causes the mandible to depress, causing the jaws to open, when the hyoid bone is stabilized by the contraction of the posterior suprahyoid muscles and the infrahyoid muscles, the other hyoid muscle group. Thus, normal jaw opening involves the lateral pterygoid muscles, which protrude the mandible, and the anterior suprahyoid muscles, which lower the mandible.

The mylohyoid (**choice E**) is an anterior suprahyoid muscle that is deep to the digastric muscle. In addition to either elevating the hyoid bone or depressing the mandible, the mylohyoid muscle also forms the floor of the mouth and helps elevate the tongue.

The buccinator (**choice C**) is a muscle of facial expression. The buccinator pulls the angle of the mouth laterally and shortens the cheek both vertically and horizontally. This action causes the muscle to keep food pushed back on the occlusal surface of the teeth, as when a person chews. By keeping the food in the correct position when chewing, this muscle assists the muscles of mastication.

45. **The correct answer is A.** As the colon ascends, crosses over from right to left, and then descends, it approaches the kidney near the area where the ascending colon turns into the transverse colon, on the right side. At this corner the colon is fairly far back, near the retroperitoneal area and at the correct height to be near the kidney. The spleen (**choice B**) is located on the left. The stomach (**choice C**) is primarily to the left as well. The pancreas (**choice D**) is located inferiorly to the stomach, again on the left. The duodenum (**choice E**) passes from the end of the stomach toward the right half of the abdomen but then quickly descends toward the midline, beginning the small intestine. It does not travel as far to the right as the corner of ascending and transverse colon.
46. **The correct answer is B.** Mesenchyme is undifferentiated primitive connective tissue. It is a developmental tissue found in the embryo and fetus. It will develop and differentiate into various types of connective tissue. Loose connective tissue is a general term for tissue with a looser open network of matrix fibers. Dense connective tissue has a tighter network. In dense connective tissue, the fibers may be in a regular (tendons, ligaments, fasciae) or irregular pattern (dermis, sheaths of tendons, nerves). Areolar connective tissue is an older alternative term for loose connective tissue.
47. **The correct answer is E.** ADH (vasopressin, antidiuretic hormone) is released by the posterior pituitary (neurohypophysis) but produced in the hypothalamus. It travels down a specialized set of nerve axons (hypothalamohypophysial tract) that connect the two organs. The pars distalis, pars tuberalis, and pars intermedia are sections of the anterior pituitary (adenohypophysis). MSH (melanocyte-stimulating hormone) is produced in

the pars intermedia. The pars distalis is the anterior lobe of the anterior pituitary and produces most of the anterior pituitary hormones, either from alpha cells (GH, prolactin) or beta cells (LH, FSH, TSH). Pars nervosa is the storage site in the posterior pituitary for ADH and oxytocin.

48. **The correct answer is B.** After ovulation, the remnants of the follicle, under the primary influence of luteinizing hormone (LH), become the corpus luteus. One of the functions of the corpus luteus is the production and secretion of progesterone. In ovulations not followed by pregnancy, the corpus luteum degenerates and becomes a corpus albicans, with no further function. The theca interna, theca externa, and granulosa are layers of cells surrounding a maturing ovum. An atretic follicle is a follicle, which will not develop into a mature follicle capable of ovulation, and degenerates instead. Approximately 99% of oocytes do not develop into mature follicles, and degenerate.
49. **The correct answer is A.** The contents of the mediastinal compartments are as follows: The middle mediastinum contains the pericardial cavity and heart, the phrenic nerves, and lung roots. The superior mediastinum contains the superior portion of the thymus gland, the great vessels running to and from the heart (aortic arch, pulmonary vein and artery, superior vena cava), trachea and main stem bronchi, and esophagus. The posterior mediastinum lies below the pericardial sac and contains the descending aorta, esophagus (also in superior mediastinum), thoracic duct, inferior vena cava, azygos and hemiazygos veins, and vagus nerve. The anterior mediastinum contains the inferior thymus gland and sternopericardial ligaments.
50. **The correct answer is C.** The orbit, or eye cavity, contains and protects the eyeballs. Many bones of the skull form the walls. The medial wall is the thinnest wall of the orbit and is therefore susceptible to “blowout” fractures. It is one of the buttress points of the skull. The ethmoid bone forms the greatest portion of the medial wall, along with the lacrimal bone (at the anterior medial corner).
- The larger orbital walls are composed of the orbital plates of the frontal bone, forming the roof (**choice A**). The orbital surfaces of the maxilla form the floor (**choice B**); and the zygomatic bone forms the anterior part of the lateral wall (**choice D**), along with the orbital surface of the greater wing of the sphenoid bone (the posterior part, **choice E**). All of these bony areas or walls are thicker than the medial wall of the orbit.
51. **The correct answer is D.** The pterygoid canal is an anteroposterior canal in the base of each medial pterygoid plate of the sphenoid bone that gives passage to the vidian nerve and is also called the vidian canal. Thus, the vidian nerve is formed from two nerves: the greater petrosal nerve, which can be found on the floor of the middle cranial fossa of the skull carrying parasympathetic information from cranial nerve VII or the facial nerve to the pterygopalatine ganglion; and the deep petrosal nerve, which is derived from sympathetic fibers that leave the internal carotid plexus. The vidian nerve forms at the junction of these nerves on the base of the skull and enters the vidian (pterygoid) canal in the anterior wall of foramen lacerum. The nerve enters the pterygopalatine ganglion from its posterior surface, and the sympathetic and parasympathetic information is distributed to all locations that communicate with the ganglion (nasal cavity, sinuses, oral cavity, and lacrimal gland via V1 and V2). Thus, this nerve in the pterygoid canal carries both sympathetic and parasympathetic fibers and not the other types of sensation fibers: taste and vision (**choice A**), pressure and touch (**choice B**), pain and temperature (**choice C**), or proprioception and touch (**choice E**).

52. **The correct answer is A.** Transitional epithelium is a folded, stretchable lining found primarily in organs that undergo stretch, such as the lining of the excretory tubes and bladder. Simple cuboidal (**choice B**) is found in the secretory parts of many glands. Simple columnar (**choice C**) is found throughout most of the lining of the digestive tract and at the ductal end of exocrine glands. Simple squamous (**choice D**) can be found in the endothelium of blood vessels or in thin sections of Bowman's capsule and the loop of Henle.
53. **The correct answer is A.** Although the vestibular lamina is involved in tooth formation indirectly, it does not form teeth. Early in tooth formation, the vestibular lamina grows into the mesoderm of the jaws, converts into a furrow, the labiogingival groove, and eventually becomes the vestibule of the mouth. Near the vestibular lamina, the dental lamina forms 20 tooth buds, which become the primary teeth. A similar successional lamina will form the 32 tooth buds of the permanent teeth.
54. **The correct answer is D.** The brachial plexus is located in the axilla and neck and is formed from ventral rami of nerves C5, C6, C7, C8, and T1. There is much intermingling of the nerves, forming trunks, divisions, cords, and branches. The three cords formed are lateral, posterior, and medial. The lateral is formed by contributions from C5 and C7. The posterior is formed by contributions from C6, C7, and C8. The medial is formed by contributions from C8 and T1.
55. **The correct answer is A.** Salivary glands are major and minor as defined by their size. The only purely serous minor salivary gland is located in the lamina propria of von Ebner's salivary glands within the base of the circumvallate papillae. These lingual papillae are of large size and vary in number from eight to 12. They are situated on the dorsum of the tongue immediately in front of the foramen cecum and sulcus terminalis, forming a row on either side; the two rows run backward and medialward and meet in the middle line, like an inverted letter V.
- All other minor salivary glands are scattered in the tissues of the buccal (**choice D**), labial, and lingual mucosa; the soft palate (**choice C**); the lateral portions of the hard palate (**choice B**); and the floor of the mouth. The attached gingiva (**choice E**) does not contain minor salivary glands. Most minor salivary glands, except for von Ebner's, secrete a mixed or mucous saliva.
56. **The correct answer is B.** The maxillary artery is the larger terminal branch of the external carotid artery. The maxillary artery begins at the neck of the mandibular condyle within the parotid salivary gland. The maxillary artery runs between the mandible and the sphenomandibular ligament anteriorly, and superiorly through the infratemporal fossa. The artery may run either superficial or deep to the lateral pterygoid muscle.
- The major arteries that supply the head and neck are the common carotid artery (**choice D**) and the subclavian artery. The common carotid artery ends by dividing into the internal carotid (**choice C**) and external carotid arteries. There are two terminal branches of the external carotid artery, the superficial temporal artery (**choice E**) and the maxillary artery. The facial artery (**choice A**) is the final anterior, nonterminal branch from the external carotid artery.
57. **The correct answer is D.** Above the elbow and across to the upper forearm, the median nerve runs parallel to the brachial artery. The artery then divides to form the ulnar (medial side) and radial (lateral side) arteries that run down the forearm. The median nerve remains between these two arteries and not next to either. The cephalic vein runs on the lateral side of the upper arm, whereas the brachial artery and median nerve run on the medial. The medial brachial cutaneous nerve supplies skin in the medial upper arm.

58. **The correct answer is C.** The superior cervical ganglion is a sympathetic ganglion. Sympathetic innervation to the eye opens (dilates) pupils as in “wide-eyed fear.” So, stimulation of the pupil-dilating muscles by sympathetic innervation will open the pupils. Sphincter pupillae (pupil closer) and ciliary muscles (focus adjuster) are stimulated by parasympathetic innervation from the ciliary ganglion. The inferior oblique muscle is innervated by the inferior division of the CN III (oculomotor nerve). The levator palpebrae superior elevates the upper eyelid and is innervated by the superior division of CN III (oculomotor nerve).

59. **The correct answer is D.** Both loose and dense connective tissue are found together in two layers in the form of a connective tissue proper in the oral cavity (lamina propria) and skin (dermis). The connective tissue proper is found deep to the epithelium and basement membrane in the deeper layers of the skin and oral mucosa. It does not have poor vascularity (**choice A**), because it has an extensive vascular system. Nor does it have poor reparative ability (**choice B**), inasmuch as it has fibroblasts as its predominant cell type and not mast cells (**choice E**). However, connective tissue proper does have more intercellular material or matrix than cells, especially when compared with epithelium. The matrix is composed of intercellular substance and fibers.

The fibroblast synthesizes certain types of fibers (depending on the connective tissue) and intercellular substance. There may be subpopulations of fibroblasts possible in connective tissues. Fibroblasts are considered “fixed” cells in connective tissue because they do not leave the tissue to enter the blood system, but that does not mean they are inactive. Young fibroblasts are actively engaged in the production of fibers and intercellular substances, and if adequately stimulated during repair, can revert to an active state.

60. **The correct answer is A.** The order of tubules and structures in the respiratory tree is the trachea, bronchi, terminal bronchioles, respiratory bronchioles, alveolar sacs, and then alveoli. The trachea and bronchi are cartilage-lined. The two bronchi diverge from the trachea, one to each lung. They divide into terminal bronchioles, which are 1 mm or less in diameter and lack cartilage. They lead to several respiratory bronchioles of similar structure, but with some attached alveoli along their walls. Bronchioles are lined by ciliated columnar epithelium. These bronchioles lead to alveolar sacs and alveoli, which are the gas-exchange units. Alveolar sacs and alveoli are much smaller than bronchioles and are composed of alveolar and capillary epithelium, which are thin squamous.

61. **The correct answer is C.** Resorption is the removal of bone tissue. The cell that causes resorption of bone tissue is the osteoclast. The osteoclast is a large, multinucleated cell located on the surface of secondary bone tissue in a large, shallow pit, created by resorption, called Howship’s lacuna. Each osteoclast contains a large number of lysosomes in its cytoplasm that are discharged breaking down bone.

Osteoblasts (**choice B**) are bone-forming cells located in the periosteum. Within fully calcified bone there are osteocytes (**choice A**), which are entrapped mature osteoblasts similar to chondrocytes (**choice D**), which are entrapped chondroblasts (**choice E**) in partially calcified cartilage. The cell body of the osteocyte is surrounded by bone except for the space immediately around it, the lacuna.

62. **The correct answer is A.** Different types of dentin can be designated by their relationship to the dentinal tubules. Dentin that creates the wall of the dentinal tubule is called intratubular or peritubular dentin. Peritubular dentin is highly mineralized after dentin maturation.

The dentin that is found between the tubules is called intertubular dentin (**choice B**). Intertubular dentin is highly mineralized, but less so than peritubular dentin.

The incomplete fusion during the secondary mineralization phase results in differences noted in the microscopic features of the crystalline form of dentin. Areas where there has been both primary and secondary mineralization with complete crystalline fusion are called globular dentin. In contrast, in interglobular dentin (**choice C**) only primary mineralization has occurred within the predentin and the globules of dentin did not fuse completely. Thus interglobular dentin is slightly less mineralized than globular dentin.

Mantle dentin (**choice D**) is the first predentin that forms and matures within the tooth. It also has more peritubular dentin than do the inner portions of dentin, thus higher levels of mineralization. Primary dentin is the dentin formed in a tooth before the completion of the apical foramen of the root, which is the opening in the root's pulp canal.

63. **The correct answer is C.** The pterygomandibular raphe is a connective tissue line found at the posterior limit of the buccinator and anterior limit of the superior pharyngeal constrictor. Sulcus terminalis (**choice B**) divides the anterior two-thirds and posterior one-third of the tongue. The retromolar pad (**choice A**) is fibrous soft tissue just distal to the mandibular third molar. The sphenomandibular ligament (**choice E**) is a fibrous band connecting the sphenoid bone to the lingula of the mandible. The stylomandibular ligament (**choice D**) is a fibrous band connecting the styloid process of the temporal bone to the posterior ramus.
64. **The correct answer is E.** Tertiary, or reparative, dentin is dentin formed quickly in localized regions in response to a localized injury to the exposed dentin. Tertiary dentin thus forms underneath the exposed dentin's tubules along the outer pulpal wall. The injury could be caries, cavity preparation, attrition, or recession.

Mantle dentin (**choice A**) is the first predentin that forms and matures within the tooth. Primary dentin (**choice B**) is the dentin formed in a tooth before the completion of the apical foramen of the root, which is the opening in the root's pulp canal. Secondary dentin is formed after the completion of the apical foramen and continues to form throughout the life of the tooth.

The incomplete fusion during the secondary mineralization phase results in differences noted in the microscopic features of the crystalline form of dentin. Areas where there has been both primary and secondary mineralization with complete crystalline fusion are called globular dentin. In contrast, in interglobular dentin (**choice D**) only primary mineralization has occurred within the predentin and the globules of dentin did not fuse completely. Thus interglobular dentin is slightly less mineralized than globular dentin.

Pulp stones, or denticles, present in the pulp tissue are calcified masses of dentin, complete with tubules and processes (true pulp stones), or they may be amorphous in structure (false pulp stones, **choice C**).

65. **The correct answer is C.** The pharyngeal constrictors (superior, middle, and inferior) run from a posterior pharyngeal raphe to an anterior point. The superior constrictor begins at the raphe, the mylohyoid line of the mandible, the medial pterygoid plate, and the pterygoid hamulus, and it meets the buccinator at the pterygomandibular raphe. The middle constrictor begins at the raphe and ends at the stylohyoid ligament and hyoid bone. The inferior constrictor starts at the raphe and ends at the thyroid and cricoid ligaments. Between the upper and middle constrictor muscles, in the lateroposterior section, pass the glossopharyngeal nerve (CN IX), the stylohyoid ligament, and the stylopharyngeal muscle.
66. **The correct answer is A.** Several coverings are found in nerve tissue. Groups of nerves in a nerve bundle (trunk) are covered by epineurium. Individual neurons are covered by endoneurium (**choice B**). Groups of neurons in a nerve are covered by perineurium (**choice C**).

67. **The correct answer is A.** The sensation of feeling, such as pain, in the temporomandibular (TMJ) (as well as muscular control) is served by a portion of the mandibular nerve of the trigeminal nerve, which penetrates the TMJ capsule and periphery of the disc, the auriculotemporal nerve.

The auriculotemporal nerve is not found throughout the meniscus (**choice C**) or disc, just in the periphery, the bilaminar band portion. The inferior alveolar nerve (**choice E**) is not found within the TMJ but is another branch of the mandibular nerve and serves the mandibular teeth.

The maxillary nerve of the trigeminal nerve (**choice D**) is not within the TMJ but instead carries sensory information for the maxilla and overlying skin, maxillary sinuses, nasal cavity, palate, nasopharynx, and a portion of the dura mater. A muscular branch of the maxillary nerve, the lateral pterygoid nerve (**choice B**) enters the deep surface of the lateral pterygoid muscle between the muscle's two heads of origin and serves as a nerve for that muscle; thus, it is not found in the TMJ. However, the masseteric nerve is another small muscular branch off the maxillary nerve that has a small sensory branch that also goes to the temporomandibular joint.

68. **The correct answer is C.** The lingual tonsils, pharyngeal tonsils, and palatine tonsils form a ring of lymphoid tissue around the posterior oral cavity. The palatine tonsils and lingual tonsils are covered by oral epithelium—stratified squamous—whereas the pharyngeal tonsils contain respiratory epithelium—ciliated columnar. Peyer's patches are lymphoid tissue found in the ileum of the small intestine. They are covered by squamous epithelium.
69. **The correct answer is B.** A good guess would be to pick *occludens* (occludes or blocks). *Zonula occludens* is a tight connection between cell membranes and is also known as a tight junction. In these areas, the membranes actually fuse. In a *zonula adherens*, the membranes are separated by 150 to 200 nm. The space contains fine filamentous material, and the junction is strong, but not as strong as that in the *zonula occludens*. A *macula adherens* is a site of desmosomes or spot junctions. A dense matrix of fine filaments converge there but do not cross to the adjacent cell. A gap junction is also called a *nexus* and contains a 20-nm space between cells. The *nexus* may be a site of ion flow or communication between cells. *Fascia adherens* refers to a cellular connection component in the intercalated discs of cardiac muscle.
70. **The correct answer is E.** The lumen is the open area inside the vessel, which carries blood. The vein lumen is generally larger than the artery lumen, inasmuch as the artery wall is generally thicker. The *tunica intima* is the endothelial lining of the vessel, which both vein and artery possess. The *tunica media* (**choice C**) is the middle layer of elastic tissue and muscle. This is more prominent in the artery, which must withstand greater pressure. The *vasa vasorum* (**choice B**) is the “blood vessels within blood vessels,” small arteries that feed the muscle of the vessel. It is more prominent in veins, reaching all the way from the *tunica adventitia* almost to the *tunica intima*. In arteries, it is not as deep or extensive. The *tunica adventitia* is the outermost layer, composed mostly of tough connective tissue. This layer is thicker in veins.
71. **The correct answer is B.** The fiber tracts passing to the thalamus are taking sensory information to the thalamus for relay to various areas of the cerebrum. The internal capsule is an area between the thalamus and cortex. It is located between the caudate nuclei and lentiform nuclei, and between the caudate nuclei and the thalamus. The caudate nucleus, internal capsule, and lentiform nucleus combined are referred to as the corpus striatum, or striped body. The majority of fibers in the internal capsule are thalamocortical fibers. The corpus callosum is a set of fibers joining the two hemispheres. The medial lemniscus

carries sensory information through the medulla, pons, and midbrain. The lateral lemniscus carries auditory information to the inferior colliculus of the pons. The anterior commissure is another connection between the hemispheres, much smaller than the corpus callosum.

72. **The correct answer is B.** The common carotid artery divides into the internal and external carotid. The internal carotid becomes the main supplier of the brain, whereas the external carotid (**choice C**) gives branches to the face and neurocranium. The vertebral arteries also aid in supplying the brain. The internal jugular (**choice A**) is a vein, not an artery.
73. **The correct answer is B.** Answering this question depends on recognizing the term “mimetic,” which means “muscles of expression.” All muscles of facial expression are innervated by the facial nerve (CN VII). The vagus (CN X) (**choice A**) supplies much of the pharynx, the larynx, the most posterior section of tongue, and several thoracic and abdominal organs. The trigeminal (CN V) (**choice C**) supplies sensation to much of the face and the anterior two-thirds of the tongue, and innervation to the muscles of mastication and others. The hypoglossal (CN XII) (**choice D**) supplies primarily intrinsic and extrinsic tongue muscles (except palatoglossus). The spinal accessory (CN XI) (**choice E**) innervates primarily the trapezius and sternocleidomastoid.
74. **The correct answer is B.** General characteristics of an older pulp include: 1) decreased size, 2) decreased cellularity, 3) decreased vascularity (both blood and lymph), 4) decreased innervation, 5) increased fiber content, and 6) increased calcification, including the possibility of pulp stones.
75. **The correct answer is C.** The “pyramids” refers to two bulges of white matter located on the ventral surface of the medulla. Motor fibers from this area may decussate (cross over) at the decussation of the pyramids. Some motor fibers reverse right/left at this point, while others do not. Some motor fibers enter the lateral corticospinal tracts, while others enter the anterior corticospinal tracts. Generally, fibers in these tracts do not travel farther down than the midthoracic region.
76. **The correct answer is D.** The prochordal plate is an early embryonic structure. It consists of ectoderm and endoderm in a bilaminar structure and is located near the cephalic end of the notochord. There is no mesoderm in this structure.
77. **The correct answer is D.** Fossae are depressions on a bony surface. The infratemporal fossa is a paired, irregularly shaped depression that is inferior to the anterior part of the temporal fossa. The infratemporal fossa contains the mandibular division of the cranial nerve V, or trigeminal nerve (including the inferior alveolar and lingual nerves), which enters by way of the foramen ovale on the fossa’s roof, the chorda tympani nerves of cranial nerve VII (or the facial nerve), the otic ganglion, and the pterygoid muscles, both the lateral (part of **choice B**) and medial; the pterygoid plexus; and the maxillary artery (second part) and branches, including the middle meningeal artery, inferior alveolar artery, and posterior superior alveolar artery.

The temporal fossa is a flat, fan-shaped depression on the lateral surface of the skull. The temporal fossa contains the body of the temporalis muscle (part of **choice A**) and area blood vessels and nerves. The parotid gland (also part of **choice A**) is found in the parotid fossa, or bed, and includes the superficial temporal artery and the parotid lymphatic nodes (**choice C**). The parotid glands form two groups in relation with the parotid salivary gland, including a group imbedded in the substance of the gland and a group of subparotid glands lying on the lateral wall of the pharynx. Nearby is the masseter muscle

(**choice B**), composed of a larger superficial portion and a minor deep part. It extends from the zygomatic arch (origin) to the lower half of the mandibular ramus (insertion).

All muscles of mastication act by moving the mandible during chewing and speech. The masseter and temporalis are superficially located, just deep to the subcutaneous tissue, and can be easily palpated. The medial and lateral pterygoid, however, lie more deeply. All muscles of mastication are innervated by motor branches of the mandibular division, and their arterial supply is provided by branches off the maxillary artery.

The pterygopalatine fossa is a cone-shaped depression, deep to the infratemporal fossa, that contains the maxillary artery (third part) and branches, including the infraorbital and sphenopalatine arteries, pterygopalatine ganglion, and maxillary nerve.

- 78. The correct answer is B.** The salivary glands produce saliva that lubricates and cleanses the oral cavity and helps in digestion. These glands are controlled by the autonomic nervous system. Salivary glands are major and minor as defined by their size. The minor salivary glands of the palate (palatine) are purely mucous, a thicker carbohydrate fluid. The hard palate is continuous with the soft palate. It is covered by a dense structure, formed by the periosteum and mucous membrane of the mouth, which are intimately adherent. The mucous membrane is thick, covered with stratified squamous epithelium, and furnished with numerous palatine glands that lie between the mucous membrane and the surface of the bone.

The minor salivary glands of von Ebner's (**choice D**) and the major salivary gland, the parotid (**choice A**), are purely serous, a watery protein fluid. The major salivary glands, the sublingual (**choice C**) and submandibular (**choice E**), have a mixed secretion of both serous and mucous, with both thick carbohydrate and watery protein fluids, with the mucous component predominating in the sublingual gland.

- 79. The correct answer is C.** The trigeminal nerve, or cranial nerve V, gives sensation to most of the tongue and all of the teeth and associated tissues (as well as the motor nerve of the muscles of mastication), so a bite of the tongue tip would be transmitted by this nerve.

The cranial nerves are composed of 12 pairs of nerves that emanate from the nervous tissue of the brain. To reach their targets they must ultimately exit/enter the cranium through openings in the skull. Hence, their name is derived from their association with the cranium. The function of the cranial nerves is, for the most part, similar to the spinal nerves (the nerves that are associated with the spinal cord).

The facial nerve, or cranial nerve VII (**choice B**) (anterior two-thirds), and the glossopharyngeal nerve, or cranial nerve IX (**choice E**) (posterior one-third), give taste sensation to the tongue, as well as the vagus nerve, or cranial nerve X (**choice A**). The hypoglossal nerve, or cranial nerve XII (**choice D**), gives motor innervation to the tongue.

- 80. The correct answer is A.** The submandibular duct (Wharton's duct) is located in the midline underneath the tongue and is covered by nonkeratinized oral mucosa. Genioglossus (**choice B**) connects the midline of the internal surface of the mandible with the tongue. Mylohyoid (**choice C**) forms the floor of the mouth and connects to the internal surface of the mandible and a midline fibrous raphe. Geniohyoid (**choice D**) connects the internal surface of the mandible to the hyoid bone. Anterior digastric (**choice E**) connects the interior surface of the mandible to the fibrous sling at the joining of anterior and posterior digastric muscles. All of these muscular structures lie inferior to (below) the submandibular duct.

- 81. The correct answer is E.** The submandibular ganglion sends parasympathetic innervation to both the submandibular and sublingual salivary glands. The parasympathetic fibers

originate with CN VII (facial) and synapse in the submandibular ganglion before traveling with the lingual nerve to the two glands.

82. **The correct answer is B.** Root development begins after enamel formation is complete. The inner and outer enamel epithelium form Hertwig's root sheath. The cells of the inner enamel epithelium influence nearby mesenchyme cells to differentiate into fibroblasts and odontoblasts. When a break in continuity of the sheath occurs, a small area does not have dentine formation, and an accessory root canal develops. This can occur anywhere along the root.
83. **The correct answer is B.** In the hard palate, the deepest mucosal layer is stratum germinativum (basale), where most mucosal mitosis occurs. Above this layer is stratum spinosum (prickle cell layer). Above spinosum is stratum granulosum (granular layer) (**choice D**). Above this layer is stratum lucidum (clear layer) (**choice A**) and then stratum corneum (keratinized layer) (**choice E**). The lamina propria (**choice C**) is connective tissue below the entire epithelial set of layers.
84. **The correct answer is E.** The hypothalamo (hypothalamus)-hypophyseal (pituitary) portal system is a connection of the capillaries of the hypothalamus into a portal vein and then to a set of pituitary capillaries. A capillary-vein-capillary circulation is known as a portal circulation. Another example is the hepatic portal system. Information in the form of hypothalamic releasing factors travels from the hypothalamus to the anterior pituitary, controlling pituitary secretions. For example, growth hormone (GH) release is controlled by growth hormone releasing factor (GHRF).
85. **The correct answer is A.** The foramen magnum is the largest foramen and is seen at the base of the skull. It carries the spinal cord and vertebral arteries and veins. All other foramen listed are much smaller. Jugular foramen (**choice C**) carries CN IX (glossopharyngeal), CN X (vagus), and CN XI (spinal accessory). Foramen lacerum (**choice B**) is partially filled by cartilage, and most texts state that no structures pass completely through foramen lacerum. Foramen spinosum (**choice D**) carries the middle meningeal artery and the meningeal branch of the mandibular nerve.
86. **The correct answer is A.** The vertebral arteries branch off from the subclavian arteries. They pass through foramen magnum and give off several branches to the brain. The thyrocervical trunk (**choice B**) supplies parts of the shoulder and neck. The costacervical trunk (**choice C**) supplies areas of the shoulder by branching into the deep cervical and superior intercostal arteries. The superior thyroid artery (**choice D**) supplies the thyroid and parathyroid glands and is a branch of the external carotid. The internal thoracic artery (**choice E**) supplies parts of the anterior thoracic and abdominal wall.
87. **The correct answer is D.** Bone, cartilage, and cellular cementum all have cells contained in lacunae surrounded by matrix. Canaliculi surround the lacunae and function in aiding transport of materials to and from these cells. Bone and cementum are not difficult to resorb. Bone undergoes constant remodeling. Bone can have concentric patterns, Haversian and Volkmann's systems, but cementum does not. Bone and cementum can be acquired throughout life, but cementum does not contain blood vessels.
88. **The correct answer is C.** Each branchial arch has a nerve associated with its development, as well as associated muscles and skeletal derivatives. The first arch forms the muscles of mastication, tensor palatini, tensor tympani, mylohyoid, and anterior digastric, and is associated with CN V. The second arch forms the muscles of facial expression, buccinator, posterior digastric, stapedius, and stylohyoid, and is associated with CN VII. The third

arch forms stylopharyngeus and upper pharynx and is associated with CN IX. The fourth arch forms pharyngeal and laryngeal muscles and is associated with CN X.

- 89. The correct answer is A.** The trigeminal nerve is the largest cranial nerve, is the great sensory nerve of the head and face, and is the motor nerve of the muscles of mastication. It emerges from the side of the pons, near its upper border, by a small motor and a large sensory root—the former being situated in front of and medial to the latter.

The brain stem has a number of parts, including the medulla, the pons, and the midbrain. The medulla oblongata (**choice D**) is closest to the spinal cord and is involved with the regulation of heartbeat, breathing, vasoconstriction, and reflex centers. The cell bodies of the motor neurons for the tongue are located in the medulla. The pons connects the medulla with the cerebellum and with higher brain centers. Cell bodies for cranial nerves V and VII are found in the pons.

The midbrain (**choice B**) includes relay stations for hearing, vision, and motor pathways, and its ventrolateral portion is composed of a pair of cerebral peduncles (**choice E**).

Superior to the brain stem, the diencephalon (**choice C**) consists primarily of the thalamus and hypothalamus. The thalamus serves as a central relay point for incoming nervous impulses, and the hypothalamus regulates homeostasis.

- 90. The correct answer is C.** The contents of the mediastinal compartments are as follows: The posterior mediastinum lies below the pericardial sac and contains the descending aorta, esophagus (also in superior mediastinum), thoracic duct, inferior vena cava, azygos and hemiazygos veins, and vagus nerve. The superior mediastinum contains the superior portion of the thymus gland, the great vessels running to and from the heart (aortic arch [**choice D**], pulmonary vein and artery, superior vena cava), trachea and main stem bronchi, and esophagus. The anterior mediastinum contains the inferior thymus gland and sternopericardial ligaments. The middle mediastinum contains the pericardial cavity and heart (**choice A**), the phrenic nerves (**choice B**), and lung roots.

- 91. The correct answer is D.** Most of the fibers of the periodontal ligament are principal fibers, which are not individual fibers but are organized into groups or bundles on the basis of their orientation to the tooth and related function. The oblique group of the alveodental ligament is the most numerous of the fiber groups and covers the apical two-thirds of the root. This group originates in the alveolar bone proper and extends apically so as to insert more apically into the cementum in an oblique manner. The function of the oblique group is to resist intrusive forces that try to push the tooth inward or move the tooth in an apical direction.

The apical group (**choice E**) of the alveodental group radiates from the apical region of the cementum to insert into the surrounding alveolar bone proper. The function of the apical group is to resist extrusive forces that try to pull the tooth outward, as well as rotational forces.

The interradicular group (**choice B**) of the alveodental group is found only on multirrooted teeth. This group is inserted on the cementum of one root to the cementum of the other root(s) superficial to the interradicular septum, and thus has no bony attachment. This group works together with the alveolar crest and apical groups to resist intrusive, extrusive, and tilting as well as rotational forces.

The alveolar crest group (**choice A**) of the alveodental ligament originates in the alveolar crest of the alveolar bone proper and fans out to insert into the cervical cementum at various angles. The function of the alveolar crest group is to resist tilting, intrusive, and extrusive as well as rotational forces.

The horizontal group (**choice C**) of the alveodental ligament originates in the alveolar bone proper apical to its alveolar crest, and inserts into the cementum in a horizontal manner. The horizontal group's function is to resist tilting forces that try to force the tooth to tip either mesially, distally, lingually, or facially, as well as rotational forces.

92. **The correct answer is E.** The general guideline is that axial skeleton, appendicular skeleton, and bones of the base of the skull (sphenoid, ethmoid, etc.) are formed endochondrally (cartilage model). Flat bones of the skull (temporal, frontal, occipital, etc.) are formed intramembranously. The mandible is an anomaly, as it is part cartilaginous (condyle) but mostly intramembranous. In the choices, all the long bones of the appendicular skeleton (femur [**choice A**], humerus [**choice D**], tibia [**choice B**]) are formed endochondrally. The stapes (**choice C**), like the skull base bones, is also endochondral. As stated earlier, the mandible is mostly endochondral.

93. **The correct answer is A.** Gnarled enamel refers to enamel rods that follow a curving course to the tooth surface. Gnarled enamel is found in the cervical area and on incisal and occlusal areas, but primarily on incisal and occlusal areas, which correspond to cusps and incisal edges.

94. **Item not scored.**

95. **The correct answer is C.** The sphenopalatine artery, a terminal end of the maxillary artery, supplies the anterior septal region of the nose. The sphenopalatine artery also gives rise to the posterior lateral nasal branches and septal branches, including a nasopalatine branch that accompanies the nasopalatine nerve through the incisive foramen on the maxilla.

Just as the maxillary artery leaves the infratemporal fossa and enters the pterygopalatine fossa, it gives off the posterior superior alveolar artery (**choice B**). The dental branches of the posterior superior alveolar artery supply the pulp tissue of the posterior maxillary teeth by way of each tooth's apical foramen. The alveolar branches of the posterior superior alveolar artery supply the periodontium of the posterior maxillary teeth, including the gingiva. Some branches also supply the maxillary sinus.

Also in the pterygopalatine fossa, the maxillary artery gives rise to the greater palatine artery (**choice D**) and lesser palatine arteries, which travel to the palate through the pterygopalatine canal and the greater and lesser palatine foramina to supply the hard and soft palate, respectively.

The angular artery (**choice A**) is the termination of the facial artery and supplies the tissues along the side of the nose.

96. **The correct answer is C.** As enamel matures, both organic content and water content decrease and mineralization increases. Mineral content can approach 100% in older teeth, although a common average mineral content is often listed at 97 to 98% mineral with the remaining 2 to 3% as the combination of water and organic content.

97. **The correct answer is E.** Parakeratinized oral mucosa is associated with the masticatory mucosa of the attached gingiva. Most researchers believe that parakeratinized epithelium is an immature form of orthokeratinized epithelium. Parakeratinized epithelium is also associated with the specialized mucosa of the lingual papillae on the dorsal surface of the tongue. The main difference between parakeratinized and orthokeratinized epithelium is in the cells of the keratin layer. In parakeratinized epithelium, the most superficial layer is still being shed or lost, but these cells of the keratin layer contain not only keratin but also their nuclei, unlike the cells of orthokeratinized epithelium. Studies have shown that even

though the epithelial cells have nuclei, they are no longer viable. Therefore, parakeratinization is one of the unique histologic features of the oral cavity.

If parakeratinization is present on the skin (**choice C**), it is considered a disease state.

Nonkeratinized oral mucosa is noted in lining mucosa such as in the labial, buccal, and alveolar mucosa; and the mucosa lining the floor of the mouth (**choice D**), the ventral surface of the tongue (**choice B**), and the soft palate (**choice A**).

98. **The correct answer is C.** Mature dentin fibers are composed of collagen. Three types of collagen exist; they are composed of various types of alpha-1 and alpha-2 fibers. Collagen from dentin, tendons, and skin is type I collagen, and has two type I alpha-1 chains linked to an alpha-2 chain. Collagen from cartilage matrix is type II (**choice D**) and contains three type II alpha-1 chains. Elastin (**choice A**) is a different protein, related to collagen but with high levels of valine and the unique desmosine and isodesmosine. Reticulin (**choice B**) was thought to be a different protein but now appears to be a different arrangement of collagen fibers.
99. **The correct answer is D.** The exception to the discussion of enamel structure is the contour lines of Owen. The imbrication lines of von Ebner in dentin are incremental lines or bands that stain darkly and can be likened to the “growth rings,” or incremental lines of Retzius, noted in enamel. The contour lines of Owen are a number of adjoining parallel imbrication lines that are present in stained dentin. These contour lines demonstrate a disturbance in body metabolism that affects the odontoblasts by altering their formation efforts. They appear together as a series of dark bands. The most pronounced contour line is the neonatal line that occurs during the trauma of birth. Other contour lines occur with tetracycline staining of the teeth because the antibiotic becomes permanently and chemically bound to the dentin.
- Enamel rods or enamel prisms (**choice A**) are the crystalline structural unit of enamel. Surrounding the inner portion of each rod is an outer portion, or interprismatic region, of the enamel rod. Recent studies of enamel make a strong argument against the existence of an organic rod sheath or lesser mineralized interprismatic substance (**choice E**) between the enamel rods, as once was believed.
- The lines or striae of Retzius (**choice C**) appear as incremental lines that stain brown in preparations of mature enamel. Associated with the lines of Retzius are the raised imbrication lines and grooves of perikymata (**choice B**) noted on the nonmasticatory surfaces of some teeth in the oral cavity. The imbrication lines and perikymata are usually lost through wear except on the protected cervical regions of some teeth, especially the permanent maxillary central incisor, canine, and first premolar.
100. **The correct answer is D.** Dentinal tubules in the living tooth contain incompletely calcified areas (interglobular dentin). When a tooth is extracted and sectioned for viewing, this material is no longer contained in the section and these areas (interglobular dentin) fill with air. The air-filled areas can appear black under light microscopy.

Biochemistry-Physiology

- 101. The correct answer is A.** Actin is a major component of the cytoskeleton and is highly conserved in all eukaryotes. F-actin is a helical filamentous polymer of globular G-actin subunits. An actin polymer, bound with proteins, constitutes a microfilament, one of the three types of fibers that form the cellular cytoskeleton. During the initial nucleation phase, ATP bound to G-actin monomers forms stable complexes of actin, eventually forming filaments. After their incorporation into a filament, subunits slowly hydrolyze ATP and become stable ADP-F-actin.

Chloride and manganese (**choices B and C**) are ions that may modulate the transformation in vitro. Pyrophosphate (**choice D**) is a by-product of ATP hydrolysis. Creatine phosphate (**choice E**) is another type of high-energy molecule.

- 102. The correct answer is D.** Chondroitin sulfate and hyaluronic acid are major components of the extracellular matrix. Associations between proteoglycans and hyaluronic acid form an aggrecan structure in the extracellular matrix. The extension of this structure yields a three-dimensional structure of proteoglycans bound to hyaluronic acid, which creates a matrix in which collagen and other components are embedded.

Cell walls of caries-related streptococci decomposition end products of oral lactobacilli (**choice A**) is incorrect because it refers to LPS and endotoxins, by-products of bacterial cell wall decomposition.

By products of carbohydrate metabolism by bacteria (**choice B**) are acids, so this is an incorrect choice. Enzymes which break down Gram-positive cell walls (**choice C**) is incorrect because the two proteins are structural and not enzymes.

- 103. The correct answer is A.** The “clearance” of a substance is defined as the volume of plasma that must be completely cleared of that substance in 1 minute to provide the amount of the substance that appears in the urine in 1 minute. It is a “virtual” or theoretical volume of plasma, and is calculated by the formula:

$$C_s = \frac{U_s V}{P_s}$$

where C_s is the clearance of substance S, U_s is the urinary concentration of S, V is the urinary volume produced in 1 minute, and P_s is the plasma concentration of S.

Normally, glucose is completely reabsorbed by the kidney and none appears in the urine ($U_s = 0$). Consequently, the clearance is zero; or, expressed differently, there is no volume of plasma that is completely cleared of glucose in 1 minute.

Choices B, C, D, and E are numerically incorrect in a normal person. If plasma glucose is very high, as may occur in diabetes mellitus, the renal threshold for glucose may be exceeded and glucose may appear in the urine. In that case, the clearance of glucose will exceed zero.

104. The correct answer is B. Antidiuretic hormone (ADH) is secreted from the posterior pituitary gland in response to water deprivation. It causes the retention of water in the body by preventing water loss through urinary excretion. ADH acts on cells of the distal tubule and collecting duct of the nephron to increase the water permeability of those cells. As a result of the increase in cellular permeability, water is drawn out of the primary urine that has been formed in the lumen of the tubule. The water is drawn into the interstitium of the kidney, which is hypertonic. The interstitium is maintained at a high osmotic pressure by the countercurrent multiplication mechanism in the loop of Henle.

Choices A, C, D, and E are erroneous and do not describe the mechanism of action of ADH.

105. The correct answer is D. Conversion of a propeptide, such as proinsulin, to the active peptide results from the enzymatic removal of a segment of the protein chain.

Disulfide bonds are not formed during this process, so **choice A** is incorrect. Disulfide bonds are formed during protein synthesis and provide stability to the secondary protein structure.

Disulfide bonds are not broken during this process, so **choice B** is incorrect; the breaking of disulfide bonds will destabilize and destroy the protein.

The polypeptide chain is not lengthened, so **choice C** is incorrect. Lengthening of the polypeptide chain occurs during synthesis of the protein, before secretion and activation via removal of the propeptide segment.

106. The correct answer is C. Gamma-aminobutyric acid (GABA) is the major inhibitory transmitter in the brain. The effect of GABA on membrane receptors is to open chloride channels. In most neurons, the membrane potential is more positive than the chloride equilibrium potential. As an illustration, the resting membrane potential may be -65 mV and the chloride equilibrium potential -70 mV. By increasing membrane permeability to chloride, GABA will cause the membrane potential to approach the chloride equilibrium potential, thereby hyperpolarizing the cell. Glycine, the inhibitory transmitter of the spinal cord and brain stem, also activates chloride channels.

Choices A, B, D, and E do not describe the mechanism of action of GABA but may apply to other neurotransmitter substances.

107. The correct answer is C. Polymerase chain reaction (PCR) is used to amplify specific DNA sequences for analysis.

Preparation of enzymes that synthesize nucleic acids (**choice A**) is done either by isolation or through production by bacteria specially modified in the lab. Isolation of the genome of an organism (**choice B**) is handled through a specific series of steps involving multiple chemicals. The method consisting of separating polyclonal antibodies (**choice D**) was used early on to isolate antibodies produced by B cells. The process of synthesizing RNA from DNA (**choice E**) is called transcription.

108. The correct answer is D. Smooth muscle is found in visceral organs; striated muscle is present in skeletal muscles and in heart muscle. Smooth muscle is innervated by the autonomic nervous system and is under involuntary control. The muscular layers of the gastrointestinal tract are composed of smooth muscle. The exceptions are at the very upper and lower ends of the tract. The upper 5% of the esophagus is composed entirely of striated muscle. The remainder of the upper half of the esophagus is a mixture of smooth and striated muscle. (The other exception to the rule is the external anal sphincter, which is also composed of skeletal muscle. This structure is not listed as a choice for this question.)

The rest of the gastrointestinal tract contains only smooth muscle. This includes the gastroesophageal sphincter (**choice E**) at the junction of the stomach and esophagus, the antrum of the stomach (**choice C**) near the pyloric sphincter, the rectum (**choice A**) at the lower end of the large intestine, and the internal anal sphincter (**choice B**).

- 109. The correct answer is C.** Substances are transported across cell membranes by the following mechanisms: passive diffusion, facilitated diffusion, primary active transport, and secondary active transport. Secondary active transport involves: 1) the establishment of a concentration gradient for Na^+ by primary active transport pumping of sodium out of the cell, and 2) the subsequent utilization of the diffusion of Na^+ back into the cell to transport another substance. The substance can move into the cell by *cotransport* with Na^+ or out of the cell by *countertransport* in exchange for Na^+ . The Ca^{2+} - Na^+ countertransporter is a protein molecule present in the membranes of nearly all cells. It drives Ca^{2+} out of cells and lowers the intracellular concentration of Ca^{2+} .

Facilitated diffusion (**choice A**) is a transport mechanism in which the passage of a solute down its concentration gradient is aided by carrier molecules present in the cell membrane. This choice is an incorrect answer because calcium is transported uphill against its concentration gradient.

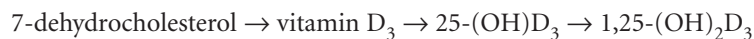
A cotransport system (**choice B**) is a secondary active transport system that moves solute into cells together with Na^+ . This is also an incorrect answer because Ca^{2+} is moved out of cells.

Choice D is incorrect because the concentration of Ca^{2+} is very much lower inside cells than in the extracellular fluid.

- 110. The correct answer is C.** In the first stage of fatty-acid synthesis, acetyl CoA, generally derived from carbohydrate metabolism, is converted to malonyl CoA under the action of the enzyme acetyl CoA carboxylase. Acetyl CoA carboxylase requires the presence of citrate or isocitrate, which allows the polymerization of the protomer that produces the active form of the enzyme.

ATP, NADPH, and cAMP (**choices A, B, and D**) are all involved in the production of fatty acids but later in the cycle. Oxaloacetate (**choice E**) is a component of the TCA cycle.

- 111. The correct answer is B.** The synthesis of the active form of vitamin D involves the following steps:



The precursor, 7-dehydrocholesterol, is present in the skin and is converted to cholecalciferol (vitamin D_3) by exposure to ultraviolet light. In the liver, cholecalciferol is converted to 25-hydroxycholecalciferol [25-(OH)D_3] by the addition of a hydroxyl group. In the kidney there is an additional hydroxylation to 1,25-dihydroxycholecalciferol [$1,25\text{-(OH)}_2\text{D}_3$]. This last metabolite is the active form of vitamin D_3 , which increases calcium absorption from the gut.

Decarboxylation in the liver (**choice A**) and deamination in the kidney (**choice D**) are incorrect because the synthesis of the active form of vitamin D_3 involves hydroxylation of the precursor in the liver and kidney—not decarboxylation or deamination.

Metabolism by gut bacteria (**choice C**) is incorrect because metabolism by gut bacteria is not involved in the synthesis of vitamin D.

112. **The correct answer is C.** During the upstroke and most of the downstroke of an action potential, the nerve fiber is in the absolute refractory period. During this period the nerve fiber cannot be stimulated to produce a second impulse no matter how intense the second stimulus. The duration of the absolute refractory period is about 1 millisecond. Consequently, nerve fibers cannot fire impulses at a frequency exceeding 1,000 spikes per second. (There are 1,000 milliseconds in a second.) It is the duration of the absolute refractory period that places an upper limit on a nerve fiber's frequency of firing.

Intensity of the stimulus (**choice A**) is incorrect because increasing the intensity of the stimulus applied to a nerve fiber does not affect the rate of firing of impulses. Once its intensity exceeds threshold, a stimulus produces an impulse, and suprathreshold stimuli do not increase firing frequency.

Diameter of the nerve fiber (**choice B**) is incorrect because the diameter of the nerve fiber affects the speed of conduction of the impulse, not the frequency of firing of impulses.

During the relative refractory period that follows the absolute refractory period, a second impulse can be elicited if the stimulus strength is sufficiently intense. Duration of the relative refractory period (**choice D**) is incorrect because duration of the relative refractory period is not the most significant factor limiting the rate of firing.

113. **The correct answer is E.** The principal reaction of the clotting mechanism is the conversion of the soluble plasma protein, fibrinogen, into insoluble fibrin. This conversion is catalyzed by thrombin. Fibrin strands form a meshwork that traps cells and plasma, forming a plug that prevents continued blood loss. Fibrin (**choice A**) is incorrect because fibrinogen, not fibrin, is the substrate for thrombin.

Thrombospondin (**choice B**) is incorrect because thrombospondins are secreted by platelets and other cells and are involved in platelet aggregation and cell matrix adhesion during wound healing and growth. They are not the substrate for thrombin.

Prothrombin (**choice C**) is incorrect because prothrombin is the precursor to thrombin, not the substrate for the catalytic action of thrombin.

Thromboplastin (**choice D**) is incorrect because thromboplastin is the factor released from damaged tissue that initiates the cascade of reactions that leads to clotting. It is not the substrate of thrombin.

114. **The correct answer is A.** Body tissues preferentially utilize carbohydrate for energy. In carbohydrate deficiency, fatty acids are metabolized instead. Fatty acids are broken down by the liver into acetyl-CoA units. Two molecules of acetyl-CoA condense to form acetoacetic acid. Some of the acetoacetic acid is converted to beta-hydroxybutyric acid, or acetone. These three substances are the ketone bodies. They enter the circulation and are oxidized for energy by cells.

Severe metabolic alkalosis (**choice B**) is an incorrect choice because two of the ketone bodies are acids and can produce a severe metabolic acidosis. A deficiency in prostaglandin formation (**choice C**) is an incorrect choice because prostaglandins are derived from membrane phospholipids, not ingested carbohydrates. An inability to synthesize ascorbic acid (**choice D**) is an incorrect choice because ascorbic acid (vitamin C) is obtained from dietary sources and is not synthesized in the body.

115. **The correct answer is E.** Fluoride incorporation into the enamel is a critical factor in developing enamel that is resistant to decay through decreasing solubility in the presence of acids (**choice D**). The fluoride gets incorporated during tooth development as well as through ion exchange at the enamel surface after eruption (**choices A and D**). It is also an

important component during remineralization following enamel dissolution subsequent to the presence of an acidic environment (**choice C**). Fluoride does not aid in hydrolyzing plaque polysaccharides (dextrans).

- 116. The correct answer is E.** Linoleic is the only choice that is a polyunsaturated (i.e., more than one double bond) fatty acid in the list. Oleic (**choice A**) is a monounsaturated fatty acid. Lactic (**choice B**) is a carbohydrate metabolism byproduct. Sialic (**choice C**) is an N-linked oligosaccharide. Stearic (**choice D**) is a saturated fatty acid.
- 117. The correct answer is A.** As DNA is denatured, the concentration of nucleic acid bases does not change. The denaturation process does result in increased UV light absorption (**choice B**), inasmuch as UV light is often involved in denaturation and breaking of hydrogen bonds. This denaturation separates the two strands but does not break A, T, C, or G bases, so the ratios of bases do not change.

Complementary strands do become random cells (**choice C**), base stacking is disrupted (**choice D**), and hydrogen bonds are broken (**choice E**), so these are incorrect choices.

- 118. The correct answer is D.** To raise body temperature in a cold environment, the body utilizes various heat-gain mechanisms. Vasodilation of the blood vessels in the skin is a heat-loss, not a heat-gain, mechanism. Vasodilation allows more blood to flow to the body surface from the core of the body. Except at environmental temperatures above 98.6°F (37°C), the surface is cooler than the core of the body because the core contains the metabolically active, heat-producing, internal organs. Peripheral vasodilation causes heat to be transferred from the blood and skin to the environment, thereby cooling the body.

Shivering (**choice A**) is a heat-gain mechanism because muscle contractions involve the breakdown of ATP. The hydrolysis of the ATP to ADP (**choice B**) is an exothermic chemical reaction (**choice C**) that releases heat in the course of the reaction. Thyroxine (**choice E**) is a hormone that increases cellular metabolism and ATP hydrolysis, so it is also a mechanism to increase body temperature.

- 119. The correct answer is A.** Amide bonds, a specific type of hydrogen bond (or peptide bonds), are formed by a condensation reaction between the amino group of one amino acid and the carboxyl group of another.

Anomeric bonds (**choice B**) are found in polysaccharides. Epimeric bonds (**choice C**) are found between epimeric monosaccharides (such as d-glucose and d-galactose), which differ in the orientation of the hydroxyl group at C4. Hydrogen bonds (**choice D**) are formed between -NH- or -OH groups and the C=O groups in the peptide bonds or -COO- in the R group. Glycosidic bonds (**choice E**) are found between carbohydrates.

- 120. The correct answer is E.** The process linking the muscle action potential to mechanical shortening of muscle is termed excitation-contraction (EC) coupling. The sequence of events in skeletal muscle involves the following steps: 1) generation of action potential on muscle membrane, 2) spread of depolarization down transverse tubules, 3) release of Ca^{2+} from the sarcoplasmic reticulum, 4) binding of Ca^{2+} to troponin C, 5) formation of cross-bridges between thick and thin filaments, and 6) shortening of muscle. Step 3, the release of calcium ions from their storage sites in the sarcoplasmic reticulum, is the key event in EC coupling.

Binding of calcium and calmodulin (**choice A**) is incorrect because the question asks about skeletal muscle. The binding of calcium to calmodulin occurs in smooth muscle.

Efflux of potassium from transverse tubules (**choice B**) is incorrect because the efflux of K^+ from transverse tubules is not an element in EC coupling.

A sudden rise in permeability to chloride ions (**choice C**) is incorrect because chloride permeability does not increase during the process of EC coupling.

Release of acetylcholinesterase from nerve terminals (**choice D**) is incorrect because acetylcholinesterase, the enzyme that hydrolyzes the transmitter acetylcholine, is not released from nerve terminals and is not involved in EC coupling.

121. The correct answer is E. Mucins are O-linked oligosaccharides and are negatively charged due to the presence of the sialic acid residues. As a result, the protein assumes an extended state, yielding a highly viscous (mucous) solution. Mucins form a protective barrier on the surface of epithelial cells, provide lubrication between surfaces, and facilitate transport processes. From this description, glycoprotein is the only correct answer. Simple protein (**choice A**), phosphoprotein (**choice B**), chromoprotein (**choice C**), and nucleoprotein (**choice D**) are all incorrect.

122. The correct answer is D. The tricarboxylic acid (TCA) cycle is initiated through the condensation of acetyl coenzyme A (acetyl CoA) and oxaloacetate.

Pyruvate is converted to acetyl CoA and malate is an intermediary in the TCA cycle (**choice A**). NAD^+ is a coenzyme that is necessary for the conversion of malate to oxaloacetate (**choice B**). Oxalosuccinate is a transient, enzyme-bound intermediate, which is decarboxylated to yield CO_2 and alpha-ketoglutarate (**choice C**). It does not condense with acetyl CoA (**choice E**).

123. The correct answer is C. Smooth muscle, in contrast to striated muscle, is often required to maintain a sustained contraction for a long period of time. For example, vascular smooth muscle may maintain constriction of a blood vessel for a considerable duration. The latch mechanism, unique to smooth muscle, allows for the persistence of myosin crossbridges and continued muscle tension after a stimulus has ended. This state does not require the utilization of a great deal of ATP and thus conserves energy.

Smooth-muscle contraction does not require more energy for a given tension (**choice A**) because the latch mechanism of smooth muscle requires less energy than the crossbridge cycle of striated muscle.

Smooth-muscle contraction is slower than striated muscle contraction, so **choice B** is incorrect.

The autonomic nervous system is the division of the nervous system that innervates smooth muscle, so **choice D** is incorrect.

124. The correct answer is A. The normal adrenal cortex synthesizes three types of steroid hormones: mineralocorticoids (aldosterone), glucocorticoids (cortisol), and a small quantity of sex hormones. The major sex hormone of the adrenal cortex is dehydroepiandrosterone, which is converted by the tissues to testosterone, the male sex hormone.

Thyroid (**choice B**) is incorrect because the thyroid gland synthesizes the hormones thyroxine and triiodothyronine, which are not sex hormones.

Adrenal medulla (**choice C**) is incorrect because the adrenal medulla synthesizes adrenaline and noradrenaline, not androgen.

Pituitary (**choice D**) is incorrect. The anterior pituitary gland synthesizes six hormones including the gonadotropins, FSH and LH, ACTH, TSH, growth hormone, and prolactin, none of which are androgens and none of which are produced by the testis.

Hypothalamus (**choice E**) is incorrect. The hypothalamus produces the posterior pituitary hormones, vasopressin (ADH) and oxytocin, and various hypophysiotropic hormones, none of which are androgens and none of which are produced by the testis.

125. **The correct answer is A.** Entropy is a measure or indicator of the degree of disorder or randomness in a system. Enthalpy (**choice B**) is heat content. Free energy (**choice C**) is a measure of the energy available to perform useful work. Potential energy (**choice D**) is stored energy.

Activation energy (**choice E**) is the energy necessary for a compound to reach a higher energy state. Example: For the reaction $S \rightarrow P$ to take place, it is necessary that we apply heat or in some manner activate the molecule; the compound must be raised to a higher energy state. The energy needed to reach the activated state is called the activation energy.

126. **The correct answer is C.** Adenosine triphosphate (ATP) is a high-energy molecule. Catabolic processes usually result in the formation of ATP. If adequate amounts of ATP are present, a feedback mechanism is initiated, inhibiting the catabolic process.

ADP (**choice A**) and AMP (**choice B**) are either cofactors or are lower-energy molecules that are converted to ATP during the catabolic process.

127. **The correct answer is E.** Blood travels in a continuous circuit from the left ventricle through the systemic circulation, venous system, right heart, pulmonary circulation, and back to the left heart. All these parts of the circulation are in series. Flow rate through a series circuit must be equal throughout. If flow rate were slower in one part of the circuit, blood would accumulate there. The flow rate through a vessel is given in units of volume of blood per unit time. The flow rate in the vascular system is termed the cardiac output. The cardiac output of the left ventricle going to the systemic circulation must be equal to the cardiac output of the right ventricle going to the pulmonary circulation.

Resistance (**choice D**) is incorrect because the resistance to flow is much greater on the systemic (left) side than on the pulmonary (right) side of the circulation. As a result of the higher resistance on the systemic side of the circulation, arterial pressure on the left side is much greater than on the right side. Typical values for systolic pressure are 120 mm Hg on the left side and 25 mm Hg on the right. Typical values for diastolic pressure are 80 mm Hg on the left side and 8 mm Hg on the right. Diastolic pressure (**choice C**) is incorrect because diastolic pressure is higher on the left side than on the right.

Pulse pressure is defined as the difference between systolic and diastolic pressures. Using the values for systemic and pulmonary systolic and diastolic pressures given in the discussion above, it can be calculated that pulse pressure on the left side is about 40 mm Hg and on the right, about 17 mm Hg. Consequently, pulse pressure (**choice A**) is incorrect.

“Capacitance” is the term used to describe the ability of a distensible vessel to hold or store blood. At any one time, the systemic veins hold 65% of the blood volume while only about 10% of the blood volume is in the pulmonary circulation. **Choice B** is incorrect because the capacitance of the systemic circulation is greater than the capacitance of the pulmonary circulation.

128. **The correct answer is A.** In the absence of oxygen, glucose is not converted entirely to CO_2 (as it is in obligate aerobes) but to one or more two- or three-carbon compounds (pyruvate) and 2 ATP. The pyruvate may eventually be used in aerobic metabolism (Krebs cycle and electron transport chain) or may be converted to lactic acid (fermentation). Without oxygen, fermentation to lactic acid occurs.

129. **The correct answer is D.** The term “hydrophilic” means “loves water.” Lipids are substances that are soluble in organic solvents and not soluble in water. Lipids are, therefore, not hydrophilic. Instead they are hydrophobic (“fears water”). The term “hydrophilic,” therefore, is the choice that is least descriptive of lipids.

The remaining choices do describe lipids. Lipids are nonpolar (**choice A**) and do not have a charge distribution that would attract water molecules. Lipids are organic compounds that contain carbon atoms (**choice B**). Some lipids (for example, phospholipids) are amphipathic (**choice C**): one end of the molecule is hydrophilic and the other end is hydrophobic.

130. **The correct answer is D.** Some animals, such as those that live in desert environments, conserve water and excrete a highly concentrated urine. The kidneys of such animals are notable for the length of their loops of Henle. The loop of Henle utilizes a countercurrent mechanism to generate high osmolarity in the renal medulla. In the presence of antidiuretic hormone, water is drawn out of the collecting ducts into the medullary interstitium.

131. **The correct answer is D.** Steroid hormones are lipids and not soluble in plasma water. Their transport in plasma is achieved by attachment of the hormone to a protein—a binding globulin—that is miscible with water. Filtration at the kidney glomerulus involves water and small molecules. Large molecules, such as the binding globulins and their attached steroid hormones, are prevented from crossing the glomerular barrier to enter the glomerular filtrate.

Urea (**choice A**), glucose (**choice B**), amino acids (**choice C**), and electrolytes (**choice E**) are particles small enough to cross glomerular membranes and enter the filtrate.

132. **The correct answer is E.** The diffusion of an ion through a membrane, without the concomitant diffusion of its counter-ion, creates a membrane potential. Na^+ ions are present in higher concentration in the extracellular fluid than in axoplasm. If the axonal membrane becomes permeable to Na^+ , the inward diffusion of this positive ion, without similar diffusion of its negative counter-ion, will make the inside of the neuron electrically positive in relation to the extracellular fluid. Thus, the membrane potential will have a positive value. It is just such a transient increase in membrane permeability to Na^+ that is the mechanism responsible for the neuronal action potential. During the impulse, the membrane voltage goes from a resting potential of about -75 mV to a peak of about $+30$ mV, approaching the equilibrium potential for sodium of about $+60$ mV.

133. **The correct answer is E.** Niacin (vitamin B_3) is a generic name for nicotinic acid or nicotinamide, either of which is an essential nutrient. Retinol (**choice A**), also known as vitamin A, may confer a protective action against cancer and cardiovascular disease and is necessary for proper retinal function. Lack of riboflavin (**choice B**) causes a generally nonfatal deficiency syndrome of inflammation of the corners of the mouth (angular stomatitis) and tongue (inflammation of glossitis), and scaly dermatitis. Tocopherols (**choice C**) make up vitamin E, an important antioxidant. Deficiency in ascorbic acid (**choice D**), also known as vitamin C, results in the disruption of collagen metabolism and, in extreme cases, in scurvy.

134. **The correct answer is B.** Translation is the process of converting RNA into protein. The sequence of DNA is copied exactly into RNA. The process by which RNA copies of selected DNA sequences are made is transcription. Streptomycin binds the small subunit of prokaryotic ribosomes (30S), interferes with the initiation of protein synthesis, and causes misreading of RNA. Considering this information, the other choices—translation in eukaryotes (**choice A**), transcription in eukaryotes and prokaryotes (**choices C and D**), and DNA replication in prokaryotes (**choice E**)—are incorrect.

- 135. The correct answer is C.** Insulin activates glucose transport by increasing the amount of glucose transporter mRNA and also by increasing the movement of transporters to the plasma membrane. Insulin also activates the glycolytic pathway, which mediates glucose catabolism, by reversing the inhibitory effects of glucagon. Insulin activates phosphofructokinase both directly and by releasing it from inhibition by fructose 2,6-bisphosphate.

Enolase (**choice A**) catalyzes elimination of water from 2-phosphoglycerate to form phosphoenolpyruvate. Phosphorylase A (**choice B**) mediates the conversion of glucose to glucose-1-phosphate. Glucose-6-phosphatase (**choice D**) mediates the conversion of glucose from glucose-6-phosphate. Fructose 1,6-diphosphatase (**choice E**) is an enzyme involved in gluconeogenesis.

- 136. The correct answer is D.** Contraction of the smooth muscle of the bronchioles of the lung is induced by parasympathetic stimulation. This results from the action of the postganglionic parasympathetic transmitter acetylcholine. Sympathetic stimulation, as in the fight-or-flight reaction, as well as application of noradrenergic compounds, causes relaxation of the smooth muscle and dilation of the bronchioles.

Decreased salivary secretion (**choice A**) is incorrect because parasympathetic stimulation increases salivary secretion.

Increased cardiac contractility (**choice B**) is incorrect because sympathetic, not parasympathetic, stimulation increases cardiac contractility.

Decreased gastric motility and tone (**choice C**) is incorrect because the parasympathetic nervous system stimulates gastric motility.

- 137. The correct answer is A.** Emphysema is a disease in which there is destruction of alveolar walls. As a result, lung elastic recoil is diminished and compliance is increased. Compliance is a measure of lung distensibility. Compliance is defined as the degree to which lung volume increases in response to a unit increase in transpulmonary pressure. In emphysema, with less elastic tissue than normal, changes in lung volume are greater for any given change in pressure. Consequently, compliance is increased. The loss of elastic tissue in emphysema also means that airways are not held open as effectively as they are in normal persons. Because the airways close more easily, air will be trapped within the lung during expiration. The result is increased residual volume and increased functional residual capacity (FRC). Residual volume is the volume of air that remains in the lungs after completion of a forceful exhalation. FRC is defined as residual volume plus expiratory reserve volume. If residual volume is increased, FRC will also be increased.

- 138. The correct answer is A.** A fall in the partial pressure of oxygen (PO_2) in arterial blood to a value below 60 mm Hg will induce an increase in ventilation. PO_2 is sensed by peripheral chemoreceptors in the carotid bodies, which are minute structures located at the bifurcation of the internal and external carotid arteries. Sensory afferents project from the carotid bodies to the brain stem.

Carotid sinuses (**choice B**) is incorrect because the carotid sinus senses arterial blood pressure. It is important to distinguish the functions of the carotid bodies and the carotid sinus.

Choices C and D are incorrect because neither the expiratory center nor the inspiratory center is directly sensitive to low PO_2 . These brain-stem centers receive information from chemoreceptors and are responsible for adjusting the respiratory rhythm.

Alveolar nerve endings (**choice E**) is incorrect because nerve endings within the lung are not receptors for blood PO_2 .

139. The correct answer is C. Cholic acid, one of the bile acids, is synthesized by the liver from cholesterol. In the conversion to cholic acid, hydroxyl groups and a carboxyl group are added to the steroid nucleus of cholesterol. Bile acids are important in the intestinal absorption of lipids.

Neither glucose (**choice A**), oxaloacetate (**choice D**), nor ketone bodies (**choice E**) are derived from cholesterol. Steroids (**choice B**) are synthesized from cholesterol but are not produced in the liver. They are produced in the gonads and adrenal glands.

140. The correct answer is E. Edema is the accumulation of fluid in the interstitial space. According to Starling's hypothesis, fluid filtration from capillaries into the interstitial space is governed by two driving forces: 1) the difference in hydrostatic pressures between the plasma and the interstitial fluid, and 2) the difference in colloid osmotic pressures between the plasma and the interstitial fluid. Another term for colloid osmotic pressure is oncotic pressure. A plasma volume expander is a solution that contains a solute of large molecular weight—i.e., a substance that is not filtered out of capillaries and remains confined to the plasma compartment. Such a substance increases plasma oncotic pressure. Increased plasma oncotic pressure draws water into the capillary from the interstitial space and thereby reduces edema.

Hypertensive agents (**choice A**) is incorrect because these agents will increase arterial blood pressure. The resulting increase in capillary hydrostatic pressure will tend to express fluid out of the capillary and increase edema.

Avoiding all diuretic agents (**choice B**) is incorrect because diuretic agents induce water excretion and are therefore useful in reducing edema. Avoiding such agents will not alleviate the edema experienced by the patients described in the question.

Increasing interstitial oncotic pressure (**choice C**) is incorrect because this will tend to draw fluid out of the capillary and will increase edema.

Decreasing interstitial hydrostatic pressure (**choice D**) is incorrect because this will enhance the exit of fluid from the capillary into the interstitial space.

141. The correct answer is B. Cholesterol is considered a nonpolar and very hydrophobic lipid. The other three choices are less hydrophobic and more polar than cholesterol, and are therefore incorrect. Ethanol (**choice A**) is a simple alcohol molecule and the most polar of the group. Palmitic acid (**choice C**) is a saturated, straight-chain fatty acid that is nonpolar but less so than cholesterol. Glycocholic acid (**choice D**) is a conjugated bile acid.

142. The correct answer is C. Phospholipid molecules are amphipathic—one end of the molecule is polar (carries a charge), while the other end of the molecule is nonpolar (does not carry a charge). The polar ends of the molecules interact with water molecules while the nonpolar ends mix with each other. When placed in water, amphipathic molecules will aggregate into tiny spherical droplets (micelles) with the polar ends of the phospholipids facing outward into the water environment and the nonpolar ends facing inward into the lipid droplet.

None of the other choices—serine (**choice A**), glycerol (**choice B**), and triglyceride (**choice D**)—are amphipathic molecules.

143. The correct answer is D. The vagus nerve is the parasympathetic nerve supplying the thoracic and abdominal organs. Increased impulse activity on the vagus nerve supplying the heart will slow the heart rate. The decreased rate of contraction will reduce oxygen consumption by the heart.

Increased heart rate (**choice A**) is incorrect because vagal activity decreases heart rate. Increased stroke volume (**choice B**) is incorrect because stimulating the vagus does not increase stroke volume.

Increased cardiac output (**choice C**) is incorrect because slowing the heart rate reduces cardiac output. Cardiac output is the product of heart rate multiplied by stroke volume. If the heart rate is decreased by vagal stimulation, then it follows that cardiac output will also be decreased.

Decreased transit time through the AV node (**choice E**) is incorrect because vagal stimulation slows the heart rate by increasing the time required for the cardiac action potential to be conducted through the AV node. This increases the transit time of the impulse through the AV node.

144. **The correct answer is C.** Phosphophoryn, a 60- to 70-kD phosphoprotein, has been identified by immunochemical and immunohistochemical methods in actively synthesizing odontoblasts and in dentin. It has high affinity for calcium and type I collagen. The rest of the choices are not specific to dentin, and are present in other cells and tissue types.

Laminins (**choice A**) are a family of noncollagenous glycoproteins in basement membranes. Vimentin (**choice B**) is a filamentous protein found in tissue derived from mesenchyme; it serves as a structural protein, often associated with microtubules. Osteonectin (**choice D**) is found in bone and facilitates the mineralization that occurs between collagen molecules. Fibronectin (**choice E**) is a structural protein found with laminin and collagen.

145. **The correct answer is A.** The explanation goes back to basic chemistry. To change from Cu^{2+} to Cu^+ , the copper ion needs to gain one electron. Gain of electrons is reduction. Meanwhile, the carbohydrate will lose an electron and be oxidized. Loss of electrons is oxidation. Remember: LEO (Loss of Electrons is Oxidation), the lion, says GER (Gain of Electrons is Reduction). Note that the carbohydrate, being oxidized, acts as a reducing agent on the copper, which gets reduced.

146. **The correct answer is D.** Coenzyme A is an important enzyme in the activation and transfer of carboxyl groups during glycolysis. Formylation (**choice A**) describes an enzyme action and is the process that results in the modification of amino acids during protein synthesis. Coenzyme A is not involved either in protein synthesis (**choice B**) or in the activation of methionine (**choice C**).

147. **The correct answer is C.** Before the carbon skeletons of most amino acids are metabolized, the alpha-amino group is removed. The principal mechanism for removal of amino groups from the common amino acids is via transamination, or the transfer of amino groups from the amino acid to a suitable alpha-keto acid acceptor. Several enzymes, called aminotransferases, are capable of removing the amino group from most amino acids and producing the corresponding alpha-keto acid. On the basis of this information, the other choices—formation of a dipeptide with glutamate (**choice A**), conjugation of the alpha amino to glucuronate (**choice B**), conjugation of the alpha carboxyl group to glucuronate (**choice D**), and decarboxylation of the alpha carboxyl group to form a primary amine (**choice E**)—would be incorrect.

148. **The correct answer is B.** Respiratory acidosis is a condition in which the blood becomes more acid because of the accumulation of CO_2 . Acidosis results from an increase in the H^+ concentration ($[\text{H}^+]$) in arterial blood. When CO_2 enters an aqueous medium, such as blood plasma, the following reactions occur:



An increase in blood CO_2 will lead to the formation of H^+ ions. pH is a measure of the acidity of a solution (pH is defined as $-\log [\text{H}^+]$). As the hydrogen ion concentration in a solution rises, pH decreases. The pH of plasma is normally 7.4. In acidosis it falls below this value.

149. **The correct answer is C.** Collagen is the major structural protein of all mineralized tissues except for enamel, which has very little protein. The other choices—elastin (**choice A**), keratin (**choice B**), amelogenin (**choice D**), and osteonectin (**choice E**)—are proteins found in mineralized tissues, but are present in small amounts compared with collagen

150. **The correct answer is E.** Both collagen and elastin are about one-third glycine. Collagen is a triple helix (**choice D**) stabilized by hydrogen bonding and has proline in its amino acid structure (**choice B**), but neither is true of elastin. Elastin has the ability to be stretched (**choice A**) but collagen does not. Neither elastin nor collagen has disulfide linkages (**choice C**).

151. **The correct answer is B.** Osmolality signifies the concentration of osmotically active solutes in 1 kg of water. The administration of antidiuretic hormone (ADH, or vasopressin) decreases the osmolality of plasma. It does this by causing the collecting duct of the nephron to become more permeable to water. Water then exits the urine being formed in the nephron tubule and is returned to blood vessels in the renal medulla. Thus, ADH prevents the excretion of water through the urine and promotes water retention within the body. The retention of water and its addition to the blood circulation decreases the concentration of solutes in plasma and thereby decreases plasma osmolality.

Aldosterone (**choice A**) is incorrect because aldosterone causes the nephron to retain sodium within the body. This will tend to increase, not decrease, plasma osmolality.

Angiotensin II (**choice C**) is incorrect because angiotensin II stimulates the adrenal cortex to secrete aldosterone, which increases plasma osmolality. Parathyroid hormone (**choice D**) is incorrect because parathyroid hormone elevates the plasma calcium ion concentration.

Isotonic saline solution (**choice E**) is incorrect because infusion of isotonic saline will increase the plasma volume but will not change plasma osmolality. An isotonic solution has the same osmolality as plasma.

152. **The correct answer is C.** Both facilitated diffusion and active transport utilize a protein carrier molecule to transport substances across the cell membrane. The process of facilitated diffusion moves substances in the direction of their electrical and concentration gradients and requires no energy input. On the other hand, active transport is a process that can move substances against their electrical and concentration gradients. This process requires energy input and is therefore associated with the breakdown of ATP.

The remaining choices do not distinguish facilitated diffusion from active transport. Both processes involve membrane carrier proteins (**choice B**), which have specificity for individual ions or molecules (**choice A**). Because the number of carrier molecules for any substance is limited, there is a transport maximum that caps the rate of transport of both processes (**choice D**).

153. **The correct answer is A.** The chief (peptic) cells within the gastric glands secrete pepsinogen. They do not secrete bicarbonate ion (HCO_3^-).

The remaining answer choices are incorrect because they are all cell types of the gastrointestinal tract that do secrete HCO_3^- . The goblet cells of the colonic mucosa (**choice B**)

secrete an aqueous fluid rich in HCO_3^- . The duct cells of the salivary gland (**choice C**) add HCO_3^- to the saliva so that saliva is basic during active secretion.

The acid secreted by the oxyntic cells could damage the wall of the stomach (**choice D**). One of the factors preventing such damage is the secretion of a basic fluid by the gastric mucosal cells. This fluid contains HCO_3^- .

154. **The correct answer is B.** The electron transport process within mitochondria generates energy. Fuel oxidation generates NADH and FADH. Oxidation of reduced nucleotides via the electron transport system reduces oxygen to water and pumps protons (H^+) out of the mitochondria, forming a proton gradient across the membrane. Influx of protons back into the mitochondrion powers the synthesis of ATP by ATP synthase. Mitochondrial ATP is then exchanged for cytoplasmic ADP and phosphate.

Excess H^+ in the matrix (**choice A**), the formation of thioesters in the matrix (**choice C**), and a conformational change in the inner membrane (**choice D**) are all incorrect.

155. **The correct answer is D.** Virtually all human cells have the capacity to make cholesterol. However, the liver is the major site of cholesterol biosynthesis. The synthesis of cholesterol requires a source of carbon atoms, a source of reducing power, and the expenditure of significant amounts of energy. Acetyl coenzyme A (acetyl CoA) provides a high-energy starting point. Acetyl CoA may be derived from several sources, including the beta-oxidation of long-chain fatty acids, the dehydrogenation of pyruvate, and the oxidation of ketogenic amino acids. The reducing power is provided by reduced nicotinamide dinucleotide phosphate (NADPH), which is generated by the enzymes of the pentose phosphate pathway.

The other choices— NA^+ (**choice A**), NADH (**choice B**), NADP^+ (**choice C**), and FADH_2 (**choice E**)—are also coenzymes but are not involved as reducing agents in the production of cholesterol.

156. **The correct answer is D.** Protein synthesis (translation) represents the transfer of genetic information stored in DNA to protein molecules. It is during translation that the information carried on an RNA molecule is used to direct the synthesis of a protein. The interaction between the RNA to be translated and the protein synthetic machinery involves three main components: ribosomes (rRNA, **choice A**), mRNA (**choice B**), and tRNA. The ribosome is the machine on which all proteins are synthesized. mRNA contains the information required to direct the synthesis of the primary sequence of the protein, although only a portion of that information is used to encode the protein. tRNAs carry the amino acids that are to be incorporated into the protein. cDNA (**choice C**) is made in the laboratory from mRNAs using the enzyme reverse transcriptase. Unlike eukaryotic genomic DNA, cDNA does not contain intervening sequences. A complete cDNA may contain all the information needed to synthesize an mRNA for a specific protein. hnRNA (heteronuclear ribonucleic acid, **choice E**) can serve as precursor to mRNA and other RNAs.

157. **The correct answer is A.** Uracil is found in RNA but not DNA; it replaces thymine (**choice C**). Guanine (**choice B**), adenine (**choice D**), and cytosine (**choice E**) are found in both RNA and DNA.

158. **The correct answer is E.** Pulmonary compliance is defined as the degree to which lung volume changes in response to a unit change in transpulmonary pressure. It is a measure of the distensibility of the lung. In the absence of surfactant, the lung is much less distensible and much more difficult to expand. In other words: In the absence of surfactant, compliance is decreased. The retractive forces that tend to collapse the lung are great. The most important force in this regard is surface tension. Surfactant is a phospholipid substance

that markedly reduces surface tension and thereby reduces the tendency of the lung to collapse. When surfactant is absent, the tendency of the lung to retract becomes great.

Vital capacity is the volume of air expelled by a full exhalation after the lungs have been filled by a maximum inhalation. If the compliance is reduced because the lungs are stiffer, a maximum inhalation will not be able to fully fill the lungs. Thus, vital capacity will be reduced.

- 159. The correct answer is D.** In almost all sensory systems, recordings of the activity of the afferent fiber during exposure to a constant stimulus show a decline in firing frequency in the course of time. This process is called adaptation.

Refraction (**choice A**), potentiation (**choice B**), perception (**choice C**), and accommodation (**choice E**) are terms used for other neural and sensory functions.

- 160. The correct answer is A.** Blood is composed of red blood cells, white blood cells, platelets, and plasma. Hematocrit is the percentage of the blood volume that is occupied by red blood cells. It averages 45% in men and 42% in women.

Venous blood with pH of 7.2 (**choice B**) is incorrect because the normal pH of venous blood is 7.4. A white blood cell count of 10,000/mm³ (**choice C**) is incorrect because the normal white cell count is about 7,000/mm³. A red blood cell count of 7 million/mm³ (**choice D**) is incorrect because the normal red blood cell count for males is 5.2 million/mm³.

A pulse pressure equal to 80 mm Hg (**choice E**) is incorrect because pulse pressure on the left is about 40 mm Hg and on the right is about 17 mm Hg. Pulse pressure is the difference between systolic and diastolic pressures.

- 161. The correct answer is E.** The middle ear cavity is normally an air-filled space. Gases of the air are continuously absorbed by the mucosal lining of the middle ear, causing pressure in this cavity to fall. Unless the pressure in the middle ear is equalized to the pressure of the external ear, the reduced pressure in the middle ear will cause the tympanic membrane (eardrum) to be stretched inward, arousing pain. The eustachian tube connects the middle ear cavity to the nasopharynx and allows the pressure in the middle ear to be equalized to the pressure of the external ear, i.e., atmospheric pressure. Contraction of the tensor veli palatini muscle during swallowing opens the eustachian tube periodically and allows air to enter the middle ear cavity to equalize pressure. If the eustachian tube is blocked, equalization of pressures cannot occur, pressure in the middle ear will fall, the eardrum will become stretched, and earache will ensue.

- 162. Item not scored.**

- 163. The correct answer is B.** This question refers to the Hering-Breuer reflex, in which lung inflation stimulates stretch receptors within lung tissue. The afferent nerve fibers from these receptors travel within the vagus nerve and terminate in the respiratory centers of the brain stem. Activity of these afferents exerts an inhibitory influence on inspiratory movement. Although not prominent in adult humans, the Hering-Breuer reflex is one of the feedbacks that limits lung expansion during breathing.

The remaining choices are incorrect because the lung does not contain receptors for hydrogen ions (**choice A**), alveolar oxygen (**choice C**), or alveolar carbon dioxide (**choice D**)—all of which, when stimulated, will affect inspiration

- 164. The correct answer is C.** Bacterial plasmid vectors are usually small (which makes **choice D**—large size to facilitate plasmid's entry into cells—an incorrect answer, are composed of only a few thousand base pairs, and are rarely associated with the large chromosomal

molecule (making **choice A**—must be able to replicate synchronously with the host chromosome—an incorrect answer). Genes within the plasmid have various functions; one of the most useful is the ability to confer antibiotic resistance to the bacterium, an attribute helpful in selecting specific colonies of the bacteria. Plasmids replicate independently of replication of the main bacterial chromosome. By having two genes that confer antibiotic resistance present in the vector, selection can be more precise.

165. The correct answer is B. This question refers to the Brown-Sequard syndrome that results from hemisection of the spinal cord. Although descending motor fibers of the corticospinal (pyramidal) tract decussate in the brain stem, they descend through the spinal cord without further crossing and they control motor neurons on the same side of the cord. The pain and temperature pathway, however, does cross in the spinal cord. Pain and temperature afferents synapse on entry to the spinal cord and the second-order fibers cross within the spinal cord. These fibers join the spinothalamic tract on the opposite side to ascend to the brain. A hemisection of the spinal cord, therefore, will cut motor fibers descending ipsilaterally to control muscles and pain and temperature fibers that are ascending from receptors on the opposite side of the body. The result of a lesion of the right half of the spinal cord will be that below the level of the lesion, there will be paralysis of muscles on the right side and loss of pain and temperature sensation on the left.

166. The correct answer is B. To maintain the geometry of the double-helical structure of DNA, a larger purine (A or G) must pair with a smaller pyrimidine (C or T). In natural DNA, A almost always hydrogen-bonds with T, and G with C, forming A•T and G•C base pairs (often called Watson-Crick base pairs). Therefore, if the percentage of A is 22%, then T would also be 22%; G and C would be 28%.

167. The correct answer is A. Striated muscle is composed of sarcomeres. A sarcomere extends from one Z line to the next. Thin filaments attach to the Z lines and extend toward the center of the sarcomere. In the center of the sarcomere are thick filaments. The region around the Z line, where only thin filaments are located, is the I (isotropic) band. The region in the center of the sarcomere where the thick filaments are located, and where these overlap thin filaments, is the A (Anisotropic) band. In an isotonic contraction, muscle shortens and the Z lines move toward each other. This results from the action of crossbridges on the thick filaments, which slide the thin filaments toward the center of the sarcomere. The thick filaments forming the A band do not shorten.

I band (**choice B**) is incorrect; the I bands do become shorter in length during contraction because the thin filaments are pulled toward the center of the sarcomere. Muscle sarcomeres (**choice C**) is incorrect because muscle shortening is the result of shortening of the individual sarcomeres. Two consecutive Z lines (**choice D**) is incorrect because sarcomere shortening means that the distance between Z lines is reduced.

Series elastic elements (**choice E**) is incorrect because muscle shortening pulls on elastic elements of muscle that are in series with sarcomeres, such as tendons, and stretches them.

168. The correct answer is B. Decreased oxygen levels in the heart, as occurs during increased cardiac work when cells utilize more oxygen, causes adenosine to be released from cardiac muscle cells. Adenosine induces dilation of coronary arterioles that supply blood to the heart muscle. This causes increased blood flow to the myocardium and allows more oxygenated blood to supply the heart.

Vasoconstriction of coronary vessels (**choice A**) is incorrect because decreased oxygen concentration in the heart causes vasodilation of the coronary vessels. **Choices C and D** are incorrect because chemoreceptors for oxygen tension are not present in the heart.

169. The correct answer is A. Insulin is the hormone secreted when there is an abundance of glucose in the blood. It lowers plasma glucose by promoting the uptake, storage, and breakdown of glucose and other metabolic fuels. Insulin insufficiency, the cause of diabetes mellitus, results in reduced uptake of carbohydrates by cells. So instead of using glucose for their energy needs, cells break down fatty acids. These are metabolized by the liver into acetyl-CoA units. Two molecules of acetyl-CoA condense to form acetoacetic acid. Some of the acetoacetic acid is converted to beta-hydroxybutyric acid and acetone. These three substances (acetoacetic acid, beta-hydroxybutyric acid, and acetone) are known as ketone bodies.

Cholesterol synthesis (**choice B**) is incorrect because insulin deficiency does not increase cholesterol synthesis. Fatty-acid synthesis (**choice C**) is incorrect because insulin deficiency causes fatty-acid synthesis to be impaired. Gluconeogenesis (**choice D**) is incorrect because the pathway for gluconeogenesis, the formation of glucose from amino acid precursors, involves pyruvate, not acetyl-CoA.

The Krebs cycle (**choice E**) is an incorrect choice because insulin promotes the utilization of acetyl-CoA in the Krebs cycle. So insulin deficiency cannot have this effect.

170. The correct answer is B. If acid is added to the body, the kidney eliminates excess H^+ in the form of ammonium ion (NH_4^+). The kidney increases its production of ammonia (NH_3) from the precursor, glutamine. Ammonia enters the tubular urine and combines with hydrogen ion to form NH_4^+ , which is excreted in the urine.

171. The correct answer is C. Calcitonin is secreted when serum calcium is elevated. It inhibits the release of calcium into the plasma by suppressing osteoclast action on bone. This will lower the serum level of calcium. In addition, calcitonin acts on the kidney to increase the excretion of both calcium and phosphate. Increased excretion lowers serum levels of these ions.

172. The correct answer is B. We label atoms by the number of protons in their nucleus. If two nuclei have the same number of protons, we say that they are the same element even if the number of neutrons is different. Atoms that have the same number of protons and different numbers of neutrons are different isotopes of the same element.

Atoms cannot have the same mass numbers but different atomic numbers (**choice C**).

173. The correct answer is B. Sodium fluoride is an important anticaries compound. Fluoride acts on hydroxyapatite of the enamel and on the bacteria of dental decay. At the high fluoride concentrations used for office topical therapy, there is at least a temporary effect on bacterial metabolism, inhibiting glycolysis through inhibition of enolase and suppressing *Streptococcus mutans*. At lower fluoride concentrations, such as systemic fluoride provided by water fluoridation, supplements, or topical fluoride from toothpastes and mouth rinses, there is an uptake of fluoride by hydroxyapatite, rendering it less soluble. Sodium fluoride does not inhibit amylase (**choice A**), phosphatase (**choice C**), or phosphorylase (**choice D**).

174. The correct answer is D. By increasing ventilation, CO_2 accumulated in alveoli from the blood is blown off. Recall the chemical equilibrium equation for carbon dioxide:



If CO_2 is removed from the blood by hyperventilation, the equilibrium will be shifted to the left and H^+ will be removed as well. Lower hydrogen ion concentration is measured as an increase in pH.

175. **The correct answer is C**, intermolecular cross-linkage. Glycosylation (**choice A**) and hydroxylation (**choice B**) occur intracellularly, before secretion. Collagen does not contain disulfide bonds (**choice D**).

176. **The correct answer is B**. The balance between acidic and basic side chains in a protein determines its isoelectric point (pI) and net charge in solution. Proteins rich in lysine and arginine are basic in solution and cationic at neutral pH, whereas acidic proteins, rich in aspartate and glutamate residues, are acidic and anionic. Because of their side-chain functional groups, all proteins become more positively charged at acidic pH and more negatively charged at basic pH.

If the pH becomes lower than its isoelectric point, a protein in a photoelectric system will not become denatured (**choice A**), migrate to the positive pole (**choice C**), remain stationary and unchanged (**choice D**), or separate into its different monomeric forms (**choice E**).

177. **The correct answer is A**. Much of the carbon flow that occurs between skeletal muscle and the liver is regulated by the release of alanine into the blood and its uptake by the liver. The alanine taken into the liver is converted to pyruvate and the nitrogen component is incorporated into urea. In this “glucose-alanine cycle” three carbons are transported to the liver for gluconeogenesis, along with a nitrogen atom. The functioning of this cycle allows the net conversion of amino acid carbons to glucose, the elimination of amino acid nitrogen as urea, and the return of carbons to the peripheral tissues in the form of glucose. Urea is by far the primary form of excreted nitrogen in humans, but in healthy individuals, small amounts of nitrogen are excreted in the form of uric acid (**choice E**), creatinine, and ammonium ion. Catabolism of amino acids generates ammonia (**choice B**), which is toxic, particularly to the central nervous system. Most ammonia is detoxified at its site of formation by amidation of glutamate to glutamine. Creatine (**choice C**) is synthesized from glycine and arginine (**choice D**) precursors.

178. **The correct answer is C**. The Henderson-Hasselbalch equation, shown below, is useful in dealing with acid-base equilibrium systems and is often used for making buffer solutions.

$$\text{pH} = \text{p}K_a + \log \left(\frac{[\text{A}^-]}{[\text{HA}]} \right)$$

When the conjugate base (A^-) and acid (HA) are present at equal concentrations, their ratio is 1, and the log is 0, so $\text{pH} = \text{p}K_a$.

179. **The correct answer is C**. Fatty acids and monoglycerides produced during intestinal digestion of lipids are absorbed by enterocytes of the small intestine. In enterocytes, monoglycerides and fatty acids are joined together into triglycerides. The triglycerides are packaged with apoproteins into chylomicrons. Chylomicrons are large lipoprotein particles that contain a substantial amount of triglyceride and are, therefore, of reduced density. Chylomicrons pass into lacteals—lymphatic vessels of the small intestine. From the lymph, chylomicrons enter the circulation. Remnants of chylomicrons are absorbed by cells of the liver.

Very low-density lipoprotein (**choice A**) and low-density lipoprotein (**choice B**) are incorrect because VLDLs and LDLs travel in the blood circulation and do not pass through the lymphatic system. Liposomes (**choice D**) is incorrect because liposomes are lipid spheres manufactured in the laboratory that are used to deliver DNA and other agents into cells. Micelles (**choice E**) is an incorrect choice because micelles (aggregates of bile salts, monoglycerides, fatty acids, and cholesterol) transport lipids within the lumen of the small intestine to the brush borders of enterocytes. Micelles do not enter the lymph system.

- 180. The correct answer is A.** The hypothalamus produces a prolactin-inhibiting substance, now known to be dopamine, that is released into the primary capillary plexus of the hypothalamus. This factor is then transported through the pituitary portal vein to the secondary capillary plexus in the anterior pituitary. The pituitary's production of prolactin is then inhibited. Blocking this portal system removes the inhibitory brake on prolactin synthesis and prolactin will be secreted from the anterior pituitary gland in large quantities.
- Oxytocin (**choice B**) is also synthesized in the hypothalamus but is not transported by the portal system. It is released into the bloodstream from the posterior pituitary.
- Both ACTH (**choice C**) and TSH (**choice D**) are anterior pituitary hormones whose control is through means of hypothalamic releasing hormones. Blocking the portal system will remove a stimulatory factor for these two trophic hormones, and their secretion rates will be reduced.
- 181. The correct answer is D.** Transferrin is the plasma protein that binds the ionized form of iron and carries it through the bloodstream. Cells that require iron have membrane receptors that bind transferrin.
- The remaining choices, although they are iron-containing substances, are not plasma proteins that transport iron in the circulation. Iron that is stored inside cells complexes with a protein and is stored in the form of ferritin (**choice A**).
- Hemoglobin (**choice C**) is present in red blood cells and consists of a protein (globin) conjugated to an iron-containing pigment (heme). Hemoglobin is not a plasma protein.
- Myoglobin (**choice B**), a compound similar to hemoglobin, is present in skeletal muscle and stores oxygen. It is not a plasma protein. Cytochrome-c (**choice E**) is a compound that is part of the electron transport chain present within mitochondria.
- 182. The correct answer is B.** Saccharin is widely used as an artificial sweetener. It provides no nutritional value. D-fructose (**choice A**), galactose (**choice C**), and maltose (**choice E**) are naturally occurring carbohydrates. Sorbitol (**choice D**) occurs naturally in cherries, plums, pears, apples, many berries, seaweed, and algae. It is prepared industrially from glucose by high-pressure hydrogenation or by electrolytic reduction.
- 183. The correct answer is D.** In liver and muscle cells, epinephrine stimulates elevation in the cAMP level and enhances the conversion of glycogen to glucose 1-phosphate by two pathways: by inhibiting glycogen synthesis, and by stimulating glycogen degradation. The entire process is reversed when epinephrine is removed and the level of cAMP drops. This reversal is mediated by phosphoprotein phosphatase, which removes the phosphate residues from the inactive form of glycogen synthase, activating it, and from the active forms of glycogen phosphorylase kinase and glycogen phosphorylase, thereby inactivating them.
- ATPase (**choice A**), adenylyl cyclase (**choice B**), glycogen synthetase (**choice C**), and glycogen phosphorylase phosphatase (**choice E**) are all incorrect answers.
- 184. The correct answer is C.** Acromegaly is a condition in which there is abnormal widening of facial and other bones. It is caused by hypersecretion of growth hormone, also called somatotropin, in adulthood. Hypersecretion of somatotropin in young persons, before fusion of the epiphyses of the long bones, results in gigantism rather than bone widening.
- 185. The correct answer is D.** Even a small increase in plasma potassium causes an immediate increase in aldosterone secretion from the adrenal gland. Aldosterone acts on cells of the distal tubule of the kidney to enhance potassium excretion. At the same time, it increases sodium retention.

Although insulin (**choice A**) stimulates muscle cells to take up potassium, insulin is not involved in potassium regulation and is not secreted in response to hyperkalemia.

Cortisol (**choice B**) is another steroid secreted by the adrenal cortex. However, it is a glucocorticoid. It affects carbohydrate metabolism but not the handling of cations by the kidney.

Calcitonin (**choice C**) and parathyroid hormone (**choice E**) are involved in regulation of calcium—not potassium.

- 186. The correct answer is A.** The Frank-Starling law states that with increased diastolic filling volume, also described as increased “preload,” the tension, or force, developed by the ventricular muscle cells increases—up to a maximum value. Filling of the ventricle during diastole increases the length of cardiac muscle fibers. With increased length, the pressure developed during systole is increased.

Although **choice B** (the strength of contraction depends on the strength of the ventricular muscle) is a correct statement, it does not express the Frank-Starling Law of the Heart. This choice describes contractility, not preload.

Choice C (the heart rate depends directly on the thickness of the ventricle) is not a correct statement and not a statement of the Frank-Starling law. Heart rate does not depend on the thickness of the ventricle.

Choice D (the strength of contraction depends on the strength of the stimulus) is not a correct statement and not a statement of the Frank-Starling law. Because the ventricular action potential is an “all-or-none” phenomenon, the strength of contraction is not a function of the strength of the stimulus.

- 187. The correct answer is D.** This question tests knowledge of the baroreceptor reflex. This reflex is a negative feedback system organized to maintain the constancy of blood pressure. An increase in arterial pressure stimulates stretch receptors of the carotid sinus. The information from the carotid sinus passes to the cardiovascular control centers of the medulla, which bring about a decrease in blood pressure. Firing on sympathetic nerve fibers, which increase heart rate and stroke volume and which cause constriction of peripheral arterioles, is reduced. Firing of parasympathetic fibers, which slow the heart rate, is increased. As a result of this inhibition of the sympathetic nervous system and stimulation of the parasympathetic nervous system, arterial blood pressure is reduced.

An increase in heart rate and strength of contraction (**choice A**), an increase in peripheral vasoconstriction (**choice B**), and excitation of the sympathetic nervous system (**choice C**) would further raise blood pressure. However, the negative feedback role of the baroreceptor reflex is to lower blood pressure in reaction to an increase in arterial pressure.

- 188. The correct answer is B.** When an increase in one variable causes a reduction in the value of a second variable, the two variables are inversely proportional. As the thickness of the alveolar membrane of the lung is increased, the rate of diffusion of oxygen and other gases across the membrane is decreased. The reason these two factors are inversely proportional is that an increase in membrane thickness increases the distance to be traveled by a molecule crossing the membrane. The rate at which molecules diffuse across this barrier is therefore reduced.

As the surface area (**choice A**), the pressure gradient (**choice C**), or the solubility of the gas in water (**choice D**) increase, it is more probable that a molecule of gas will cross the membrane. Thus, the rate of diffusion is directly proportional to these variables.

189. The correct answer is B. In excising a gland and transplanting it to a new location, the nervous connections to the gland are cut. In a successful transplant, new vascular connections grow and maintain the viability of the transplanted tissue. The exocrine pancreas is stimulated to secrete digestive juice through hormones circulating in the blood. Food products in chyme act on cells of the duodenum to induce the release into the bloodstream of the hormones secretin and cholecystokinin. These hormones travel through the circulation to excite the pancreas, wherever it is located, to secrete digestive juices.

Parotid and pancreatic transplants (**choice A**) and the fragment of the parotid only (**choice B**) are incorrect because salivary glands are stimulated to secrete saliva through neural connections, not through hormonal substances carried in the bloodstream.

190. The correct answer is B. There are several defined phases of the cardiac cycle. During atrial systole the mitral and tricuspid valves (atrioventricular, or AV, valves) leading from the atria to the ventricles are open to allow blood to flow into the ventricles while the aortic and pulmonic valves are closed. When the ventricle begins to contract, the AV valves snap shut, preventing the backflow of blood into the atria. This period, when both the valves allowing blood to enter the ventricle and the valves allowing blood to leave the ventricle are closed, is denoted the isovolumetric ventricular contraction phase. This term points to the fact that, despite the rising pressure generated by ventricular contraction, the volume of the ventricle remains constant. Once ventricular pressures exceed pressures in the aorta and pulmonary arteries, the aortic and pulmonic valves open and blood leaves the ventricles. This is the ejection phase of the cardiac cycle.

Choice A (all valves are open) is incorrect because in no phase of the cardiac cycle are the AV valves and the aortic and pulmonic valves open simultaneously. **Choice C** (aortic and pulmonary valves open, mitral and tricuspid valves closed) and **choice D** (aortic and pulmonary valves closed, mitral and tricuspid valves open) are both incorrect because if any valves are open, the contraction cannot be isovolumetric. Blood will enter or exit through open valves, thereby changing the volume of the ventricle.

191. The correct answer is B. The muscle spindle is a stretch receptor, located in skeletal muscles, that senses muscle length. The axons of the motor neurons that innervate regular (extrafusal) muscle fibers in a skeletal muscle are thickly myelinated A-alpha nerve fibers. The axons of the specialized motor neurons that innervate the polar ends of the spindle (intrafusal) fibers are the smaller A-gamma fibers. Activity on gamma motor fibers causes a slight contraction of the intrafusal muscle fibers and elevates firing of the spindle afferents. This increases the excitability and sensitivity of the spindle.

Load on the muscle (**choice A**) and length of the extrafusal fibers (**choice D**) are incorrect because attaching a load to the muscle lengthening the extrafusal fibers is the normal stimulus to the spindle receptor. These do not represent an increase in excitability.

Alpha efferent discharge (**choice C**) is incorrect because alpha motor neurons innervate the extrafusal fibers, which make up the bulk of the muscle, and cause the muscle to shorten. The spindle is sensitive to lengthening, not shortening, of muscle. Firing of the sensory afferent fibers from the spindle may actually be reduced during muscle shortening.

192. The correct answer is D. In a normal person, muscular exercise is accompanied by an increase in sympathetic discharge, which increases cardiac output by increasing heart rate and stroke volume. If the heart is denervated, as in patients with heart transplants, cardiac output rises during muscle exercise despite the absence of a sympathetic nerve supply. The increased cardiac output in this case is a function of the Frank-Starling mechanism. When workload is increased, venous return increases. Contraction of limb muscles squeezes veins, thereby pushing blood toward the heart. The increased venous return increases diastolic filling of the

ventricle. An increase in end diastolic volume induces an increase in stroke volume. The increased stroke volume is responsible for the increase in cardiac output.

- 193. The correct answer is A.** The rise in plasma glucose that occurs during the absorptive period immediately after a meal stimulates the release of insulin from pancreatic beta cells. Insulin acts to remove glucose and other fuels from the blood. In the postabsorptive state, as glucose is utilized for tissue metabolism, plasma glucose levels fall and the secretion of insulin is reduced.

Glucagon (**choice B**) is incorrect because the action of glucagon is to raise plasma levels of glucose and other metabolic fuels. It is not secreted when plasma glucose is rising, as it is during the absorptive state.

Cortisol (**choice C**) and epinephrine (**choice E**) are incorrect because cortisol and epinephrine secretion are triggered by hypoglycemia, not by the absorption of glucose. Thyroxine (**choice D**) is incorrect because the rate of thyroid hormone secretion is not affected by the absorptive process or by the levels of metabolites in plasma.

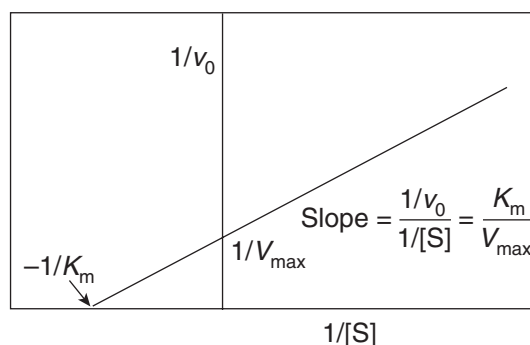
- 194. The correct answer is D.** Impaired systolic emptying, which is the defining problem in congestive heart failure, results in elevated ventricular end diastolic pressure because blood accumulates in the ventricle. This increase in diastolic pressure is reflected back into the atrium and veins, increasing venous pressure. This may become noticeable as distension of neck veins.

- 195. The correct answer is A.** Parathyroid hormone (PTH) acts to elevate plasma calcium and to depress plasma phosphate. PTH acts on bone and the kidney to bring about these changes in plasma ion concentrations. It stimulates osteoclasts and increases phosphate excretion. Removal of the parathyroid glands will, therefore, result in a drop in plasma calcium and an increase in plasma phosphate.

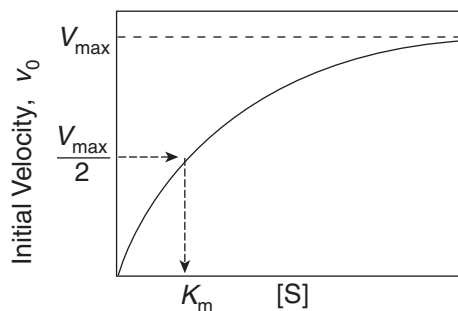
- 196. The correct answer is B.** This linear form of the Michaelis-Menten equation

$$\text{Velocity} = v = \frac{V_{\max} \cdot [S]}{K_m + [S]}$$

is often referred to as the Lineweaver-Burk, or double-reciprocal plot.



Using this graph, the y-intercept = $1/V_{\max}$. The K_m can be determined by the x-intercept. K_m (**choice C**) is determined using the normal plot. $[S]$ (**choice D**) can be determined through use of the equation.



197. **The correct answer is A.** Carbonic anhydrase is an enzyme present in red blood cells. It accelerates the hydration of CO_2 to H_2CO_3 . The H_2CO_3 dissociates to H^+ and HCO_3^- (bicarbonate ion). Much of the bicarbonate leaves the red blood cells. As a result of the action of carbonic anhydrase, at least 70% of the CO_2 transported in the blood is carried in the form of HCO_3^- in red blood cells and plasma. In the absence of carbonic anhydrase, the capacity of the blood to carry CO_2 would be severely impaired.

Alkaline phosphatase (**choice B**), pyruvate carboxykinase (**choice C**), histidine decarboxylase (**choice D**), and serum glutamic-oxaloacetate transaminase (**choice E**) are incorrect because these enzymes are not involved in processes that affect the carriage of CO_2 .

198. **The correct answer is C.** Diabetes mellitus is a disease in which there is a deficiency of insulin (type 1) or of insulin receptors (type 2). Insulin is a hormone that lowers blood glucose. In the absence of insulin action, plasma glucose levels are elevated. This hyperglycemia results in an increased filtration of glucose at the kidney glomerulus. When the reabsorptive capacity of the kidney for glucose is exceeded, glucose will spill into the urine, resulting in glucosuria.

Choice A is incorrect because pellagra, in which there is a deficiency of the vitamin niacin (nicotinic acid), does not result in hyperglycemia or glucosuria. **Choice B** is incorrect because Addison's disease, in which there is a deficiency of mineralocorticoids, causes hyponatremia and hyperkalemia, not hyperglycemia or glucosuria. **Choice D** is incorrect because diabetes insipidus, in which there is a deficiency of ADH and the ensuing water diuresis, does not result in hyperglycemia or glucosuria. **Choice E** is incorrect because Parkinson's disease is a neurologic disease that does not affect glucose metabolism.

199. **The correct answer is A.** The primary urine is formed by the filtration of plasma at the glomerulus of the nephron. Most of the solute material dissolved in plasma is in the form of sodium salts (NaCl and NaHCO_3). About two-thirds of urinary sodium is reabsorbed by active transport in the proximal tubule. Because water reabsorption is osmotically coupled to salt reabsorption, it follows that the major site for reabsorption of the glomerular filtrate is the proximal tubule.

The loop of Henle (**choices B and C**), the distal convoluted tubule (**choice D**), and the collecting duct (**choice E**) together reabsorb the remainder of the Na^+ and water. Only a small fraction of the primary filtrate is excreted.

200. **The correct answer is B.** The monosaccharides with six carbon atoms are called hexoses; among these are glucose, galactose, fructose, and mannose. Conversion of the open chain to the ring structure may be considered as the formation of a hemiacetal between the aldehyde group at carbon 1 and the hydroxyl group at carbon 5. The carbon atom that may have a carbonyl group is known as the anomeric carbon. In the case of glucose the anomeric carbon is carbon 1. In the case of fructose, the anomeric carbon is carbon 2.

Microbiology-Pathology

1. **The correct answer is E.** Lead, a heavy metal, is often still present in items such as batteries, solder, ammunition, roofing materials, and old house paint. People are exposed to lead by breathing air, drinking water, eating food, or swallowing or touching dust or dirt that contains lead (children's main exposure is the paint particles in the dust of older homes).

Mood swings, irritability, severe abdominal pain, headaches, and loss of motor coordination are symptoms of lead poisoning, as well as central nervous system damage as evidenced by peripheral neuropathy of wrist or foot drop. This latter is the inability to maintain the hand or foot in a normal position due to weakness of muscle tone caused by the nerve damage. Adults may also have kidney damage, anemia, hypertension, impotence, sterility, and miscarriages. Young children have speech delay, hyperactivity, attention deficit disorder, learning disabilities, behavioral disorders, neurologic and renal damage, stunted growth, anemia, hearing loss, and sometimes mental retardation. Lead levels can be reduced with certain techniques, but the damage that lead poisoning causes is not always reversible. Chelation therapy is the injection of organic acids that binds tightly with the lead. The blood test is the blood lead level (BLL). Blood lead is monitored in workers whose environments contain lead.

Carbon tetrachloride (**choice A**) is a colorless liquid with a characteristic ether-like odor, with poisoning causing human fatalities from acute kidney damage.

Carbon monoxide (CO) (**choice B**) is a colorless, odorless gas that is produced as a result of incomplete burning of carbon-containing fuels, which reduces the blood's ability to carry oxygen. Breathing low levels of CO can cause fatigue and increase chest pain in people with chronic heart disease. Breathing higher levels of CO causes flulike symptoms such as headaches, dizziness, and weakness in healthy people, as well as sleepiness, nausea, vomiting, confusion, and disorientation. At very high levels, it causes loss of consciousness and death.

Bismuth (**choice C**) is another heavy metal-like lead that can lead to abnormalities from deposition of the metal in the skeleton. In particular, in pregnant women receiving bismuth injections for syphilis, the metal may be deposited in the fetal skeleton after crossing the placenta. Radiographically, the metaphyses of tubular bones may show radiodense lines or bands that resemble those of lead poisoning; the presence of thick transverse radiodense lines in the metaphyses of growing tubular bones.

Mercury (**choice D**) is found naturally in the environment in several forms. In its elemental form, mercury is a shiny, silver-white liquid metal used in thermometers and some electrical switches. It can be combined with other elements to form inorganic compounds. Mercury can evaporate to form colorless, odorless mercury vapors. People are most likely to be exposed to metallic mercury in minute amounts from mercury released from dental fillings; however the amount of mercury released from dental fillings is not considered to be high enough to cause adverse health effects. Exposure and health risks may be determined by measuring the amounts of mercury in blood, urine, breast milk, and hair. Over time, the body can rid itself of some contamination. Adults who consume

an unusually large amount of contaminated fish on a regular basis may also be at risk. The primary symptoms are vague, with short-time memory deteriorating and an inability to concentrate on tasks that require attention and thinking.

- The correct answer is C.** Herpes zoster (shingles) is a viral infection caused by the same virus that causes chickenpox (varicella zoster), and anyone who has had this childhood infection can develop shingles. The virus remains dormant or inactive in certain nerve root cells of the body and can later reactivate. It is not clear what prompts the virus to reactivate in healthy people—possibly a temporary weakness in immunity. People whose immunity is weakened for any reason are more prone to develop shingles. The first symptom is burning pain, tingling, or extreme sensitivity in one area of the skin, usually limited to one side of the body. This may be present for 1 to 3 days before a red rash appears at the site that soon turns into groups of vesicles that look like chickenpox.

Measles (**choice A**), or rubeola, is best known for its typical skin rash. It is, however, primarily a respiratory infection also caused by a virus. The first symptoms are irritability, runny nose, eyes that are red and sensitive to light, hacking cough, and a fever, as well as Koplik's spots (small, red, irregularly shaped spots with blue-white centers on the buccal mucosa). There is a vaccine to protect against measles, given as part of the combination MMR vaccine that protects against measles, mumps, and rubella.

Roseola (**choice B**) is also a viral illness caused by a herpes virus. A child may first have a mild upper respiratory illness and then develop a high fever. During this time the child may appear fussy or irritable, and there may be a sore pharynx with swollen glands in the neck. A pink, raised rash appears on the child's trunk as the fever ends.

Meningitis is an infection of the fluid in the spinal cord and the fluid that surrounds the brain. Viral meningitis (**choice D**) is usually relatively mild. It clears up in a week or two without specific treatment and is caused by any of a number of different viruses, many of which are associated with other diseases. About half of the cases in the United States are caused by common intestinal viruses.

Infectious mononucleosis (**choice E**) ("mono") is an illness caused by the Epstein-Barr virus (EBV), also a member of the herpes virus family.

- The correct answer is A.** Oncogenes are genes involved in cancer formation. Benign versions of these genes, present in normal cells and not currently involved in active cancer activity, are known as protooncogenes. They may be individual components of complicated pathways that control cell and tissue growth. Incorrect expression of these oncogenes might result in uncontrolled growth (tumors). Note that the oncogenes come from viruses (tumor viruses) but cause cancer in eukaryotic host cells. Most of the tumorviruses are retroviruses, but retroviruses have many other genes besides oncogenes. Homologous chromosomes (**choice E**) refers to the two chromosomes of a pair (for example, chromosome 17), one inherited from each parent.
- The correct answer is E.** Bacteria are single-celled microorganisms that can replicate and live independently and also can be seen by light microscope. However, medically they are a major cause of disease. Major advances in bacteriology over the last century have resulted in the development of many effective vaccines for certain bacterial infections (e.g., diphtheria toxoid, pertussis, and tetanus toxoid; pneumococcal polysaccharide) as well as of other vaccines (e.g., cholera, typhoid, plague) that are less effective or have side effects. Diphtheria, tetanus (lockjaw), and pertussis (whooping cough) are serious diseases. Diphtheria and pertussis spread when bacteria pass from an infected person to the nose or pharynx of another. Tetanus is caused by the bacteria entering the body through a cut or wound. Most children should have a total of five routinely given DTaP vaccinations at

set ages (containing all three vaccines: diphtheria, tetanus, and acellular pertussis). The newer form of the vaccination (containing purified antigenic components of *Bordetella pertussis*) is less likely to cause the mild and moderate problems present with the older DTP vaccine, which contains whole-cell pertussis.

Viruses are a group of minute infectious agents, with certain exceptions (e.g., poxviruses) not resolved in the light microscope, that are characterized by a lack of independent metabolism and by the ability to replicate only within living host cells that can cause disease in their hosts. Viruses are simpler structures than bacteria, and effective vaccines for diseases such as polio, rubella, and measles have been available for a long while. MMR contains three separate vaccines (weakened viruses grown in chick embryos or human fibroblasts) in one injection because it protects children against three viral infections: measles (rubeola), mumps, and rubella (German measles) (**choice D**). These viruses are spread in ways similar to those of the bacterial infections noted earlier. In the United States, MMR is routinely given to children in a series of two shots at set ages.

The attenuated bacillus Calmette-Guerin, or BCG (**choice A**), vaccine is administered to prevent tuberculosis (another bacterial infection spread by aerosol contamination) in certain high-risk groups but not generally for children in the United States.

At the present time, the manufacture and sale of the only licensed cholera (**choice B**) vaccine in the United States has been discontinued. It has not been recommended for travelers because of the brief and incomplete immunity it offers against this bacterial infection, which is usually caused by consumption of fecally contaminated water and food.

Polyvalent pneumococcal (Pneumovax; **choice C**) vaccines immunize against infections from the bacteria *Streptococcus pneumoniae*. It is given to older adults, as well as to at-risk children four times at set ages.

5. **The correct answer is B.** *Streptococcus salivarius* (within the *Viridans streptococci* category) is a Gram-positive cocci, a facultative anaerobe, and an alpha hemolytic, commonly located on the dorsum of the tongue.

Actinomycosis is usually caused by a facultative or strictly anaerobic Gram-positive bacilli, *Actinomyces israelii* (**choice A**). This is a nonpathogenic organism found as normal flora in the nose and pharynx. Its normal location in the nose and pharynx accounts for actinomycosis most commonly appearing in the face and neck. Because this organism is part of the normal flora, the infection is not contagious. *Actinomyces* produces disease when it is introduced into the facial tissues by trauma, surgery, or infection. A common cause is dental abscess or oral surgery. The infection is characterized by “sulfur granules” of mycelium-like bacterial fibers, debris, and leukocytes.

Lactobacillus acidophilus (**choice C**) is in either an anaerobic or microaerobic Gram-positive rod that also produces lactic acid. The organism is usually found in the cavitated area of a tooth. The lactic acid reacts with enamel of the tooth, which decalcifies teeth. It is not the first bacteria to colonize a tooth, and may not be able to form caries by itself; they are late colonizers of carious lesions and will contribute to demineralization; they are not initiators of caries. It is also an integral part of the normal flora of the intestinal tract. For these reasons, oral supplements composed of active cultures of this strain are taken to restore the normal flora.

Streptococcus mutans (**choice E**) secretes a biofilm that allows it to adhere and colonize the smooth surface of enamel. Later on, *L. acidophilus* colonizes the biofilms. Both of these bacteria can not only survive in a low pH (acidophilic) but also maintain the ability to produce lactic acid (aciduric) and thus help decay teeth. The organism is a Gram-positive cocci, a facultative anaerobe (within the *Viridans streptococci* category), and an alpha

hemolytic and is frequently found in the pharynx. Colonization of *S. mutans* is thought to begin with the eruption of teeth, at around 10 months of age. It is the primary initiator of caries in pits and fissures and on smooth surfaces.

Prevotella melaninogenica (**choice D**) (previously known as *Bacteroides melaninogenicus*) is involved in periodontal disease as a Gram-negative anaerobic rod and is found in periodontal pockets, part of the subgingival microflora. It is a black to brown-pigmented bacteria: a heme derivative colors the colony. One of the virulence factors is that it can produce IgA proteases that may impair local immunity. The other factors (like other oral anaerobes) are that it can produce the enzyme beta-lactamase, possession of a capsule that inhibits phagocytosis, and production of potent enzymes and metabolic byproducts. Vitamin K₁ is a growth factor and is produced by surrounding aerobic bacteria. *P. melaninogenica* has also been associated with endodontic lesions.

6. **The correct answer is C.** Epstein Barr virus (EBV), which causes infectious mononucleosis, can be detected through the use of a nonspecific test known as heterophil agglutination. Substances appearing in the serum during infection have the property of agglutinating sheep cells. A rise in agglutination over the course of the infection helps to confirm the diagnosis of mononucleosis. The specifics of the reaction are unclear.
7. **The correct answer is D.** The pyogenic pathogens are cocci bacteria that cause various acute suppurative (pus-producing) inflammatory responses to infections. Included are the Gram-positive *Staphylococcus aureus*, *Streptococcus pyogenes*, and *Streptococcus pneumoniae*, and the Gram-negative *Neisseria gonorrhoeae* and *N. meningitidis*. In terms of their phylogeny, physiology, and genetics, these genera of bacteria are unrelated to one another. They share a common background in causing a major portion of bacterial infections.

Catarrhal (**choice A**) reaction is an inflammation of a mucous membrane, especially in the air passages of the head and pharynx, with a free discharge of mucus, usually caused by the rhinovirus of the common cold.

Granulomatous (**choice B**) reaction involves aggregates of particular types of chronic inflammatory cells that form nodules. The essential components of a granuloma are collections of modified macrophages, termed epithelioid cells, usually with a surrounding zone of lymphocytes. They are present with the *Mycobacteria* of such diseases as tuberculosis and leprosy.

Pseudomembranous (**choice C**), or false membrane, is a layer that resembles an organized and living membrane but is made up of coagulated fibrin with bacteria and leukocytes, such as may be formed on mucous membranes in diphtheria or in the gut with *Clostridium difficile* infection.

8. **The correct answer is A.** Anaerobic bacteria are bacteria that do not live or grow in the presence of oxygen, which is the normal situation within the gingival sulcus and even more so within the deeper periodontal pocket. *Mycobacterium* is the least likely of the list to be found among the normal anaerobic flora of the gingival sulcus because it is highly aerobic in its oxygen demands. *Mycobacterium* is a genus of bacteria of the family Mycobacteriaceae, order Actinomycetales, occurring as Gram-positive, mostly slow-growing, slightly curved or straight rods, sometimes branching and filamentous, and is distinguished by acid-fast staining. It contains many species, including the highly pathogenic organisms that cause tuberculosis (*M. tuberculosis*) and leprosy (*M. leprae*).

Fusobacterium (**choice B**) is a genus of Gram-negative, anaerobic, nonsporulating bacteria, consisting of slender cells with tapered ends that are normal inhabitants of cavities such as the oral cavity. Some species are pathogenic, causing purulent or gangrenous infections, and are involved in periodontal disease.

Prevotella (**choice C**) is a genus of Gram-negative, obligately anaerobic, nonmotile, non-spore forming, pleomorphic rod-shaped bacteria. They are normal inhabitants of the mucous membranes and are found especially in the oral cavity, colon, and vagina; some cause human infections, and they are involved in periodontal disease. Included here are a number of species formerly included in the genus *Bacteroides*.

Actinobacillus (**choice D**) is a genus of Gram-negative, facultative anaerobic fermentative nonmotile, coccoid or rod-shaped bacteria that is part of the normal microflora. They are potentially pathogenic, causing granulomatous lesions; and are involved in periodontal disease, including *Actinobacillus actinomycetemcomitans*.

Porphyromonas (**choice E**) is a genus of Gram-negative, obligately anaerobic, nonmotile, non-spore forming, rod-shaped bacteria that are normal inhabitants of the mucous membranes of the oral cavity; organisms have been isolated from oral infections, including periodontal disease. Included here are species formerly included in the genus *Bacteroides*.

9. **The correct answer is A.** Note that only two choices are possible here. Individuals with type B blood have circulating antibodies against A-antigen (known as anti-A). So upon detecting the entrance of type A blood, the anti-A antibodies will agglutinate the incoming red cells that contain A-antigen. So only choices A and B show a reaction of the individual's existing type B blood (with anti-A antibodies) against the incoming type A blood. The question now depends on the type of antibody involved. Anti-A (and also anti-B, found in individuals with blood type A) is an IgM, not an IgA, molecule, making choice A correct. Note that IgA antibodies are usually involved in secretory and mucosal reactions.
10. **The correct answer is C.** Antibiotics are antimicrobial agents produced by microorganisms that kill or inhibit other microorganisms. The most appropriate alternative for treating a patient who is allergic to penicillin and who has an infection caused by bacteria sensitive to penicillin is controversial at this time. Erythromycin is a common substitute for penicillin because it has a similar spectrum of activity. Erythromycins are also used to prevent "strep" infections in patients with a history of rheumatic heart disease who may be allergic to penicillin. These medicines may also be used to treat Legionnaires' disease and are of the macrolides class of antibiotics that inhibit bacterial protein synthesis. They are used to treat Gram-positive bacteria as well as certain Gram-negative bacteria, but not usually the enterics.

Penicillin is a member of a large class of beta-lactam antibiotics. In addition, closely similar antibiotics include ampicillin and amoxicillin (**choice B**). It is important to note that the incidence of cross-reactions between cephalosporins (around 10% of population) (**choice E**) and penicillins is very low, but serious reactions have occasionally been reported and this antibiotic does have the beta-lactam ring. Penicillins kill bacteria by interfering with the ability to synthesize cell wall and are used to treat certain infections caused by bacteria (such as pneumonia, scarlet fever, and ear, skin, and pharyngeal infections), as well as to prevent recurrent rheumatic fever and all Gram-positive infections.

Tetracycline (**choice D**) is of its own class of antibiotics that inhibit the protein production in bacteria, and it is given to treat Lyme disease, pneumonia, acne, sexually transmitted disease, bladder infections, and the infection that causes ulcers (*Helicobacter pylori*). It affects both Gram-positive and -negative bacteria but does not have a similar spectrum of activity as penicillin.

Rifampin (**choice A**) is an antibiotic given as a treatment for *Mycobacterium avium complex* and *Mycobacterium tuberculosis* infections. These are not common flora or infections of the oral cavity.

11. **The correct answer is E.** Lung cancer is the largest single cause of cancer deaths (mortality rate) in the United States, and now the world. For years, men were at higher risk for lung cancer because of their higher smoking rates. However, with the rising number of women who smoke, in the last 30 years lung cancer has surpassed breast cancer as the leading cause of cancer deaths among women.

Breast cancer (**choice D**) accounts for the second largest proportion of cancer-related deaths among women in the United States. The recent increase in the incidence of breast cancer probably reflects greater use of screening and early detection, because the increase has occurred mostly among women diagnosed with early-stage disease. Deaths from colorectal (**choice B**) cancer ranked third after lung and breast cancer for women. The overall incidence increased until 1985 and then began decreasing steadily. Mortality rates for stomach (**choice C**) cancer have been declining for several decades. Mortality rates for invasive cancer of the uterine cervix (**choice A**) have declined steadily over the past three decades.

12. **The correct answer is E.** Even low doses of aspirin can cause internal bleeding in the stomach and intestine, without changes in normal clotting time and normal platelet count. However, many doctors recommend that their patients take aspirin to reduce their risk of heart problems. The drug thins the blood and reduces the risk of clots forming in key blood vessels. However, it does cause prolonged bleeding time, which must be taken into account during dental treatment.

Hemophilia (**choice A**) is a hereditary bleeding disorder. Low levels, or the complete absence, of a blood protein essential for clotting causes both. Polycythemia vera (**choice C**) is a clonal stem-cell disorder characterized by excessive erythrocyte production. Its etiology is not fully established, but hypersensitivity to interleukin-3 may play a role in the sustained erythrocytosis observed in this disease. Clinical features include headaches, weakness, weight loss, and pruritus (itching without visible eruption on the skin).

Thrombocytopenic purpura (**choice E**) is an autoimmune disorder in which patients produce antiplatelet autoantibodies that destroy blood platelets. This destruction results in a low blood platelet count (thrombocytopenia) that may produce bruising or excessive bleeding.

Steatorrhea (**choice B**) results in fecal matter that is frothy and foul-smelling and floats because of a high fat content, which is typical in malabsorption syndromes.

13. **The correct answer is D.** Sterilization is the complete destruction or removal of all living microorganisms. Dry-heat sterilization involves exposing the product to hot air circulated in a chamber. Dry-heat sterilization of dental instruments for 60 minutes requires a temperature of 171°C. Dry heat is an effective mode of sterilization but is limited in its applicability because it requires prolonged exposure at high temperatures. It is used for glassware, metal, and objects that will not melt. In addition, dry heat dulls sharp items less than steam autoclaving.

Sterilization of instruments at a temperature of 160°C would require 2 hours, not 30 minutes (**choice C**). The other choices—3 minutes at 132°C (**choice A**), 20 minutes at 121°C (**choice B**), and 6 hours at 38°C (**choice E**)—are not correct for their times and temperatures. Note that dry heat requires more time and higher temperatures than does steam autoclaving.

14. **The correct answer is A.** Hepatitis B vaccine given in a series of three injections prevents the viral infection of hepatitis B disease and its serious consequences, such as lifelong infection, cirrhosis of the liver, liver cancer, liver failure, and death. Successful immunization results in development of serum antibodies to HBsAg, the complex of surface antigens (also called the envelope antigen, or Australian antigen) of the virus, for the short

term, and then immune memory to them indefinitely. It is currently recommended for children and high-risk persons such as dental personnel due to the high risk of infection involved in dental practice.

The virus, or HBV, consists of a thick outer shell and an inner core. The core contains a small, circular, partially double-stranded DNA molecule and an endogenous DNA polymerase (**choice D**). HBcAg (**choice B**) is an antigen of the core of the HBV. HBeAg (**choice C**) is the antigen associated with the nucleocapsid of HBV. It also circulates as a soluble protein in serum.

15. **The correct answer is C.** Neither type 1 nor type 2 diabetes is inherited as a simple autosomal dominant trait, although there is a genetic predisposition to both diseases. The same is true for gout and cleft palate, which also are more common in certain families. Gardner syndrome is inherited as a simple dominant disorder (as in basic Mendelian genetics). It is found in patients with osteochondromatosis, multiple bony exostoses capped by cartilage. These exostoses are associated with sebaceous cysts, desmoid tumors, and colonic polyps.
16. **The correct answer is B.** Congestive heart failure (CHF) occurs when the heart is unable to pump blood throughout the body. There are two categories of congestive heart failure: systolic and diastolic. In the systolic type of the disease, blood coming into the heart from the lungs may be regurgitated so that fluid accumulates in the lungs (pulmonary congestion). In the diastolic type, the heart muscle becomes stiff and cannot relax, leading to an accumulation of fluid in the feet, ankles, legs, and abdomen. CHF is in itself not a diagnosis. Rather, it is the physiologic result of damage to the heart caused by some underlying condition. Therefore, it is not enough to say that a person “has CHF.” The CHF has to be due to some underlying process, and that diagnosis is important in terms of treatment and prognosis. The most common underlying causes for CHF are hypertension and diabetes.

Other forms of cardiac disease, such as valve disease and rheumatic heart disease also increase the potential for developing CHF out of the list noted above. Rheumatic heart disease (RHD) is a condition in which permanent damage to heart valves, such as valvular insufficiency, is caused by rheumatic fever. The heart valve is damaged by a disease process that generally begins with a strep throat caused by streptococcus A bacteria that may eventually cause rheumatic fever.

Heard by a physician through a stethoscope, a heart murmur (**choice A**) is an abnormal heart sound that results from the turbulent flow of blood through the heart. Many heart murmurs are harmless (or “innocent”) or functional, affecting many people at some point during their childhood. However, pathogenic heart murmurs may also be the result of an underlying heart condition, such as the narrowing of one of the heart’s four valves (valvular stenosis) or a heart disease that has been present from birth (congenital heart disease). Thus, murmurs may increase the potential for CHF if they are pathogenic but they could be a functional type of heart murmur.

Aschoff bodies in coronary arteries (**choice E**) are tiny granulomas found in the myocardium in patients with RHD; their discovery is pathognomonic for RHD.

Cor pulmonale (**choice D**) is a complication of disorders that slow or block blood flow in the lungs, resulting from raised blood pressure in the lungs. A deadly form of CHF, it creates enlargement, or hypertrophy, of the right ventricle in response to increased right ventricular afterload. Cor pulmonale presents as right heart failure, which is marked by a sustained increase in right ventricular pressures combined with an inability to balance the cardiac output in response to exercise or other stimuli.

Digitalis toxicity (**choice C**) is the result of the body accumulating more digitalis than it can tolerate at that time. It can be caused by high levels of digitalis in the body, or by “normal” levels but decreased tolerance by the body. Digitalis toxicity can occur from a single exposure or chronic overmedication, or can be precipitated with normal or therapeutic blood levels of digitalis if other risks are present. The heart rate may be rapid or slow, it may be irregular, and the ECG may show any of a variety of arrhythmias.

17. **The correct answer is C.** In basic genetics, a gene may be dominant or recessive. If a person inherits one dominant and one recessive gene, the dominant expresses itself and the person is heterozygous or hybrid (**choices D and E**) for that trait. In codominance, the person may receive two different genes (alleles) but they both express themselves—there is no dominance. Penetrance (**choice A**) refers to the frequency of appearance of a particular phenotype when a mutant allele is present in a population. Lyonization (**choice B**) refers to inactivation of one of the two X-chromosomes in female cells.

18. **The correct answer is B.** Hereditary angioedema results from a deficiency of C1 esterase inhibitor (a glycoprotein). As a result, there is increased C1 (complement protein) activity that releases a vasoactive kinin from C2. The result is acute, transient, local buildup of edematous fluid.

19. **The correct answer is E.** *Legionella pneumophila* is a Gram-negative rod bacteria that usually resides in the environment in pools of stagnant water. It is found as an intracellular agent within protozoa. In humans, it survives as a facultative intracellular pathogen. It often infects hot-water towers and air-conditioning cooling tower systems where it is spread as an aerosolization of organisms.

L. pneumophila is not spread by person-to-person contacts such as sexual contact (**choice A**), by water contaminated with human waste (**choice B**), by direct contact with respiratory droplets from a contaminated person (**choice D**), or by aerosolization of organisms in contaminated soil (**choice B**). *L. pneumophila* was first isolated and characterized in 1976 after a major outbreak of pneumonia at an American Legion convention in Philadelphia, Pennsylvania; thus, the name “Legionnaires’ disease.” It is now recognized to be a common cause of community-acquired and nosocomial pneumonia.

20. **The correct answer is C.** Hepatitis A is a liver disease caused by the hepatitis A virus. Hepatitis A can affect anyone. In the United States, hepatitis A can occur in situations ranging from isolated cases of disease to widespread epidemics. Good personal hygiene and proper sanitation can help prevent it. Vaccines are also available for long-term prevention of hepatitis A virus infection, and immune globulin is available for short-term prevention. Hepatitis A is usually a mild illness characterized by sudden onset of fever, malaise, nausea, anorexia, and abdominal discomfort, possibly followed in several days by jaundice. Thus, not all persons with hepatitis A will get jaundice because not all will have liver damage, and most damage to the liver is not as extensive as that associated with hepatitis B or C.

Jaundice is a yellow discoloring of the skin, mucous membranes, and sclera caused by too much bilirubin in the blood. It is a condition produced when excess amounts of bilirubin circulating in the bloodstream dissolve in the subcutaneous fat, causing a yellowish appearance of the skin and the sclera or whites of the eyes. With the exception of physiologic jaundice in the newborn, all other jaundice indicates overload or damage to the liver, or inability to move bilirubin from the liver through the biliary tract to the gut due to a damaged liver or cirrhosis. Most cirrhosis, however, occurs secondarily with chronic alcohol abuse.

Normally, blood is carried to the liver by the portal vein. If blood cannot flow easily through the liver because of high levels of cirrhosis, the blood gets slowed down in this vein and the pressure inside the vein increases. This higher blood pressure in the portal vein is termed portal hypertension (**choice B**). If blood cannot flow normally through the portal vein, it must return to the heart using other blood vessels. These vessels become swollen because of the increased amount of blood flowing through them and now are termed varices. They have thin walls and can easily break open because they are not meant to handle such high-pressure blood flow. Bleeding from a broken blood vessel is serious and can even be fatal. This occurs with extensive cirrhosis.

Cirrhosis is the end stage of many forms of liver injury characterized initially by fibrosis. The progression of fibrosis to cirrhosis, and the morphology of the cirrhosis, depend on the extent of injury, the presence of continuing damage, and the response of the liver to damage. Massive fibrosis (**choice D**) would occur with the other hepatitis forms and with chronic alcohol abuse more than with hepatitis A.

Obstruction of main bile ducts (**choice E**) involves the blockage of any duct that carries bile from the liver to the gallbladder or from the gallbladder to the small intestine; it can cause jaundice due to increased bilirubin and may lead to severe infection.

During massive hemolysis (**choice A**) or extreme premature breakdown of red blood cells in patients with severe sickle-cell syndrome, the total serum bilirubin rises because the hepatocytes may not be able to conjugate all the unconjugated (indirect) bilirubin delivered to them and form conjugated (direct) bilirubin.

21. **The correct answer is B.** Karyolysis is the disintegration and dissolution of a cell nucleus when a cell dies. In hematoxylin and eosin stains, a very early sign of karyolysis may be a lessening of nuclear basophilia, i.e., less staining with hematoxylin. Karyolysis is usually followed by pyknosis, a shrinking of the nucleus that is associated with an increase of nuclear basophilia. Karyolysis is irreversible. If it happens to myocardial cells, those cells are lost due to extensive cellular injury, as can occur with an acute myocardial infarction.

Fatty change in liver cells (**choice A**) (hepatic steatosis) is an excessive accumulation of lipid in hepatocytes, the most common response of the liver to injury. Potentially reversible, macrovesicular fatty liver (large fat droplets balloon the liver cell, displacing the nucleus to the periphery of the cell, like an adipocyte) usually is not in itself harmful. It is reversible even in potentially fatal instances (e.g., in fatty liver of pregnancy, early delivery may be lifesaving). Alcoholic fatty liver may be accompanied by inflammation and necrosis (alcoholic hepatitis) and permanent damage in the form of cirrhosis. Microvesicular fatty liver (fat droplets accumulate, cells appear foamy, and nuclei are central) presents acutely but is reversible if the patient survives.

Excess glycogen deposition in hepatocyte nuclei (**choice C**) of the liver is present in most diabetic mellitus patients. Nuclear glycogen deposition is also seen in sepsis, tuberculosis, some patients with hepatitis (particularly autoimmune chronic hepatitis), Wilson's disease, and cirrhosis. The mechanism for nuclear glycogen deposition is also unclear, with the stored glycogen resembling muscle glycogen more than hepatocyte cytoplasmic glycogen. Patients showing solely excessive glycogen deposition may exhibit hepatomegaly and liver enzyme abnormalities, and may have abdominal pain and even nausea and vomiting and rarely ascites, but all of these abnormalities are reversible and may improve with sustained glucose control.

Hydropic vacuolization of renal tubular epithelial cells (**choice D**) is an early manifestation of cell injury in the loss of the ability to maintain membrane transporters and channels controlling salt and water homeostasis. This results in intracellular accumulation of solutes and water, producing cell edema, or "hydropic change." The fluid may be in vacuoles initially but

will eventually dilute the cytosol throughout the cell. As long as the cell remains viable, cell membranes will remain intact and the process is reversible.

22. **The correct answer is B.** Cytomegalovirus (CMV) is the most common viral cause of congenital defects, even in developed countries. A newborn can be infected with CMV before birth, almost always because the child's mother developed a first-time CMV infection during pregnancy. Most of the time the infected infant shows no symptoms at birth, but in some cases symptoms appear over the next several years. These symptoms may include neurologic, growth, or developmental problems; sight or hearing problems; and dental abnormalities.

Developed countries, however, now have a vaccine for rubella (**choice D**), or "German measles," because it can cause birth defects. Rubella infection during early pregnancy can cause abnormalities of the heart, eyes, and ears. Any woman planning a pregnancy should be tested for rubella immunity and vaccinated if necessary. She must wait 3 months after vaccination before becoming pregnant, however, because the vaccine itself can endanger a developing fetus.

Measles (**choice A**), or rubeola, also is now prevented in developed countries by vaccination. If a woman gets measles while she is pregnant, the risk of miscarriage or premature birth is increased. However, measles infection does not cause birth defects.

Before birth, fetuses of mothers with genital herpes from herpes simplex (**choice C**) are at risk for birth defects. An active genital herpes sore at the time of birth can cause extremely serious results, including blindness, birth defects, and even death. Cesarean section, which is available in developed countries, is advisable for mothers with active herpes eruptions at the time of delivery.

Pregnant women who become infected with the varicella-zoster (**choice E**) virus, whether in the form of chickenpox or shingles, are at increased risk for serious pneumonia—but only in the lesser-developed countries because there is now a vaccine for chickenpox and medication to lower risk. In addition, the risk for the infant is lower or higher depending on when the mother became infected. Chickenpox in the mother during early pregnancy poses a slightly increased risk for birth defects in the infant, but it is not usually viewed as grounds for terminating a pregnancy. Birth defects may result in only minor skin abnormalities. More serious defects include a smaller-than-normal head, eye problems, low birth weight, and mental retardation if women develop chickenpox (not shingles) within 5 days before and 2 days after delivery. Their newborns are at risk for life-threatening varicella, which usually does not happen in developed countries.

23. **The correct answer is A.** Papillomaviruses have many strains and are generally thought to be responsible for skin and genital warts. They are small, non-enveloped viruses that contain a double-stranded DNA genome. They are highly host-specific, cannot be propagated in tissue culture, and with the exception of some ungulate papillomaviruses, infect only epithelial cells. However, a link has now been discovered between certain ones and cervical cancer with some association with the herpes virus.

Herpesvirus (**choice B**) also has many strains. They are associated with herpes simplex, genital herpes, chickenpox, and zoster. It is a characteristic of all herpesviruses that after primary infection, the virus establishes a latent infection in the host and may reactivate at any stage. Reactivation is frequently, but not always, associated with further disease. All herpesviruses are morphologically identical: they have a large, double-stranded DNA genome.

Rhinoviruses (**choice C**) are one of the families of viruses that can cause the common cold, although many other viruses can infect the respiratory tract and cause cold-like symptoms.

It is estimated that about one-third of “colds” are caused by rhinovirus infections. There are many strains of rhinoviruses, explaining why vaccines against rhinoviruses have proved difficult to develop. Rhinoviruses are positive-stranded RNA viruses.

Adenoviruses (**choice D**) are usually mild pathogens and can cause respiratory illness or conjunctivitis. Adenoviruses are double-stranded DNA viruses.

Rotaviruses (**choice E**) are one of the causes of severe viral gastroenteritis. Mature virus particles are double-stranded RNA.

24. **The correct answer is A.** HIV is a virus that causes acquired immune deficiency syndrome (AIDS). It damages the immune system by binding to and attacking the white blood cell or lymphocyte CD4 T cell. CD4 T cells activate B cells, natural killer (NK) cells, and phagocytes upon recognition of foreign antigen, and for this reason they play a pivotal role in the immune response of healthy individuals. The CD4 T cell activates these effector cells by secreting cytokines.

MHC Class I (**choice C**) and Class II (**choice D**) are molecules expressed on the surfaces of cells that involve binding and attacking factors within the immune system.

CD8 (**choice B**) cells, or suppressor T cells, specifically suppress the action of other cells in the immune system, notably B cells and T cells, thereby preventing the establishment of an immune response. Like CD4 cells, functional CD8 cells are reduced with HIV infection. CD8 lymphocytes probably play a key role in the immunologic defense against HIV. The evidence is that they control viral replication by at least two mechanisms: direct antigen-specific cytolysis, which appears to be required for optimal suppression; and release of soluble antiviral factors. New therapeutic strategies are taking into account mechanisms by which the virus may evade CD8 control.

Immunoglobulin (**choice E**), or antibody, is produced by plasma cells (matured B-cell lymphocytes). Test-enzyme-linked immunosorbent assay (ELISA) is a test that detects HIV antibodies.

25. **The correct answer is E.** Rabies is acquired from virus in saliva entering a bite wound caused by an infected animal, usually a rabid dog. The severity of the bite determines the risk of infection. The disease does not usually spread from human to human. After inoculation, the virus enters small nerve endings at the site of the bite. The virus travels slowly up the nerve to reach the CNS, where it replicates, and then travels down nerves to the salivary glands, where there is further replication. The time it takes to do this depends upon the length of the nerve—a bite on the foot will have a very much longer incubation period than a bite on the face. The incubation period may last from 2 weeks to 6 months, a very long incubation period compared to the other infections listed, which have less than 2 weeks' incubation. Very often the primary wound is healed and forgotten by the time of clinical presentation.

When the virus reaches the CNS the patient presents with headache, fever, irritability, restlessness, and anxiety. This may progress to muscle pains, salivation, and vomiting. After a few days to a week, the patient may experience a stage of excitement and be wracked with painful muscle spasms, sometimes triggered by swallowing of saliva or water. The stage of excitement lasts only a few days before the patient lapses into coma and death.

For (primary) herpetic gingivostomatitis (**choice A**) the incubation period is 3 to 7 days. It is a primary infection with herpes simplex within the oral cavity, and there is a spectrum of severity of clinical illness ranging from a few intraoral ulcers and no systemic features to severe oral ulceration with constitutional upset.

For the common cold (**choice B**), the incubation period is 1 to 3 days, with symptoms including malaise, low fever, watery rhinorrhea, nasal congestion, headache, sneezing, cough, and/or sore pharynx, all showing that this is mainly an infection of the upper respiratory tract.

Influenza (**choice C**) is an infectious disease of the respiratory tract with an incubation period of 1 to 5 days. After the incubation period, systemic and local symptoms emerge. The former include fever, headache, general weakness, feeling of discoordination, lumbago, and arthralgia. Local symptoms of the respiratory system often appear a day or two later, characterized by sneeze, pharyngalgia, stuffy nose, and cough. In addition to these respiratory symptoms, mild symptoms of the digestive tract are often found, including anorexia, vomiting, gastroenteritis, abdominalgia, and diarrhea.

Measles (**choice D**) is an acute, highly communicable viral disease with prodromal fever, conjunctivitis, coryza, cough, and Koplik spots on the buccal mucosa. A characteristic red blotchy rash appears. The incubation period for measles, or rubeola, is 8 to 13 days.

26. **The correct answer is D.** Thromboembolus is the most common pulmonary embolic lesion; the thrombus arises from calf or pelvic veins. Position of a thromboembolus is considered “saddle” if it is at the bifurcation of right and left pulmonary arteries. This condition can result in sudden death.

Bronchiectasis (**choice A**) is a relatively rare condition that affects the lungs; the bronchial tubes become enlarged and distended, forming pockets where infection such as pneumonia may gather if not promptly treated.

Pneumoconiosis (**choice B**) is fibrosis and scarring of the lungs due to the chronic occupational inhalation of dusts such as coal, silica, or asbestos. It can result in serious lung disease.

Pulmonary emphysema (**choice C**) is a chronic lung condition in which alveoli are damaged in the lungs and the disease progresses to a serious disability.

Idiopathic pulmonary fibrosis (**choice E**) is a disease of inflammation that results in scarring, or fibrosis, of the lungs. In time, this fibrosis can slowly build up to the point where the lungs are unable to provide oxygen to the tissues of the body and there is infection and difficulty breathing.

27. **The correct answer is E.** Wound healing follows an orderly sequence of steps. In the first stage, coagulation occurs, including clotting. Infection prevention occurs later, during which neutrophils are essential. The proliferative stage, primarily involving fibroblasts and macrophages, does not occur until about 2 weeks. By the third or fourth week, connective tissue remodeling occurs, with some return of strength of the tissue. At 3 days, a mature cicatrix (scar) is several weeks away, as is possible keloid (abnormal, collagen-rich scar) formation, because both of these structures involve collagen formation and maturation. Granulomatous inflammation will not occur in this case, inasmuch as the healing is described as “uncomplicated.” There should be some inflammation because the wound is new. At 3 days we should expect fresh clot formation, early inflammation, neutrophil concentration, and ulceration at the surface, inasmuch as insufficient time has occurred for full epithelial healing.

28. **The correct answer is B.** A heart attack, or myocardial infarction (MI), occurs when an area of heart muscle dies or is permanently damaged because of an inadequate supply of oxygen to that area. Most MI (as noted upon autopsy findings) is caused by a clot that blocks one of the coronary arteries, or coronary thrombosis. The clot usually forms in a coronary artery that has been previously narrowed from changes related to atherosclerosis. The

atherosclerotic plaque inside the arterial wall sometimes cracks, and this triggers the formation of a thrombus, or clot. A clot in the coronary artery interrupts the flow of blood and oxygen to the heart muscle, leading to the death of heart cells in that area. The damaged heart muscle permanently loses its ability to contract, and the remaining heart muscle needs to compensate for it. Thus, most sudden death is due to coronary thrombosis.

Rupture of the coronary vessel (**choice E**) can also cause an MI but it is not as common as the coronary thrombosis.

Ventricular aneurysm (of the heart wall) (**choice D**) is a complication of an MI. It is a ballooning of a section of a blood vessel in the heart that first appears several days or weeks after an acute MI.

The mitral valve is one of the four valves of the heart and is usually the valve associated with valvular prolapse (**choice A**). It is located in the left side of the heart, and it separates the left atrium from the left ventricle. Mitral valve prolapse (MVP) is a condition in which there is a slight variation in shape or structure of the mitral valve, causing one or both of the mitral valve leaflets to “billow” or “bulge” backward into the upper left atrium during the contraction of the lower left ventricle. It may be associated with a syndrome of symptoms that involve an imbalance of the nervous system and panic attacks.

Fibrinous pericarditis (**choice C**) is the usual lesion of acute pericarditis in which inflammation produces large quantities of fibrin. It may follow infection, trauma, or hemopericardium, or it may accompany connective tissue disease, including rheumatic fever; often, the cause is unknown. It may have no hemodynamic effects, or it may gradually cause chronic constrictive pericarditis. The latter may cause chronic elevation of systemic venous and hepatic venous pressure, which may lead to cardiac cirrhosis.

29. **The correct answer is A.** T cells and macrophages represent the characteristic cellular infiltrate in delayed-type hypersensitivity (DTH), or type IV hypersensitivity. The first DTH reaction described was the tuberculin antigen (tuberculin reaction), but the definition was later expanded to include cell-mediated reactions to other bacterial and viral antigens, responses to pure protein with adjuvant or haptens, and host responses to allograft. The DTH skin test is used to test whether prior exposure to an antigen has occurred. When small quantities of antigen are injected dermally, a hallmark response is elicited that includes induration, swelling, and monocytic infiltration composed of macrophages into the site of the lesion within 24 to 72 hours (thus, the “delayed” portion of the description). This reaction has been shown to be absolutely dependent on the presence of memory T cells. Both the CD4+ and CD8+ fractions of cells have been shown to modulate a response.

“Hypersensitivity” refers to undesirable reactions produced by the normal immune system. Hypersensitivity reactions require a presensitized (immune) state of the host. Hypersensitivity reactions can be divided into four types—I, II, III, and IV—on the basis of the mechanisms involved and time taken for the reaction. Frequently, a particular clinical condition (disease) may involve more than one type of reaction.

Eosinophils (**choice B**) present in great numbers in the cellular infiltrate suggests an immediate or anaphylactic, or type I, hypersensitivity reaction. Mast cells and basophils (**choice E**) may also be present in the cellular infiltrate with a type I reaction.

Type II hypersensitivity, also known as cytotoxic hypersensitivity, contains antibody (made from plasma cells, a form of lymphocytes), complement, and neutrophils (**choice C**) in its cellular infiltrate. Type III hypersensitivity is also known as immune complex hypersensitivity, with the primary component of the cellular infiltrate being soluble immune complexes and complement (C3a, 4a, and 5a).

30. **The correct answer is B.** Chronic hyperplastic is the type of oral candidiasis that is likely to produce a white plaque on the oral mucosa that is firmly adherent and does not scrape off. The most common sites are the anterior buccal mucosa along the occlusal line, and the laterodorsal surfaces of the tongue. Candidiasis is an opportunistic infectious condition usually caused by *Candida albicans*. Candidiasis is usually limited to the skin and mucous membranes.

Acute pseudomembranous (**choice A**) is the most common form of oral candidiasis, with the most common sites being the buccal mucosa, dorsal tongue, and palate. Most frequent etiologies include antibiotic therapy or immunosuppression. Acute pseudomembranous oral candidiasis appears as soft, creamy white to yellow, elevated plaques that are easily wiped off affected oral tissues and leave an erythematous, eroded, or ulcerated surface that may be tender.

Chronic atrophic (**choice C**) oral candidiasis is usually found on the hard palate under a denture, but atrophic candidiasis may also be found on the dorsal tongue and other mucosal surfaces. The most common etiology is poor denture hygiene and/or continuous denture insertion, but it may also be caused by immunosuppression, xerostomia, or antibiotic therapy. The most common appearance is that of a red patch or velvet-textured plaque and it is frequently associated with papillary hyperplasia. Patients may complain of a burning sensation associated with this type of candidiasis.

Acute atrophic (**choice D**) is a type of candidiasis that is characterized, especially on the tongue, by marked erythema and depapillation. This is not easily recognized and it can be mistaken for trauma or other infections. Patients may complain of a burning sensation. When in the buccal mucosa it has a spotty appearance. This variety is generally seen in patients undergoing long-term treatment with antibiotics, for whatever cause, and also in HIV-positive and AIDS patients.

31. **The correct answer is D.** If a foreign antigen enters the body through the skin, the antigen is most likely to reach the lymph nodes, a portion of the lymphoid system, first. The lymph nodes are bean-shaped bodies grouped in clusters along the connecting lymphatic vessels. Along the lymphatic vessels, the lymph nodes are positioned to filter toxic products from the lymph to prevent their entry into the blood system. The lymph nodes are composed of organized lymphoid tissue and contain lymphocytes, white blood cells of the immune system that actively remove the toxic products.

The thymus gland (**choice C**) is a large gland of the lymphoid system. T-cell lymphocytes mature in the gland in response to stimulation by thymus hormones.

The spleen (**choice B**) is a large, gland-like organ of the lymphoid system that disintegrates the red blood cells and sets free the hemoglobin, which the liver converts into bilirubin. The spleen also gives rise to new red blood cells during fetal life and in the newborn, serves as a reservoir of blood, and produces lymphocytes and plasma cells.

Mucosal-associated lymphoid tissue (**choice E**) (MALT) is based on primed T and B lymphocytes that migrate from the site of antigen presentation via the lymphatics and blood to selectively “home” to lymphoid tissue at distant sites in gastrointestinal, respiratory, genitourinary, and other mucosal-associated regions.

The liver (**choice A**) is a large organ with functions that include the storage and filtration of blood, the secretion of bile, the excretion of bilirubin and other substances formed elsewhere in the body, and numerous metabolic functions, including the conversion of sugars into glycogen, which it stores.

32. **The correct answer is C.** The one exception to an association with congestive heart failure (CHF) on the list is anasarca. Generalized swelling or massive edema, or anasarca, is a common sign in severely ill people. Although slight edema may be difficult to detect, especially in an overweight person, massive edema is obvious. Edema can indicate a chronic and progressive medical illness. The edema noted with CHF is not generalized but more specific, as noted below.

CHF is a condition in which the heart cannot pump enough blood to the body's other organs. CHF causes symptoms such as shortness of breath (or dyspnea; **choice A**), fatigue, weakness, and swelling (or edema) of the ankles (**choice D**), legs, and sometimes abdomen. As the CHF worsens, there is darkening of the finger- and toenails (or cyanosis; **choice B**) from oxygen-poor blood perfusing the extremities at a slower rate of flow. There is also prominent engorged veins from blood backup, noticeable as prominent neck and abdominal wall veins, and a large, palpable, swollen liver from passive congestion of the liver (**choice E**).

33. **The correct answer is D.** The significance of the question involves the difficulty of producing vaccines against HIV virus. This virus mutates rapidly, and a vaccine that is effective today may be ineffective next month. Specifically, a glycoprotein, gp120, sticks out of the envelope of the virus and is involved in linking to the CD4 receptor. Antibody against gp120 would prevent infectivity. However, it is believed that the lack of an editing function of reverse transcriptase makes variation of the glycoprotein common. This change, or error, occurs during transcription (copying of DNA from RNA genome).

34. **The correct answer is A.** Esophageal varices are swollen veins that occur in the lining of the lower esophagus; they can rupture and cause dangerous bleeding. Esophageal varices almost always occur as a complication in people who have cirrhosis of the liver. The portal vein delivers blood from the stomach and intestines to the liver. Normally, this blood flows easily and rapidly through the liver and back to the heart and lungs. However, cirrhosis causes a scarred liver, which causes blood to back up in the portal vein, the condition of portal hypertension. Portal hypertension causes collateral blood vessels to form around the stomach and esophagus to try to accommodate the backed-up blood.

A hiatal hernia (**choice B**) occurs when a part of the stomach slides above the diaphragm. It may allow stomach acid to flow back into the esophagus. With time, the stomach acid may irritate the esophagus and cause problems.

Pancreatic carcinoma (**choice C**) is a malignancy of the pancreas. Pancreatic cancer can result in weight loss, liver dysfunction, infections, and pain.

Chronic active hepatitis (**choice D**) is a continuing inflammation of the liver that damages the liver cells. Causes of chronic active hepatitis include viral infection, drug ingestion, metabolic disorders, or autoimmune diseases. It can result in jaundice.

Hepatocellular carcinoma (**choice E**) is a malignancy that arises from hepatocytes, the major cell type of the liver. Chronic infection with the hepatitis B or C virus increases the risk of developing hepatocellular carcinoma. The symptoms include easy bruising or bleeding, and jaundice.

35. **The correct answer is E.** Neuroblastoma is a common, solid, malignant tumor of childhood, arising mainly in the adrenal gland; thus, it is the primary site of origin. In this tumor, cancerous tumors form from neural crest cells, similar to those found in the developing nervous systems of an embryo or a fetus. The tumor can start in the bundle of nerves in the adrenals.

Neuroblastoma may also arise in some less common cases from any portion of the extra-adrenal sympathetic chain, including in the retroperitoneum or chest. The presenting symptoms and signs depend on the site of origin and disease stage; e.g., a palpable abdominal mass or respiratory problems due to a thoracic tumor. Occasionally, presenting symptoms or signs may be due to metastases: an enlarged liver due to hepatic metastases; bone pain due to bone metastases (such as the mandible; **choice D**); or pallor (anemia), petechiae (thrombocytopenia), and leukopenia due to bone-marrow metastases.

Other less common sites of metastasis include the skin and brain (**choice A**). But the stomach (**choice C**) and kidney (**choice B**) are not associated with the origin of the neuroblastoma. However, a tumor in the stomach area can cause a child's belly to swell and can cause constipation or urinary problems of the kidney.

36. **The correct answer is A.** In the process of cell death, lysosomal enzymes function mainly to autolyze necrotic cells. A deficiency of any one of these enzymes will lead to a "storage disease" that is usually associated with developmental regression. Examples of such diseases include the mucopolysaccharidoses, Tay-Sachs disease, and metachromatic leukodystrophy.

Lysosomal enzymes do not mediate cell degeneration (**choice B**), act as a major target for cell injury (**choice C**), or activate the complement sequence (**choice D**). The complement sequence has three separate activation triggers: 1) antibody binding to a cell surface, 2) formation of immune complexes, and 3) a carbohydrate component of a microbe's cell membrane to then lyse and destroy the cell.

37. **The correct answer is A.** An antibody or immunoglobulin (Ig) is a protein that associates noncovalently with a foreign substance such as an antigen and initiates a process that eliminates the substance. The antigen-binding site of immunoglobulin molecules is localized in the Fab fragment.

Fc receptor (**choice B**) is the "crystallizable" fragment of the immunoglobulin that mediates phagocytosis, triggers inflammation, and targets the antibody to particular tissues. J-chain (**choice C**) is the immunoglobulin fragment found in the light-chain fractions of secretory IgA and polymeric IgM, which probably serves either to bind the components of the immunoglobulin together or to transfer the immunoglobulin across membranes. The constant region (**choice E**) is the portion of an immunoglobulin's heavy and light chains having an amino acid sequence that does not vary within a given class or subclass of immunoglobulin.

38. **The correct answer is E.** *Staphylococcus* is the genera of bacteria that are most commonly found on the skin, mainly *Staphylococcus epidermidis*. Most bacteria that are normal flora, such as *S. epidermidis*, are beneficial to the skin because they prevent colonization of the skin by pathogens and they control the other organisms on the skin. But if damage occurs to the skin, these bacteria become opportunistic and can enter the deeper layers of the body, as can the pathogens, and cause further damage.

Cutaneous candidiasis involves a fungal infection of the skin with *Candida* (**choice A**). It may involve almost any skin surface on the body, but usually occurs in warm, moist, creased areas such as armpits and groins and is the most common cause of diaper rash in infants. The most common fungus to cause these infections is *Candida albicans*.

Streptococci ("strep") (**choice D**) are bacteria that are normal flora of the respiratory, gut, and genitourinary systems. Skin diseases due to direct infection with streptococci include impetigo, cellulitis, and erysipelas.

Brucellosis is an infectious disease caused by pathogens of the genus *Brucella* (**choice B**). These bacteria are passed primarily among animals. Humans become infected by coming in contact with animals or contaminated animal products by eating or drinking, inhalation, or having the bacteria enter the body through skin wounds.

Anthrax is an acute infectious disease caused by the spore-forming *Bacillus* (**choice C**) pathogen *B. anthracis*. Anthrax most commonly occurs in animals but can also occur in humans when they are exposed to infected animals or to tissue from infected animals, and it does have a cutaneous form.

39. **The correct answer is D.** A component of the cell wall of most Gram-negative bacteria is endotoxin, or lipopolysaccharide (LPS), which is mostly unique to these bacteria and which can serve to increase their virulence. Unlike Gram-positive bacteria, which assume a violet color in Gram staining, Gram-negative bacteria incorporate the counterstain rather than the primary stain. Because the cell wall of Gram-negative bacteria is high in lipid content and low in peptidoglycan content, the primary crystal, violet, escapes from the cell when the decolorizer is added. This is because primary stains like to bind with peptidoglycan, something of which the Gram-negative cell has very little.

A flagellum (**choice A**) is an appendage organelle of locomotion (mobility) for bacteria. It is found in both Gram-positive and -negative bacteria. Also, a capsule (**choice B**), a gelatinous layer of polysaccharide or protein surrounding the cell wall of some bacteria, thought to be responsible for the virulence in pathogens, is not unique to Gram-negative bacteria.

Ribosomes (**choice C**) give the cytoplasm of all bacteria a granular appearance in electron micrographs and function in translating the genetic message in messenger RNA into the production of peptide sequences.

Bacterial endospores (**choice E**) are highly resistant to hostile physical and chemical conditions. Only a few genera of bacteria, such as *Bacillus* and *Clostridium*, are capable of forming endospores, and both are Gram-positive.

40. **The correct answer is C.** Pseudarthrosis is the deossification of a weight-bearing long bone, followed by bending and pathologic fracture, with inability to form a normal callus leading to existence of the “false joint” that gives the condition its name. Improper immobilization and alignment after bone fracture may lead to nonunion with pseudoarthrosis formation. There is an intolerance of bone repair tissue to motion, especially elongation (strain).

Osteomyelitis (**choice A**) is an acute or chronic bone infection usually caused by bacteria. The infection that causes it is often in another part of the body and spreads to the bone via the blood. Affected bone may have been predisposed to infection because of recent trauma, such as compound fracture.

Osteoarthritis (**choice B**) is also referred to as “degenerative joint disease.” It is generally believed to be caused by the wear and tear to which joints are subjected over time.

Heberden’s nodes (**choice D**) are a lumpy malformation of the distal interphalangeal joint. They represent the formation of osteophytic lumps at the joint margins. These nodes may be seen in patients with degenerative joint disease such as osteoarthritis and gout. The involved digits may have other abnormalities, such as flexion deformities.

Rheumatoid arthritis (RA) (**choice E**) involves inflammation in the lining of the joints and/or other internal organs. RA typically affects many different joints. It is typically chronic and can have flare-ups. In late stages, deformity and ankylosis develop. The cause is unknown but autoimmune mechanisms and virus infection have been postulated.

41. **The correct answer is C.** Viruses (phage particles) can transfer pieces of RNA or DNA to bacteria in the process of transduction, not transformation. In transformation, a bacterial cell picks up soluble DNA from the environment, not a phage. Several bacterial virulence factors are carried by phage particles, including staphylococcal enterotoxin and pyrogenic toxin, and *S. pneumoniae* capsule. Neither beta-galactose production nor nitrogen-fixing by *Rhizobium* is phage-controlled.

42. **The correct answer is E.** Sterilization is the complete destruction or removal of all living microorganisms. It is used on any object in dental practice that touches bone, penetrates tissue, or comes into contact with blood, such as scalpels, forceps, scalers, probes, and implants. It may also be used if the object can withstand the heat of sterilization, such as mirrors, etc. The best way to verify heat sterilization is testing with a biological indicator, a spore test. A number of factors affect sterilization that might not be apparent to the operator and may interfere with the effectiveness of processing; therefore, it is recommended that heat sterilization be routinely monitored with spore tests to ensure that equipment is functioning properly. CDC recommends weekly testing, corresponding to hospital protocol. It is important to check with the manufacturer of the sterilizer to assure usage of the proper spore test; *Bacillus stearothermophilus* is used for chemical and steam sterilizers, and *Bacillus subtilis var. niger* is appropriate for dry-heat sterilizers.

The other methods listed are not the best way to test for sterilization. Recording sterilizer pressure (**choice B**), duration of exposure (**choice C**), and sterilizer temperature (**choice D**) may be helpful but do not meet the legal requirements.

Chemical monitors (**choice A**) or indicators should be placed on the outside of the packaging and on the inside of one package during each load. A process indicator, generally taped or printed on the package, is a chemical mark that changes color when exposed to heat. A change in color simply means that the indicator has been exposed to heat; it does not necessarily mean that the package contents have been sterilized.

43. **The correct answer is B.** Candidiasis (**choice A**) normally causes mucosal lesions from hyphae. Blastomycosis (**choice C**), histoplasmosis (**choice D**), and coccidioidomycosis (**choice E**) are usually mild fungal infections. *Blastomyces* and *Coccidioides* usually infect the lungs, whereas *Histoplasma* causes a mild generalized yeast infection. All of these diseases can be much worse in the immunocompromised patient. Mucormycosis is caused by *Mucor* or *Rhizopus* molds from the environment. Infection is characterized by proliferation in walls of blood vessels of the sinuses, lungs, or gut, resulting in tissue necrosis.

44. **The correct answer is B.** In either an allergic reaction or a parasitic infection, the eosinophils increase in number in the bloodstream; their numbers in the blood are normally quite low. The eosinophils release various substances from their eosinophilic granules, especially in cases of infections by parasitic worms. Eosinophils are cytotoxic, releasing the contents of their granules on the invader. These include major basic protein, plus cationic proteins, peroxidase, arylsulfatase B, phospholipase D, and histaminase.

The number of basophils (**choice A**) also increases during infection. Basophils leave the blood and accumulate at the site of infection or other inflammation. There they discharge the contents of their granules, releasing a variety of mediators such as histamine, serotonin, prostaglandins, and leukotrienes, which increase the blood flow to the area and in other ways add to the inflammatory process. The mediators released by basophils also play an important part in some allergic responses, such as hay fever, and in anaphylactic response to insect stings, but not in any parasitic infections.

Plasma cells (**choice C**) are the mature form of B lymphocytes. They are antibody-producing cells and increase in numbers during any form of inflammation.

Atypical lymphocytes (**choice D**) are atypical because they are larger (more cytoplasm) and have nucleoli in their nuclei. The cytoplasm tends to be indented by surrounding red blood cells. Such atypical lymphocytes are often associated with infectious mononucleosis.

Nucleated erythrocytes (**choice E**) are seen in both sickle-cell anemia and HbS-beta-thalassemia, as well as erythroblastosis fetalis, due to increased red blood cell regeneration.

45. **The correct answer is D.** Recurrent herpes simplex is caused by a latent virus in the trigeminal ganglion that is reactivated, travels down one of the branches of the trigeminal nerve, and infects epithelial cells, resulting in necrosis and vesicle formation. The latency period is characteristic of herpesviruses and multiple, repeated episodes can occur with latent period between each. Triggering factors include nerve damage, ultraviolet light, trauma, and illness with fever (hence the name “fever blister” or “cold sore”). Trauma during a dental procedure will frequently trigger a recurrent episode.

Smallpox, or variola (**choice A**), is another viral disease. Smallpox is most often spread by the respiratory secretions of people with smallpox to people who have close contact. Influenza (**choice B**), also known as the flu, is a contagious disease that is also caused by a virus. It is spread by aerosols and contact with contaminated surfaces.

Rubella (**choice C**) is another viral disease and is spread by the aerosol route. Although rubella is generally a mild rash illness, if contracted during the early months of pregnancy it is associated with a high rate of birth defects, known as congenital rubella syndrome (CRS). Hand, foot, and mouth disease (HFMD) is caused by coxsackievirus A (**choice E**). This viral disease is spread from person to person by direct contact with nose and pharynx discharges or the stool of infected persons.

46. **The correct answer is B.** This question can be answered by asking, “What is the function of a pilus?” Pili are short extensions from the cell wall of some bacteria and are composed of glycoprotein. They are also known as fimbria. They help the bacteria adhere to surfaces. In the disease process, they help the bacteria adhere to the host cell or tissue. Note that a sex pilus may be used to exchange DNA during conjugation. However, this is *not* as important to the disease process as is the use of pili for attachment.
47. **The correct answer is C.** *Streptococcus pneumoniae* are surrounded by polysaccharide capsules of more than 85 different types. Specific antisera (antibodies) react with each type. These antibodies act as opsonins, making the combined antibody-bacteria susceptible to phagocytosis by white cells. The production of the specific antibodies (opsonins) depends on either previous exposure to the bacteria or on vaccination with *Pneumococcus* vaccine (Pneumovax®) containing the given type of antigen.
48. **The correct answer is D.** Most rickettsial diseases can produce severe illness in humans because rickettsiae are destructive for endothelial cells. They penetrate the skin or mucous membranes and multiply in the endothelial cells of small blood vessels, causing a vasculitis consisting of endothelial proliferation, perivascular infiltration, and thrombosis. The endovasculitis causes the rash, encephalitic signs, and gangrene of skin and tissues. Rickettsioses comprise four groups: typhus, such as epidemic typhus, Brill-Zinsser disease, murine (endemic) typhus, and scrub typhus; spotted fever, such as Rocky Mountain spotted fever, Eastern tick-borne rickettsiosis, and rickettsialpox; Q fever; and trench fever.

Rickettsial diseases do not produce potent exotoxins (**choice A**) like Gram-positive bacteria because they are Gram-negative. They do not cause extensive CNS damage (**choice B**), nor are they destructive for epithelial cells (**choice C**).

49. **The correct answer is D.** Transformation involves a bacterial cell absorbing soluble RNA or DNA from the environment. Transduction (**choice B**) involves entry of DNA or RNA through injection by a phage (viral) particle. Conjugation (**choice A**) involves exchange of DNA from one bacterial cell to another by way of a conjugation bridge (sex pilus). Translocation does not have meaning within bacterial genetics. Gene conversion (**choice E**) is a term involving genetic recombination in eukaryotic cells during meiosis.
50. **The correct answer is D.** Cushing's syndrome is a hormonal disorder caused by prolonged exposure of the body's tissues to high levels of the hormone cortisol. Many people suffer the symptoms of Cushing's syndrome because they take glucocorticoid hormones such as prednisone for asthma, rheumatoid arthritis, lupus, or other inflammatory diseases. Common features of Cushing's syndrome include upper body obesity, such as a fatty hump between the shoulders (buffalo hump), a rounded face (moon face), and severe fatigue and muscle weakness, high blood pressure, backache, elevated blood sugar, easy bruising, and bluish-red stretch marks (striae) on the skin. People with Cushing's syndrome must be carefully evaluated for osteoporosis by use of tests, such as the bone density test.
- Myxedema (**choice A**) is hypothyroidism occurring in adulthood. Clinical features include lethargy, cold intolerance, decreased sweating, bradycardia, tongue enlargement, and non-pitting edema of the skin due to infiltration of the subcutaneous tissues by metachromatic proteoglycans.
- Acromegaly (**choice B**) is a chronic metabolic disorder caused by the presence of too much growth hormone in adults. It results in gradual enlargement of body tissues, including the bones of the face, mandible, hands, feet, and skull.
- Addison's disease (**choice C**) is a glandular disorder caused by failure of function of the cortex of the adrenal gland and is marked by anemia and prostration with brownish skin.
- Diabetes insipidus (**choice E**) is caused by the inability of the kidneys to conserve water, which leads to frequent urination and pronounced thirst. Patients may have all the signs of dehydration: dry skin and mucous membranes, rapid heartbeat, and weight loss.
51. **The correct answer is B.** This question is an indirect reference to the fact that *Streptococcus mutans* can produce sticky polysaccharides (dextrans and glucans) that help it to colonize the enamel surface. These sticky polymers allow the accumulation of large colonies of *S. mutans*, and aid in the elimination of competing species. Note that a virulence factor is a characteristic of the organism which helps it to survive, thrive, and cause disease. *S. mutans* takes in substrate, particularly sucrose, and splits it into glucose and fructose. Fructose is used in anaerobic metabolism for energy. Glucose is used to produce glucans and dextrans through the use of the enzyme glucosyltransferase. *S. mutans* does not have special properties for the other answer choices listed.
52. **The correct answer is B.** Only *Clostridium* and *Bacillus* form endospores. These are highly resistant survival forms of bacteria that are difficult to kill. They form under harsh conditions and re-form bacterial cells when conditions improve. Note that *Bacillus stearothermophilus* spores are used for biologic monitoring of autoclaves (spore tests). Note also that *B. cereus* survives reheating (especially in rice) and causes diarrheal disease. These are two examples of the difficulty of killing spores.
53. **The correct answer is D.** One way of identifying the answer is to ask, "Which of the listed chemicals is the strongest disinfectant?" Ethanol (**choice B**) and isopropanol (**choice C**), at 70%, are moderate-level disinfectants, good for soaking but ineffective at wiping because they evaporate readily. Quaternary amines ("quats") (**choice E**) are famous for low activity and are generally not very useful in dental applications. That leaves phenol (**choice A**) and

glutaraldehyde. Both are effective (phenols include Lysol®; glutaraldehyde includes Cidex®). Of the two, glutaraldehyde is stronger and can approach being a sterilant if used long enough (12 hours or more) because it can be sporicidal in high concentrations for extended time periods.

54. **The correct answer is A.** Of the list, the exception to establishing a latent infection is the poliovirus. All the others do establish latent infections as part of their pathogenesis. Poliovirus can cause an acute infectious disease of polymyelitis, occurring sporadically or in epidemics.

Epstein-Barr virus (EBV) (**choice B**) causes infectious mononucleosis during adolescence or young adulthood. EBV also establishes a lifelong latent or dormant infection in some cells of the body's immune system. A late event in a very few carriers of this virus is the emergence of Burkitt's lymphoma and nasopharyngeal carcinoma.

Recurrent herpes simplex (**choice C**) is caused by a virus that establishes a latent infection in the trigeminal ganglion that is reactivated, travels down one of the branches of the trigeminal nerve, and infects epithelial cells, resulting in necrosis and vesicle formation.

Herpes zoster (shingles) is caused by the varicella-zoster virus (**choice D**), the same virus that causes chickenpox, and anyone who has had this childhood infection can develop shingles. The virus remains dormant or inactive in certain nerve root cells of the body, establishing a latent infection that can reactivate.

For most healthy people who acquire cytomegalovirus (CMV) (**choice E**) after birth there are few symptoms and no long-term health consequences. Some individuals with symptoms experience a mononucleosis-like syndrome with prolonged fever, and a mild hepatitis. After becoming infected, a person usually carries a latent or dormant infection within the body for life. Recurrent disease rarely occurs unless the person's immune system is suppressed due to therapeutic drugs or to disease.

55. **The correct answer is D.** Cor pulmonale is a complication or direct result of disorders that slow or block blood flow in the lungs, resulting from raised blood pressure or resistance to blood flow through the lungs. A deadly form of congestive heart failure, it creates enlargement or hypertrophy of the right ventricle in response to increased right ventricular afterload. Cor pulmonale presents as right heart failure, which is marked by a sustained increase in right ventricular pressures combined with an inability to balance the cardiac output in response to exercise or other stimuli.

Viral pneumonia (**choice A**) is an inflammation with irritation and swelling with presence of extra immune cells of the lungs, and is caused by infection with a virus.

A myocardial infarction, or heart attack, occurs when an area of heart muscle dies or is permanently damaged because of an inadequate supply of oxygen to that area. Most are caused by a clot that blocks one of the coronary arteries. The clot in the coronary artery interrupts the flow of blood and oxygen to the heart muscle, leading to the death of heart cells in that area, or myocardial ischemia (**choice B**).

Systemic hypertension (**choice C**) is a disorder characterized by high blood pressure; generally, this includes systolic blood pressure (the pressure generated when the heart beats) consistently higher than 140 mm Hg, or diastolic blood pressure (the pressure in the vessels when the heart is at rest) consistently over 90 mm Hg. Blood pressure is determined by the amount of blood pumped by the heart, and the size and condition of the arteries.

Poststreptococcal hypersensitization (**choice E**) is a hypersensitivity reaction that follows infection with beta-hemolytic streptococci and includes rheumatic fever and poststreptococcal glomerulonephritis.

56. **The correct answer is C.** The one function of macrophages in immunity is to present antigen to antigen-specific T cells. A macrophage is a large white blood cell, or lymphocyte, derived from monocytes (a subclass of mononuclear leukocytes). Properties include phagocytosis, as well as presentation.

After an antigen binds receptors on an individual T cell, the antigen stimulates the T cell to secrete interleukin (IL)-2 (**choice A**), an immunologic cytokine. The plasma cell from B cell lymphocytes produces antibody (**choice B**) during an immune reaction. An antibody-producing B cell has reached the end of its differentiation pathway.

Type II hypersensitivity is mediated antibody-dependent cellular cytotoxicity (**choice D**) by specific antibody binding to cells or tissue antigens. The antibodies are of the IgM or IgG classes and cause cell destruction by Fc-dependent mechanisms, either directly or by recruiting complement via the classic pathway.

57. **The correct answer is C.** The role of lactobacilli in coronal caries is to cause progression of existing lesions. Lactobacilli are either an anaerobic or microaerobic Gram-positive rod that also produces lactic acid. The organism is usually found in the cavitated area of a tooth. The lactic acid reacts with the tooth's enamel to decalcify the tooth. It is not the first bacteria to colonize a tooth (that would be *Streptococcus mutans*), and may not be able to form caries by itself. Lactobacilli are late colonizers of carious lesions and will contribute to demineralization; they are not initiators of caries.

S. mutans is the primary pathogen in coronal caries (**choice A**) and is a highly adherent colonizer of smooth surfaces (**choice D**), also due to certain factors that include production of dextrans (glucans). Neither cariogenic microbe is highly pathogenic in animal models (**choice B**).

58. **The correct answer is A.** Thrombosis represents a formation of an intravascular blood clot. It may form in the roughened vein wall in a varicosity, form around arteriosclerotic plaques, or result from trauma and surgery. The tendency rises with thick blood, age, and obesity, and in people once physically active but now sedentary.

Hemorrhage (**choice B**) is the escape of blood from the vessels; i.e., bleeding. Small hemorrhages are classified according to size as petechiae (very small), purpura (up to 1 cm), and ecchymoses (larger). A large accumulation of blood within a tissue is a hematoma.

Embolization (**choice D**) is the sudden blocking by an embolus of an artery by a clot (thrombus) or foreign material that has been brought to its site of lodgment by the blood current. Infarction (**choice C**) is an area of coagulation necrosis in a tissue due to local ischemia resulting from obstruction of circulation to the area, most commonly by a thrombus or embolus.

Transudation (**choice E**) is the passage of serum or other body fluid through a blood vessel as a result of hydrodynamic forces; it may be the result of inflammation.

59. **The correct answer is C.** Glioblastoma is a general term that refers to malignant astrocytoma, a type of brain tumor. Astrocytoma is a tumor that begins in the brain or spinal cord in small, star-shaped cells, the astrocytes. Glioblastoma multiforme (GBM) is the most common type of astrocytoma and also the most aggressive.

GBMs are the most common primary brain tumors in adults, so they are not the most common before puberty (**choice A**). GBM forms from glial (supportive) tissue of the brain and not the epithelial lining of ventricles (**choice E**). Ependymal cells are cells of the epithelial membrane lining the ventricles of the brain and the canal of the spinal cord, as a type of glial cell. Ependymoma is the type of brain tumor that usually develops in the lining of the ventricles of the brain, but may also occur in the canal of the spinal cord.

GBM is grade IV astrocytoma so its prognosis is generally not more favorable than grade I astrocytoma (**choice D**). It is not classified as a type of meningioma (**choice B**) because meningioma is a type of tumor that occurs in the meninges, the membranes that cover and protect the brain and spinal cord.

60. **The correct answer is B.** There are five antibody or immunoglobulin classes: IgG, IgA, IgM, IgE and IgD, which are distinguished by their heavy chains. IgE antibodies are responsible for the difficulty in breathing when a patient states that he immediately begins wheezing and has difficulty breathing when exposed to penicillin. Penicillin is a member of a large family of beta-lactam antibiotics; closely similar antibodies include ampicillin and amoxicillin. The most severe type of reaction due to high IgE levels is an anaphylactic reaction or anaphylaxis, or a severe type I hypersensitivity. The bronchi constrict, making it hard to breathe. This happens because the mast cells and basophils degranulate such products as histamine. A less severe type I reaction is an urticarial rash.

The only way to tell if the patient is currently allergic to penicillin is for him to undergo specific allergy skin testing with penicillin that has been shown to be safe. A patient with a positive test should take an alternative antibiotic. It's also important to note that a negative test doesn't mean that the patient is free of allergy but that the risk is roughly the same as that of the general population (about 2%). Furthermore, people can develop new allergies to penicillin at any time.

IgA (**choice A**) antibodies have two different types: serum IgA, located in the blood; and secretory IgA, located in the saliva, which has a component that helps protect it from digestion in body secretions. IgG (**choice C**) is the most common circulating antibodies and only IgG can cross the placenta and give neonates protection. IgM (**choice D**) antibodies are the first ones made and are of a larger size. Type II, or cytotoxic antibody, reaction and type III hypersensitivity, or immune complex reaction, are mediated by IgG and IgM to specific antigens. Little is known about the IgD (**choice E**) class of antibodies.

61. **The correct answer is A.** Plasmids are highly involved in the transfer of antibiotic resistance in bacteria and, in particular, the existence of multidrug-resistant strains. Plasmids are intracellular but extrachromosomal pieces of genetic material found in bacterial cytoplasm. They are usually circular, double-stranded DNA molecules that can be transferred to other bacterial cells, often through conjugation, in which material is transferred from one cell to another through a conjugation bridge (sex pilus). Transduction (**choice C**) refers to genetic material transfer by bacteriophage (virus). Transformation (**choice D**) refers to a bacterial cell absorbing soluble DNA or RNA from the environment. These two processes are not highly linked to antibiotic resistance.
62. **The correct answer is A.** Staphylococcus can produce both a pyrogenic toxin, causing high fever, and an enterotoxin, causing diarrhea and food poisoning. Both toxins are coded for by phage particles. Rashes (**choice B**) can be caused by erythrogenic toxin of *Staphylococcus pyogenes*. Muscle spasms (**choice D**) can be caused by toxins of *Clostridium tetani* (tetanus). Neuromuscular paralysis (**choice C**) can be caused by toxins of *C. botulinum* (botulism).
63. **The correct answer is E.** Endotoxin is found in the capsule of Gram-negative bacteria and is liberated on disintegration of the bacterial cell. It consists of lipopolysaccharides including, most importantly, lipid A. Somatic O polysaccharide and core polysaccharide are part of the structure but the actual toxicity is associated with lipid A.
64. **The correct answer is C.** Whooping cough, or pertussis, is a serious infection of the respiratory system caused by *Bordetella pertussis* bacteria. People become infected with *B.*

pertussis by inhaling contaminated droplets of an infected person's cough or sneeze. Before a vaccine was available, whooping cough killed thousands of people in the United States each year.

Haemophilus influenzae bacteria (**choice A**) type b (Hib) was formerly the number one cause of bacterial meningitis. More than half of the cases of Hib infection in the United States involve bacterial meningitis. Hib disease has been greatly reduced since a vaccine was introduced.

Streptococcus pneumoniae (**choice B**) remains a major cause of pneumonia, meningitis, sepsis, and otitis media. In the United States it is estimated to be responsible for at least one-fourth of all cases of community-acquired pneumonia. A progressive increase in antimicrobial resistance has been observed worldwide, particularly to penicillin and more recently to other commonly used antibiotics. A vaccine is also available for it.

Klebsiella pneumoniae (**choice E**) tends to affect people with underlying diseases, such as alcoholism, diabetes, and chronic lung disease. Classically, *K. pneumoniae* causes a severe, rapid-onset illness that often causes areas of destruction in the lung.

Brucella melitensis (**choice D**) is a bacterium that can affect most species of domestic animals; sheep and goats, particularly milking breeds, are the most susceptible.

65. **The correct answer is B.** The main issue involved here is location. Acute appendicitis will normally present with lower gastrointestinal tract pain (right side) because the source is the appendix, at the end of the small intestine/beginning of colon. Crohn's disease (**choice A**) and Meckel's diverticulitis (**choice C**) are, similarly, diseases of the distal small intestine (ileum) and/or colon. Pelvic inflammatory disease (**choice D**) occurs in the female reproductive tract but pain will also be from the lower abdomen. Pain from peptic ulcer (**choice B**), in the stomach, is higher and will not be confused with pain from the other conditions.

66. **The correct answer is B.** The strict translation of dimorphism implies two body forms. In the case of fungi, these two forms are yeast (single cell) and mycelial (mold, hyphal, multicell branching) forms. Many fungi are dimorphic, including *Candida*, *Blastomyces*, and *Histoplasma*. Note that *Aspergillus* and *Coccidioides* are not dimorphic and exist as yeasts only.

In most cases, temperature is the crucial factor that dictates the form in which the fungus will grow; *Candida*, however, is an exception to this rule and what causes it to grow in either form is not clear.

67. **The correct answer is C.** Disorders included with type I hypersensitivity reactions are allergic rhinitis, allergic conjunctivitis, atopic dermatitis, allergic asthma, urticaria, gastrointestinal food reactions, and systemic anaphylaxis. Histamine, leukotrienes, and other mediators, such as prostaglandin D₂, are generated or released when antigen reacts with IgE on basophils and mast cells.

Arachidonic acid (**choice C**) is an essential fatty acid used to synthesize regulatory molecules such as prostaglandins and thromboxanes. As the basophil or mast cell is activated there is also activation of a membrane enzyme called phospholipase A₂, which breaks down membrane components to arachidonic acid. Arachidonic acid is further metabolized by one of two enzyme pathways into various prostaglandins (by cyclooxygenase) or leukotrienes (by lipoxygenase). Both prostaglandins and leukotrienes are highly proinflammatory, bronchospastic, and vasodilatory.

When released from the granules of mast cells and basophils (**choice E**), histamine (**choice B**) causes vasodilation and an increase in permeability of blood vessel walls.

The kinin system (**choice D**) is a group of proteins that ultimately produce the nonapeptide bradykinin. Bradykinin increases vascular permeability, dilates blood vessels, contracts nonvascular smooth muscle, and causes pain during type I hypersensitivity reactions.

The thymus gland (**choice A**) is a large gland of the lymphoid system. T-cell lymphocytes mature in the gland in response to stimulation by thymus hormones.

68. **The correct answer is B.** A graft-versus-host reaction implies that the graft of foreign tissue is mounting an immunologic reaction against the host (rather than vice versa). A host-versus-graft reaction would be expected, and is reduced through immunosuppressive drugs. For a graft to mount an immunologic response, the graft must contain cells capable of that function. Remember that all immunologic responses depend on lymphocytes, so the graft must contain active lymphoid tissue. This can occur in bone marrow grafts.

69. **The correct answer is E.** Obesity is associated with an increased risk of breast cancer. Obesity is an increase in body weight beyond the limitation of skeletal and physical requirement, as the result of an excessive accumulation of fat in the body. Risk also increases with age, number of first-degree relatives affected, earlier menarche, alcohol consumption and smoking, older age at first term live birth, and having BRCA1 or BRCA2 genes, as well as other factors.

Risk increases when breasts contain mammographically dense fibroglandular tissue. Fibroadenoma (**choice D**) is a benign breast tumor that is associated with only a slight increase in the risk of breast cancer. There is no association between breast silicone implants (**choice C**) and the subsequent risk of breast cancer. There is an increased risk if the woman has never borne children but no increased risk for a history of bearing multiple children (**choice A**).

The appearance of increased risk for invasive but not in situ breast cancer after only 4 years of use may suggest that combined hormone replacement therapy or increasing estrogen (the therapy is for postmenopausal women who have an estrogen deficiency; **choice B**) in part does not increase the risk of new breast cancers but rather accelerates the development of incipient breast cancers already present. However, cancer patients may face an increased risk of depression and other side effects as a result of treatment that disrupts their bodies' supply of estrogen, thus making them estrogen deficient.

70. **The correct answer is D.** The destruction of glomerular basement membranes in a patient with glomerulonephritis is due to polymorphonuclear leukocytes, or neutrophils or PMNs. PMNs are mature granular leukocytes that are polymorphonuclear (its nucleus having three to five lobes connected by slender threads of chromatin, and cytoplasm containing fine granules); PMNs have the properties of chemotaxis, adherence to immune complexes, and phagocytosis. Glomerulonephritis may be a temporary and reversible condition or may be progressive and result in destruction of the kidney glomeruli, chronic renal failure, and end-stage renal disease.

In type III hypersensitivity, the deposited immune complexes trigger PMNs to discharge their granule contents with consequent damage to the surrounding endothelium and basement membranes. The complexes may be deposited in a variety of sites, such as kidney glomeruli, and a postinfection complication such as glomerulonephritis occurs.

Type I reaction involves eosinophils (**choice A**) and IgE antibodies (**choice C**) with such disease states as allergy, asthma, and anaphylaxis. Type IV reaction involves lymphokines (**choice B**) in such disease states as transplant reaction and tuberculosis. Type II reaction involves IgG, IgM, and also PMNs, and is involved in hemolytic disease of newborns.

71. **The correct answer is B.** The key to the effectiveness of antibiotics is the ability to be toxic to part of the procaryotic bacterial cell while remaining nontoxic to the eukaryotic host cell. Cell walls (only in bacteria, not in humans) and 70S ribosomes (found in bacteria only—human ribosomes are 80S) are common sites of antibiotic action. Because bacterial cell walls contain peptidoglycans, and they are not found in human cells, penicillins can inhibit peptidoglycan linkage without being toxic to the host cell.
72. **The correct answer is B.** Bacteria can respire aerobically or anaerobically, depending on species. Anaerobic bacteria take in substrate (often a sugar) and begin glycolytic reactions without oxygen, resulting in ATP production and a final waste product of lactic acid. This is known as lactic acid fermentation, and is similar to alcoholic fermentation employed by other species, such as yeasts. Oxygen is not required, and oxidative phosphorylation does not occur. An example of an organism using this process is *Streptococcus mutans*, which splits sucrose into glucose and fructose and then ferments the fructose, gaining ATP and secreting lactic acid waste on tooth structure. Catalase and superoxide dismutase are not involved in the process. These enzymes degrade peroxides and superoxides. Respiration (**choice A**) is not correct. “Respiration” is a confusing term, sometimes referring to any energy-producing process (aerobic or anaerobic) and sometimes referring to aerobic steps. Either way, it is not as specific to anaerobic bacteria as is fermentation.
73. **The correct answer is D.** Viral particles must pass through the host cell membrane in order to infect the cell and replicate. The normal way that viruses accomplish this is to attach to an existing receptor on the membrane. A good example of this phenomenon is HIV virus attaching to CD4 receptors of lymphocytes. The virus does not have to insert pieces into the membrane or be phagocytized. Although interferon binds to receptors to initiate its defense response, a virus does not have to neutralize interferon to enter a cell.
74. **The correct answer is E.** *Neisseria gonorrhoeae* is the cause of the sexually transmitted disease gonorrhea. This, by itself, is sufficient to answer the question. Gonorrhea is an infection of the mucous lining (epithelium) of the urethra, and is particularly acute in males. Both pili and protein II are involved in attachment to host cells. Mucous membranes of the genitourinary tract, eye, oral cavity, and rectum can be infected.
75. **The correct answer is E.** The lesion of peptic ulcer disease (PUD) is a disruption in the mucosal layer of the stomach or duodenum. An ulcer is distinguished from an erosion by its penetration of the muscularis mucosa, or the muscular coating of the gastric or duodenal wall. A bleeding ulcer can cause anemia, usually from iron deficiency, and if the ulcer eats into a major blood vessel there may be severe internal hemorrhaging or chronic blood loss. “Anemia” is an inadequate number of circulating red blood cells.

Chronic gastritis may occur when the body’s own immune system attacks the acid-secreting cells of the stomach lining in a form of autoimmune disease. The inflammation of the gastric lining continues over many years until the stomach’s ability to secrete acid is lost (achlorhydria). Also lost is the ability to secrete intrinsic factor, necessary for binding and absorption of the important vitamin B₁₂, which leads to a deficiency of vitamin B₁₂ and pernicious anemia (**choice C**).

Aplastic anemia (**choice A**) is not a single disease but a group of closely related disorders characterized by the failure of the bone marrow to produce all three types of blood cells: red blood cells, white blood cells, and platelets. Aplastic anemia is rare and its exact cause is unknown.

Hemolytic anemia (**choice B**) is caused by premature destruction of red blood cells. There are also a number of specific types of hemolytic anemia. Causes of hemolytic anemia include infection, certain medications, autoimmune disorders, and inherited disorders.

Any anemia condition that arises from a space-occupying lesion in the bone marrow is myelophthitic anemia (**choice D**). The circulating blood contains immature cells of the granulocytic series and nucleated red blood cells, frequently in numbers that are disproportionately large in relation to the degree of anemia. The most common causes of infiltrative myelopathy are metastatic carcinomas (e.g., lung, breast, and prostate cancer), lymphoproliferative malignancies (e.g., lymphomas), and disseminated granulomatous diseases (e.g., miliary tuberculosis).

76. **The correct answer is A.** Cholelithiasis is gallstone disease. Gallstones form in the gallbladder and are accompanied by hyperbilirubinemia (elevated bilirubin) and low urobilinogen. The high bilirubin levels aid in stone formation. However, excess bilirubin does not leave the gallbladder and enter the intestine to be converted to urobilinogen. Common risk factors for cholelithiasis include the “Four F’s”: fat, fertile, female, forty. Note that the patient does not have a fever or pain, so cholecystitis (obstruction) is not occurring. Aplastic anemia (**choice B**) would be accompanied by low WBC, RBC, and platelet counts, as well as a hypocellular marrow. Hemolytic anemia (**choice C**) would be accompanied by increased RBC destruction as well as increased bilirubin and urobilinogen. Acute hepatitis (**choice D**) would be accompanied by severe pain, jaundice and fever. Alcoholic cirrhosis (**choice E**) would be accompanied by fatty liver, jaundice, fever, and hepatomegaly.

77. **The correct answer is A.** *Candida albicans* is considered to be part of the normal oral flora and can be found in small amounts on the tongue, buccal mucosa, and other oral tissues. In immunosuppressed patients, in patients undergoing antibiotic therapy, and in other conditions, *Candida* may overgrow, producing candidiasis (or thrush).

None of the other fungi listed are normal oral flora. *Aspergillus* (**choice B**) is found in the environment on decaying vegetation, and can cause Aspergillosis, a fungal infection. Infection of the lungs with “fungus ball” formation is possible. *Histoplasma* (**choice C**), *Blastomyces* (**choice D**), and *Coccidioides* (**choice E**) are also environmental and are found in soil. They usually cause mild disease in healthy patients but often cause problematic fungal infections in seriously immunocompromised patients.

78. **The correct answer is E.** Although all of the chemicals listed can be used as disinfectants, alcohol has the most serious limitations. Although 70% alcohol (ethyl or isopropyl) is a good soaking disinfectant, it is a poor surface disinfectant because it evaporates before it has enough contact time to kill the microorganism. Rhinoviruses are often transferred from the mucus of a person with a cold to a surface, to a hand of someone else touching the surface, and then to the other person’s nose or mouth. So rhinoviruses may survive the short contact time with alcohol wiping. All of the other disinfectants listed do not evaporate quickly, and they remain on the surface longer for better killing.

79. **The correct answer is A.** The chemotactic accumulation of inflammatory cells that occurs at the sites where immune complexes are deposited is most probably due to the presence of C5a. C5a is a split product of the complement protein, C5. It is an exceptionally important and potent proinflammatory mediator because it has both anaphylatoxic and chemotactic effects. Therefore, it is active in both the vascular and cellular phases of the inflammatory response. Because it is a plasma protein and therefore almost instantly available at the site of an immune response, it is probably the most important mediator in terms of initiating the complex series of events that results in amplification of the initial inflammatory stimulus.

Complement is a defense mechanism that uses at least 30 proteins in the blood. It was named “complement” because the system helps antibody kill invaders. It is active during type III hypersensitivity when immune complexes are formed in large quantities. The

combination of IgM or IgG antibodies with antigen activates the complement cascade, generating active peptides such as C5a, which, in addition to dilating capillaries and increasing vascular permeability, contracts smooth muscle and mobilizes phagocytic cells. Binding of immune complexes to neutrophils and macrophages also activates the respiratory burst with generation of toxic oxygen products such as hydrogen peroxide, hydroxyl radical, hypochlorous acid, and chloramines. Lysosomal proteolytic enzymes, together with toxic oxygen products, produce a potent system that can damage protein and lead to blood vessel damage with hemorrhagic necrosis and local tissue destruction.

Factor B (**choice B**) is another complement component that participates in the alternative pathway of complement activation, binding to C3b to form C3bB, which is a substrate for factor D. IgE (**choice E**) is involved in type I hypersensitivity, and IgA (**choice D**) is involved in oral secretions (secretory type) as well as the serum (serum type). After an antigen binds receptors on an individual T cell, the antigen stimulates the T cell to secrete interleukin (IL)-2 (**choice C**), an immunologic cytokine.

80. **The correct answer is C.** Ascending infections refer to infections that begin in another tissue or organ and then travel through tissues or organs to infect a different tissue or organ. Kidneys are often infected from microorganisms traveling from areas distal to the kidney, in the urinary tract. Specifically, infections may begin in the urethra, spread to the bladder, travel up the ureter, and infect the kidney. In particular, the proximity of the urethral opening to the anus makes these urethral infections common. Fortunately, most are treated before reaching the kidney. None of the other choices listed have a similar likelihood of ascending infections.

81. **The correct answer is C.** Emphysema, a lung disease most often caused by smoking, is characterized by destruction of alveoli, the spaces where gas exchange takes place. As the alveolar walls continue to break down, larger spaces (or bullae) result.

When large bullae compress the remaining lung, breathing out (expiration), and not in (inspiration) (**choice D**), becomes difficult. Emphysema is characterized by a large, barrel-shaped chest; a poor air-pumping system; and shortness of breath. In advanced stages, every breath is difficult.

A cough (**choice A**) may or may not be present with emphysema. Lung capacity is either normal or increased. There is no chest pain (**choice B**) associated with emphysema. In fact, lung reduction surgery—the removal of the most severely damaged portions of emphysematous lung—is an increasingly popular treatment for patients with advanced emphysema.

82. **The correct answer is B.** Cancers are the result of a disruption of the normal restraints on cellular proliferation. Viruses involved in cancers are oncogenic. There are two classes of tumor viruses: the DNA tumor viruses and the RNA tumor viruses, or retroviruses. The region of the viral genome (DNA in DNA-tumor viruses or RNA in RNA-tumor viruses) that can cause a tumor is called an oncogene. This foreign gene can be carried into a cell and cause it to take on new properties such as immortalization and anchorage-independent growth.

Herpesvirus (**choice C**) is a DNA virus strongly associated with cancer. Epstein-Barr virus, specifically, is causally associated with Burkitt's lymphoma, B-cell lymphomas in immune-suppressed individuals, and Hodgkin's lymphoma.

Papillomavirus (**choice E**) is a DNA wart-causing virus that also causes neoplasms; warts are usually benign but can convert to malignant carcinomas. Papillomaviruses are also found associated with human penile, uterine, and cervical carcinomas and are very likely

to be their cause; moreover, genital warts can convert to carcinomas. Squamous cell carcinomas of the larynx, esophagus, and lung histologically appear very like cervical carcinoma, and these may also involve papillomaviruses.

Rotavirus (**choice A**) is an RNA virus that commonly causes seasonal diarrhea in infants and young children. Paramyxovirus (**choice D**) is an RNA virus that causes chiefly respiratory infections.

83. **The correct answer is C.** *Candida albicans* often inhabits oral mucosa as normal flora. Immunocompromised states or antibiotic use may cause uncontrolled growth of the organism, resulting in candidiasis, or thrush. In the case of antibiotics, the antibiotic eliminates the normal bacterial flora, and *Candida*, a fungus, which is not affected by antibiotics, takes over the habitat, resulting in overgrowth.

84. **The correct answer is D.** The most common AIDS neoplasms are Kaposi's sarcoma (KS) and non-Hodgkin's lymphoma (NHL). Deficient cell-mediated immunity predisposes AIDS patients to the development of neoplasms. Although classically described as multicentric, reddish-purple, raised lesions, they may be hypopigmented. KS lesions, which are sarcomatous cancers of the endothelium, usually involve the oral cavity as well as the skin. NHL are cancers of lymphoid tissue (lymph nodes, spleen, and other organs of the immune system) with the involved tissue being enlarged, and are accompanied by night sweats and fever.

Mycosis fungoides (MF) (**choice A**) is a malignant lymphoma characterized by the expansion of a clone of CD4+ (or helper) memory T cells that frequently lack other normal T-cell antigens (CD7); it is associated with declining immunocompetence.

Testicular cancer (**choice B**) is an abnormal, rapid, and invasive growth of cancer in the testicles. Although the exact cause of testicular cancer has not been identified, several predisposing factors seem to increase risk. These include a past medical history of undescended testicle(s), abnormal testicular development, Klinefelter's syndrome, or previous testicular cancer. Testicular cancer can involve embryonal carcinomas, yolk sac tumors, teratoma, and choriocarcinomas.

Neuroblastoma (**choice C**) is a sarcomatous cancer that arises in immature nerve cells and affects mostly infants and children. Rhabdomyosarcoma (**choice E**) is a sarcomatous cancer of muscle tissue.

85. **The correct answer is A.** Sarcoma is a malignant neoplasm that originates in connective tissue, which is originally a mesenchymal tissue.

Adenoma (**choice B**) is a benign neoplasm having a glandular origin and structure. Carcinoma (**choice C**) is a malignant neoplasm of epithelial tissue origin.

Hamartoma (**choice D**) is a benign neoplasm that is made up of tissues normally found in the area in which it is located, but in an unusual mixture. This type of tumor results from a developmental anomaly of embryonic cells.

Choristoma (**choice E**) is a mass of tissue that is histologically normal, but not normal for the site in which it is located.

86. **The correct answer is C.** Suppuration is the formation of pus, usually yellowish (to green) liquid. Pus is formed by the collection of large numbers of polymorphonuclear neutrophils (PMN), a type of white blood cells, in a localized area of the body in response to the presence of bacterial infection. These cells break down and release chemicals, such as enzymes (e.g., lysozyme), that kill the bacteria as well as cause enlargement or inflammation of the

blood vessels. These enzymes released by the PMN may also be responsible for pain and swelling. This includes such bacterial infections as bacterial pneumonia, sinusitis, otitis media, and boils. An abscess is a collection of pus within a cavity or pocket.

The pus also attracts (chemotaxis) more white blood cells such as lymphocytes (**choice D**) and plasma cells (**choice E**) from the B-cell lymphocytes that produce antibodies to further fight an infection.

Within the pus, there will be serum (**choice A**) from the blood system, as well as debris from the tissue (**choice B**) and dead bacteria. Serum is the clear liquid part of the blood that remains after blood cells and clotting proteins have been removed.

87. **The correct answer is B.** Rheumatoid arthritis (RA) is a systemic inflammatory autoimmune disease. It is characterized by a symmetric polyarthritis. The most widely recognized skin lesion is the rheumatoid nodule. White blood cells that are part of the normal immune system travel to the synovium and cause a reaction. This reaction, or inflammation or synovitis, results in the warmth, redness, swelling, and pain that are typical symptoms of RA. During the inflammation process, the cells of the synovium grow and divide abnormally, thickening the normally thin synovium and resulting in a joint that is swollen and puffy to the touch.

As the disease progresses, the synovium may grow considerably larger, eventually forming a pannus, a sheet of inflammatory granulation tissue that spreads from the synovial membrane and invades the joint in rheumatoid arthritis, ultimately leading to fibrous ankylosis. Pannus can be considered the most destructive element that affects joints in patients with rheumatoid arthritis, and is the classical microscopic lesion of RA.

Tophus (**choice A**) is a deposit of urates in the skin and tissue around a joint or in the external ear, occurring in gout. Heberden's node (**choice D**) is any of the bony knots at joint margins (as at the terminal joints of the fingers) commonly associated with osteoarthritis.

An Aschoff body (**choice C**) is a histologic feature of rheumatic carditis. In its typical form it is a granuloma composed of a central area of fibrinoid necrosis surrounded by histocytes. Aschoff bodies heal by scarring.

Wire-loop lesion (**choice E**) is a thickening of the basement membrane, with fibrinoid staining, of scattered peripheral capillaries in renal glomeruli; it is characteristic of renal involvement in systemic lupus erythematosus. The appearance of an affected capillary wall resembles a wire loop used in microbiology.

88. **The correct answer is D.** The most probable diagnosis for a woman who exhibits radiographic evidence of an osteolytic lesion of the humerus, elevated serum calcium level, and a bone lesion showing numerous giant cells is hyperparathyroidism. This condition is due to the increased secretion of parathyroid hormone (PTH) from the parathyroid glands. This excess PTH triggers the release of too much calcium into the bloodstream, resulting in hypercalcemia. The bones may also lose calcium, resulting in osteolytic lesions from osteomalacia. The most common cause of this condition is the development of a benign tumor in one of the parathyroid glands. Changes in bone include replacement of marrow by fibrous tissue and brown tumors, which arise secondary to increased osteoclastic activity and are histologically indistinguishable from giant cell tumors of bone. The risk of hyperparathyroidism increases with age and occurs most often in postmenopausal women.

Rickets is a disorder involving softening and weakening of the bones, primarily caused by lack of vitamin D, calcium, and/or phosphate. Renal rickets (**choice A**) occurs in people with chronic renal failure. The manifestation is virtually identical to that of rickets in children and that of osteomalacia or osteoporosis in adults.

Fibrous dysplasia (**choice B**) is a disorder in which bone expands due to abnormal development of fibrous tissue. It may result in uneven growth of bones, brittle bones, and deformity of bones. Fibrous dysplasia usually occurs in children and young adults, and is found equally in males and females.

Osteitis deformans (**choice C**), or Paget's disease, is rare before the age of 60. It involves the thickening of the bones but instead of becoming tougher and stronger, paradoxically, the bones become softer and tend to deform easily.

89. **The correct answer is D.** The one exception on the list that does not cause adult respiratory distress syndrome (ARDS) is cigarette smoking, which is only a risk factor. ARDS is characterized by progressive hypoxemia due to inflammation of the lungs and accumulation of fluid in the alveoli. The syndrome follows a direct pulmonary or systemic insult, resulting in injury to the alveolar-capillary unit. Although originally described in adults, ARDS does occur in children; hence, the recent change in name from "adult" to "acute" respiratory distress syndrome.

Thus, ARDS follows primary pulmonary disease or injury, such as viral pneumonia (**choice C**) or aspiration of gastric contents; and systemic illnesses, such as sepsis or hemorrhagic shock (**choice A**); as well as drug abuse, such as heroin overdose (**choice B**). Also included is inhaling high concentrations of smoke, toxins, or oxygen, such as breathing 100% O₂ (**choice E**).

Treatment for ARDS consists of mechanical ventilation, along with careful attention to fluid balance and a supportive breathing technique called positive end-expiratory pressure (PEEP). These are combined with continuing treatment of the precipitating illness or injury. The oxygen deprivation caused by this syndrome can produce complications in other organs soon after the condition starts or, if the situation does not improve, days or weeks later.

90. **Item not scored.**

91. **The correct answer is C.** Rheumatic fever (RF) can be a sequela to streptococcal infections such as scarlet fever, a nonsuppurative acute inflammatory complication of group A streptococcal infection characterized mainly by arthritis, chorea, or carditis (sometimes followed by residual heart disease), alone or in combination. The skin (subcutaneous nodules and erythema marginatum) may also be involved.

Pyoderma (**choice A**) is any purulent skin disease. Diphtheria (**choice B**) is an acute infectious disease caused by toxigenic strains of *Corynebacterium diphtheriae*. Dental caries (**choice D**) is mainly caused by *Streptococcus mutans*. Streptococcal gangrene (**choice E**) is a form of necrotizing fasciitis and gangrene, often referred to as "flesh-eating disease."

92. **The correct answer is A.** The epithelial change most predictive of cancer is dysplasia. Dysplasia is an abnormal type of excessive cell proliferation characterized by loss of normal tissue arrangement and cell structure. Often such cells revert back to normal behavior, but occasionally they gradually become malignant. Because of their potential for becoming malignant, areas of dysplasia should be closely monitored; sometimes they are treated.

Metaplasia (**choice B**) is a change of cells to a form that does not normally occur in the tissue in which it is found. Acanthosis (**choice C**) is a diffuse hyperplasia of the spinous layer of the skin.

Parakeratosis (**choice D**) is the persistence of the nuclei of the keratinocytes into the stratum corneum (horny layer) of the skin in certain diseases. However, parakeratosis is normal in the epithelium of the oral cavity in certain locations.

Hyperkeratosis (**choice E**), or callus, is hypertrophy of the stratum corneum of the skin or certain areas of the oral cavity, or any disease characterized by it. It may be mistaken for cancer in the oral cavity if examination is only visual.

93. **The correct answer is A.** Acute leukemias are most often seen in the under-20 age group and not the others listed, from 20 to 80 years of age (**choices B through E**). Leukemia is a cancer of the blood cells. There are a variety of leukemias, each with its own peculiar signs, symptoms, prognosis, and behavior.

Acute leukemia refers to leukemia that, if left untreated, can cause fatal complications in a very short period of time. Acute leukemias usually present with hemorrhage, anemia, infection, or infiltration of organs. There are two main types of acute leukemias. Acute myeloid leukemia originates in myeloid cells of the bone marrow and may happen at any age, however the peak is in the elderly, after age 60. Acute lymphoid leukemia originates in lymphatic cells of the bone marrow, and most patients who have it are under the age of 10 or over the age of 50.

Chronic leukemias, if left untreated, in some cases may not cause complications for years. Many patients with chronic leukemias are asymptomatic. There are two main types of chronic leukemias: myeloid and lymphoid. Chronic myeloid leukemia is due to an overproduction of myeloid cells and is more commonly seen after age 50 but can be seen in any age group, even in children. Chronic lymphoid leukemia is a result of overproduction of mature lymphoid cells and is more commonly seen after age 50. It is the most common leukemia in adults.

94. **The correct answer is D.** Nephrotic syndrome is a condition marked by very high levels of protein in the urine, or proteinuria, as well as low levels of albumin protein in the blood, or hypoalbuminemia; by swelling, especially around the eyes, feet, and hands; and by high cholesterol. Thus, proteinuria is a major component of the nephrotic syndrome. Nephrotic syndrome results from damage to the kidneys' glomeruli. Most proteins are too large to pass through the glomeruli into the urine. The glomeruli are negatively charged, so they repel the negatively charged proteins. Thus, a size and charge barrier keeps protein molecules from entering the urine. But when the glomeruli are damaged, proteins of various sizes pass through them and are excreted in the urine. Nephrotic syndrome can occur with many diseases, including the kidney diseases caused by diabetes mellitus, but some causes are unknown.

If your blood is low in red blood cells (RBCs), you have anemia (**choice A**). Anemia is common in people with kidney disease. Healthy kidneys produce the hormone erythropoietin (EPO), which stimulates the bone marrow to produce the proper number of RBCs. Diseased kidneys, however, often do not make enough EPO. As a result, the bone marrow makes fewer RBCs.

Hematuria (**choice B**) is the presence of RBCs in the urine. Concern and treatment for hematuria depend on the cause. Red cell casts in the urine (**choice E**) are present in many diseases that affect the glomerulus, such as Goodpasture's syndrome, sickle-cell anemia, and malignant hypertension, or as a result of renal infarction.

After diabetes, high blood pressure—or hypertension (**choice C**)—is the leading cause of kidney failure or end-stage renal disease (ESRD) because the kidneys play a role in keeping blood pressure at the right level. Patients with ESRD must either go on dialysis or receive a new kidney through transplant.

95. **The correct answer is B.** The most common skin cancer in humans is basal cell carcinoma. These cancers arise in the basal cells, the lowest layer of the epidermis. Until recently, those most often affected were older people, particularly men who had worked outdoors. Although the number of new cases has increased sharply each year in the last few decades, the average age of onset of the disease has steadily decreased. Chronic exposure to sunlight is the cause of almost all basal cell carcinomas, which occur most frequently on exposed parts of the body.

The chronic exposure to sunlight is also a factor in squamous cell carcinoma (**choice C**) as well as malignant melanoma (**choice A**). Even though these carcinomas of the skin have risen in numbers, they are below the levels of basal cell carcinomas. Squamous cell cancers may occur on all areas of the body, including the mucous membrane, but are most common in areas exposed to the sun (especially the lower lip). They arise from the epidermis and resemble the squamous cells that comprise most of the upper layers of skin. Melanoma is a cancer of the pigment producing cells in the skin, the melanocytes. In some cases, the risk of developing melanoma runs in families. Both squamous cell carcinomas and malignant melanomas can metastasize, unlike most basal cell carcinomas. These cancers must be considered during all examinations of the head and neck and oral cavity of patients as part of a complete dental examination.

Sebaceous adenocarcinoma (**choice D**) is a cancer composed of cells showing differentiation toward sebaceous epithelium. The face and scalp are the most common sites. Metastasis is uncommon. Renal transitional cell carcinoma (**choice E**) is cancer arising from the transitional epithelium lining of the renal pelvis.

96. **The correct answer is E.** Leukemia is a group of diseases of the reticuloendothelial system involving uncontrolled proliferation of white blood cells, or leukocytes. People with leukemia may have thrombocytopenia (a decrease in the number of blood-clotting platelets, which can result in excessive bruising), abnormal bleeding, or frequent bleeding of the nose or gingiva. Thus, the most probable cause for prolonged bleeding time in a patient with leukemia is a decreased number of blood platelets.

von Willebrand's disease, or decreased factor VIII (**choice A**), is the most common inherited bleeding disorder. Unlike hemophilia, which is a sex-linked trait, it may be discovered at any age and in either sex. While hemophilia is usually associated with bleeding into joints and muscles, it is more commonly associated with easy bruising, recurrent nosebleeds, prolonged postoperative or posttraumatic bleeding, excessive bleeding from the gingiva, and menorrhagia. Like factor IX, factor VIII is a protein produced naturally in the body. It helps the blood form clots to stop bleeding.

Injections to increase factor IX (**choice B**) are used to treat hemophilia B, or Christmas disease.

Myeloproliferative disease is chronic diseases caused by clonal proliferation of bone marrow cells leading to excess production of one or more hemopoietic lineage that in some cases shows increased megakaryocytes (**choice C**). A platelet is a disk-shaped fragment of a megakaryocyte, a large cell found in bone marrow.

Calcium is vital for muscle contractility, cardiac function, neural transmission, and blood clotting. Serum calcium is used to evaluate parathyroid function and calcium metabolism. Bone and teeth act as calcium reservoirs. When serum calcium levels decrease (**choice D**), parathormone is released to increase absorption, decrease excretion, and increase release from bone.

97. **The correct answer is C.** Actinomycosis is usually caused by a facultative or strictly anaerobic Gram-positive bacilli, *Actinomyces israelii*. This is a nonpathogenic organism found as normal flora in the nose and pharynx. Its normal location in the nose and pharynx accounts for actinomycosis most commonly appearing in the face and neck. Because this organism is part of the normal flora, the infection is not contagious. *Actinomyces* produces disease when it is introduced into the facial tissues by trauma, surgery, or infection. A common cause is dental abscess or oral surgery. Once in the tissue it forms an abscess, producing a hard, red to reddish-purple lump, often on the mandible, from which comes the name “lumpy jaw.” Examination of drained fluid or pus from the abscess under a microscope demonstrates “sulfur granules” in the fluid. Thus, an abscess in the oral cavity with central necrosis extruding pus containing sulfur granules would be actinomycosis.

A furuncle (**choice A**), or boil, is a skin infection involving the entire hair follicle and the adjacent subcutaneous tissue. It is generally caused by *Staphylococcus aureus* but may be caused by other bacteria or fungi. A furuncle may drain spontaneously, producing pus.

With the decline in numbers, tuberculous lesions caused by *Mycobacterium tuberculosis* of the oral cavity have become so rare that they are frequently overlooked in the differential diagnosis of oral lesions. Thus, tuberculosis (**choice B**) should always be considered as a possible cause of chronic oral ulceration, especially if on the tongue.

Vincent’s infection (trench mouth) (**choice D**) is an older name for acute necrotizing ulcerative gingivitis (ANUG), recently categorized as necrotizing periodontal disease. A painful infection of the mouth and pharynx characterized by ulcerations of the mucous membranes, bleeding, and foul breath, it is caused by the bacterium *Fusobacterium fusiforme* in combination with the spirochete *Treponema vincentii*.

98. **The correct answer is C.** All of the cancers listed have generally poor prognoses, especially if not detected and treated early. Symptoms of pancreatic cancer may be vague (abdominal pain, diarrhea, and weight loss) and late, when the cancer is already advanced. Five-year survival of patients with carcinoma of the head of the pancreas is estimated at 2 to 5%.

Oral squamous cell carcinoma (**choice E**) survival varies greatly, depending on location and developmental stage of the cancer. Patients with early lip lesions have a high survival rate. Late-discovered floor of mouth or tongue lesions have a much poorer prognosis. Carcinoma of the colon (**choice D**) similarly has a varied cure rate, but its 5-year survival can be as high as 50 to 70% if discovered early. Carcinoma of the lung (**choice A**) can have a 5-year survival of 10 to 15% but may be as high as 40% after curative resection. Malignant melanoma (**choice B**) survival varies highly, depending on both thickness and metastasis. It may be as high as 99% in very thin lesions or as low as 10% with metastasis of thick lesions.

99. **The correct answer is D.** Typhoid fever is a life-threatening illness caused by the bacterium *Salmonella typhi*. People with typhoid fever carry the bacteria in their bloodstream and intestinal tract. In addition, asymptomatic carriers recover from typhoid fever but continue to carry the bacteria. Both ill people and these carriers shed *S. typhi* in their feces (stool). If a person eats food or drinks beverages that have been handled by one who is shedding *S. typhi*, or if sewage contaminated with the bacteria gets into the water used for drinking or washing food, the disease can spread. Therefore, typhoid fever is more common in areas of the world where hand-washing is less frequent and water is likely to be contaminated with sewage. Thus, asymptomatic carriers are a major hazard of typhoid fever.

Plague (**choice A**) is an infectious disease of animals and humans caused by a bacterium named *Yersinia pestis*. People usually get plague from being bitten by a rodent flea that is carrying the plague bacterium or by handling an infected animal, so there is no carrier state.

Shigellosis (**choice B**) is an infectious disease caused by the *Shigella* group of bacteria. The bacteria pass from one infected person to the next. *Shigella* bacteria are present in the diarrheal stools of infected people while they are sick, so there is no carrier state.

Salmonellosis (**choice C**) is an infection with the bacterium *Salmonella*. The bacteria pass from the feces of people or animals to other people or other animals, so there is no carrier state.

Legionellosis, or Legionnaires' disease (**choice E**), is an infection caused by the bacterium *Legionella pneumophila*. Outbreaks have occurred after people have breathed mists that come from a water source (e.g., air-conditioning cooling towers, whirlpool spas, showers) contaminated with *Legionella* bacteria. People may be exposed to these mists in homes, workplaces, hospitals, or public places. Legionellosis is not passed from person to person, so there is no carrier state.

- 100. The correct answer is E.** The prostate gland in men is a rich source of prostatic acid phosphatase (PAP). It normally contributes a small amount to the serum concentration. The clinical use of this prostate-specific fraction is in cases of prostatic adenocarcinoma, where it is elevated most commonly in men with metastatic carcinoma of the prostate. It is a much less sensitive test in men with localized disease. Prostate-specific antigen (PSA) is the preferred laboratory test in prostate cancer.

Multiple myeloma (**choice A**) develops from plasma cells within the bone marrow. Plasma cells produce antibodies, which help to fight infection. In myeloma, a single plasma cell develops faults and multiplies out of control. This makes the immune system much less effective at fighting infection. Myeloma cells produce excessive amounts of a single type of antibody known as paraprotein, or monoclonal spike, which are present upon blood testing.

The most common type of carcinoma of the breast (**choice B**) begins in the lining of the ducts, resulting in ductal carcinoma. For most types of breast cancer the cause is unknown. Recently, two genes, *BRC1* and *BRC2*, have been implicated in a familial type of breast cancer. Surgical biopsy removes a portion of the mass for further evaluation.

Squamous cell carcinoma (**choice C**), the second most common skin cancer after basal cell carcinoma, arises from the epidermis and resembles the squamous cells. Early biopsy is often the key to diagnosis. Suspicious lip lesions that demonstrate irregular growth, changes in color or appearance, or discharge of a purulent or bloody nature should be biopsied to rule out cancerous entities.

The most common thyroid carcinoma (**choice D**) is papillary carcinoma. A thyroid nodule should be evaluated by blood work and a thyroid ultrasound. Any large nodule seen on ultrasound should be further evaluated with fine-needle aspiration.

Dental Anatomy and Occlusion

- 101. The correct answer is D.** The primary maxillary second molars are the last primary teeth to erupt; they erupt at 25 to 33 months of age. After this eruption the child has all her/his primary teeth, or deciduous dentition. This time period of the primary dentition eruption is within the primary dentition period, which starts at 6 to 10 months of age and ends with eruption of the first permanent tooth at 6 to 7 years of age.

The primary maxillary canines (**choice A**) erupt at 16 to 22 months, followed by the primary mandibular canines (**choice B**) at 17 to 23 months. The primary mandibular first molars (**choice C**) erupt much earlier, at 14 to 18 months, and the primary maxillary first molars even earlier, at 13 to 19 months. However, earlier than the primary maxillary second molars are the primary mandibular second molars (**choice E**), erupting at 23 to 31 months.

- 102. The correct answer is B.** The correct sequence of mineralized dental tissues from softest to hardest is cementum, dentin, enamel. Cementum is 65% inorganic matter, 23% organic material, and 12% water, similar to that found in bone. Dentin is 70% inorganic, 20% organic, 10% water. Enamel is 96% inorganic matter, 1% organic material, and 3% water. Rates of dental decay per tissue follow this pattern, with cementum and dentin being more easily decalcified than enamel.

The other sequences listed are incorrect. Mature enamel is the hardest calcified tissue in the human body. This crystalline formation of the enamel consists mainly of calcium hydroxyapatite, with the empirical formula of $\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$, which is also similar to that found in bone. Other minerals, such as carbonate, magnesium, potassium, sodium, and fluoride, are also present in smaller amounts.

- 103. The correct answer is C.** Maxillary premolars are usually wider buccolingually than mesiodistally. The crown dimensions of the mandibular premolars are approximately equal to each other. All premolars have two cusps but only the maxillary second has buccal and lingual cusps of generally equal height. Therefore, the correct choice is C.

- 104. The correct answer is E.** In the mandibular first premolar, the lingual cusp is very small. Very often, this cusp can be considered more a tubercle than a cusp. It is usually no more than half the size of the buccal. Because of its size, it is a nonfunctional cusp. Therefore, it does not occlude with any maxillary tooth.

- 105. The correct answer is B.** Starting from the intercuspal position, the mesiolingual cusp of the maxillary molar is in contact with the central fossa of the mandibular molar. As you move into a lateral excursive movement, the mesiolingual cusp passes through the lingual groove of the mandibular molar on the working side. When the mandible moves to the working side, the mandibular buccal cusps and inclines oppose the maxillary buccal cusps and inclines.

106. The correct answer is B. Lingual cusps of maxillary teeth and buccal cusps of mandibular teeth provide the major support of occlusal vertical dimension. Centric stops are the areas of contact that a supporting cusp makes with an opposing tooth. The centric stop is usually the central fossa for molars. So in this case, the facial cusps of mandibular teeth oppose the central fossa line of the maxillary teeth. Both the facio-occlusal line and linguo-occlusal line provide the necessary support for vertical dimension. The curve of Spee is the curvature that begins at the tip of the canines and follows the buccal cusp tips, premolars, and molars posteriorly. The curve of Wilson is the mediolateral curvature of the occlusal plane of posterior teeth.

107. The correct answer is D. The upper compartment of the temporomandibular joint (TMJ) is that space between the disc and the articular fossa and eminence. The disc completely divides the TMJ into two compartments. These two compartments are synovial cavities, an upper and a lower compartment (or synovial cavity). The articulating area on the temporal bone of the TMJ is located on the bone's inferior aspect. This articulating area includes the bone's articular eminence and the articular fossa.

The mandible articulates with each temporal bone at the head of the condyle of the mandible so that the lower compartment, or synovial cavity, is between the condylar head and the disc (**choice A**). The back, or posterior, portion of the TMJ has the inferior and superior retrodiscal lamina (**choice B**). The medial and lateral surface of the TMJ has the capsular ligament (part of **choice C**).

108. The correct answer is A. There are usually three main pulp canals in the maxillary first molar, one for each of the three roots. The lingual (or palatal, **choice C**) pulp canal is the largest, with the distofacial pulp canal (**choice B**) the smallest and the mesiofacial pulp canal between these two in size. Sometimes the maxillary first molar has four pulp canals, with two pulp canals in the mesiofacial root. This tooth does not have a fourth root (**choice D**).

109. The correct answer is D. The general crown form of canines, as viewed from the labial aspect as well as the lingual, is pentagonal (or five-sided). The crown of each is about the same size, and when viewed from the proximal, appears triangular (**choice B**), like all anterior teeth. Canines are also wider labiolingually than the incisors, even wider than a maxillary central incisor. The crown outlines of all posterior mandibular teeth are rhomboidal (**choice C**), four-sided with opposite sides parallel, from the proximal view, and maxillary first molars (sometimes second molars) seen from the occlusal view are also shaped that way. The outline for both maxillary premolars is somewhat hexagonal (**choice A**), or six-sided, compared with the "round" mandibular premolars. The crown outline from the occlusal of the mandibular first premolar is diamond-shaped (**choice E**).

110. The correct answer is C. The height of contour, or crest of curvature, is the greatest elevation of the tooth, either incisocervically or occlusocervically, on a specific surface of the crown. The labial and lingual surfaces of a tooth also have a height of contour that is easily seen when viewing the tooth's profile from the proximal. On the crown of the maxillary canine, the height of contour is normally located in the cervical third of both labial and lingual surfaces, similar to all anterior teeth.

Choice D, neither labial or lingual surface, is incorrect. For posterior teeth, the height of contour for the crown's labial (**choice A**) surface is in the cervical third. The cingulum is present on all anterior teeth in the cervical third on the lingual (**choice B**) surface.

111. **The correct answer is E.** The mesial and distal surfaces between adjacent teeth are considered the proximal surfaces. The surface closest to the midline is considered the mesial surface; the surface farthest away from the midline is considered the distal (**choice A**) surface. Note that a distal surface usually, not always, contacts another tooth (third molars are the eruption).

Those closest to the facial surface are considered the facial surface (**choice B**). The facial surfaces close to the lips are termed the labial surface. Tooth surfaces closest to the tongue are termed the lingual surface. The lingual surfaces closest to the palate on the maxillary arch are sometimes also termed the palatal (**choice C**) surface. Facial and lingual surfaces do not normally contact other teeth.

The masticatory, or chewing, surface on the most superior surface of the crown is the incisal surface for anterior teeth and the occlusal (**choice D**) surface for posterior teeth.

112. **The correct answer is A.** During protrusive movement, incisal guidance, along with its condylar inclination, will in most cases cause the mandible to open slightly, resulting in disclusion of all the posterior teeth. As the mandible moves into a protrusive motion, the pathway of the mandibular cusps on the maxillary posterior is in the mesial direction.

113. **The correct answer is A.** When the mandible moves into lateral excursive movement, the nonworking-side condyle moves forward and down, and the working side rotates. This causes the maxillary teeth to follow a pathway that is facial and distal to the mandibular molars on the nonworking side.

114. **The correct answer is D.** The maxillary first molar is the largest tooth in the arch and is the largest crown in the mouth. There are normally three roots, two buccal and one lingual. From the distal aspect, the distal resembles the mesial with slightly smaller dimensions. The crown has a rhomboidal shape and from the distal, much of the buccal surface can be seen. Note that both the mesiobuccal and distobuccal roots can be seen from this view because the distobuccal is smaller.

115. **The correct answer is C.** When compared with the maxillary central incisor, the maxillary canine normally exhibits a thicker crown labiolingually. However, the canine crown is noticeably narrower mesiodistally and not wider mesiodistally (**choice B**). The crown of the maxillary canine is similar in length to, or even shorter than, that of the maxillary central incisor and thus is not a longer crown incisogingivally (**choice D**). The cingulum on the lingual surface is more developed and larger than that of the central incisor of the same arch, making the tooth stronger during mastication. In addition, the crown of the canine may be the same or shorter but the root of the maxillary canine is longer, not shorter (**choice A**) than the maxillary central incisor and does not have a shorter root length (part of **choice E**). In fact, it has the longest root in the maxillary arch.

116. **The correct answer is B.** Permanent mandibular central incisors have proximal contact areas at approximately the same levels cervicoincisally or cervico-occlusally on the mesial and the distal. The mesial contact with the other mandibular central is at the incisal third. The distal contact with the lateral incisor is also at the incisal third. Thus, it is the simplest tooth of the permanent dentition, inasmuch as the crown of the mandibular central incisor is very symmetrical from the labial view, having a fan shape.

Maxillary central incisors' (**choice A**) mesial contact with the other maxillary central is in the incisal third and its distal contact with the maxillary lateral is at the junction of the incisal and middle third, farther cervical than the mesial contact.

The mesial and distal contacts of the maxillary canines (**choice C**) are on two different levels, which also helps to distinguish the right maxillary canine from the left. The mesial contact with the lateral incisor is at the junction of the incisal and middle thirds. The distal contact with the first premolar is more cervical and is located at the middle third.

Similar to the maxillary canine, the mesial and distal contacts of the mandibular canines (**choice D**) are on a different level, which helps distinguish the right mandibular canine from the left. The mesial contact with the lateral incisor is in the incisal third. The distal contact with the first premolar is at the junction of the incisal and middle thirds, which is more cervically located than that of the mesial

- 117. The correct answer is D.** When viewing the incisal outline of a mandibular canine from the facial, the distoincisor cusp ridge is usually longer and has a steeper angle than the mesiolincisor cusp ridge. The distoincisor edge of the mandibular canine normally occludes with the mesioincisor ridge of the maxillary canine, whereas the mesial cusp ridge occludes with the distal lingual portion of the maxillary lateral incisor.
- 118. The correct answer is A.** On the mesial surface of the maxillary first premolar is a depressed area that is usually limited to the cervical third of the crown. This depression often makes it difficult to adapt a matrix-band to the tooth, forming a gap between tooth structure and the matrix-band.
- 119. The correct answer is D.** Both the maxillary and mandibular arches have a parabolic shape. However, the maxilla is slightly larger than the mandible. Because of this size difference, the maxilla tends to have a more rounded shape to accommodate all of the posterior teeth. The mandible is slightly more constricted, and the alignment of the posterior segment (molars and second premolar) is generally straight.
- 120. The correct answer is A.** The permanent maxillary first premolar has a faciolingual crown dimension greater than its mesiodistal crown dimension. Thus, the outline of its occlusal surface is somewhat hexagonal, or six-sided, yet still wider faciolingually than mesiodistally. Because it has two root branches it is considered bifurcated in the apical third, with one buccal root and one lingual or palatal root, unlike the other single-rooted (usually) premolars.

The crown outline of the mandibular first premolar (**choice B**) is diamond-shaped from the occlusal. Usually the tooth is single-rooted, and only occasionally the tooth will have a bifurcated root, with the root divided into a buccal and a lingual portion.

The general shape of the crown outline of the mandibular second premolar (**choice C**) is more nearly square, especially in the three-cusp type, when compared with the mandibular first premolar. The convergence of the mesial and distal margins toward the lingual is as severe. The tooth is single-rooted.

The crown outline of the mandibular first molar (**choice D**) is roughly pentagonal, with the fifth side created by the distal cusp. It usually has two roots, a mesial and a distal. It is wider mesiodistally than buccolingually.

The outline of the crown of the maxillary second molar (**choice E**) has two crown outline types when viewed from the occlusal: rhomboidal and is heart-shaped. The rhomboidal has four sides, with opposite sides parallel, and is the most common. The heart-shaped type is the less common occlusal outline and is similar to the typical maxillary third molar. It has three roots, one lingual or palatal and two buccal (one mesiobuccal root and one distobuccal root).

- 121. The correct answer is B.** The primary maxillary second molar typically has a transverse ridge, an oblique ridge, and a distolingual groove. This tooth most closely resembles the form of the permanent maxillary first molar, yet it is smaller in all dimensions. Thus, it usually has a cusp of Carabelli, the minor fifth cusp. The distal triangular ridge meets the lingual triangular ridge of the distobuccal cusp to form a prominent oblique ridge. The mesiolingual cusp also has four inclined planes that are all functional. A typical transverse ridge is also present on the occlusal table of the primary maxillary first molar. It is formed by the buccal triangular ridge of the mesiolingual cusp and the lingual triangular ridge of the mesiobuccal cusp. The lingual outline of the occlusal table is also divided unequally into two parts by the distolingual groove.

The crown of the primary maxillary first molar (**choice A**) does not resemble any other crowns of either dentition. The occlusal table also has a very prominent transverse ridge. Additionally, there is an oblique ridge running between the mesiolingual cusp and the distobuccal cusp; however, it is not as prominent as the one on its permanent counterpart. There is no distolingual groove.

The primary mandibular first molar (**choice C**) has a crown unlike any other tooth of either dentition. There is a transverse ridge that runs between the mesiobuccal and mesiolingual cusps but there is no oblique ridge or distolingual groove.

The primary mandibular second molar (**choice D**) most closely resembles the form of the permanent mandibular first molar that erupts distal to it. It has a transverse ridge but no oblique ridge or distolingual groove.

- 122. The correct answer is B.** The articular disc serves as a fibrous structure that permits the complex movements of the temporomandibular joint. It is composed of dense fibrous connective tissue, and its central area is devoid of any blood vessels or nerve fibers. It can be divided into three regions according to thickness: intermediate, anterior, and posterior. The intermediate is the thinnest and is thicker in the posterior and anterior. Usually the posterior is slightly thicker than the anterior.

- 123. The correct answer is D.** The permanent mandibular second premolar usually has two lingual cusps. This is a three-cusp type (tricuspidate form). Unlike mandibular first premolars (**choice C**), the more common three-cusp type of the second premolar has three cusps: one large buccal cusp and two smaller lingual cusps. Similar to mandibular first premolars, the less common two-cusp type of mandibular second premolars has a larger buccal cusp and a single smaller lingual cusp.

Both the maxillary first (**choice A**) and maxillary second (**choice B**) premolars have two cusps each, one buccal and one lingual.

- 124. The correct answer is B.** The permanent maxillary lateral incisor exhibits the greatest deviation in crown morphology of any permanent tooth except the third molars. Because of the variations in form and the possibility of developmental disturbances, such as dens in dente or partial microdontia, the permanent maxillary lateral incisor presents challenges during preventive, restorative, and orthodontic procedures. There may be unattractive open contacts in the dental arch in this area because of these variations in form, as well as asymmetrical tooth size and position across the maxillary arch. The other teeth listed (**choices A, C, D, and E**) are more consistent in crown morphology.

Dens in dente leaves the tooth with a deep lingual pit due to invagination of the enamel organ into the dental papilla. This may lead to pulpal exposure and pathology. This disturbance may be hereditary. The permanent maxillary lateral incisor is one of the most common teeth of the permanent dentition to exhibit partial microdontia. This disturbance leads to a smaller sized lateral incisor crown or peg lateral, either unilaterally or

bilaterally. This disturbance occurs in the process of proliferation during tooth development. It may be hereditary or due to other factors. Treatment to improve appearance may include full-coverage crowns.

125. **The correct answer is B.** The periodontal ligament (PDL) is that part of the periodontium that provides for the attachment of the teeth to the surrounding alveolar bone by way of the cementum, providing support for the tooth during function. The oblique PDL fibers provide the major support to the tooth during function because the oblique group of the alveodental ligament is the most numerous of the fiber groups and covers the apical two-thirds of the root. This group originates in the alveolar bone proper and extends apically so as to insert more apically into the cementum in an oblique manner. The function of the oblique group is to resist intrusive as well as rotational forces.

Less numerous are the alveolar crest (**choice D**) group of the alveodental ligament, which originate in the alveolar crest of the alveolar bone proper and fan out to insert into the cervical cementum at various angles. The function of the alveolar crest group is to resist tilting, intrusive, extrusive, and rotational forces.

Less numerous are the apical (**choice A**) group of the alveodental group, which radiate from the apical region of the cementum to insert into the surrounding alveolar bone proper. The function of the apical group is to resist extrusive as well as rotational forces.

Also less numerous are the horizontal (**choice C**) group of the alveodental ligament, which originates in the alveolar bone proper apical to the alveolar crest and inserts into the cementum in a horizontal manner. The function of the horizontal group is to resist tilting forces that try to make the tooth tip either mesially, distally, lingually, or facially, as well as rotational forces.

Less numerous and only found on multirrooted teeth are the interradicular (**choice E**) group of the alveodental group. This group is inserted on the cementum of one root to the cementum of the other root(s) superficial to the interradicular septum, and thus has no bony attachment. This group works together with the alveolar crest and apical groups to resist intrusive, extrusive, and tilting as well as rotational forces.

126. **The correct answer is C.** The maxillary first molar is the largest tooth in the maxillary arch. It has three roots (mesiobuccal, distobuccal, and lingual) with generous proportions. The roots of this tooth are well developed and well separated, giving the maxillary first molar maximum anchorage against forces that would tend to unseat it. The root form of this tooth consists of three roots and three canals. The palatal root has the largest dimensions, followed by the distobuccal, with the mesiobuccal being the smallest. Very often, a small accessory canal can be found in the mesiobuccal root, giving this tooth four canals.

127. **The correct answer is A.** The rank of the roots of the maxillary first molar in order from largest to smallest is palatal, mesiobuccal, distobuccal. The palatal root is the largest and longest, inclines lingually, and extends beyond the crown outline. The palatal root has a “banana”-like curvature, inasmuch as it is so curved toward the buccal, whereas both the mesiobuccal and distobuccal roots have an extreme curvature that makes them together look like the handle of a set of pliers. The mesiobuccal root is the second largest and longest and is inclined mesially and buccally, with its apical third curving distally. The distobuccal root is the smallest, shortest, and thus the weakest of the three. This root inclines distally and buccally, and its apical one-third curves mesially. The other sequences listed (**choices B, C, and D**) are incorrect.

128. The correct answer is B. In an ideal occlusal relationship, the mesiobuccal cusp of the maxillary first molar occludes in the mesiofacial groove of the mandibular first molar. This relationship is found in about 70% of the population.

129. The correct answer is D. When proximal surfaces of adjacent teeth diverge from an area of contact, an embrasure is formed lingually, facially, occlusally, and cervically. When two teeth in the same arch contact, their curvatures next to the contact areas form spaces that are called embrasures. Such spaces are also called spillways because they provide channels or passages through which food escapes from the occlusal surfaces of the teeth during mastication. These embrasures are continuous with the interproximal spaces between the teeth. These teeth contours are important in the function and health of the masticatory system. The other answers (**choices A, B, and C**) are incorrect because space exists above, below, in front of, and in back of the contact point.

A buccal embrasure is an opening out toward the cheek. A labial embrasure widens out from the area of contact toward the lips. A lingual embrasure widens out from the area of contact toward the lingual sides of the teeth. An occlusal or incisal embrasure is a space bounded by the marginal ridges as they join the cusps and incisal ridges.

130. The correct answer is C. The mass of pulp is contained within the pulp chamber of the tooth, which contains blood vessels and nerves and all connective tissues.

When the pulp is injured by extensive caries, cavity preparation, or traumatic injury, it may undergo inflammation, or pulpitis, involving its blood vessels. Initially, this inflammation remains localized within the confines of the dentin. The pressure from this confined pulpitis can result in extreme pain as the inflammatory edema presses on the afferent nerves contained in the pulp.

Cementoblasts (**choice D**), which are cells that form cementum, are found in a layer in the periodontal ligament. Ameloblasts (**choice E**) are cells that form enamel and are located on the innermost region of the enamel organ; they are lost when the tooth erupts. The cells that continue to form primary dentin (**choice A**) are odontoblasts (only their cell bodies) and they are found on the outer wall of pulp before the apical foramen is formed in an immature tooth. The apical foramen is the opening from the pulp at the apex of the tooth. This opening is surrounded by cementum and allows arteries, veins, lymphatics, and nerves to enter and exit the pulp from the periodontal ligament.

Once the apical foramen is completed, the dentin formed from these odontoblasts within the pulp is secondary, possibly tertiary, dentin. The pulp does not have an enamel lining for thermal protection (**choice B**), although linings of a restorative nature are placed within the preparation to prevent pulpal pain from thermal changes.

131. The correct answer is D. It is considered normal to have certain interproximal spaces between the primary teeth because it necessary for the proper alignment of the future permanent dentition. These spaces are called the primate spaces and mainly involve spaces between the primary lateral incisor and canine and between the primary canine and first molar of the mandible. They are called primate spaces because they are most marked in the dentition of primates. The other teeth listed (**choices A, B, C and E**) are incorrect.

If primate spacing exists in the primary mandibular arch after the eruption of the permanent first molar, the permanent first molar will put pressure on the primary second and first molars, causing forward movement of the primary mandibular canine and first molar. Thus, this primate space actually allows for this movement, which then facilitates the development of an ideal permanent molar relationship along with the presence of a mesial step relationship.

132. **The correct answer is E.** The collateral ligaments attach the medial and lateral borders of the articular disc to the poles of the condyle. They are commonly referred to as the discal ligaments. They are responsible for restricting the movement of the disc away from the condyle, and they allow the disc to be rotated anteriorly and posteriorly on the articular surface of the condyle. Both the sphenomandibular ligament and the stylomandibular ligament are accessory ligaments. The superior retrodiscal and inferior retrodiscal tissue connect the articular disc posteriorly to a region of loose connective tissue that is highly vascularized and innervated.

133. **The correct answer is D.** The permanent mandibular lateral incisor has its distal proximal contact area with the mandibular canine located entirely in the incisal one-third but located more cervical than the mesial contact because its mesial contact with the mandibular central incisor is also in the incisal third but higher incisally.

The maxillary canine (**choice A**) has its mesial contact with the lateral incisor at the junction of the incisal and middle thirds and its distal contact with the first premolar more cervical and located at the middle third. The mandibular canine (**choice B**) has its mesial contact with the lateral incisor in the incisal third and its distal contact with the first premolar at the junction of the incisal and middle thirds. This is more cervically located than that on the mesial.

The maxillary lateral incisor (**choice C**) has its mesial contact with the maxillary central at the incisal third or at the junction of the incisal and middle third and its distal contact area with the maxillary canine at the middle third or at junction of incisal and middle third.

The mandibular second premolar (**choice E**) has its mesial contact and distal contact at the same location: just cervical to the junction of the occlusal and middle thirds.

134. **The correct answer is D.** The occlusal outline of a mandibular first molar is usually similar to a pentagon, five-sided, with the fifth side created by the distal cusp. The distal portion of the buccal outline converges toward the distal to create the fifth side of the outline. The buccal outline has rounded line angles and is divided into three portions by the two buccal grooves, the mesiobuccal and distobuccal. The length of the buccal cusps decreases distally, as noted from the buccal view.

The crown outline of the tooth from the proximal view (like all posterior mandibular teeth) is rhomboidal (**choice C**), four-sided with opposite sides parallel. No view resembles a circle (**choice A**) or a square (**choice B**) with four equal sides.

135. **The correct answer is E.** The mandibular canine can have the developmental disturbance of an accessory root or bifurcated root in the apical third, with labial and lingual branches. This tooth is the anterior tooth (compared with **choices A-D**) most likely to have a bifurcated root, although this still is rare. Normally, the tooth is single-rooted. In addition, there is the possibility of mesial and distal developmental depression on the root surface that may give the tooth the appearance of being double-rooted.

136. **The correct answer is C.** The occlusal surface or occlusal table is defined as the area bound by the marginal ridges and inner inclines of the cusps of posterior teeth. It is centered over the root of the tooth to provide the best functional position to withstand the occlusal forces. This area forms between 50 and 60% of the buccolingual dimension of the tooth.

137. **The correct answer is C.** The permanent mandibular second molars are teeth #18 and #31 within the Universal Tooth Designation System. The coronal pulp is located in the crown of the tooth. Smaller extensions of coronal pulp into the cusps of posterior teeth form the pulp horns. Pulp horns are not found on anterior teeth. There would be four pulp horns expected on a newly erupted Tooth #18 because there are four corresponding cusps.

The mandibular first premolar has two (**choice A**) pulp horns corresponding to its two cusps, as does the two-cusp mandibular second molar. The three-cusp mandibular second premolar has three (**choice B**) pulp horns. The mandibular first molar has five (**choice D**) cusp horns corresponding to its five cusps.

138. **The correct answer is B.** The facial plate of the alveolar process of the mandibular central incisors is thinner than the body of the mandible in that area and even thinner than the facial or lingual (**choice D**) plate of the alveolar process of the posterior teeth, such as the mandibular first molars. However, the lingual plate of the alveolar bone of the posterior teeth is thinner than the facial plate. This degree of thinness of the plates allows local infiltration of the facial of the mandibular incisors with varying degrees of success with a local anesthetic, more so than that of the posterior teeth. Thus, the facial surface of the posterior mandibular teeth is very thick compared with other areas of both jaws, and very few practitioners ever consider facial infiltration with failure of the inferior alveolar block.

That is why infiltration on the maxillary alveolar process, such as lingual to the maxillary central incisor (**choice A**) or maxillary canines (**choice C**), or even facial to the maxillary second molars (**choice E**), is so much more successful than in the posterior mandible—because it is so much thinner than any of the posterior plates of the mandible. The facial of the mandibular incisors is one of the only thin areas of the mandibular bone. The width of the alveolar bone in an area also determines the route dental infection takes with abscess and fistula formation. Finally, the differences in alveolar process thickness determine the easiest and more convenient areas of bony fracture during tooth extraction.

139. **The correct answer is B.** Most pit and fissure caries occur on the occlusal surface of posterior teeth and the lingual surface of certain anterior teeth. Pit and fissure caries on smooth surfaces of posterior teeth are most likely to occur on the lingual surfaces of maxillary molars and buccal surfaces of mandibular molars in naturally occurring pits. This susceptibility to caries is from both increased plaque retention and the thinness of enamel forming the walls of the pit. Teeth with a deep pit should have enamel sealants placed on them shortly after eruption, an extension of the occlusal sealants. Yet lingual pit sealants due to the histology of enamel in the area do not bond as well as they do on the occlusal surface.

In addition, the mesiobuccal groove on the mandibular first molar extends straight cervically to a point about midway occlusocervically but slightly mesial to the center mesiodistally. The mesiobuccal groove almost always ends in the buccal pit, which is also at risk of pit and fissure caries. Sealants placed in these areas may again prevent these caries. The other teeth listed (**choices A, B, C, and E**) do not have this risk.

140. **The correct answer is C.** Axial position is described as the inclination of a tooth from a vertical axis. This inclination is usually described in terms of direction: mesiodistal and buccolingual. Also, it is described in terms of root position, so that the crown of a tooth would be in the opposite direction. Mandibular molars' root inclinations are to the buccal and to the distal. Therefore, the crown of a mandibular second molar inclines mesially and lingually.

141. **The correct answer is D.** The figure represents right lateral movement of the mandible. Assuming normal occlusion, the distolingual cusp would be in contact with distal marginal ridge of the mandibular molar. This cusp would follow this path during right lateral movement and in this case would be on the nonworking side of the mandible.
142. **The correct answer is E.** In an ideal intercuspal relationship, all teeth have contacts with two teeth in the opposite arch. The only exceptions are the mandibular central incisor and the maxillary third molar. The maxillary arch is slightly larger than the mandibular arch, so each tooth will occlude against its corresponding mandibular tooth and the tooth distal to it.
143. **The correct answer is B.** On the crown of a maxillary canine, a mesial marginal ridge is located immediately to the mesial of the mesiolingual fossa. It has a large and smooth cingulum and pronounced marginal ridges on its lingual surface, a mesial and a distal (**choice C**). It also has a vertical, centrally placed lingual ridge (**choice A**) that runs from the cusp tip to the cingulum. The lingual ridge creates two separate and shallow lingual fossae between it and the bordering marginal ridges, the shallow but visible mesiolingual fossa and distolingual fossa (**choice D**).

On the maxillary canine, the cingulum and the incisal half of the lingual surface are sometimes separated by a shallow lingual groove and not a mesial developmental groove (**choice E**). This groove may contain a lingual pit near its center.

144. **The correct answer is E.** The epithelial attachment (EA) is always an actual part of the tooth's periodontium. The junctional epithelium is attachment of the gingival tissues to the tooth surface. The periodontium consists of the supporting soft and hard dental tissues between and including portions of the tooth and the alveolar bone. The periodontium serves to support the tooth in its relationship to the alveolar bone. Thus, the periodontium includes dentogingival junction tissues (such as the EA), cementum, alveolar bone, and periodontal ligament, as well as individual components of these tissues.

Some of the items listed are landmarks of the tooth surface in relationship with the EA that shift with time. The clinical crown (**choice B**) is that portion of the anatomical crown that is visible and not covered by the gingiva, the height of which is determined by the location of the gingival margin, or gingival line (**choice C**). The clinical crown of a tooth can change over time, especially as the gingiva recedes. Gingival recession, with its lower gingival margin, can also occur due to periodontal disease, tooth position, abrasion from hard toothbrushes, strong frenal attachments, and changes due to the aging process.

Others are constant landmarks of the tooth. The anatomical crown, which is the portion of the tooth covered by enamel, remains mostly constant throughout the life of the tooth, except for attrition and other physical wear. The cervical line (**choice D**) is the where the enamel of the crown and cementum of the root usually meet close to the cemento-enamel junction (CEJ), an external line.

145. **The correct answer is C.** The dentition of a normally developed 6½-year-old child falls within the mixed dentition period. This period occurs approximately between 6 and 12 years of age. Both primary and permanent teeth are present during this transitional stage. During this time, shedding of the primary teeth and the eruption of the permanent teeth begin. Thus, this period begins with the eruption of the first permanent teeth, the permanent first molars erupting between 6 and 7 years of age, and the shedding of the primary central incisors. The eruption of the permanent central incisors follows closely, at 7 to 8 years. This period usually ends with the shedding of the last primary tooth, the primary maxillary canine. Thus, the child could have 18 primary and 6 permanent due to the shedding of some of the primary teeth (2) and eruption of some of the molar teeth (4),

since these are only averages. Note that regardless of the exact teeth involved, the 20 primaries (or replacements) and the 4 permanent first molars add up to 24 teeth total.

In the primary dentition period, which occurs from 6 months to 6 years, the child would have 20 primary teeth (**choice D**), 10 maxillary and 10 mandibular.

- 146. The correct answer is A.** Eruption can be defined as “the process of continuous tooth movement through the surrounding tissue to occlusal contact.” Attrition (**choice B**) describes the process of wearing away of tooth structure.
- 147. The correct answer is B.** During protrusive movements, the mandible moves downward and then moves forward, aligning the anterior teeth at points that are most favorable for the incising of food. In an ideal intercuspal relationship, the maxillary left central incisor is in very light or no contact with the mandibular central and lateral incisor (#22 and #23, **choice A**). As the mandible goes into protrusive movement, the incisal edges of the incisors could come into contact with each other.
- 148. The correct answer is A.** The primary maxillary first molar has a crown somewhat resembling a permanent premolar, but the root form is typical of a permanent molar. It does resemble the permanent maxillary first premolar, the tooth that will replace it. However, the crown is slightly larger than the premolar that will replace it. The two main cusps of the four cusps are a wide mesiobuccal cusp and a narrow, slightly more distinct mesiolingual cusp. Note that sometimes only three cusps are present. The primary maxillary first molars do have the same number and position of roots as the permanent maxillary molars. The three root branches are thinner and have greater flare than is seen on the permanent molar; and there is a short root trunk.
- The primary maxillary second molar (**choice B**) most closely resembles the form of the permanent maxillary first molar but is smaller in all dimensions. The primary mandibular first molar (**choice C**) has a crown unlike any other tooth of either dentition. The primary mandibular second molar (**choice D**) most closely resembles the form of the permanent mandibular first molar that erupts distal to it because it has five cusps.
- 149. The correct answer is A.** In the intercuspal position, which is reached with maximal jaw closure, the anterior teeth should make either very light or no actual contact. The lingual surfaces of the maxillary incisor teeth provide incisal guidance for the mandibular teeth in opening-protruding movements.
- 150. The correct answer is C.** Twelve to 13 years represents the earliest age by which the roots of the maxillary first premolar are completely formed. However, the crown of the tooth erupts earlier, between 10 and 11 years. The other ages listed (**choices A, B, and D**) are incorrect. Expect approximately 2 to 3 years between eruption and root completion for permanent teeth.
- 151. The correct answer is D.** Viewed from the occlusal, the basic coronal outline of a permanent mandibular second premolar is pentagonal, five-sided. There are two forms of the mandibular second premolar: three-cusp type (tricuspidate form) and two-cusp type (bicuspidate form). The two types of this tooth differ mainly in their occlusal features, whereas other surface features are similar. The three-cusp type also appears more angular from the occlusal view, whereas the two-cusp type appears more rounded. The five sides can be viewed as a lingual flat base, a straight mesial and distal file, and two sides coming to a point on the buccal surface.

152. **The correct answer is A.** The location of distal cervical line, or cementoenamel junction (CEJ), is more apical than that of the mesial cervical line on a permanent mandibular lateral incisor. Thus, there is greater height to the CEJ curvature on the mesial than the distal surface, which helps to distinguish the right mandibular lateral incisor from the left with extracted teeth. Also, from the mesial view, more of the lingual surface is visible due to the distal tilt or twist of the incisal edge. The distal view is similar to the mesial view of the tooth, yet the CEJ is curved less highly on the distal than on the mesial surface. The other surfaces and placements of the CEJ (**choices B through E**) are incorrect.

153. **The correct answer is A.** In a normal occlusion, the maxillary second premolar would occlude with mandibular second premolar and mandibular first molar. The lingual cusp of the second premolar is in contact with distal fossa of the mandibular second premolar, distal marginal ridge of the premolar, and mesial marginal ridge of the first molar.

154. **The correct answer is B.** Ligaments associated with the TMJ (temporomandibular joint) serve to protect surrounding and supporting tissues from damages. There are three paired ligaments associated with the TMJ.

The TMJ ligament is located on the lateral side of each joint and forms a reinforcement of the capsule of the TMJ. This ligament prevents retrusive movement from occurring (**choice D**), a situation that might lead to problems with the TMJ. The sphenomandibular ligament is not a part of the TMJ. It is located on the medial side of the mandible, some distance from the joint. This ligament runs from the angular spine of the sphenoid bone to the lingula of the mandibular foramen. The stylomandibular ligament is a variable ligament that is formed from a thickened cervical fascia in the area. This ligament runs from the styloid process of the temporal bone to the angle of the mandible. The ligaments do not inhibit the normal masticatory cycle (**choice A**) but help to promote it. They do not assist the musculature in producing movement (**choice C**), nor do they provide elastic potential to allow for border movements (**choice E**), inasmuch as they are neither contractile nor expandable.

155. **The correct answer is A.** From a facial view, the cementoenamel junction (CEJ) would be most apically positioned on a primary mandibular first molar at the mesial one-third of the crown. Thus, the cervical line of the CEJ slopes occlusally from mesial to distal. Thus also, the mesial portion of the crown is longer because the occlusal border slopes cervically from the mesial to the distal. The tooth also has a prominent buccal cervical ridge on the mesial half of the buccal surface, similar to other primary molars. The height of contour on the buccal is at the cervical one-third, and for the lingual in the middle one-third (**choice B**).

156. **The correct answer is B.** Enamel rods in a primary tooth extend from the dentinoenamel junction (DEJ) occlusally in the cervical third of the crown (cervix). Enamel consists of rods or prisms bound together by interprismatic substance (IS). Each rod is produced by a Tome's process of a single ameloblast and extends through the entire thickness of the enamel. The IS is produced by smaller projections of the ameloblast and is identical in chemical composition but different in mineral crystal arrangement. The demineralization of caries follows the direction of enamel rods and is due to the lower density of the IS. In addition, this slope of the enamel rods occlusally in primary teeth at the cervix is unlike that of permanent teeth (**choice C**), which slope cervically at the cervix. The other directions and descriptions (**choices A and D**) are incorrect.

157. **The correct answer is B.** The permanent mandibular first molar has the largest mesiodistal measurement of its crown because it has a fifth major cusp. Thus, it has five cusps: two buccal, two lingual, and one distal. The crown itself is also larger mesiodistally than

occlusocervically and its buccolingual measurement is the smallest of the three measurements. This tooth also has the most complex developmental groove pattern of all the permanent mandibular molars.

The mandibular second molar (**choice D**) crown measurements are generally smaller than those of the first molar. The four cusps of the second are nearly equal in size, in comparison with the five cusps with differing size of the first molar.

The maxillary first molar (**choice A**) is the largest tooth in the maxillary arch and also has the largest crown in the permanent dentition. The maxillary second molar (**choice C**) has much variation in form, especially in the size of the distolingual cusp. The crown usually has four cusps similar to the four major cusps of the first molar, yet can have three cusps.

158. The correct answer is C. The permanent maxillary lateral incisor is the tooth most likely to be congenitally absent. The lack of initiation during tooth development, which results in the absence of a single tooth (partial) or multiple teeth (complete), is called anodontia. Partial anodontia is more common and most frequently occurs (listed in order of occurrence) with the permanent maxillary lateral incisors, third molars, and mandibular second premolars. It may cause disruption of occlusion and aesthetic problems. The patient may need partial or full dentures, bridges, and/or implants to replace the missing tooth/teeth. The other teeth listed (**choices A, B, D, and E**) are incorrect.

159. The correct answer is B. The permanent maxillary first premolars are posterior teeth that normally exhibit two root canal orifices because they usually have two root canals with the two roots.

Maxillary second premolars (**choice C**) and mandibular first premolars (**choice A**) normally exhibit one root canal orifice each because they usually have one root canal for their one root each.

Maxillary first molars (**choice D**) normally exhibit three root canal orifices because they have three root canals each with their three roots; four canals are sometimes present. Mandibular first molars (**choice E**) normally exhibit three root canals with their two roots each.

160. The correct answer is C. The contact between a permanent maxillary central incisor and a maxillary lateral incisor is located near the incisal third of both teeth. Buccolingually, it is located toward the buccal, so the contact is not offset to the lingual (**choice A**). The lingual embrasure is therefore larger than the buccal embrasure. The incisal embrasure of this tooth is not the largest of all embrasures (**choice D**), inasmuch as it exists only incisal to the contact point, which is high toward the incisal edge.

161. The correct answer is A. A crown concavity that is confluent with a longitudinal groove of the root is a rather common feature of the mesial surface of the permanent maxillary first premolar. It is a mesial developmental depression located cervical to the contact area, across the CEJ. Also, a mesial marginal groove is sometimes present. This developmental groove crosses the mesial marginal ridge and runs from the occlusal to the middle third of the crown, lingual to the contact area. These prominent mesial features help to distinguish the right maxillary first premolar from the left on an extracted tooth. These areas also can collect dental calculus in patients with some degree of root exposure due to periodontal disease.

The distal surface of the maxillary first premolar (**choice B**) is similar to the mesial except that it does not have a depression and more of the occlusal surface shows because the distal marginal ridge is more cervically located than is the mesial marginal ridge. Sometimes there is a distal marginal groove across the distal marginal ridge, yet this distal groove is shallower than the groove on the mesial surface.

The mesial surface of the mandibular first premolar (**choice C**) has a mesiolingual groove, which can be seen near the lingual margin, but the distal surface of the same tooth (**choice D**) is similar to the mesial except there is no groove near the lingual margin.

The mesial surface of the mandibular second premolar (**choice E**) has no mesiolingual groove.

- 162. The correct answer is B.** A peg-shaped crown form is an occasional anomalous occurrence. The permanent maxillary lateral incisor is one of the most common teeth of the permanent dentition to exhibit this type of partial microdontia. This disturbance leads to a smaller-sized lateral incisor crown or peg lateral, either unilaterally or bilaterally. This disturbance occurs in the process of proliferation during tooth development. It may be hereditary or due to other factors. Treatment to improve appearance may include full coverage crowns.

The maxillary central incisor (**choice A**) is a common location for a supernumerary tooth (between the two permanent maxillary centrals) and it is called a mesiodens. It is due to the presence of an extra tooth germ during tooth development. The presence of this extra tooth may affect spacing in the maxillary arch whether or not it is erupted.

Developmental disturbances are rarely noted in the mandibular central incisor (**choice C**) or in the mandibular lateral incisor (**choice D**).

- 163. The correct answer is A.** The crown of a mandibular lateral incisor, compared with the crown of a mandibular central incisor in the same mouth, is best described as wider mesiodistally, not narrower mesiodistally (**choice B**). The lateral is less symmetrical than the central and not more symmetrical (**choice C**) because the distal outline is slightly more rounded and shorter compared with the slightly flatter and longer mesial outline. The lateral appears tilted or twisted distally on the root, from the labial view. The lateral is also more developed on the lingual surface than the central and thus does not have a smoother lingual surface (**choice D**). The small single cingulum lies just distal to the long axis of the root. On the lingual surface, the mesial marginal and the distal marginal ridges are each more developed than on the central, yet the mesial marginal ridge is longer than the distal marginal ridge. A single lingual fossa is also present. A lingual pit is rarely present on the lateral, but more often than on the central.

- 164. The correct answer is E.** The number of developmental grooves distinguishes the permanent mandibular first molar from a mandibular second molar. The first molar has five cusps and thus has more developmental grooves, whereas the second has only four cusps and thus has less developmental grooves. These developmental, or primary, grooves are due to developmental lobe formation. The grooves are sharp, deep, V-shaped, linear depressions.

Both mandibular posterior molars have the same number of roots (**choice A**), two. In addition, they both have the same number of lingual cusps (**choice B**), two; and the same position of the lingual cusps (**choice D**). The additional cusp (distal) of the first molar is usually considered a third buccal cusp. They both have the presence of a lingual groove (**choice C**) between the mesiolingual cusp and distolingual cusp, dividing the occlusal outline.

- 165. The correct answer is B.** An incisal embrasure is a triangular space between the proximal surfaces of two adjacent teeth. In general, incisal embrasures increase in relative size from the anterior teeth toward the posterior teeth. Therefore, the incisal embrasure space between the maxillary central incisors is smaller than the space between the maxillary central and the maxillary lateral incisor.

166. The correct answer is A. When viewed from the buccal aspect, the maxillary first premolar has a trapezoidal shape. The mesial slope of the buccal cusp is straight and longer than that of the distal slope, which is shorter and more curved. In the maxillary second premolar and both of the mandibular premolars, the mesial slope of the buccal cusp ridge is smaller.

167. The correct answer is A. In both the maxillary first and second premolars, the lingual cusp tip is offset toward the mesial. The lingual cusp of the maxillary first is generally smaller and rounder than the buccal cusp. The lingual and buccal cusps of the maxillary second premolar are nearly equal in size. The mesial root concavity is a feature unique to the maxillary first premolar.

168. The correct answer is E. In a molar, the root canals join the pulp chamber apical to the cemento-enamel junction (CEJ). The inner portion of the dentin of both crown and root also covers the pulp cavity. The pulp cavity has a pulp chamber, pulp canals, with apex and apical foramen, and possibly pulp horns. The enamel of the crown and cementum of the root usually meet close to the CEJ, an external line at the neck or cervix of the tooth. The other locations listed (**choices A through D**) are incorrect.

In addition, molars usually are multirouted, with maxillary molars usually having three and mandibular molars having two root branches. Molars originate as a single root on the base of the crown, as do anterior teeth; this portion is called the root trunk. The cervical cross section of root trunk follows the form of the crown, but the root then divides into the number of root branches from the root trunk for its type.

169. The correct answer is C. The lingual aspect of a permanent mandibular first molar presents with the lingual surface of each cusp possessing a slightly convex shape in the occlusal third.

The lingual aspect does not have three lingual cusps (**choice D**); it has two: the mesiolingual and distolingual. And it does not have two lingual grooves (**choice E**); it has only one, between the mesiolingual and distolingual cusps. This lingual groove does extend onto the lingual surface (part of **choice A**) but does not end in the cervical third of the crown (part of **choice A**). Finally, it does have a large mesiolingual cusp (it is second in size to the mesiobuccal cusp, the largest of all the five cusps) (part of **choice B**) but it does not have a much smaller distolingual cusp (part of **choice B**); its distolingual cusp is only slightly smaller in size than the mesiolingual cusp.

170. The correct answer is C. On the crown of a maxillary canine, a mesial marginal ridge is located immediately to the mesial of the mesiolingual fossa. It has a large and smooth cingulum and pronounced marginal ridges on its lingual surface, a mesial and a distal (**choice B**). It also has a vertical, centrally placed lingual ridge (**choice A**) that runs from the cusp tip to the cingulum. The lingual ridge creates two separate and shallow lingual fossae between it and the bordering marginal ridges, the shallow but visible mesiolingual fossa and the distolingual fossa (**choice D**).

On the maxillary canine, the cingulum and the incisal half of the lingual surface are sometimes separated by a shallow lingual groove and not a mesial developmental groove (**choice E**). This groove may contain a lingual pit near its center.

171. The correct answer is C. The principal fiber of the periodontal ligament other than the alveodental ligament is the interdental ligament, or transseptal group. This fiber group inserts mesiodistally or interdentially (not via the facial aspect) into the cervical cementum of neighboring teeth over the alveolar crest of the alveolar bone proper or alveolus (tooth

socket). Thus, the fibers travel from the cementum of one root to the cementum of the adjacent root surface without any bony attachment, unlike most of the other principal fiber groups of the periodontal ligament, other than the interradicular group. So the first statement about the transseptal group (the transseptal group of periodontal fibers travel from one root to an adjacent root surface) is true and the second (this pathway occurs via the facial aspect of the alveolus) is false. The function of the transseptal group is to resist rotational forces and thus hold the teeth in interproximal contact.

172. The correct answer is B. When the mandible moves to the right side and the mandibular buccal cusps and inclines oppose the maxillary buccal cusps and inclines, the right side is considered to be the working side. Therefore, the excursive tooth contacts, which occur with the molars on the right side of the mandible, are called working-side contacts. When this occurs, the relationship of the left-side maxillary lingual cusps to the mandibular buccal cusps would be the nonworking side.

173. The correct answer is D. The maxillary third begins its development with the first evidence of calcification between 7 and 9 years of age. Eruption occurs sometime between 17 and 21 years. The completion of the roots occurs between the ages of 18 and 25. Therefore, an individual who is 26 years old would have a completely formed third molar.

174. The correct answer is C. The usual order of eruption of primary teeth after the central incisors is: lateral incisors, first molars, canines, second molars. This holds true for both arches, maxillary and mandibular. All the other sequences listed are incorrect.

Many endocrine problems can cause changes in the eruption schedule in children. For example, untreated hypothyroidism will lead to delay in eruption of primary teeth, delay in exfoliation of these teeth, and subsequent delay in the eruption of the permanent teeth. Hyperpituitarism can result in early eruption and exfoliation of the primary teeth and early eruption of the permanent teeth.

175. The correct answer is C. In the international numbering system, the mandibular first premolar is #21. It often looks like a mandibular canine with an extra small cusp. Most of these teeth have one canal, but a second canal is possible. The buccal pulp horn is much larger than the lingual pulp, which can also be completely absent. If a second canal exists, it can be usually located under the lingual cusp.

176. The correct answer is B. When there is a posterior crossbite relationship, the maxillary mesiolingual cusps are not occluding with central fossa of the mandibular molars. In posterior crossbite, the maxillary facial cusp occludes with central fossa of the mandibular molar, and the mandibular facial cusp is occluding in the central fossa of the maxillary molar. These cusps are then considered the supporting cusp because they are in primary contact in centric occlusion and help support occlusal vertical dimension. This is the opposite case compared with a normal, or noncrossbite, relationship.

177. The correct answer is A. The central fossa of the permanent maxillary first molar has the central pit in its most central, deepest portion. The central pit of the maxillary first molar is formed at the bases of the triangular ridges of the mesiobuccal, mesiolingual, and distobuccal cusps. Triangular ridges, which are cusp ridges, descend from the cusp tips toward the central portion of the occlusal table such as the central pit. These ridges are so named because the slopes of each side of the ridge are inclined in a way that resembles two sides of a triangle. The central pit also divides the central groove into two portions: the mesial groove and distal groove. Thus, the central pit is at the junction of three developmental grooves: buccal, mesial, and distal. There are three triangular grooves present:

mesiobuccal triangular groove, mesiolingual triangular groove, and distobuccal triangular groove. Note that the cusp not involved (the distolingual) is the smallest in the tooth. The other cusps listed are incorrect.

- 178. The correct answer is A.** The mesiolingual developmental groove on a permanent mandibular first premolar originates in an occlusal pit and extends onto a proximal surface. The lingual surface is much narrower than the buccal on this tooth, with the crown tapering to the lingual. This allows most of the mesial and distal surfaces to be seen from the lingual. The lingual cusp is small and nonfunctional during occlusion, with the lingual cusp tip often pointed. Because the lingual cusp is small, most of the occlusal surface can be seen from this view. The lingual cusp tip lines up with the buccal triangular ridge. The mesial fossa and distal fossa are on each side of this ridge. Usually, there is a developmental groove, the mesiolingual developmental groove, that separates the mesial marginal ridge from the mesial cusp slope of the small lingual cusp.

There is no distolingual developmental groove (**choice B**). The distal marginal ridge is much more developed than that of the mesial, and its continuity is unbroken by any deep developmental grooves. Also, the distal marginal ridge does not show quite as steep a slope toward the lingual as is present on the mesial. There is no mesial marginal groove (**choice C**) but there is a distal marginal groove. The distal pit is the junction of the central groove, distal marginal groove, distolingual triangular groove, and distobuccal triangular groove. There is no linguogingival groove (**choice D**).

- 179. The correct answer is A.** The physiologic rest position of the mandible is when the mandibular musculature is in a state of minimal tonic contraction, to maintain posture and to overcome the force of gravity.
- 180. The correct answer is C.** In the ideal occlusion, the mesiolingual cusp of the maxillary first molar occludes with the central fossa. The distal buccal cusp of the mandibular first molar occludes in the central fossa of the maxillary first molar. This is an example of the occlusal concept that all supporting cusps occlude in fossae.
- 181. The correct answer is A.** When the mandible moves to the right side, the right condyle will primarily rotate and not move down the eminentia. **Choices C and D** could occur only if the lateral movement were to the left.
- 182. The correct answer is D.** Horizontal and vertical overlap that are within normal limits help prevent damage to soft tissue in the oral cavity. Insufficient horizontal overlap can lead to cheek-biting, and excessive vertical overlap (overbite) can cause trauma to the gingiva.
- 183. The correct answer is D.** The first portion of an anterior tooth that is formed is the incisal ridge, so it would be the first structure that also calcifies. Later, the cingulum (**choice A**) and marginal ridge (**choice C**) of the lingual surfaces will form and calcify. Much later would be the formation of the root apex (**choice E**). Only permanent molars, not anterior teeth, have cervical ridges (**choice B**); each buccal surface of a molar has a prominent cervical ridge running mesiodistally in the cervical one-third.

The cingulum (**choice A**) is a raised, rounded area on the cervical third of the lingual surface in varying degrees of prominence or development on anterior teeth. The cingulum corresponds to the lingual developmental lobe. There are also ridges on the lingual surface. The lingual surface on anterior teeth is bordered mesially and distally by rounded, raised borders called marginal ridges.

- 184. The correct answer is B.** When compared with a permanent maxillary first molar, the crown of a maxillary second molar normally exhibits a shorter distolingual groove. The distolingual groove does not extend as far mesially or cervically as the groove on the first molar. Thus, the distolingual groove ends at a point that is occlusal and distal to the center of the lingual surface. However, a lingual pit is usually present at the end of the distolingual groove.

There is much variation in the form of the maxillary second molars, especially in the size of the distofacial cusp (**choice A**). The distolingual cusp of the maxillary second molar is smaller in both size and height than on the first molar, and is sometimes not present. Thus, the outline of the largest cusp of the occlusal surface, the mesiolingual cusp, is much longer and larger, but the cusp is not as sharp as the distolingual cusp, which helps to distinguish the right maxillary second molar from the left. In addition, there is usually no fifth cusp (or cusp of Carabelli).

The maxillary second molar is shorter occlusocervically (**choice D**) and narrower mesiodistally (**choice C**) than the first molar.

- 185. The correct answer is C.** If the entire temporalis muscle contracts, the main action is to elevate the mandible, raising the lower jaw. Elevation of the mandible occurs during the closing of the jaws. If only the posterior portion contracts, the muscle moves the lower jaw backward. Moving the lower jaw backward causes retraction of the mandible. Retraction of the jaw often accompanies the closing of the jaws. The temporalis is a muscle of mastication, as is the masseter.

The action of the masseter (**choice A**) muscle when there is bilateral contraction of the entire muscle is to elevate the mandible, raising the lower jaw.

The posterior belly of the digastric (**choice B**) is part of the posterior suprahyoid muscle group, and there are two actions associated with mastication resulting from the contraction of the suprahyoid muscles. One action of both the anterior and posterior suprahyoid muscles is to cause the elevation of the hyoid bone and larynx if the mandible is stabilized by contraction of the muscles of mastication. This action occurs during swallowing. The other action associated with mastication is from only the contraction of the anterior suprahyoid muscles, which causes the mandible to depress, causing the jaws to open, when the hyoid bone is stabilized by the contraction of the posterior suprahyoid muscles and the infrahyoid muscles, the other hyoid muscle group.

Deeper yet similar in form to the superficial masseter muscle is another muscle of mastication, the medial pterygoid, or internal pterygoid (**choice D**). The action of this muscle is to elevate the mandible, raising the lower jaw. Elevation of the mandible occurs during the closing of the jaws. This muscle is weaker than the masseter muscle in this action.

- 186. The correct answer is D.** In the intercuspal position, the facio-incisal surface of the mandibular central incisor will oppose the mesial marginal ridge of the maxillary central incisor. Note that the mandibular central contacts only on the maxillary tooth in protrusion.

- 187. The correct answer is C.** Excessive calcified tissue formation at the root apices is known as hypercementosis. The resulting root may have a larger circumference than the upper portion, bulbous or pear-shaped. It occurs most frequently on premolar teeth. It can be due to increased or decreased forces, Paget's disease, hyperparathyroidism, or chronic infection in an adjacent area.

Excess cementum formation can occur with concrescence (**choice A**). This is the union of the root structure of two or more teeth through the cementum only, usually occurring with permanent maxillary molars. The teeth involved are originally separate, but join

because of excessive cementum deposition of one or more teeth following eruption. This occurs due to traumatic injury or crowding of the teeth in the area during the apposition and maturation stage of tooth development. All of these forms of calcified tissue formation at the root apices may present problems during extraction and endodontic treatment, and thus preoperative radiographs are important in the detection of this disturbance.

Misplaced ameloblasts can migrate to the root area, resulting in enamel being abnormally deposited on the cemental root surface. These are called enamel pearls (**choice B**), or enamelons. They appear as small, spherical-shaped enamel projections on the root surface, especially at the cemento-enamel junction or in the furcation area on molars where the roots divide. They have a tiny dentin-and-pulp core and appear radiopaque on radiographs. Enamel pearls may be confused as a calculus deposit upon exploration of the root surface.

Cemental pearls (**choice D**), or spurs, can be found at or near the CEJ. These are symmetrical spheres of cementum attached to the cemental root surface, similar to enamel pearls. They can present some clinical problems in the differentiation of them from calculus, yet they are not easily removed. Cemental pearls occur due to irregular deposition of cementum on the root.

188. The correct answer is D. The midroot cross-section of the mesial root of a mandibular molar has the greatest area. The mesial root of this tooth contains two canals, mesial buccal and mesial lingual, making this root very broad in the buccal lingual direction. The two next largest would be lingual of the maxillary and distal of the mandibular.

189. The correct answer is A. The major function of teeth located in the anterior of the arch is to cut into food during mastication. Teeth in this region tend to have steeper cusp inclinations to help facilitate this function. As teeth move more posteriorly in the mouth, they function more in mashing and chewing of food and have a flatter cuspal inclination. The maxillary first premolar is the most anterior of the teeth listed, so it would have the greatest cuspal inclination of the choices present.

190. The correct answer is D. The permanent mandibular first molar normally exhibits five major cusps: three buccal and two lingual. Listed from largest to smallest, they are: mesiobuccal, mesiolingual, distolingual, distobuccal, and distal. The listing of the cusps in order of highest to lowest is: mesiolingual, distolingual, mesiobuccal, distobuccal, and distal. Each cusp has four cusp ridges, a triangular ridge, and four inclined cuspal planes.

The primary mandibular first molar (**choice A**) has four cusps, with the mesial cusps being larger. The primary maxillary second molar (**choice B**) most closely resembles the form of the permanent maxillary first molar, yet it is smaller in all dimensions. Thus, it usually has a cusp of Carabelli, the minor fifth cusp.

The maxillary first molar (**choice C**) can have five cusps, but one is only a minor and non-functional cusp, the cusp of Carabelli. Some anatomists view it not as a cusp but rather as a variable trait. The mandibular second molar (**choice E**) has four cusps, two buccal and two lingual: the mesiobuccal, distobuccal, mesiolingual, and distolingual. The occlusal surface on the second molar is considerably different from the first with this view because there is no distal cusp and all cusps are of equal size.

191. The correct answer is E. In the diagram of the envelope of opening, the maximum opening position is found at the most inferior point. This represents maximum opening with translation of the condyle.

192. The correct answer is E. The primary mandibular first molar normally exhibits a distal triangular fossa as well as a mesial triangular fossa. There is also a distal, mesial, and central

pit but there is no central fossa. The tooth has four cusps, with the mesial cusps being larger. The mesiolingual cusp is long, pointed, and angled in on the occlusal table. A transverse ridge runs between the mesiobuccal and mesiolingual cusps.

The tooth has two roots that are positioned similarly to those of other primary and permanent mandibular molars; it does not have three roots (**choice C**). Also, there is no distal groove (**choice D**) but there is a facial and lingual groove. Unlike the primary maxillary molars, there is no oblique ridge (**choice A**) or facial pit (**choice B**) like the permanent mandibular first molar.

- 193. The correct answer is A.** Exhibiting four cusps best characterizes a mandibular second molar. The four cusps, two buccal and two lingual, are: mesiobuccal, distobuccal, mesiolingual, and distolingual. The occlusal surface on the second molar is considerably different from the first because there is no distal cusp (**choice C**), and thus there is no DF groove (**choice B**); also all cusps are of equal size. So it is not similar to the five-cusp variety mandibular third molar (**choice E**).

The two roots of the second molar are smaller, shorter, less divergent, and closer together than that of the first molar but there is not one fused root (**choice D**). The root trunk of the second is also longer than that of the first molar. The mesial root of the second is not as broad as that of the first molar, yet the furcation is farther to the CEJ. All the root depressions are shallower.

- 194. The correct answer is D.** In the intercuspal position, the facial cusp of the second premolar would be in contact with the distal marginal ridge of the maxillary first premolar and the mesial marginal ridge of the maxillary second premolar. The mandibular second premolar would be on the nonworking side during this movement.

- 195. The correct answer is D.** This is a protrusive movement of the mandible. The condyle would move forward and downward as the condyle hits the articular eminence. During this movement, incisal guidance, along with its condylar inclination, causes the mandible to open slightly, resulting in disclusion of all the posterior teeth.

- 196. The correct answer is C.** The mandibular canine, the third tooth from the midline, usually erupts between the ages of 9 and 10. The mandibular first premolar would be the fourth tooth from the midline and it erupts between the ages of 10 and 12. In the maxillary arch, the permanent canine erupts later than the first premolar. In the primary dentition, the first molar erupts after the canine.

- 197. The correct answer is C.** A primary maxillary canine is usually exfoliated at 10 to 11 years of age (after it erupts at 16 to 22 months). It will be replaced by the permanent maxillary canine, which erupts at 10 to 12 years.

The primary maxillary central incisor is exfoliated at 6 to 7 years of age (**choice A**). The primary maxillary lateral incisor is already exfoliated by 8 to 9 years (**choice B**). At 12 to 13 years (**choice D**), the primary maxillary first and second molars should already have been exfoliated. By 14 to 15 years of age (**choice E**) the person has entered the permanent dentition period, when only permanent teeth are present and all permanent teeth have erupted except for the permanent third molars of both arches.

- 198. The correct answer is E.** The central groove on a permanent maxillary first molar runs from the mesial pit to the central pit on the occlusal surface. The mesial pit is in the mesial triangular fossa, distal to the mesial marginal ridge. Thus, the mesial pit is at the junction of four developmental grooves: mesial, mesiobuccal triangular, mesiolingual triangular, and mesial marginal.

The distal groove, as part of the central groove, usually runs from the central pit across the oblique ridge to the distal pit and is sometimes referred to as the transverse groove of the oblique ridge (**choice A**). The lingual outline is also divided unequally into two parts by the distolingual groove (**choice C**). The distolingual groove usually ends in a lingual pit in the middle of the lingual surface, but may fade out. The other grooves listed (**choices B and D**) are incorrect.

- 199. The correct answer is D.** The permanent maxillary lateral incisor is usually equal to or larger than the maxillary central incisor in root length (cervicoapically). However, it is smaller in root width (faciolingually) (**choice A**). The maxillary lateral incisor has a single root that is conical in shape and relatively smooth and straight, yet may curve slightly to the distal.

The lateral has a smaller crown width (both mesiodistally, **choice B**, and faciolingually, **choice C**) and crown length (cervicoincisally) (**choice E**). The maxillary lateral usually resembles the maxillary central incisor in all views of the tooth but has a smaller and slightly more rounded crown.

- 200. The correct answer is D.** The permanent maxillary canine is the last anterior tooth to erupt and it does so at age 11 to 12 years, not 9 to 10 years (**choice B**), of age. It replaces the primary maxillary canine, which was exfoliated at 10 to 12 years of age.

Because the permanent maxillary canine erupts after the maxillary incisors, and possibly the maxillary premolars, often its arch space is partially closed and it may erupt labial or lingual to the surrounding teeth. The maxillary canine may also fail to erupt and remain impacted within the alveolar bone. An impacted tooth is an unerupted or partially erupted tooth that is positioned against another tooth, bone, or even soft tissue so that complete eruption is unlikely. This may result in the need for surgical exposure and follow-up orthodontic treatment. This problem may be avoided through careful evaluation of the mixed-dentition patient and the institution of preventive orthodontic care.

The mandibular canine erupts at age 11 to 12 years of age (**choice C**), but it occurs before the maxillary canine. It does not erupt at 9 to 10 years of age (**choice A**).

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