

# Full-Length Practice Test 4

## Reading Comprehension

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**Time:** 50 minutes

**Questions:** 1-40

**Directions:** Read each passage carefully and answer the questions that follow. Choose the best answer based on the information provided in the passage.

### PASSAGE 1

The skeletal system provides the structural framework for the human body, serving multiple essential functions beyond simple mechanical support. Composed of 206 bones in adults, along with cartilage, ligaments, and tendons, the skeletal system enables movement, protects vital organs, produces blood cells, stores minerals, and maintains metabolic balance. Understanding skeletal structure, bone tissue composition, and the dynamic processes of bone remodeling is fundamental to comprehending both normal physiology and various pathological conditions affecting bone health.

Bones are classified by shape into five categories, each adapted for specific functions. Long bones, such as the femur and humerus, consist of a shaft (diaphysis) and two ends (epiphyses), providing leverage for movement and supporting body weight. Short bones, like those in the wrist and ankle, provide stability with limited movement. Flat bones, including the skull, ribs, and sternum, protect internal organs and provide extensive surfaces for muscle attachment. Irregular bones, such as vertebrae and facial bones, have complex shapes suited to specialized functions. Sesamoid bones, like the patella, develop within tendons and modify the angle of muscle pull.

Bone tissue exists in two structural forms: compact bone and spongy bone. Compact bone forms the dense outer layer, providing strength and protection. Its microscopic structure features osteons (Haversian systems), cylindrical units composed of concentric layers of mineralized matrix surrounding a central canal containing blood vessels and nerves. This organization allows efficient nutrient delivery and waste removal while maintaining structural integrity. Spongy bone, found inside bone ends and within flat bones, consists of a lattice of thin plates called trabeculae that orient along lines of stress, providing strength while minimizing weight. The spaces between trabeculae contain red bone marrow, where hematopoiesis (blood cell formation) occurs.

Bone matrix consists of both organic and inorganic components that together create bone's unique properties. The organic portion, primarily collagen fibers, provides flexibility and tensile strength, allowing bones to bend slightly under stress without breaking. The inorganic component, mainly calcium phosphate crystals in the form of hydroxyapatite, provides hardness and compressive strength. This

combination of organic flexibility and inorganic rigidity creates a composite material stronger than either component alone—bones can support tremendous weight while also absorbing shock and resisting fracture.

Bone constantly undergoes remodeling, a dynamic process where old bone tissue is removed and new bone is formed. This continuous renovation serves multiple purposes: it repairs microscopic damage before it accumulates into fractures, releases minerals into the bloodstream to maintain homeostasis, and allows bones to adapt their structure in response to mechanical stress. Two types of cells orchestrate bone remodeling. Osteoclasts are large, multinucleated cells that break down bone tissue through secreting acids and enzymes, creating small cavities on bone surfaces. Osteoblasts are cells that synthesize new bone matrix, filling in the cavities created by osteoclasts with fresh bone tissue that subsequently mineralizes. Under normal conditions, bone resorption and formation remain balanced, maintaining skeletal integrity.

Several factors regulate bone remodeling, with mechanical stress, hormones, and nutrition playing crucial roles. Wolff's Law states that bone adapts to the loads placed upon it—bones subjected to increased stress become thicker and stronger, while bones that experience reduced loading lose density. This explains why weight-bearing exercise strengthens bones and why prolonged bed rest or spaceflight leads to bone loss. Parathyroid hormone and calcitonin regulate calcium homeostasis, indirectly affecting bone remodeling. Vitamin D is essential for calcium absorption, while vitamin K is necessary for proper bone matrix formation. Adequate dietary calcium and phosphorus provide the raw materials for bone mineralization.

Bone disorders can result from genetic factors, nutritional deficiencies, hormonal imbalances, or aging. Osteoporosis, characterized by decreased bone density and increased fracture risk, commonly affects postmenopausal women due to declining estrogen levels that accelerate bone resorption. Osteomalacia results from vitamin D deficiency in adults, causing inadequate bone mineralization and soft, weak bones. Paget's disease involves excessive, disorganized bone remodeling, producing enlarged, deformed bones that are structurally weak. Osteogenesis imperfecta, a genetic disorder affecting collagen synthesis, results in extremely fragile bones that fracture easily.

For dental professionals, understanding bone physiology is particularly relevant to oral health. The maxilla and mandible undergo constant remodeling in response to occlusal forces during chewing. Tooth loss leads to alveolar bone resorption because the mechanical stimulation from tooth roots is eliminated. This bone loss can complicate dental implant placement and denture fitting. Periodontal disease accelerates bone loss around teeth through inflammatory processes. Additionally, medications like bisphosphonates, used to treat osteoporosis, can affect jaw bone healing and must be considered before invasive dental procedures. Recognizing the interconnection between systemic bone health and oral conditions enables dental professionals to provide comprehensive, informed care.

1. According to the passage, how many bones does the adult skeletal system contain?  
A. 106

- B. 206
- C. 306
- D. 256

2. The passage indicates that long bones are primarily designed to:
  - A. Protect internal organs
  - B. Provide stability with limited movement
  - C. Provide leverage for movement and support body weight
  - D. Develop within tendons
3. Based on the passage, osteons (Haversian systems) are found in:
  - A. Spongy bone
  - B. Red bone marrow
  - C. Trabeculae
  - D. Compact bone
4. The passage states that the organic component of bone matrix primarily consists of:
  - A. Collagen fibers
  - B. Calcium phosphate crystals
  - C. Hydroxyapatite
  - D. Minerals
5. According to the passage, what is the primary function of osteoclasts?
  - A. Synthesize new bone matrix
  - B. Fill cavities with bone tissue
  - C. Break down bone tissue
  - D. Produce blood cells
6. The passage describes Wolff's Law as stating that:
  - A. Bones become weaker with increased stress
  - B. Bone adapts to the loads placed upon it
  - C. Bone remodeling is independent of mechanical stress
  - D. Hormones have no effect on bone density
7. Based on the passage, osteoporosis is characterized by:
  - A. Decreased bone density and increased fracture risk
  - B. Excessive bone mineralization
  - C. Inadequate collagen synthesis
  - D. Enlarged, deformed bones

8. According to the passage, tooth loss leads to alveolar bone resorption because:
- A. Oral bacteria increase dramatically
  - B. Mechanical stimulation from tooth roots is eliminated
  - C. Calcium absorption decreases
  - D. Blood flow to the jaw increases

## PASSAGE 2

The human digestive system is a complex series of organs and glands that processes food, extracting nutrients essential for energy production, growth, and cellular repair while eliminating waste products. This approximately 30-foot-long pathway involves mechanical and chemical digestion, nutrient absorption, and waste elimination, orchestrated by intricate neural and hormonal regulation. Understanding digestive anatomy, physiology, and the biochemical transformations that occur at each stage is fundamental to comprehending nutrition, metabolism, and numerous gastrointestinal disorders.

Digestion begins in the oral cavity, where food undergoes both mechanical and chemical breakdown. Teeth mechanically break food into smaller pieces through mastication, increasing surface area for enzyme action. Salivary glands secrete saliva containing water, mucus, and the enzyme salivary amylase, which initiates carbohydrate digestion by breaking down starch into smaller polysaccharides and maltose. Saliva also contains lysozyme, an antibacterial enzyme, and immunoglobulin A, providing initial immune defense. The tongue manipulates food, mixing it with saliva to form a bolus that can be swallowed. This seemingly simple process is critical—inadequate chewing and insufficient saliva production can impair subsequent digestion and contribute to gastrointestinal discomfort.

After swallowing, the bolus travels down the esophagus through peristalsis, rhythmic muscular contractions that propel food toward the stomach. The esophagus is simply a transport tube with no digestive function, but the lower esophageal sphincter at its base prevents stomach contents from refluxing back into the esophagus. When this sphincter malfunctions, gastric acid enters the esophagus, causing gastroesophageal reflux disease (GERD), characterized by heartburn and potential esophageal damage.

The stomach serves as a temporary storage reservoir that continues digestion through mechanical churning and chemical breakdown. Gastric glands in the stomach lining secrete gastric juice, a highly acidic mixture containing hydrochloric acid, pepsinogen, and intrinsic factor. Hydrochloric acid creates an extremely acidic environment (pH 1.5-2.0) that denatures proteins, activates pepsinogen into pepsin (a protein-digesting enzyme), and kills most ingested bacteria. The stomach's thick mucus layer protects its own cells from acid damage, but when this protective barrier is compromised, peptic ulcers can develop. Mechanical churning mixes food with gastric juice, producing a semi-liquid mixture called chyme that gradually empties into the small intestine through the pyloric sphincter.

The small intestine, approximately 20 feet long, is where most chemical digestion and virtually all nutrient absorption occur. It consists of three regions: the duodenum, jejunum, and ileum. The duodenum receives chyme from the stomach along with secretions from the pancreas and liver. Pancreatic juice contains sodium bicarbonate, which neutralizes acidic chyme, and digestive enzymes including pancreatic amylase (digests carbohydrates), pancreatic lipase (digests fats), and various proteases (digest proteins). The liver produces bile, stored in the gallbladder and released into the duodenum, which emulsifies fats, breaking large fat globules into smaller droplets that enzymes can act upon more efficiently.

The small intestine's inner surface features circular folds, villi, and microvilli—structural modifications that dramatically increase surface area for absorption. Each villus contains a network of capillaries and a central lacteal (lymphatic vessel). Digested nutrients cross the intestinal epithelium and enter either blood capillaries (for amino acids, monosaccharides, and water-soluble vitamins) or lacteals (for fatty acids, glycerol, and fat-soluble vitamins). This absorption is remarkably efficient, with the small intestine extracting over 90% of available nutrients from digested food. Various diseases, including celiac disease and Crohn's disease, damage intestinal villi, severely impairing nutrient absorption and causing malnutrition.

The large intestine, about 5 feet long, receives undigestible food residues, primarily fiber, along with water and electrolytes. Its primary functions are water absorption, electrolyte absorption, and formation of feces. Trillions of beneficial bacteria inhabiting the large intestine ferment remaining carbohydrates, producing short-chain fatty acids that colonocytes (colon cells) use for energy. These bacteria also synthesize certain vitamins, particularly vitamin K and some B vitamins. The large intestine compacts waste into feces, which are stored in the rectum until defecation. Fiber, though indigestible, plays crucial roles in promoting regular bowel movements, feeding beneficial gut bacteria, and potentially reducing colon cancer risk.

Digestive health significantly impacts oral health through several mechanisms. Gastroesophageal reflux exposes teeth to gastric acid, causing dental erosion. Eating disorders involving vomiting, such as bulimia nervosa, similarly damage tooth enamel through repeated acid exposure. Nutritional deficiencies resulting from malabsorption disorders affect oral tissues—vitamin C deficiency causes bleeding gums, B vitamin deficiencies can cause oral ulcers, and iron deficiency may contribute to angular cheilitis. Additionally, medications used to treat digestive disorders, such as proton pump inhibitors for GERD, may reduce calcium absorption, potentially affecting jaw bone health. Dental professionals who understand digestive function can better recognize oral manifestations of systemic digestive disorders and provide appropriate referrals and care modifications.

9. According to the passage, salivary amylase functions to:
- A. Digest proteins
  - B. Kill bacteria
  - C. Break down starch
  - D. Neutralize acid

10. The passage indicates that the lower esophageal sphincter prevents:
- A. Stomach contents from refluxing into the esophagus
  - B. Food from entering the esophagus
  - C. Acid production in the stomach
  - D. Nutrient absorption
11. Based on the passage, the stomach's mucus layer protects against:
- A. Bacterial infections
  - B. Nutrient malabsorption
  - C. Excessive churning
  - D. Acid damage to stomach cells
12. The passage states that pancreatic juice contains sodium bicarbonate, which:
- A. Digests carbohydrates
  - B. Neutralizes acidic chyme
  - C. Emulsifies fats
  - D. Kills bacteria
13. According to the passage, bile functions to:
- A. Emulsify fats into smaller droplets
  - B. Neutralize stomach acid
  - C. Digest proteins
  - D. Absorb water
14. The passage indicates that lacteals absorb:
- A. Amino acids and monosaccharides
  - B. Water and electrolytes
  - C. Bacteria and fiber
  - D. Fatty acids and fat-soluble vitamins
15. Based on the passage, beneficial bacteria in the large intestine:
- A. Digest all proteins
  - B. Absorb all nutrients
  - C. Produce vitamins and ferment carbohydrates
  - D. Cause colon cancer
16. According to the passage, gastroesophageal reflux can affect oral health by:
- A. Reducing saliva production
  - B. Exposing teeth to gastric acid

- C. Increasing beneficial bacteria
- D. Improving enamel strength

### **PASSAGE 3**

Pain is a complex, multidimensional experience involving sensory, emotional, and cognitive components that serves as a critical protective mechanism, alerting the body to potential or actual tissue damage. While acute pain typically resolves once the underlying injury heals, chronic pain persists beyond normal healing time and can become a debilitating condition in itself. Understanding pain mechanisms, transmission pathways, and the various factors that modulate pain perception is essential for healthcare professionals who must assess and manage pain effectively while considering both its physiological basis and its impact on quality of life.

Pain perception begins with nociceptors, specialized sensory receptors that detect noxious (potentially harmful) stimuli. These free nerve endings are distributed throughout body tissues except the brain itself and respond to mechanical damage, extreme temperatures, or chemical irritants. Different nociceptor types have varying response characteristics: A-delta fibers are thinly myelinated and transmit sharp, localized pain rapidly, while C fibers are unmyelinated and conduct dull, aching, poorly localized pain more slowly. This explains why injury often produces an immediate sharp sensation followed by a slower-onset, lingering ache.

When tissue damage occurs, injured cells and immune cells release numerous chemical mediators that sensitize and activate nociceptors. Prostaglandins, produced through the cyclooxygenase (COX) pathway, enhance nociceptor sensitivity. Bradykinin directly stimulates nociceptors and promotes inflammation. Substance P and histamine increase blood vessel permeability and contribute to the inflammatory response. This chemical soup at the injury site lowers nociceptor activation thresholds, causing normally non-painful stimuli to become painful (allodynia) and increasing the pain response to painful stimuli (hyperalgesia). Understanding these mechanisms explains how anti-inflammatory medications like NSAIDs work—by inhibiting COX enzymes, they reduce prostaglandin production and thereby decrease pain and inflammation.

Pain signals travel from nociceptors through peripheral nerves to the spinal cord, where they synapse with second-order neurons that cross to the opposite side and ascend to the brain via the spinothalamic tract. The brain does not have a single "pain center" but rather processes pain through multiple regions. The thalamus acts as a relay station, directing sensory information to the somatosensory cortex (which identifies pain location and intensity) and the limbic system (which processes the emotional aspects of pain). The anterior cingulate cortex and prefrontal cortex are involved in the cognitive and emotional evaluation of pain. This distributed processing explains why pain is not simply a sensory experience but includes emotional suffering and can be influenced by attention, expectation, and psychological state.

The nervous system possesses endogenous pain modulation mechanisms that can either amplify or suppress pain signals. The gate control theory, proposed by Melzack and Wall, suggests that non-painful sensory input can "close the gate" to pain signals at the spinal cord level, explaining why rubbing an injured area can reduce pain. Descending pain modulation pathways from the brain to the spinal cord can inhibit pain transmission through releasing endogenous opioids (endorphins, enkephalins) and other neurotransmitters. This system underlies placebo analgesia and explains how psychological factors like distraction, positive expectations, and relaxation techniques can genuinely reduce pain perception.

Chronic pain differs fundamentally from acute pain in both mechanism and significance. While acute pain results from active tissue damage and serves protective functions, chronic pain often persists without ongoing tissue injury and may result from maladaptive changes in the nervous system itself. Central sensitization occurs when repeated or prolonged pain input causes neurons in the spinal cord and brain to become hyperexcitable, amplifying pain signals even in the absence of continued nociceptor activation. This neural plasticity can transform pain from a symptom into a disease. Chronic pain conditions like fibromyalgia, complex regional pain syndrome, and some forms of chronic headache may involve central sensitization, making them particularly difficult to treat with conventional approaches targeting peripheral tissue damage.

Various factors influence individual pain experiences and responses. Genetics affect pain sensitivity and analgesic response—some people naturally produce more endogenous opioids or have variations in pain receptor genes. Previous pain experiences and learned associations shape pain perception. Cultural factors influence pain expression and coping strategies. Psychological factors including anxiety, depression, and catastrophic thinking can amplify pain perception. Sleep deprivation lowers pain thresholds. These individual differences explain why the same injury produces vastly different pain experiences in different people and why effective pain management often requires individualized, multimodal approaches.

For dental professionals, understanding pain mechanisms has immediate clinical relevance. Local anesthetics block sodium channels in nociceptors and peripheral nerves, preventing pain signal generation and transmission. The inflammatory component of dental pain responds to NSAIDs, which reduce prostaglandin production. Dental anxiety can amplify pain perception through attentional focusing and fear-induced hyperalgesia. Some patients experience persistent pain after dental procedures without apparent ongoing pathology, possibly reflecting central sensitization. Additionally, understanding referred pain patterns is important—dental infections or temporomandibular disorders can cause pain felt in locations distant from the actual problem. Recognizing pain's multifaceted nature enables dental professionals to employ comprehensive pain management strategies combining pharmacological interventions, behavioral approaches, and clear communication that addresses patients' emotional and cognitive responses to pain.

17. According to the passage, nociceptors are best described as:

- A. Brain cells that process pain

- B. Chemical mediators of inflammation
  - C. Neurons that transmit pain to muscles
  - D. Sensory receptors that detect potentially harmful stimuli
18. The passage indicates that C fibers:
- A. Conduct dull, aching pain more slowly
  - B. Are heavily myelinated
  - C. Transmit sharp, localized pain
  - D. Only respond to temperature
19. Based on the passage, prostaglandins:
- A. Enhance nociceptor sensitivity
  - B. Block pain signal transmission
  - C. Reduce inflammation
  - D. Increase endogenous opioid production
20. The passage states that NSAIDs reduce pain by:
- A. Directly blocking nerve signals
  - B. Increasing endorphin production
  - C. Inhibiting COX enzymes and reducing prostaglandin production
  - D. Desensitizing nociceptors permanently
21. According to the passage, the brain's processing of pain involves multiple regions because:
- A. Pain is only a sensory experience
  - B. The brain has one dedicated pain center
  - C. Pain signals bypass the thalamus
  - D. Pain includes sensory, emotional, and cognitive components
22. The passage describes the gate control theory as suggesting that:
- A. Pain gates can never be closed
  - B. All pain signals reach the brain equally
  - C. Non-painful sensory input can reduce pain signals
  - D. Rubbing an injury increases pain
23. Based on the passage, central sensitization is characterized by:
- A. Neurons becoming hyperexcitable and amplifying pain signals
  - B. Complete elimination of pain perception
  - C. Reduced sensitivity to painful stimuli
  - D. Healing of tissue damage

24. According to the passage, local anesthetics work by:
- A. Increasing prostaglandin production
  - B. Enhancing nociceptor activity
  - C. Reducing anxiety levels
  - D. Blocking sodium channels in nociceptors and nerves

#### **PASSAGE 4**

The endocrine and nervous systems work in coordination to regulate body functions, yet they operate through distinctly different mechanisms and time scales. While the nervous system provides rapid, precise communication through electrical impulses and neurotransmitters acting across synapses, the endocrine system achieves slower, more widespread effects through hormones released into the bloodstream. This hormonal regulation influences virtually every physiological process, including metabolism, growth, reproduction, stress responses, and fluid balance. Understanding endocrine function, hormone mechanisms, and common endocrine disorders is crucial for healthcare professionals, as hormonal imbalances produce diverse symptoms affecting multiple body systems.

Hormones are classified chemically into three main categories, each with distinct synthesis, transport, and mechanism of action. Peptide and protein hormones, including insulin, growth hormone, and many pituitary hormones, are chains of amino acids synthesized in the endoplasmic reticulum and Golgi apparatus, stored in vesicles, and released through exocytosis. Being water-soluble, they dissolve readily in blood plasma but cannot cross cell membranes. Instead, they bind to receptors on the cell surface, triggering intracellular signaling cascades through second messengers like cyclic AMP. These effects occur relatively quickly, within seconds to minutes.

Steroid hormones, derived from cholesterol, include sex hormones (estrogens, androgens, progesterone) and adrenal corticosteroids. Their lipid-soluble nature allows them to pass directly through cell membranes. Once inside target cells, steroid hormones bind to intracellular receptors in the cytoplasm or nucleus. These hormone-receptor complexes then act as transcription factors, binding to specific DNA sequences and regulating gene expression. Because protein synthesis is required, steroid hormone effects develop more slowly, over hours to days, but they often persist longer than peptide hormone effects.

Amine hormones, derived from the amino acid tyrosine, include thyroid hormones and catecholamines (epinephrine and norepinephrine). Thyroid hormones behave similarly to steroid hormones despite their different chemical origin—they enter cells and regulate gene expression. Catecholamines, in contrast, act like peptide hormones, binding to surface receptors and producing rapid effects through second messenger systems. This diversity in hormone chemistry and mechanism allows the endocrine system to fine-tune both the speed and duration of physiological responses.

The hypothalamus-pituitary axis represents the endocrine system's master control network. The hypothalamus, a brain region linking the nervous and endocrine systems, produces releasing and inhibiting hormones that control the anterior pituitary gland. The anterior pituitary then secretes tropic hormones that regulate other endocrine glands: thyroid-stimulating hormone (TSH) controls the thyroid, adrenocorticotropic hormone (ACTH) controls the adrenal cortex, and gonadotropins (FSH and LH) control the gonads. The posterior pituitary stores and releases two hormones produced by hypothalamic neurons: antidiuretic hormone (ADH), which regulates water retention, and oxytocin, which stimulates uterine contractions and milk ejection.

Negative feedback mechanisms maintain hormone levels within narrow ranges. In a typical negative feedback loop, rising levels of a hormone or its effects inhibit further hormone release. For example, when thyroid hormone levels rise sufficiently, they suppress TSH release from the pituitary and thyrotropin-releasing hormone from the hypothalamus, reducing thyroid stimulation. When thyroid hormone levels fall, this inhibition decreases, allowing increased TSH release. This self-regulating system maintains homeostasis without requiring conscious control. However, feedback mechanisms can malfunction, leading to hormonal disorders.

Common endocrine disorders illustrate the consequences of hormonal imbalances. Diabetes mellitus, affecting insulin function, is the most prevalent endocrine disorder. Type 1 diabetes results from autoimmune destruction of insulin-producing pancreatic beta cells, requiring insulin replacement. Type 2 diabetes involves insulin resistance, where target tissues become less responsive to insulin despite adequate or elevated production. Both types result in elevated blood glucose, but through different mechanisms requiring different management approaches. Thyroid disorders are also common. Hypothyroidism, often caused by autoimmune thyroiditis (Hashimoto's disease), produces fatigue, weight gain, cold intolerance, and slowed metabolism. Hyperthyroidism, frequently due to Graves' disease, causes weight loss, heat intolerance, anxiety, and elevated metabolism.

Hormonal effects extend significantly into oral health. Diabetes profoundly affects the oral cavity—elevated blood glucose promotes bacterial growth, impairs immune function, and compromises wound healing, increasing risks for periodontal disease, infections, and poor healing after dental procedures. Thyroid disorders can affect tooth development in children. Pregnancy and menopause, representing periods of dramatic hormonal change, can increase gingival inflammation and periodontal disease risk. Corticosteroid medications used to treat various inflammatory and autoimmune conditions can suppress immune function and impair healing. Growth hormone deficiency can affect craniofacial development. Understanding these endocrine-oral health connections enables dental professionals to recognize oral manifestations of systemic endocrine disorders, modify treatment plans for patients with hormonal conditions, and collaborate effectively with physicians managing patients' endocrine health.

25. According to the passage, peptide hormones differ from steroid hormones in that peptide hormones:
- A. Cross cell membranes easily

- B. Bind to surface receptors and use second messengers
  - C. Are derived from cholesterol
  - D. Directly regulate gene expression
26. The passage indicates that steroid hormones produce effects by:
- A. Binding to surface receptors
  - B. Triggering rapid responses within seconds
  - C. Acting as transcription factors that regulate gene expression
  - D. Using cyclic AMP as a second messenger
27. Based on the passage, thyroid hormones behave similarly to:
- A. Steroid hormones in entering cells and regulating genes
  - B. Catecholamines in speed of action
  - C. Peptide hormones in mechanism
  - D. Neurotransmitters in structure
28. The passage states that the anterior pituitary secretes tropic hormones that:
- A. Regulate water retention
  - B. Stimulate uterine contractions
  - C. Are produced by the hypothalamus
  - D. Regulate other endocrine glands
29. According to the passage, negative feedback mechanisms function to:
- A. Increase hormone production continuously
  - B. Eliminate all hormone secretion
  - C. Maintain hormone levels within narrow ranges
  - D. Bypass the hypothalamus completely
30. The passage indicates that Type 1 diabetes results from:
- A. Insulin resistance in target tissues
  - B. Autoimmune destruction of pancreatic beta cells
  - C. Excessive insulin production
  - D. Thyroid dysfunction
31. Based on the passage, elevated blood glucose in diabetes affects oral health by:
- A. Improving immune function
  - B. Reducing bacterial growth
  - C. Accelerating wound healing
  - D. Promoting bacterial growth and impairing healing

32. According to the passage, which hormone regulates water retention?
- A. Antidiuretic hormone (ADH)
  - B. Thyroid-stimulating hormone (TSH)
  - C. Growth hormone
  - D. Insulin

## **PASSAGE 5**

Evolution by natural selection represents one of biology's most powerful explanatory frameworks, unifying diverse observations about living organisms and providing a scientific foundation for understanding biodiversity, adaptation, and the relationships among species. Charles Darwin and Alfred Russel Wallace independently proposed this mechanism in the mid-19th century, fundamentally transforming biological sciences. Modern evolutionary theory integrates genetics, molecular biology, paleontology, and ecology, offering increasingly detailed insights into how populations change over time and how new species arise. Understanding evolutionary principles is essential for comprehending topics ranging from antibiotic resistance to biodiversity conservation.

Natural selection operates through three essential conditions that, when present, inevitably lead to evolutionary change. First, variation must exist within a population—individuals differ in their traits. Second, this variation must be heritable, passed from parents to offspring through genetic mechanisms. Third, individuals with certain heritable traits must have differential reproductive success, producing more surviving offspring than individuals with other traits. When these conditions are met, traits that enhance survival and reproduction become more common in subsequent generations while less advantageous traits decline in frequency. Importantly, natural selection acts on existing variation; it does not create new traits but rather sorts existing genetic variation based on reproductive success.

Genetic variation, the raw material for evolution, arises through several mechanisms. Mutations are random changes in DNA sequence that can create new alleles. Most mutations are neutral or harmful, but occasionally mutations produce advantageous traits. Sexual reproduction generates variation by shuffling existing alleles through independent assortment of chromosomes during meiosis and through crossing over, which creates new allele combinations. Gene flow, the movement of alleles between populations through migration, introduces new genetic variants. Genetic drift, random changes in allele frequencies particularly in small populations, can cause evolutionary change independent of natural selection. These mechanisms ensure that populations maintain genetic diversity upon which selection can act.

Adaptation, the fit between organisms and their environments, results from natural selection favoring traits that enhance survival and reproduction in specific conditions. Adaptations can be structural, such as the streamlined bodies of aquatic mammals that reduce drag; physiological, such as the ability of desert animals to concentrate urine and conserve water; or behavioral, such as migration patterns that allow access to seasonal resources. However, not all traits are adaptations—some result from genetic drift, others

are byproducts of developmental processes, and still others represent historical compromises constrained by evolutionary history. For example, the human appendix appears vestigial, a remnant of digestive structures useful in herbivorous ancestors but no longer serving significant function.

Evidence for evolution comes from multiple, independent sources that converge on the same conclusions. The fossil record documents gradual changes in organisms over time and reveals transitional forms bridging major groups, such as fossils showing intermediate characteristics between fish and amphibians. Comparative anatomy reveals homologous structures—features with similar underlying structure but different functions in different species, like the bones in human arms, whale flippers, and bat wings, all derived from the same ancestral structures. Vestigial structures, like the remnants of pelvic bones in whales, represent evolutionary leftovers. Biogeography shows that species distributions reflect evolutionary history—for example, marsupials dominate Australia because it separated from other landmasses before placental mammals diversified. Molecular biology provides perhaps the most compelling evidence: DNA and protein similarities reflect evolutionary relationships, with more similar sequences indicating more recent common ancestry.

Evolutionary medicine applies evolutionary principles to understanding health and disease. Many diseases result from mismatches between our evolved biology and modern environments. Humans evolved as hunter-gatherers in environments vastly different from modern industrialized societies, and our bodies are adapted for high physical activity, variable food availability, and exposure to diverse pathogens. Modern lifestyles featuring sedentary behavior, abundant processed foods, and sanitized environments create conditions our biology did not evolve to handle, contributing to obesity, diabetes, cardiovascular disease, and some immune disorders. Understanding these evolutionary mismatches can inform prevention strategies.

Pathogens evolve rapidly, with significant medical implications. Antibiotic resistance exemplifies evolution in action—when antibiotics kill susceptible bacteria, resistant mutants survive and reproduce, quickly increasing in frequency. Overprescription and incomplete antibiotic courses accelerate this process, leading to "superbugs" resistant to multiple drugs. Similarly, cancer can be viewed as somatic evolution, where cells acquire mutations that allow uncontrolled growth, evading immune surveillance and spreading to new locations. Understanding the evolutionary dynamics of cancer may improve treatment strategies.

For dental professionals, evolutionary perspectives provide valuable insights. Human tooth structure reflects our evolutionary history as omnivores, with different tooth types adapted for various functions. The modern epidemic of dental caries results partly from evolutionary mismatch—our teeth evolved in environments without refined sugars and processed carbohydrates that oral bacteria efficiently ferment into enamel-dissolving acids. Wisdom teeth problems reflect evolutionary changes in jaw size as human diets softened with cooking and agriculture, leaving insufficient space for third molars. Understanding these evolutionary contexts helps explain why certain dental problems are so common and informs

preventive approaches emphasizing diet and oral hygiene practices that mitigate evolutionarily novel challenges.

33. According to the passage, natural selection requires which of the following conditions?

- A. Only variation within a population
- B. Only heritability of traits
- C. Variation, heritability, and differential reproductive success
- D. Creation of new traits by selection itself

34. The passage indicates that natural selection:

- A. Creates new genetic variations
- B. Sorts existing genetic variation based on reproductive success
- C. Only operates in large populations
- D. Requires human intervention

35. Based on the passage, genetic drift is best described as:

- A. Selective breeding by humans
- B. Movement of alleles between populations
- C. DNA sequence changes
- D. Random changes in allele frequencies

36. The passage states that homologous structures are features that:

- A. Have similar underlying structure but different functions in different species
- B. Serve identical functions in all organisms
- C. Appeared recently in evolution
- D. Have no evolutionary relationship

37. According to the passage, molecular biology provides evidence for evolution through:

- A. Fossil discoveries
- B. Anatomical dissections
- C. DNA and protein sequence similarities reflecting relationships
- D. Geographic distributions of species

38. The passage indicates that antibiotic resistance develops because:

- A. Bacteria intentionally mutate to resist drugs
- B. Antibiotics create resistance genes
- C. All bacteria are naturally immune
- D. Resistant bacteria survive antibiotic treatment and reproduce

39. Based on the passage, the modern epidemic of dental caries results partly from:

- A. Evolutionary mismatch between our teeth and modern diets high in refined sugars
- B. Recent evolutionary changes in tooth structure
- C. Decreased oral bacteria in modern humans
- D. Evolution of stronger tooth enamel

40. According to the passage, wisdom teeth problems reflect:

- A. Recent increase in jaw size
- B. Evolution of larger third molars
- C. Dietary changes leaving insufficient jaw space
- D. Evolutionary changes in jaw size with softer diets leaving insufficient space for third molars

## Language Usage

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**Time:** 30 minutes

**Questions:** 1-40

**Directions:** Each question presents a sentence or passage with underlined portions or asks you to identify errors or select the best revision. Choose the answer that corrects any errors or represents the best version.

1. The dental clinic scheduled appointments for patients, it also confirmed them by phone the day before.
  - A. patients, it also confirmed
  - B. patients it also confirmed
  - C. patients; because it also confirmed
  - D. patients and also confirmed
2. Neither the dentist nor the hygienists was available to see the emergency patient that afternoon.
  - A. nor the hygienists was available
  - B. or the hygienists was available
  - C. nor the hygienists were available
  - D. or the hygienists were available
3. The patient asked the receptionist when could he reschedule his appointment for the following week.
  - A. when could he reschedule
  - B. when he could reschedule
  - C. when could he have rescheduled
  - D. when he could have reschedule
4. Between you and I, the new sterilization protocol seems more thorough than the previous one.
  - A. Between you and me, the new sterilization protocol seems

- B. Between you and I, the new sterilization protocol seem
  - C. Between you and me, the new sterilization protocol seem
  - D. Between you and I, the new sterilization protocols is
5. The clinic provides comprehensive services such as cleanings, examinations, and will perform root canals.
- A. cleanings, examinations, and will perform root canals
  - B. cleanings, examinations, and performing root canals
  - C. cleaning, examination, and root canal
  - D. cleanings, examinations, and root canals
6. After reviewing the patient's medical history the dentist decided to proceed with the treatment plan.
- A. After reviewing the patient's medical history the dentist decided
  - B. After reviewing, the patient's medical history the dentist decided
  - C. After reviewing the patient's medical history, the dentist decided
  - D. After reviewing the patient's medical history; the dentist decided
7. The new equipment is more reliable than the old one, it also requires less maintenance.
- A. old one, it also requires
  - B. old one, and it also requires
  - C. old one it also requires
  - D. old one; because it also requires
8. Everyone in the dental program must submit their research project by the deadline posted online.
- A. must submit their research project
  - B. must submit his or her research projects
  - C. must submit its research project
  - D. must submit his or her research project
9. The dentist recommended that the patient brushes her teeth after every meal and flosses daily.
- A. recommended that the patient brushes her teeth
  - B. recommended that the patient brushed her teeth
  - C. recommended that the patient brush her teeth
  - D. recommends that the patient brushes her teeth
10. Running late for work, the dentist's car got a flat tire on the highway during rush hour.
- A. Running late for work, the dentist's car got a flat tire
  - B. Running late for work, the car of the dentist got a flat tire
  - C. Running late for work, the dentist got a flat tire
  - D. The dentist's car got a flat tire, running late for work

11. Each of the dental assistants have completed their infection control training before starting work.
- A. have completed their infection control
  - B. has completed his or her infection control
  - C. have completed his or her infection control
  - D. has completed their infection control
12. The office is open Monday through Friday, however it is closed on weekends and major holidays.
- A. Friday; however, it is
  - B. Friday, however it is
  - C. Friday however, it is
  - D. Friday, however, it is
13. Less people visited the dental office during the holiday season than during other months.
- A. Less people visited
  - B. Less person visited
  - C. Lesser people visited
  - D. Fewer people visited
14. The hygienist cleaned the instruments, sterilized the equipment, and was organizing the operatory.
- A. cleaned the instruments, sterilized the equipment, and was organizing
  - B. cleans the instruments, sterilized the equipment, and organized
  - C. cleaned the instruments, sterilized the equipment, and organized
  - D. cleaned the instruments, sterilizes the equipment, and organized
15. Dr. Williams told Dr. Chen that she needed to review the treatment plan before the consultation.
- A. Dr. Williams told Dr. Chen that she needed
  - B. Dr. Williams told Dr. Chen that Dr. Williams needed
  - C. Dr. Williams told Dr. Chen that Chen needed
  - D. Dr. Williams told Dr. Chen she needed
16. The new policy effects all staff members and will be enforced starting immediately.
- A. effects all staff members and will be
  - B. effects all staff members and will have been
  - C. affects all staff members and will be
  - D. affects all staff members and will have been
17. Maintaining proper hygiene is crucial in dental practice, all team members must follow safety protocols.
- A. practice, all team members must follow

- B. practice. All team members must follow
  - C. practice; all team members must follow
  - D. practice all team members must follow
18. The dentist which graduated from the dental school last spring has opened a new practice downtown.
- A. which graduated from the dental school
  - B. who graduated from the dental school
  - C. which had graduated from the dental school
  - D. whom graduated from the dental school
19. Having carefully examined all the x-rays, a treatment recommendation was made by the dentist.
- A. Having carefully examined all the x-rays, the dentist made a treatment recommendation
  - B. Having carefully examined all the x-rays, a treatment recommendation was made by the dentist
  - C. A treatment recommendation was made by the dentist, having carefully examined all the x-rays
  - D. The dentist made a treatment recommendation, having carefully examined all the x-rays
20. The patient should of scheduled a follow-up appointment before leaving the office yesterday.
- A. should of scheduled
  - B. should of schedule
  - C. should had scheduled
  - D. should have scheduled
21. The treatment options include a crown, filling, or extracting the tooth entirely.
- A. a crown, filling, or extracting
  - B. a crown, a filling, or extracting
  - C. a crown, a filling, or extraction
  - D. crowning, filling, or extracting
22. Dental implants are an effective solution, they provide permanent replacement for missing teeth.
- A. solution, they provide
  - B. solution; they provide
  - C. solution they provide
  - D. solution; and they provide
23. Among the three treatment options available, the surgical procedure is the more expensive choice.
- A. the more expensive choice
  - B. the more expensively choice
  - C. the most expensively choice
  - D. the most expensive choice

24. The dental office is located at 456 Main street in the historic downtown area.
- A. Main Street in the historic downtown area
  - B. main street in the historic downtown area
  - C. Main street in the historic Downtown area
  - D. main Street in the Historic downtown area
25. After the extraction was completed the oral surgeon provided detailed post-operative care instructions.
- A. After the extraction was completed the oral surgeon provided
  - B. After the extraction, was completed the oral surgeon provided
  - C. After the extraction was completed, the oral surgeon provided
  - D. After the extraction was completed; the oral surgeon provided
26. The dentist asked the patient when can she return for her next cleaning appointment.
- A. when can she return
  - B. when she could return
  - C. when could she return
  - D. when she can return
27. The hygienist and her assistant both agrees that preventive care is essential for patients.
- A. both agree that
  - B. both agrees, that
  - C. both agrees that
  - D. both agree, that
28. Regular checkups, proper brushing, and flossing daily is necessary for good oral health.
- A. is necessary
  - B. is necessarily
  - C. are necessary
  - D. are necessarily
29. The new dental chair will improve patient comfort, it will also increase treatment efficiency.
- A. comfort, it will also increase
  - B. comfort, and it will also increase
  - C. comfort it will also increase
  - D. comfort; because it will also increase
30. The practice serves patients with various needs including routine care, cosmetic procedures, and emergency treatment.
- A. needs, including routine care, cosmetic procedures, and emergency treatment
  - B. needs including, routine care, cosmetic procedures, and emergency treatment

- C. needs including routine care cosmetic procedures and emergency treatment
  - D. needs including routine care, cosmetic procedures, and emergency treatment
31. Dentists, hygienists, and assistants all plays important roles in providing quality dental care.
- A. all plays important roles
  - B. all play important role
  - C. all plays important role
  - D. all play important roles
32. The dentist asked the patient to lay down in the chair and remain still during the procedure.
- A. to lay down in the chair
  - B. to lie down in the chair
  - C. to lie down on the chair
  - D. to lay down on the chair
33. Advanced dental technology has improved significantly, allowing dentists to provide superior care to patients.
- A. significantly, allowing dentists to provide
  - B. significantly; allowing dentists to provide
  - C. significantly allowing dentists to provide
  - D. significantly. Allowing dentists to provide
34. Fluoride treatments strengthen tooth enamel, they help prevent cavities in children and adults.
- A. enamel, they help prevent
  - B. enamel. They help prevent
  - C. enamel they help prevent
  - D. enamel; and they help prevent
35. The dental hygiene curriculum requires students to complete practical training before they graduate.
- A. requires students to complete practical training, before they graduate
  - B. require students to complete practical training before they graduate
  - C. requires students to complete practical training before, they graduate
  - D. requires students to complete practical training before they graduate
36. The patient's insurance covers preventive services such as cleanings and examinations but not elective procedures.
- A. services, such as cleanings and examinations but
  - B. services, such as cleanings and examinations, but
  - C. services such as, cleanings and examinations, but
  - D. services such as cleanings and examinations, but

37. The clinic's extended hours are more convenient for working patients than the old schedule.
- A. more convenient for working patients than the old schedule
  - B. more conveniently for working patients than the old schedule
  - C. most convenient for working patients than the old schedule
  - D. more convenient for working patients than the old schedule was
38. The dentist explained that maintaining oral health requires brushing regularly, flossing daily, and to visit for checkups.
- A. brushing regularly, flossing daily, and visiting for checkups
  - B. brushing regularly, flossing daily, and to visit for checkups
  - C. to brush regularly, flossing daily, and visiting for checkups
  - D. to brush regularly, to floss daily, and to visit for checkups
39. The patient complained that her tooth has been hurting for two weeks before she called the office.
- A. has been hurting
  - B. has hurt
  - C. had been hurting
  - D. will have been hurting
40. Orthodontic treatment can correct alignment issues, it also improves bite function and aesthetics.
- A. issues, and it also improves
  - B. issues it also improves
  - C. issues, it also improves
  - D. issues; because it also improves

## Quantitative Reasoning

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**Time:** 45 minutes

**Questions:** 1-40

**Directions:** Solve each problem and select the best answer from the choices provided. You may use scratch paper for calculations.

1. Solve for  $x$ :  $3x + 8 = 23$
- A. 5
  - B. 15
  - C. 31
  - D. 8

2. A dental practice increased patient visits from 200 per month to 250 per month. What is the percent increase?
- A. 20%
  - B. 50%
  - C. 200%
  - D. 25%
3. If  $6y - 4 = 3y + 8$ , what is the value of  $y$ ?
- A. 12
  - B. 4
  - C. 2
  - D. 6
4. A hygienist earns \$45 per hour and works 8 hours per day for 5 days per week. How much does she earn per week?
- A. \$360
  - B. \$225
  - C. \$1,800
  - D. \$2,250
5. What is 15% of 240?
- A. 15
  - B. 24
  - C. 40
  - D. 36
6. If  $a = 4$  and  $b = -3$ , what is the value of  $2a^2 - 5b$ ?
- A. 47
  - B. 17
  - C. 62
  - D. 32
7. A medication dosage is 0.8 mg per kilogram of body weight. How many milligrams should be given to a patient weighing 65 kilograms?
- A. 50 mg
  - B. 52 mg
  - C. 65 mg
  - D. 81.25 mg
8. Solve:  $4(x + 2) = 3x + 14$

- A. 2
- B. 4
- C. 8
- D. 6

9. A box contains 9 red balls, 6 blue balls, and 5 green balls. If one ball is selected at random, what is the probability it is blue?

- A.  $\frac{3}{10}$
- B.  $\frac{1}{3}$
- C.  $\frac{9}{20}$
- D.  $\frac{1}{4}$

10. Convert 3.8 kilometers to meters.

- A. 38 meters
- B. 380 meters
- C. 38,000 meters
- D. 3,800 meters

11. If  $x = 7$ , what is the value of  $3x^2 + 5x$ ?

- A. 180
- B. 196
- C. 182
- D. 175

12. Clinic expenses decreased from \$3,000 to \$2,400. What is the percent decrease?

- A. 20%
- B. 25%
- C. 600%
- D. 30%

13. Simplify:  $6(2x - 4) - 5(x + 1)$

- A.  $12x - 29$
- B.  $7x - 29$
- C.  $x - 19$
- D.  $11x - 29$

14. The ratio of dentists to patients is 1:30. If there are 120 patients, how many dentists are there?

- A. 3
- B. 30
- C. 90

D. 4

15. Solve for x:  $x/5 + 3 = 9$

A. 12

B. 60

C. 30

D. 45

16. A patient's heart rate increased from 70 bpm to 84 bpm. What is the amount of increase?

A. 10 bpm

B. 14 bpm

C. 20 bpm

D. 84 bpm

17. If  $5x - 2y = 25$  and  $x = 7$ , what is the value of y?

A. 5

B. 10

C. 15

D. 3

18. A clinic offers a 20% discount on whitening services. If the original price is \$500, what is the discounted price?

A. \$480

B. \$450

C. \$400

D. \$100

19. Solve for x:  $8x - 5 = 5x + 16$

A. 3

B. 11

C. 21

D. 7

20. What is the mean of the data set: 12, 18, 24, 30, 36?

A. 24

B. 18

C. 30

D. 20

21. A solution contains 500 mL of liquid. If 28% is active ingredient, how many milliliters of active ingredient does it contain?
- A. 28 mL
  - B. 100 mL
  - C. 150 mL
  - D. 140 mL
22. If  $x^2 = 100$ , what are the possible values of  $x$ ?
- A. 10 only
  - B. 10 and -10
  - C. 100 only
  - D. -10 only
23. A dentist sees 15 patients per day for 4 days per week for 3 weeks. How many patients in total?
- A. 180
  - B. 60
  - C. 45
  - D. 240
24. Simplify:  $(3x^3)(5x^5)$
- A.  $8x^8$
  - B.  $15x^{15}$
  - C.  $15x^8$
  - D.  $8x^{15}$
25. What is  $7/8$  expressed as a percent?
- A. 78%
  - B. 0.875%
  - C. 78.5%
  - D. 87.5%
26. A patient takes medication every 8 hours. How many doses in 4 days?
- A. 8
  - B. 12
  - C. 16
  - D. 32
27. If the perimeter of a rectangle is 60 cm and the width is 12 cm, what is the length?
- A. 24 cm
  - B. 30 cm

- C. 18 cm
- D. 36 cm

28. Solve:  $7x - 10 = 6x - 2$

- A. 12
- B. 8
- C. -8
- D. 2

29. Supplies cost \$900 before tax. With 8% sales tax, what is the total cost?

- A. \$908
- B. \$900
- C. \$950
- D. \$972

30. What is the median of: 8, 12, 16, 20, 24?

- A. 16
- B. 12
- C. 20
- D. 14

31. If  $4x - 6 = 14$ , what is the value of  $3x$ ?

- A. 20
- B. 5
- C. 15
- D. 30

32. A bottle holds 1.8 liters. How many milliliters is this?

- A. 18 mL
- B. 1,800 mL
- C. 180 mL
- D. 18,000 mL

33. Evaluate:  $(-3)^2 + 4(-5)$

- A. -11
- B. 29
- C. -29
- D. 11

34. A clinic has 25 employees. If 32% are dental hygienists, how many hygienists work there?

- A. 6
- B. 7
- C. 10
- D. 8

35. Solve for  $x$ :  $x/9 = 7$

- A. 16
- B. 7
- C. 63
- D. 2

36. What is 0.625 expressed as a fraction in simplest form?

- A.  $625/1000$
- B.  $5/8$
- C.  $25/40$
- D.  $6/10$

37. If  $x - y = 8$  and  $x + y = 22$ , what is the value of  $x$ ?

- A. 7
- B. 14
- C. 8
- D. 15

38. A patient's temperature is  $37^{\circ}\text{C}$ . Using  $F = (9/5)C + 32$ , what is the temperature in Fahrenheit?

- A.  $98.6^{\circ}\text{F}$
- B.  $100^{\circ}\text{F}$
- C.  $96.8^{\circ}\text{F}$
- D.  $99.6^{\circ}\text{F}$

39. What is the range of: 14, 20, 26, 32, 38?

- A. 20
- B. 14
- C. 24
- D. 38

40. A clinic treated 160 patients in March and 240 patients in April. What is the ratio of March to April patients in simplest form?

- A. 160:240
- B. 2:3
- C. 16:24

## Perceptual Ability

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**Time:** 45 minutes

**Questions:** 1-60

**Directions:** This section tests your ability to visualize and mentally manipulate objects in space. Carefully examine each question and select the best answer.

### ANGLE DISCRIMINATION (Questions 1-15)

**Directions:** For each question, rank the angles from smallest to largest or identify relationships between angles.

- Four angles are shown. Angle 1 measures  $52^\circ$ , Angle 2 measures  $110^\circ$ , Angle 3 measures  $73^\circ$ , and Angle 4 measures  $135^\circ$ . Which angle is closest to  $75^\circ$ ?
  - Angle 1
  - Angle 2
  - Angle 3
  - Angle 4
- Three angles are presented. Angle A =  $48^\circ$ , Angle B =  $122^\circ$ , Angle C =  $85^\circ$ . Which angle is obtuse and greater than  $100^\circ$ ?
  - Angle A
  - Angle C
  - All angles
  - Angle B
- Five angles measure  $24^\circ$ ,  $86^\circ$ ,  $55^\circ$ ,  $148^\circ$ , and  $91^\circ$ . Which is the largest angle?
  - $24^\circ$
  - $86^\circ$
  - $91^\circ$
  - $148^\circ$
- Four angles are displayed:  $38^\circ$ ,  $102^\circ$ ,  $64^\circ$ , and  $127^\circ$ . Which is the smallest angle?
  - $38^\circ$
  - $64^\circ$
  - $102^\circ$
  - $127^\circ$

5. Three angles measure  $76^\circ$ ,  $118^\circ$ , and  $42^\circ$ . What is the correct order from largest to smallest?
- A.  $42^\circ$ ,  $76^\circ$ ,  $118^\circ$
  - B.  $76^\circ$ ,  $118^\circ$ ,  $42^\circ$
  - C.  $118^\circ$ ,  $76^\circ$ ,  $42^\circ$
  - D.  $118^\circ$ ,  $42^\circ$ ,  $76^\circ$
6. Five angles are shown:  $29^\circ$ ,  $95^\circ$ ,  $68^\circ$ ,  $143^\circ$ , and  $52^\circ$ . Which angle is acute and closest to  $70^\circ$ ?
- A.  $29^\circ$
  - B.  $68^\circ$
  - C.  $95^\circ$
  - D.  $143^\circ$
7. Four angles measure  $17^\circ$ ,  $93^\circ$ ,  $46^\circ$ , and  $158^\circ$ . Which is the second smallest angle?
- A.  $46^\circ$
  - B.  $17^\circ$
  - C.  $93^\circ$
  - D.  $158^\circ$
8. Three angles are presented:  $31^\circ$ ,  $87^\circ$ , and  $151^\circ$ . Which angle is obtuse and greater than  $120^\circ$ ?
- A.  $31^\circ$
  - B.  $87^\circ$
  - C. All three
  - D.  $151^\circ$
9. Five angles measure  $39^\circ$ ,  $101^\circ$ ,  $65^\circ$ ,  $133^\circ$ , and  $47^\circ$ . Which angle measures exactly  $65^\circ$ ?
- A.  $39^\circ$
  - B.  $47^\circ$
  - C.  $65^\circ$
  - D.  $101^\circ$
10. Four angles are shown:  $62^\circ$ ,  $124^\circ$ ,  $28^\circ$ , and  $89^\circ$ . Which is the third smallest angle?
- A.  $89^\circ$
  - B.  $28^\circ$
  - C.  $62^\circ$
  - D.  $124^\circ$
11. Three acute angles measure  $37^\circ$ ,  $69^\circ$ , and  $58^\circ$ . Which is closest to  $60^\circ$ ?
- A.  $37^\circ$
  - B.  $58^\circ$

- C.  $69^\circ$
- D. All equal

12. Five angles measure  $112^\circ$ ,  $84^\circ$ ,  $49^\circ$ ,  $161^\circ$ , and  $73^\circ$ . Which is the largest?

- A.  $49^\circ$
- B.  $84^\circ$
- C.  $112^\circ$
- D.  $161^\circ$

13. Four angles are displayed:  $21^\circ$ ,  $98^\circ$ ,  $71^\circ$ , and  $139^\circ$ . Which angle is closest to  $20^\circ$ ?

- A.  $21^\circ$
- B.  $71^\circ$
- C.  $98^\circ$
- D.  $139^\circ$

14. Three angles measure  $114^\circ$ ,  $43^\circ$ , and  $82^\circ$ . Which is obtuse and less than  $120^\circ$ ?

- A.  $43^\circ$
- B.  $82^\circ$
- C.  $114^\circ$
- D. None

15. Five angles are shown:  $34^\circ$ ,  $103^\circ$ ,  $61^\circ$ ,  $147^\circ$ , and  $79^\circ$ . Which lists the three smallest in order?

- A.  $147^\circ$ ,  $103^\circ$ ,  $79^\circ$
- B.  $34^\circ$ ,  $61^\circ$ ,  $79^\circ$
- C.  $34^\circ$ ,  $147^\circ$ ,  $103^\circ$
- D.  $103^\circ$ ,  $79^\circ$ ,  $61^\circ$

### APERTURES (Questions 16-30)

**Directions:** A three-dimensional object is shown along with aperture openings. Determine which aperture the object could pass through if properly oriented.

16. A rectangular prism measures  $5\text{ cm} \times 9\text{ cm} \times 11\text{ cm}$ . Which aperture allows the largest face to pass through?

- A. A circle 9 cm diameter
- B. A square  $9\text{ cm} \times 9\text{ cm}$
- C. A triangle 11 cm base
- D. A rectangle  $9\text{ cm} \times 11\text{ cm}$

17. A cylinder with diameter 9 cm and height 15 cm is shown. When entering circular end first, what aperture is needed?

- A. A rectangle  $9\text{ cm} \times 15\text{ cm}$
  - B. A square  $15\text{ cm} \times 15\text{ cm}$
  - C. A circle with at least  $9\text{ cm}$  diameter
  - D. A triangle  $9\text{ cm}$  sides
18. A pyramid with square base  $9\text{ cm} \times 9\text{ cm}$  is presented. Which aperture accommodates the base?
- A. A square  $9\text{ cm} \times 9\text{ cm}$  or larger
  - B. A circle  $9\text{ cm}$  diameter
  - C. A rectangle  $7\text{ cm} \times 9\text{ cm}$
  - D. A triangle  $9\text{ cm}$  sides
19. A cube measuring  $8\text{ cm}$  per side is shown. What is the smallest square aperture needed?
- A.  $6\text{ cm} \times 6\text{ cm}$
  - B.  $10\text{ cm} \times 10\text{ cm}$
  - C.  $12\text{ cm} \times 12\text{ cm}$
  - D.  $8\text{ cm} \times 8\text{ cm}$
20. A triangular prism has base  $7\text{ cm}$  per side and length  $13\text{ cm}$ . Which aperture allows triangle-first passage?
- A. A square  $7\text{ cm} \times 7\text{ cm}$
  - B. An equilateral triangle  $7\text{ cm}$  sides
  - C. A circle  $13\text{ cm}$  diameter
  - D. A rectangle  $7\text{ cm} \times 13\text{ cm}$
21. An L-shaped object measures  $7\text{ cm}$  wide and  $10\text{ cm}$  tall overall. Which aperture accommodates it?
- A. A square  $7\text{ cm} \times 7\text{ cm}$
  - B. A circle  $8\text{ cm}$  diameter
  - C. A rectangle  $7\text{ cm} \times 10\text{ cm}$  or larger
  - D. A triangle  $10\text{ cm}$  base
22. A sphere with diameter  $12\text{ cm}$  is presented. What aperture is required?
- A. A circle with at least  $12\text{ cm}$  diameter
  - B. A square  $10\text{ cm} \times 10\text{ cm}$
  - C. A rectangle  $11\text{ cm} \times 13\text{ cm}$
  - D. A triangle  $12\text{ cm}$  sides
23. A rectangular block  $7\text{ cm} \times 9\text{ cm} \times 5\text{ cm}$  is shown. When oriented with  $7\text{ cm} \times 9\text{ cm}$  face forward, what aperture?
- A. A rectangle  $7\text{ cm} \times 9\text{ cm}$
  - B. A circle  $9\text{ cm}$  diameter

- C. A square  $9\text{ cm} \times 9\text{ cm}$
  - D. A rectangle  $5\text{ cm} \times 7\text{ cm}$
24. A hexagonal prism with  $7\text{ cm}$  wide base and  $14\text{ cm}$  length is displayed. Which aperture for hexagon-first entry?
- A. A circle  $6\text{ cm}$  diameter
  - B. A hexagon approximately  $7\text{ cm}$  across
  - C. A rectangle  $7\text{ cm} \times 14\text{ cm}$
  - D. A square  $7\text{ cm} \times 7\text{ cm}$
25. A T-shaped object measures  $11\text{ cm}$  wide and  $13\text{ cm}$  tall. What minimum aperture?
- A. A rectangle  $9\text{ cm} \times 11\text{ cm}$
  - B. A square  $11\text{ cm} \times 11\text{ cm}$
  - C. A circle  $13\text{ cm}$  diameter
  - D. A rectangle  $11\text{ cm} \times 13\text{ cm}$
26. An ellipsoid measures  $8\text{ cm} \times 11\text{ cm} \times 6\text{ cm}$ . When oriented with  $8\text{ cm} \times 11\text{ cm}$  face forward, which aperture?
- A. An ellipse or rectangle  $8\text{ cm} \times 11\text{ cm}$
  - B. A circle  $11\text{ cm}$  diameter
  - C. A square  $11\text{ cm} \times 11\text{ cm}$
  - D. A rectangle  $6\text{ cm} \times 8\text{ cm}$
27. A cross-shaped object has arms extending  $9\text{ cm}$  in each direction. What aperture for face-first passage?
- A. A square  $7\text{ cm} \times 7\text{ cm}$
  - B. A circle  $9\text{ cm}$  diameter
  - C. A square  $9\text{ cm} \times 9\text{ cm}$  or larger
  - D. A triangle  $9\text{ cm}$  sides
28. A cone with base diameter  $11\text{ cm}$  is shown. Which aperture fits the base?
- A. A square  $9\text{ cm} \times 9\text{ cm}$
  - B. A rectangle  $8\text{ cm} \times 11\text{ cm}$
  - C. A triangle  $11\text{ cm}$  sides
  - D. A circle with at least  $11\text{ cm}$  diameter
29. A rectangular block with rounded ends measures  $7\text{ cm} \times 9\text{ cm} \times 13\text{ cm}$  with  $2\text{ cm}$  radius curves. Which aperture for curved end?
- A. A rectangle  $6\text{ cm} \times 8\text{ cm}$
  - B. A rounded rectangle approximately  $7\text{ cm} \times 9\text{ cm}$
  - C. A circle  $9\text{ cm}$  diameter

D. A square  $9\text{ cm} \times 9\text{ cm}$

30. An irregular object with dimensions  $8\text{ cm} \times 10\text{ cm} \times 6\text{ cm}$  is shown. When oriented with smallest face forward, which aperture?
- A. A rectangle  $8\text{ cm} \times 6\text{ cm}$
  - B. A square  $8\text{ cm} \times 8\text{ cm}$
  - C. A circle  $8\text{ cm}$  diameter
  - D. A rectangle  $10\text{ cm} \times 6\text{ cm}$

### **ORTHOGRAPHIC PROJECTIONS (Questions 31-45)**

**Directions:** Three views (top, front, and end) of an object are shown. Select the answer that correctly represents the object or its views.

31. The top view shows a circle, front view shows a rectangle, end view shows a circle. What is the object?
- A. A sphere
  - B. A cone
  - C. A cylinder
  - D. A cube
32. Top view shows a square, front view shows a rectangle, end view shows a rectangle. What is the object?
- A. A cube
  - B. A cylinder
  - C. A cone
  - D. A rectangular prism
33. A stepped object has two levels. Which view shows both levels most clearly?
- A. Top view only
  - B. Front view only
  - C. End view only
  - D. All three equally
34. Top view is triangle, front view is rectangle, end view is triangle. What is the object?
- A. A pyramid
  - B. A cone
  - C. A triangular prism
  - D. A rectangular prism
35. Top view shows hexagon, front view shows rectangle, end view shows hexagon. What is the object?
- A. A hexagonal prism

- B. A cube
  - C. Six rectangular prisms
  - D. A hexagonal pyramid
36. Top view shows square with smaller square inside, front view shows nested rectangles, end view shows nested rectangles. What does this represent?
- A. A solid cube
  - B. A pyramid in a box
  - C. Two cubes
  - D. A hollow rectangular frame
37. Top view shows cross, front view shows rectangle, end view shows cross. What is the object?
- A. A cross-shaped pyramid
  - B. A cross-shaped prism
  - C. Four rectangular prisms
  - D. A plus sign
38. Top view shows circle with line, front view shows rectangle with line, end view shows circle with line. What is the object?
- A. A cylinder with slot or hole
  - B. A sphere with rod
  - C. Two cylinders
  - D. A disc
39. Top view shows T-shape, front view shows rectangle, end view shows T-shape. What is the object?
- A. A T-shaped pyramid
  - B. Two rectangular prisms
  - C. A T-shaped prism
  - D. An L-shaped beam
40. Top view shows four squares in row, front view shows long rectangle, end view shows square. What is the object?
- A. One long rectangular prism
  - B. A pyramid
  - C. An L-structure
  - D. Four cubes in a row
41. Top view shows octagon, front view shows rectangle, end view shows octagon. What is the object?
- A. An octagonal pyramid
  - B. An octagonal prism

- C. Eight rectangular prisms
  - D. A cube
42. Top view shows oval, front view shows rectangle, end view shows oval. What is the object?
- A. A sphere
  - B. A cube
  - C. An elliptical cylinder
  - D. A cone
43. Top view shows pentagon, front view shows rectangle, end view shows pentagon. What is the object?
- A. A pentagonal prism
  - B. A pentagonal pyramid
  - C. Five rectangular prisms
  - D. A cube
44. Top view shows two circles, front view shows two rectangles, end view shows circle. What is the object?
- A. Two spheres
  - B. A dumbbell
  - C. Two cones
  - D. Two cylinders stacked
45. Top view shows L-shape, front view shows rectangle, end view shows L-shape. What is the object?
- A. An L-shaped pyramid
  - B. An L-shaped prism
  - C. Two separate cubes
  - D. A T-shaped beam

**CUBE COUNTING (Questions 46-60)**

**Directions:** A three-dimensional structure built from cubes is shown. Answer questions about cubes or painted surfaces.

46. A structure contains 4 layers arranged  $2 \times 2 \times 4$ . How many total cubes?
- A. 16
  - B. 8
  - C. 12
  - D. 32
47. In a  $4 \times 4 \times 4$  cube, how many cubes are on the surface (have at least one face exposed)?
- A. 64

- B. 56
- C. 8
- D. 60

48. A  $2 \times 3 \times 5$  structure is built. How many total cubes?

- A. 30
- B. 10
- C. 15
- D. 35

49. In a  $6 \times 6 \times 6$  cube where all faces are painted, how many cubes have exactly three painted faces?

- A. 24
- B. 64
- C. 12
- D. 8

50. A structure has 5 layers with 8 cubes per layer arranged  $2 \times 4$ . How many total cubes?

- A. 20
- B. 40
- C. 32
- D. 48

51. In a  $2 \times 3 \times 4$  structure, how many cubes are on corners?

- A. 8
- B. 6
- C. 12
- D. 24

52. A structure is 6 cubes high, 5 cubes wide, 4 cubes deep. How many total cubes?

- A. 60
- B. 80
- C. 120
- D. 15

53. In an L-shaped structure with 8 cubes on one arm and 7 on the other (sharing 1 corner), how many total cubes?

- A. 15
- B. 8
- C. 7
- D. 14

54. A  $6 \times 6 \times 1$  flat structure has all faces painted. How many cubes have exactly two painted faces?  
A. 4  
B. 20  
C. 36  
D. 16
55. A staircase has 3 cubes on first step, 5 on second, 7 on third. How many total cubes?  
A. 7  
B. 10  
C. 15  
D. 21
56. A  $5 \times 6 \times 7$  structure is built. How many cubes are on corners?  
A. 6  
B. 12  
C. 18  
D. 8
57. In an  $8 \times 1 \times 1$  structure (8 cubes in row), if all surfaces painted, how many cubes have exactly four painted faces?  
A. 6  
B. 2  
C. 8  
D. 4
58. A pyramid has layers: bottom  $5 \times 5 = 25$  cubes, next  $3 \times 3 = 9$  cubes, top 1 cube. How many total?  
A. 25  
B. 30  
C. 35  
D. 40
59. In a  $5 \times 5 \times 5$  cube with one corner removed, how many cubes remain?  
A. 125  
B. 124  
C. 120  
D. 123
60. A plus-shaped structure uses 6 cubes for vertical arm and 6 for horizontal (sharing 1 center). How many total?

- A. 12
- B. 11
- C. 10
- D. 13

## Biology

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**Time:** 30 minutes

**Questions:** 1-30

**Directions:** Select the best answer for each question based on your knowledge of biological concepts.

1. What is the primary function of ribosomes in a cell?
  - A. Protein synthesis
  - B. DNA storage
  - C. Energy production
  - D. Lipid digestion
  
2. Which organelle is responsible for breaking down cellular waste and debris?
  - A. Ribosome
  - B. Mitochondrion
  - C. Golgi apparatus
  - D. Lysosome
  
3. During which phase of mitosis do the sister chromatids move to opposite poles of the cell?
  - A. Prophase
  - B. Metaphase
  - C. Anaphase
  - D. Telophase
  
4. What type of transport requires energy to move substances across a cell membrane?
  - A. Diffusion
  - B. Active transport
  - C. Osmosis
  - D. Facilitated diffusion
  
5. What is the function of transfer RNA (tRNA) during translation?
  - A. Stores genetic information
  - B. Copies DNA sequences

- C. Forms ribosomal structure
  - D. Brings amino acids to the ribosome
6. How many chromosomes does a human gamete contain?
- A. 23
  - B. 46
  - C. 92
  - D. 12
7. In DNA, cytosine pairs with which nitrogenous base?
- A. Adenine
  - B. Thymine
  - C. Guanine
  - D. Uracil
8. Which inheritance pattern results in an intermediate phenotype in heterozygotes?
- A. Complete dominance
  - B. Incomplete dominance
  - C. Codominance
  - D. Sex-linked inheritance
9. During which phase of meiosis does crossing over occur?
- A. Prophase I
  - B. Metaphase I
  - C. Anaphase II
  - D. Telophase I
10. Which blood component transports oxygen throughout the body?
- A. Platelets
  - B. Plasma
  - C. White blood cells
  - D. Red blood cells
11. What is the primary function of the large intestine?
- A. Nutrient absorption
  - B. Protein digestion
  - C. Water absorption and feces formation
  - D. Bile production
12. Which type of tissue connects bones to other bones?

- A. Tendons
  - B. Ligaments
  - C. Cartilage
  - D. Epithelial tissue
13. In a dihybrid cross between two heterozygous parents ( $AaBb \times AaBb$ ), what is the phenotypic ratio?
- A. 3:1
  - B. 1:2:1
  - C. 1:1:1:1
  - D. 9:3:3:1
14. Which process reduces chromosome number from diploid to haploid?
- A. Meiosis
  - B. Mitosis
  - C. Binary fission
  - D. Cytokinesis
15. What molecule carries genetic information from the nucleus to the cytoplasm?
- A. DNA
  - B. mRNA
  - C. tRNA
  - D. Ribosome
16. Which component is responsible for blood clotting?
- A. Red blood cells
  - B. White blood cells
  - C. Platelets
  - D. Plasma
17. What type of muscle tissue is found in the walls of hollow organs?
- A. Skeletal muscle
  - B. Cardiac muscle
  - C. Voluntary muscle
  - D. Smooth muscle
18. What is the end product of translation?
- A. DNA
  - B. mRNA
  - C. tRNA
  - D. Protein

19. Which organelle contains the cell's genetic material?
- A. Ribosome
  - B. Nucleus
  - C. Mitochondrion
  - D. Golgi apparatus
20. What is the function of osteoclasts in bone tissue?
- A. Build new bone
  - B. Store minerals
  - C. Break down bone
  - D. Produce blood cells
21. Viruses differ from bacteria because viruses:
- A. Cannot reproduce independently
  - B. Have cell walls
  - C. Are larger than bacteria
  - D. Contain multiple chromosomes
22. What byproduct is produced during cellular respiration besides ATP?
- A. Oxygen
  - B. Glucose
  - C. Nitrogen
  - D. Carbon dioxide and water
23. Which system regulates body functions through chemical messengers?
- A. Nervous system
  - B. Endocrine system
  - C. Digestive system
  - D. Respiratory system
24. If a DNA strand is TACG, what is the complementary DNA strand?
- A. ATGC
  - B. UACG
  - C. GCTA
  - D. CGTA
25. Which blood vessel carries oxygenated blood away from the heart?
- A. Vein
  - B. Artery

- C. Capillary
- D. Venule

26. What is the primary function of the smooth endoplasmic reticulum?

- A. Protein synthesis
- B. DNA replication
- C. Lipid synthesis
- D. Energy production

27. What term describes the genetic makeup of an organism?

- A. Genotype
- B. Phenotype
- C. Allele
- D. Trait

28. During which phase of interphase does DNA replication occur?

- A. G1 phase
- B. G2 phase
- C. M phase
- D. S phase

29. What are the main components of the nervous system?

- A. Heart and blood vessels
- B. Bones and muscles
- C. Brain, spinal cord, and nerves
- D. Lungs and airways

30. Prokaryotic cells differ from eukaryotic cells because prokaryotic cells:

- A. Are always larger
- B. Lack a membrane-bound nucleus
- C. Have mitochondria
- D. Cannot perform cellular respiration

## General Chemistry

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**Time:** 30 minutes

**Questions:** 1-30

**Directions:** Select the best answer for each question. A periodic table is available for reference during this section.

1. What is defined as the number of protons in an atom's nucleus?
  - A. Atomic number
  - B. Mass number
  - C. Atomic mass
  - D. Electron number
2. Which subatomic particle is located outside the nucleus?
  - A. Proton
  - B. Neutron
  - C. Nucleon
  - D. Electron
3. What type of bond forms when atoms share electrons?
  - A. Ionic bond
  - B. Covalent bond
  - C. Metallic bond
  - D. Hydrogen bond
4. How many electrons can the third energy level hold?
  - A. 2
  - B. 8
  - C. 18
  - D. 32
5. What is produced when a hydrocarbon undergoes complete combustion?
  - A. Carbon dioxide and water
  - B. Carbon monoxide only
  - C. Oxygen and hydrogen
  - D. Carbon and oxygen
6. What is the molar mass of carbon dioxide (CO<sub>2</sub>)? (C = 12 g/mol, O = 16 g/mol)
  - A. 28 g/mol
  - B. 32 g/mol
  - C. 40 g/mol
  - D. 44 g/mol
7. Which pH value indicates a basic solution?

- A. 3
  - B. 7
  - C. 11
  - D. 6
8. In the equation  $2\text{Na} + \text{Cl}_2 \rightarrow 2\text{NaCl}$ , what is the coefficient of Na?
- A. 1
  - B. 2
  - C. 3
  - D. 4
9. Atoms of the same element with different mass numbers are called:
- A. Isotopes
  - B. Ions
  - C. Molecules
  - D. Compounds
10. According to Boyle's Law, if volume decreases at constant temperature, what happens to pressure?
- A. Pressure stays constant
  - B. Pressure becomes zero
  - C. Pressure decreases
  - D. Pressure increases
11. What happens when electrons are shared between two atoms?
- A. An ionic bond forms
  - B. A metallic bond forms
  - C. A covalent bond forms
  - D. No bond forms
12. How many moles are in 72 grams of water ( $\text{H}_2\text{O}$ )? (Molar mass = 18 g/mol)
- A. 18 moles
  - B. 4 moles
  - C. 72 moles
  - D. 90 moles
13. What unit measures the amount of substance in chemistry?
- A. Grams
  - B. Liters
  - C. Atoms
  - D. Moles

14. Which characteristic describes bases?
- A. Taste bitter and feel slippery
  - B. Taste sour
  - C. Have pH less than 7
  - D. Turn litmus paper red
15. Which state of matter has particles that are close together but can move past each other?
- A. Solid
  - B. Gas
  - C. Liquid
  - D. Plasma
16. How do atoms typically achieve stability in covalent bonds?
- A. By losing electrons
  - B. By transferring electrons
  - C. By gaining protons
  - D. By sharing electrons
17. How many total atoms are in  $3\text{H}_2\text{SO}_4$ ?
- A. 7
  - B. 21
  - C. 3
  - D. 10
18. What is the pH of a neutral solution?
- A. 14
  - B. 0
  - C. 7
  - D. 1
19. Which group contains the alkali metals?
- A. Group 1
  - B. Group 2
  - C. Group 17
  - D. Group 18
20. What type of reaction is represented by  $\text{A} + \text{B} \rightarrow \text{AB}$ ?
- A. Synthesis
  - B. Decomposition

- C. Single replacement
- D. Combustion

21. How many times more acidic is pH 3 compared to pH 5?

- A. 2 times
- B. 100 times
- C. 10 times
- D. 50 times

22. What charge does a neutron carry?

- A. Positive
- B. Negative
- C. Neutral (no charge)
- D. Variable

23. How many valence electrons does an element in Group 1 have?

- A. 1
- B. 7
- C. 8
- D. 2

24. What happens to atoms during a chemical reaction according to the Law of Conservation of Mass?

- A. Atoms are created
- B. Atoms are destroyed
- C. Atoms change into different elements
- D. Atoms are rearranged

25. A 6 M solution is diluted from 20 mL to 60 mL. What is the new concentration?

- A. 6 M
- B. 2 M
- C. 3 M
- D. 1 M

26. According to the Arrhenius definition, what do bases produce in water?

- A.  $H^+$  ions
- B.  $Na^+$  ions
- C.  $OH^-$  ions
- D.  $Cl^-$  ions

27. What is Avogadro's number?

- A.  $3.14 \times 10^{23}$
- B.  $1.66 \times 10^{24}$
- C.  $6.022 \times 10^{22}$
- D.  $6.022 \times 10^{23}$

28. According to Charles's Law, what happens to gas volume when temperature increases at constant pressure?
- A. Volume increases
  - B. Volume stays the same
  - C. Volume becomes zero
  - D. Volume decreases
29. A neutral nitrogen atom (atomic number = 7) has how many electrons?
- A. 14
  - B. 6
  - C. 7
  - D. 8
30. What happens to gas pressure when temperature decreases at constant volume?
- A. Pressure increases
  - B. Pressure decreases
  - C. Pressure stays constant
  - D. Pressure becomes infinite

## Answer Explanations - Practice Test 4

### Reading Comprehension

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#### 1. Correct Answer: B (206)

The passage explicitly states in the first paragraph that the skeletal system is "composed of 206 bones in adults." This is a specific factual detail provided about the adult skeletal system.

#### 2. Correct Answer: C (Provide leverage for movement and support body weight)

The passage states that "long bones, such as the femur and humerus, consist of a shaft (diaphysis) and two ends (epiphyses), providing leverage for movement and supporting body weight." This identifies their primary design functions.

#### 3. Correct Answer: D (Compact bone)

The passage explains that "compact bone forms the dense outer layer" and "its microscopic structure features osteons (Haversian systems), cylindrical units composed of concentric layers." Osteons are specifically described as structures within compact bone.

**4. Correct Answer: A (Collagen fibers)**

The passage states that "the organic portion, primarily collagen fibers, provides flexibility and tensile strength." Collagen fibers are explicitly identified as the primary organic component of bone matrix.

**5. Correct Answer: C (Break down bone tissue)**

The passage explains that "osteoclasts are large, multinucleated cells that break down bone tissue through secreting acids and enzymes, creating small cavities on bone surfaces." This is their primary function in bone remodeling.

**6. Correct Answer: B (Bone adapts to the loads placed upon it)**

The passage states that "Wolff's Law states that bone adapts to the loads placed upon it—bones subjected to increased stress become thicker and stronger, while bones that experience reduced loading lose density."

**7. Correct Answer: A (Decreased bone density and increased fracture risk)**

The passage defines osteoporosis as "characterized by decreased bone density and increased fracture risk, commonly affecting postmenopausal women due to declining estrogen levels that accelerate bone resorption."

**8. Correct Answer: B (Mechanical stimulation from tooth roots is eliminated)**

The passage explains that "tooth loss leads to alveolar bone resorption because the mechanical stimulation from tooth roots is eliminated." The absence of this mechanical stimulation causes bone loss.

**9. Correct Answer: C (Break down starch)**

The passage states that saliva contains "the enzyme salivary amylase, which initiates carbohydrate digestion by breaking down starch into smaller polysaccharides and maltose." This is salivary amylase's function.

**10. Correct Answer: A (Stomach contents from refluxing into the esophagus)**

The passage explains that "the lower esophageal sphincter at its base prevents stomach contents from refluxing back into the esophagus." This sphincter acts as a barrier preventing backward flow.

**11. Correct Answer: D (Acid damage to stomach cells)**

The passage states that "the stomach's thick mucus layer protects its own cells from acid damage, but when this protective barrier is compromised, peptic ulcers can develop." The mucus layer shields cells from the highly acidic environment.

**12. Correct Answer: B (Neutralizes acidic chyme)**

The passage explicitly states that "pancreatic juice contains sodium bicarbonate, which neutralizes acidic chyme." This neutralization is necessary to protect the small intestine from stomach acid.

**13. Correct Answer: A (Emulsify fats into smaller droplets)**

The passage states that bile "emulsifies fats, breaking large fat globules into smaller droplets that enzymes can act upon more efficiently." This is bile's primary function.

**14. Correct Answer: D (Fatty acids and fat-soluble vitamins)**

The passage explains that lacteals are lymphatic vessels in villi and that nutrients "enter either blood capillaries (for amino acids, monosaccharides, and water-soluble vitamins) or lacteals (for fatty acids, glycerol, and fat-soluble vitamins)."

**15. Correct Answer: C (Produce vitamins and ferment carbohydrates)**

The passage states that beneficial bacteria in the large intestine "ferment remaining carbohydrates, producing short-chain fatty acids" and "also synthesize certain vitamins, particularly vitamin K and some B vitamins."

**16. Correct Answer: B (Exposing teeth to gastric acid)**

The passage explains that "gastroesophageal reflux exposes teeth to gastric acid, causing dental erosion." The acid exposure is the mechanism by which reflux damages teeth.

**17. Correct Answer: D (Sensory receptors that detect potentially harmful stimuli)**

The passage defines nociceptors as "specialized sensory receptors that detect noxious (potentially harmful) stimuli." They are free nerve endings that respond to damaging or potentially damaging stimulation.

**18. Correct Answer: A (Conduct dull, aching pain more slowly)**

The passage states that "C fibers are unmyelinated and conduct dull, aching, poorly localized pain more slowly." This contrasts with A-delta fibers which transmit sharp pain rapidly.

**19. Correct Answer: A (Enhance nociceptor sensitivity)**

The passage states that "prostaglandins, produced through the cyclooxygenase (COX) pathway, enhance nociceptor sensitivity." They lower the threshold for nociceptor activation.

**20. Correct Answer: C (Inhibiting COX enzymes and reducing prostaglandin production)**

The passage explains that NSAIDs work "by inhibiting COX enzymes, they reduce prostaglandin production and thereby decrease pain and inflammation." This is the mechanism of action.

**21. Correct Answer: D (Pain includes sensory, emotional, and cognitive components)**

The passage states that "the brain does not have a single 'pain center' but rather processes pain through multiple regions" and that "this distributed processing explains why pain is not simply a sensory

experience but includes emotional suffering and can be influenced by attention, expectation, and psychological state."

**22. Correct Answer: C (Non-painful sensory input can reduce pain signals)**

The passage describes the gate control theory as suggesting "that non-painful sensory input can 'close the gate' to pain signals at the spinal cord level, explaining why rubbing an injured area can reduce pain."

**23. Correct Answer: A (Neurons becoming hyperexcitable and amplifying pain signals)**

The passage states that "central sensitization occurs when repeated or prolonged pain input causes neurons in the spinal cord and brain to become hyperexcitable, amplifying pain signals even in the absence of continued nociceptor activation."

**24. Correct Answer: D (Blocking sodium channels in nociceptors and nerves)**

The passage explains that "local anesthetics block sodium channels in nociceptors and peripheral nerves, preventing pain signal generation and transmission." This is how they produce anesthesia.

**25. Correct Answer: B (Bind to surface receptors and use second messengers)**

The passage states that peptide hormones "being water-soluble, they dissolve readily in blood plasma but cannot cross cell membranes. Instead, they bind to receptors on the cell surface, triggering intracellular signaling cascades through second messengers."

**26. Correct Answer: C (Acting as transcription factors that regulate gene expression)**

The passage explains that steroid hormones "bind to intracellular receptors in the cytoplasm or nucleus. These hormone-receptor complexes then act as transcription factors, binding to specific DNA sequences and regulating gene expression."

**27. Correct Answer: A (Steroid hormones in entering cells and regulating genes)**

The passage states that "thyroid hormones behave similarly to steroid hormones despite their different chemical origin—they enter cells and regulate gene expression." This similarity in mechanism distinguishes them from other amine hormones.

**28. Correct Answer: D (Regulate other endocrine glands)**

The passage states that "the anterior pituitary then secretes tropic hormones that regulate other endocrine glands: thyroid-stimulating hormone (TSH) controls the thyroid, adrenocorticotrophic hormone (ACTH) controls the adrenal cortex, and gonadotropins (FSH and LH) control the gonads."

**29. Correct Answer: C (Maintain hormone levels within narrow ranges)**

The passage explains that "negative feedback mechanisms maintain hormone levels within narrow ranges" and describes how rising hormone levels inhibit further release, creating a self-regulating system.

**30. Correct Answer: B (Autoimmune destruction of pancreatic beta cells)**

The passage states that "Type 1 diabetes results from autoimmune destruction of insulin-producing pancreatic beta cells, requiring insulin replacement." This is the underlying cause of Type 1 diabetes.

**31. Correct Answer: D (Promoting bacterial growth and impairing healing)**

The passage explains that "elevated blood glucose promotes bacterial growth, impairs immune function, and compromises wound healing, increasing risks for periodontal disease, infections, and poor healing after dental procedures."

**32. Correct Answer: A (Antidiuretic hormone (ADH))**

The passage states that "the posterior pituitary stores and releases two hormones produced by hypothalamic neurons: antidiuretic hormone (ADH), which regulates water retention, and oxytocin." ADH is specifically identified as regulating water retention.

**33. Correct Answer: C (Variation, heritability, and differential reproductive success)**

The passage states that "natural selection operates through three essential conditions: First, variation must exist within a population. Second, this variation must be heritable. Third, individuals with certain heritable traits must have differential reproductive success."

**34. Correct Answer: B (Sorts existing genetic variation based on reproductive success)**

The passage states that "natural selection acts on existing variation; it does not create new traits but rather sorts existing genetic variation based on reproductive success." This clarifies that selection works on pre-existing variation.

**35. Correct Answer: D (Random changes in allele frequencies)**

The passage defines genetic drift as "random changes in allele frequencies particularly in small populations, can cause evolutionary change independent of natural selection."

**36. Correct Answer: A (Have similar underlying structure but different functions in different species)**

The passage states that "comparative anatomy reveals homologous structures—features with similar underlying structure but different functions in different species, like the bones in human arms, whale flippers, and bat wings, all derived from the same ancestral structures."

**37. Correct Answer: C (DNA and protein sequence similarities reflecting relationships)**

The passage states that "molecular biology provides perhaps the most compelling evidence: DNA and protein similarities reflect evolutionary relationships, with more similar sequences indicating more recent common ancestry."

**38. Correct Answer: D (Resistant bacteria survive antibiotic treatment and reproduce)**

The passage explains that "antibiotic resistance exemplifies evolution in action—when antibiotics kill susceptible bacteria, resistant mutants survive and reproduce, quickly increasing in frequency."

**39. Correct Answer: A (Evolutionary mismatch between our teeth and modern diets high in refined sugars)**

The passage states that "the modern epidemic of dental caries results partly from evolutionary mismatch—our teeth evolved in environments without refined sugars and processed carbohydrates that oral bacteria efficiently ferment into enamel-dissolving acids."

**40. Correct Answer: D (Evolutionary changes in jaw size with softer diets leaving insufficient space for third molars)**

The passage states that "wisdom teeth problems reflect evolutionary changes in jaw size as human diets softened with cooking and agriculture, leaving insufficient space for third molars." This explains the modern problem with wisdom teeth.

## Language Usage

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**1. Correct Answer: D (patients and also confirmed)**

The original sentence contains a comma splice (two independent clauses joined only by a comma). Option D corrects this by removing the comma and creating a compound predicate with "and," making it concise and grammatically correct: "scheduled...and also confirmed."

**2. Correct Answer: C (nor the hygienists were available)**

With "neither...nor" constructions, the verb must agree with the subject closest to it. Since "hygienists" (plural) is nearest to the verb, the verb must be "were" (plural), not "was" (singular). Option C correctly uses the plural verb form.

**3. Correct Answer: B (when he could reschedule)**

In indirect questions embedded within statements, normal word order (subject-verb) is used, not inverted question order (verb-subject). The original uses inverted order "when could he." Option B correctly uses "when he could reschedule."

**4. Correct Answer: A (Between you and me, the new sterilization protocol seems)**

After the preposition "between," pronouns must be in the objective case. "Between" requires "me" (objective case), not "I" (subjective case). Additionally, "protocol" (singular) requires the singular verb "seems."

**5. Correct Answer: D (cleanings, examinations, and root canals)**

The sentence requires parallel structure. The original uses two nouns and then a verb phrase ("will perform root canals"), which is not parallel. Option D maintains parallel structure by using three nouns: "cleanings, examinations, and root canals."

**6. Correct Answer: C (After reviewing the patient's medical history, the dentist decided)**

Introductory dependent clauses should be followed by a comma to separate them from the main clause. The phrase "After reviewing the patient's medical history" is an introductory adverbial clause that requires a comma before the independent clause.

**7. Correct Answer: B (old one, and it also requires)**

The original sentence is a comma splice (two independent clauses joined only by a comma). Option B corrects this by adding the coordinating conjunction "and" after the comma, properly connecting the two independent clauses.

**8. Correct Answer: D (must submit his or her research project)**

"Everyone" is a singular indefinite pronoun and requires a singular pronoun and singular noun. Option D correctly uses "his or her" (singular pronoun) and "project" (singular noun) to agree with "everyone."

**9. Correct Answer: C (recommended that the patient brush her teeth)**

After verbs like "recommended," "suggested," or "required," the subjunctive mood is used, requiring the base form of the verb without "s." The correct construction is "recommended that the patient brush" (not "brushes").

**10. Correct Answer: C (Running late for work, the dentist got a flat tire)**

The original sentence contains a dangling modifier. "Running late for work" must modify a subject that can logically be running late—the dentist, not the car. Option C correctly places "the dentist" as the subject being modified.

**11. Correct Answer: B (has completed his or her infection control)**

The subject "each" is singular and requires a singular verb and pronoun. Option B correctly uses "has" (singular verb) and "his or her" (singular pronoun) to agree with "each."

**12. Correct Answer: A (Friday; however, it is)**

"However" is a conjunctive adverb connecting two independent clauses. When used this way, it requires a semicolon before it and a comma after it. Option A uses the correct punctuation.

**13. Correct Answer: D (Fewer people visited)**

"Less" is used with uncountable nouns, while "fewer" is used with countable nouns. "People" is countable, so "fewer" is correct. Option D properly uses "fewer people."

**14. Correct Answer: C (cleaned the instruments, sterilized the equipment, and organized)**

The original sentence lacks parallel structure. The first two verbs are in simple past tense ("cleaned," "sterilized"), but the third uses past progressive ("was organizing"). Option C maintains parallel structure by using three simple past tense verbs.

**15. Correct Answer: B (Dr. Williams told Dr. Chen that Dr. Williams needed)**

The original sentence has an ambiguous pronoun. "She" could refer to either Dr. Williams or Dr. Chen. Option B eliminates ambiguity by using the proper name "Dr. Williams" instead of the unclear pronoun.

**16. Correct Answer: C (affects all staff members and will be)**

"Affect" is a verb meaning to influence or impact. "Effect" is usually a noun meaning result. The sentence needs the verb "affects" to indicate that the policy influences staff members. Option C uses the correct verb form.

**17. Correct Answer: B (practice. All team members must follow)**

The original sentence is a comma splice (two independent clauses incorrectly joined by only a comma). Option B corrects this by using a period to create two separate sentences, providing the clearest separation.

**18. Correct Answer: B (who graduated from the dental school)**

"Which" is used for things; "who" is used for people. Since "the dentist" is a person, the correct relative pronoun is "who," not "which." Option B makes this correction.

**19. Correct Answer: A (Having carefully examined all the x-rays, the dentist made a treatment recommendation)**

The original sentence contains a dangling modifier. The phrase "Having carefully examined all the x-rays" must modify "the dentist" (who did the examining), not "a treatment recommendation." Option A correctly places "the dentist" immediately after the modifying phrase.

**20. Correct Answer: D (should have scheduled)**

"Should of" is incorrect; the correct phrase is "should have." "Of" is a preposition and cannot function as a helping verb. Option D correctly uses "should have," which contracts to "should've" in speech.

**21. Correct Answer: C (a crown, a filling, or extraction)**

The original sentence lacks parallel structure. "A crown" and "extracting" are not grammatically parallel (article + noun vs. gerund). Option C maintains parallel structure by using three noun forms: "a crown, a filling, or extraction."

**22. Correct Answer: B (solution; they provide)**

The original sentence is a comma splice (two independent clauses joined only by a comma). Option B correctly uses a semicolon to connect two closely related independent clauses without a coordinating conjunction.

**23. Correct Answer: D (the most expensive choice)**

When comparing more than two items (three treatment options), use the superlative form ("most expensive"), not the comparative form ("more expensive"). Option D properly uses the superlative.

**24. Correct Answer: A (Main Street in the historic downtown area)**

Street names should be capitalized ("Main Street," not "Main street"). The phrase "historic downtown area" uses lowercase for "downtown" as it's a common adjective/noun combination, not a proper name. Option A correctly capitalizes the street name.

**25. Correct Answer: C (After the extraction was completed, the oral surgeon provided)**

Introductory dependent clauses should be followed by a comma to separate them from the main clause. Option C correctly includes the necessary comma after the introductory clause.

**26. Correct Answer: B (when she could return)**

In indirect questions within reported speech, normal word order (subject-verb) is used, and the tense typically shifts back. "Asked" (past tense) in the main clause suggests shifting "can" to "could." Option B uses correct word order and appropriate tense.

**27. Correct Answer: A (both agree that)**

The compound subject "the hygienist and her assistant" is plural (two people), so the verb must be "agree" (plural), not "agrees" (singular). Option A correctly uses the plural verb form.

**28. Correct Answer: C (are necessary)**

The compound subject consists of three items ("checkups," "brushing," and "flossing") connected by commas and "and," making it plural. Therefore, the verb must be "are" (plural), not "is" (singular). Option C correctly uses the plural verb with the adjective "necessary."

**29. Correct Answer: B (comfort, and it will also increase)**

The original sentence is a comma splice (two independent clauses joined only by a comma). Option B corrects this by adding the coordinating conjunction "and" after the comma, which properly connects the two independent clauses.

**30. Correct Answer: A (needs, including routine care, cosmetic procedures, and emergency treatment)**

When "including" introduces a nonrestrictive phrase (providing supplementary examples), a comma is used before "including." The examples are additional information rather than essential to identify which needs. Option A correctly places the comma before "including."

**31. Correct Answer: D (all play important roles)**

The compound subject "dentists, hygienists, and assistants" is plural, so the verb must be "play" (plural), not "plays" (singular). Additionally, "roles" (plural) is correct since there are multiple people playing multiple roles. Option D uses correct subject-verb agreement and plural noun.

**32. Correct Answer: B (to lie down in the chair)**

"Lie" means to recline or rest in a horizontal position (intransitive verb). "Lay" means to place or put something down (transitive verb requiring an object). Since the patient is reclining, "lie" is correct. The preposition "in" (not "on") is more appropriate for being positioned within/inside the chair. Option B is correct.

**33. Correct Answer: C (significantly allowing dentists to provide)**

The participial phrase "allowing dentists to provide superior care" modifies the main clause. While a comma is optional here, omitting it creates a tighter connection between the advancement and its result. Option C correctly presents this without the comma, maintaining smooth flow without unnecessary punctuation.

**34. Correct Answer: B (enamel. They help prevent)**

The original sentence is a comma splice (two independent clauses joined only by a comma). Option B corrects this by using a period to create two separate sentences, providing clear separation between the complete thoughts.

**35. Correct Answer: D (requires students to complete practical training before they graduate)**

The sentence is correct as written. "Curriculum" (singular subject) takes "requires" (singular verb). The clause structure is correct, and no comma is needed before "before" because the dependent clause is restrictive (essential to meaning). Option D maintains the correct structure.

**36. Correct Answer: A (services, such as cleanings and examinations but)**

The phrase "such as cleanings and examinations" provides examples and requires a comma before "such as" to introduce the nonrestrictive element. No comma is needed before "but" because it connects parts of a compound object (covers preventive services but not elective procedures), not two independent clauses. Option A uses appropriate punctuation.

**37. Correct Answer: D (more convenient for working patients than the old schedule was)**

When making comparisons, both elements should be grammatically complete and parallel. Option D completes the comparison properly by adding "was" to create parallel structure, making it clear we're comparing "new hours are convenient" to "old schedule was [convenient]."

**38. Correct Answer: A (brushing regularly, flossing daily, and visiting for checkups)**

The original sentence lacks parallel structure with an infinitive phrase at the end. Option A maintains parallel structure by using three gerunds: "brushing, flossing, and visiting." All three verb forms are consistent.

**39. Correct Answer: C (had been hurting)**

The past perfect progressive tense "had been hurting" is correct because the hurting began in the past and continued up to another past point (calling the office). This sequence of past events requires past perfect to show the earlier, ongoing action.

**40. Correct Answer: A (issues, and it also improves)**

The original sentence is a comma splice (two independent clauses joined only by a comma). Option A corrects this by adding the coordinating conjunction "and" after the comma, which properly connects the two independent clauses.

## Quantitative Reasoning

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**1. Correct Answer: A (5)**

To solve  $3x + 8 = 23$ , first subtract 8 from both sides:  $3x = 15$ . Then divide both sides by 3:  $x = 5$ .  
Verification:  $3(5) + 8 = 15 + 8 = 23$  ✓

**2. Correct Answer: D (25%)**

Percent increase formula:  $(\text{New} - \text{Old})/\text{Old} \times 100$ . Calculate:  $(250 - 200)/200 \times 100 = 50/200 \times 100 = 0.25 \times 100 = 25\%$ . Patient visits increased by 25%.

**3. Correct Answer: B (4)**

To solve  $6y - 4 = 3y + 8$ , subtract  $3y$  from both sides:  $3y - 4 = 8$ . Add 4 to both sides:  $3y = 12$ . Divide by 3:  $y = 4$ . Verification:  $6(4) - 4 = 24 - 4 = 20$ , and  $3(4) + 8 = 12 + 8 = 20$  ✓

**4. Correct Answer: C (\$1,800)**

Calculate weekly earnings:  $\$45/\text{hour} \times 8 \text{ hours/day} \times 5 \text{ days/week} = \$1,800$  per week. Break it down: Daily earnings =  $\$45 \times 8 = \$360$ ; Weekly earnings =  $\$360 \times 5 = \$1,800$ .

**5. Correct Answer: D (36)**

To find 15% of 240, multiply:  $0.15 \times 240 = 36$ . Alternatively, 15% is the same as  $15/100$ , so  $(15/100) \times 240 = 3,600/100 = 36$ .

**6. Correct Answer: A (47)**

Substitute  $a = 4$  and  $b = -3$  into  $2a^2 - 5b$ . Calculate:  $2(4)^2 - 5(-3) = 2(16) - (-15) = 32 + 15 = 47$ .

**7. Correct Answer: B (52 mg)**

Multiply the dosage rate by body weight:  $0.8 \text{ mg/kg} \times 65 \text{ kg} = 52 \text{ mg}$ . The units of kilograms cancel out, leaving milligrams as the answer.

**8. Correct Answer: D (6)**

Expand the left side:  $4(x + 2) = 4x + 8$ . Set equal to right side:  $4x + 8 = 3x + 14$ . Subtract  $3x$  from both sides:  $x + 8 = 14$ . Subtract 8:  $x = 6$ .

**9. Correct Answer: A (3/10)**

Total balls =  $9 + 6 + 5 = 20$  balls. Blue balls = 6. Probability of selecting blue =  $6/20 = 3/10$  (simplified by dividing numerator and denominator by 2).

**10. Correct Answer: D (3,800 meters)**

To convert kilometers to meters, multiply by 1,000 (since  $1 \text{ km} = 1,000 \text{ m}$ ):  $3.8 \text{ km} \times 1,000 \text{ m/km} = 3,800$  meters. This is a standard metric conversion.

**11. Correct Answer: C (182)**

Substitute  $x = 7$  into  $3x^2 + 5x$ . Calculate:  $3(7)^2 + 5(7) = 3(49) + 35 = 147 + 35 = 182$ . Follow the order of operations: first calculate the exponent ( $7^2 = 49$ ), then multiply by the coefficient ( $3 \times 49 = 147$ ), calculate the second term ( $5 \times 7 = 35$ ), and finally add ( $147 + 35 = 182$ ).

**12. Correct Answer: A (20%)**

Percent decrease =  $(\text{Old} - \text{New})/\text{Old} \times 100 = (3,000 - 2,400)/3,000 \times 100 = 600/3,000 \times 100 = 0.20 \times 100 = 20\%$ . The expenses decreased by 20%.

**13. Correct Answer: B ( $7x - 29$ )**

Distribute:  $6(2x - 4) - 5(x + 1) = 12x - 24 - 5x - 5$ . Combine like terms:  $(12x - 5x) + (-24 - 5) = 7x - 29$ . Remember to distribute the negative sign in  $-5(x + 1)$ .

**14. Correct Answer: D (4)**

If the ratio is 1:30 and there are 120 patients, find the number of dentists:  $120 \div 30 = 4$  dentists. This maintains the 1:30 ratio ( $4:120 = 1:30$ ).

**15. Correct Answer: C (30)**

Solve  $x/5 + 3 = 9$ . First subtract 3 from both sides:  $x/5 = 6$ . Then multiply both sides by 5:  $x = 30$ . Verification:  $30/5 + 3 = 6 + 3 = 9 \checkmark$

**16. Correct Answer: B (14 bpm)**

The increase is found by subtracting the original value from the new value:  $84 - 70 = 14 \text{ bpm}$ . This represents the amount of increase in heart rate.

**17. Correct Answer: A (5)**

Substitute  $x = 7$  into  $5x - 2y = 25$ :  $5(7) - 2y = 25$ , which gives  $35 - 2y = 25$ . Subtract 35 from both sides:  $-2y = -10$ . Divide by  $-2$ :  $y = 5$ .

**18. Correct Answer: C (\$400)**

Calculate the 20% discount amount:  $0.20 \times \$500 = \$100$ . Subtract the discount from the original price:  $\$500 - \$100 = \$400$ . The discounted price is \$400.

**19. Correct Answer: D (7)**

Solve  $8x - 5 = 5x + 16$ . Subtract  $5x$  from both sides:  $3x - 5 = 16$ . Add 5 to both sides:  $3x = 21$ . Divide by 3:  $x = 7$ .

**20. Correct Answer: A (24)**

To find the mean, add all values and divide by the count:  $(12 + 18 + 24 + 30 + 36)/5 = 120/5 = 24$ . The mean is the arithmetic average of the data set.

**21. Correct Answer: D (140 mL)**

Calculate 28% of 500 mL:  $0.28 \times 500 = 140$  mL. Alternatively, 28% is the same as  $28/100$ , and  $500 \times 28/100 = 14,000/100 = 140$  mL.

**22. Correct Answer: B (10 and -10)**

When  $x^2 = 100$ , take the square root of both sides. Remember that square roots have both positive and negative solutions:  $x = +10$  or  $x = -10$ . Both values satisfy the equation:  $(10)^2 = 100$  and  $(-10)^2 = 100$ .

**23. Correct Answer: A (180)**

Multiply:  $15 \text{ patients/day} \times 4 \text{ days/week} \times 3 \text{ weeks} = 180$  patients total. Calculate step by step:  $15 \times 4 = 60$  patients per week, then  $60 \times 3 = 180$  patients in 3 weeks.

**24. Correct Answer: C ( $15x^8$ )**

When multiplying powers with the same base, multiply the coefficients and add the exponents:  $(3x^3)(5x^5) = (3 \times 5)(x^{3+5}) = 15x^8$ . Coefficient:  $3 \times 5 = 15$ . Exponent:  $3 + 5 = 8$ .

**25. Correct Answer: D (87.5%)**

Convert the fraction to a decimal first:  $7/8 = 0.875$ . Then multiply by 100 to get the percentage:  $0.875 \times 100 = 87.5\%$ . Alternatively,  $7/8 = 87.5/100 = 87.5\%$ .

**26. Correct Answer: B (12)**

Calculate total hours in 4 days:  $4 \text{ days} \times 24 \text{ hours/day} = 96$  hours. Divide by the dosing interval:  $96 \text{ hours} \div 8 \text{ hours/dose} = 12$  doses. The patient takes medication 3 times per day for 4 days.

**27. Correct Answer: C (18 cm)**

Perimeter formula for rectangle:  $P = 2L + 2W$ . Substitute known values:  $60 = 2L + 2(12)$ , which gives  $60 = 2L + 24$ . Subtract 24:  $36 = 2L$ . Divide by 2:  $L = 18$  cm.

**28. Correct Answer: B (8)**

Solve  $7x - 10 = 6x - 2$ . Subtract  $6x$  from both sides:  $x - 10 = -2$ . Add 10 to both sides:  $x = 8$ . Verification:  $7(8) - 10 = 56 - 10 = 46$  and  $6(8) - 2 = 48 - 2 = 46$  ✓

**29. Correct Answer: D (\$972)**

Calculate 8% tax on \$900:  $0.08 \times \$900 = \$72$ . Add tax to original cost:  $\$900 + \$72 = \$972$ . The total cost including sales tax is \$972.

**30. Correct Answer: A (16)**

The median is the middle value when data is arranged in order. The data set 8, 12, 16, 20, 24 is already ordered. With 5 values, the middle (3rd) value is 16.

**31. Correct Answer: C (15)**

First solve for  $x$ :  $4x - 6 = 14$ . Add 6 to both sides:  $4x = 20$ . Divide by 4:  $x = 5$ . Then calculate  $3x$ :  $3(5) = 15$ .

**32. Correct Answer: B (1,800 mL)**

Convert liters to milliliters by multiplying by 1,000 (since  $1 \text{ L} = 1,000 \text{ mL}$ ):  $1.8 \text{ L} \times 1,000 \text{ mL/L} = 1,800 \text{ mL}$ . This is a standard metric conversion.

**33. Correct Answer: A (-11)**

Calculate step by step:  $(-3)^2 + 4(-5)$ . First,  $(-3)^2 = 9$  (squaring a negative gives a positive). Second,  $4(-5) = -20$  (multiplying positive and negative gives negative). Finally,  $9 + (-20) = -11$ .

**34. Correct Answer: D (8)**

Calculate 32% of 25:  $0.32 \times 25 = 8$  hygienists. Alternatively, 32% is the same as  $32/100$ , and  $25 \times 32/100 = 800/100 = 8$  hygienists work at the clinic.

**35. Correct Answer: C (63)**

Solve  $x/9 = 7$  by multiplying both sides by 9:  $x = 7 \times 9 = 63$ . Verification:  $63/9 = 7$  ✓

**36. Correct Answer: B (5/8)**

Convert 0.625 to a fraction:  $0.625 = 625/1000$ . Simplify by dividing both numerator and denominator by 125:  $625/1000 = 5/8$ . This fraction is in simplest form since 5 and 8 share no common factors.

**37. Correct Answer: D (15)**

Use the elimination method. Add the two equations:  $(x - y) + (x + y) = 8 + 22$ , which gives  $2x = 30$ . Divide by 2:  $x = 15$ . The  $y$  terms cancel when adding the equations.

**38. Correct Answer: A (98.6°F)**

Substitute  $C = 37$  into  $F = (9/5)C + 32$ :  $F = (9/5)(37) + 32 = 1.8(37) + 32 = 66.6 + 32 = 98.6^\circ\text{F}$ . This represents normal body temperature.

**39. Correct Answer: C (24)**

The range is the difference between the maximum and minimum values:  $38 - 14 = 24$ . Range measures the spread of the data from lowest to highest value.

**40. Correct Answer: B (2:3)**

Write the ratio: 160:240. Simplify by dividing both numbers by their GCF (80):  $160/80 = 2$  and  $240/80 = 3$ . The simplest form of the ratio is 2:3.

## Perceptual Ability

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### ANGLE DISCRIMINATION (Questions 1-15)

**1. Correct Answer: C (Angle 3)**

The angles measure: Angle 1 =  $52^\circ$ , Angle 2 =  $110^\circ$ , Angle 3 =  $73^\circ$ , Angle 4 =  $135^\circ$ . The question asks which is closest to  $75^\circ$ . Comparing distances from  $75^\circ$ : Angle 1 ( $52^\circ$ ) is  $23^\circ$  away, Angle 2 ( $110^\circ$ ) is  $35^\circ$  away, Angle 3 ( $73^\circ$ ) is only  $2^\circ$  away, and Angle 4 ( $135^\circ$ ) is  $60^\circ$  away. Angle 3 at  $73^\circ$  is closest to  $75^\circ$ .

**2. Correct Answer: D (Angle B)**

Obtuse angles measure between  $90^\circ$  and  $180^\circ$ . From the three angles ( $A = 48^\circ$ ,  $B = 122^\circ$ ,  $C = 85^\circ$ ), only Angle B at  $122^\circ$  is both obtuse AND greater than  $100^\circ$ . Angle C ( $85^\circ$ ) is acute, not obtuse.

**3. Correct Answer: D (148°)**

The five angles measure  $24^\circ$ ,  $86^\circ$ ,  $55^\circ$ ,  $148^\circ$ , and  $91^\circ$ . Comparing all measurements,  $148^\circ$  is the largest angle shown.

**4. Correct Answer: A (38°)**

The four angles measure  $38^\circ$ ,  $102^\circ$ ,  $64^\circ$ , and  $127^\circ$ . Comparing all measurements,  $38^\circ$  is the smallest angle.

**5. Correct Answer: C (118°, 76°, 42°)**

The three angles measure  $76^\circ$ ,  $118^\circ$ , and  $42^\circ$ . Arranging from largest to smallest:  $118^\circ$ ,  $76^\circ$ ,  $42^\circ$ . This represents the correct descending order.

**6. Correct Answer: B (68°)**

Acute angles measure less than  $90^\circ$ . From the five angles ( $29^\circ$ ,  $95^\circ$ ,  $68^\circ$ ,  $143^\circ$ ,  $52^\circ$ ), the acute angles are  $29^\circ$ ,  $68^\circ$ , and  $52^\circ$ . Comparing distances from  $70^\circ$ :  $29^\circ$  is  $41^\circ$  away,  $68^\circ$  is  $2^\circ$  away, and  $52^\circ$  is  $18^\circ$  away. Angle  $68^\circ$  is closest to  $70^\circ$ .

**7. Correct Answer: A ( $46^\circ$ )**

The four angles measure  $17^\circ$ ,  $93^\circ$ ,  $46^\circ$ , and  $158^\circ$ . Ordering from smallest to largest:  $17^\circ$ ,  $46^\circ$ ,  $93^\circ$ ,  $158^\circ$ . The second smallest angle is  $46^\circ$ .

**8. Correct Answer: D ( $151^\circ$ )**

Obtuse angles measure between  $90^\circ$  and  $180^\circ$ . From the three angles ( $31^\circ$ ,  $87^\circ$ ,  $151^\circ$ ), only  $151^\circ$  is both obtuse AND greater than  $120^\circ$ . Angles  $31^\circ$  and  $87^\circ$  are both acute.

**9. Correct Answer: C ( $65^\circ$ )**

The five angles measure  $39^\circ$ ,  $101^\circ$ ,  $65^\circ$ ,  $133^\circ$ , and  $47^\circ$ . The angle measuring exactly  $65^\circ$  is the third option listed.

**10. Correct Answer: A ( $89^\circ$ )**

The four angles measure  $62^\circ$ ,  $124^\circ$ ,  $28^\circ$ , and  $89^\circ$ . Ordering from smallest to largest:  $28^\circ$ ,  $62^\circ$ ,  $89^\circ$ ,  $124^\circ$ . The third smallest is  $89^\circ$ .

**11. Correct Answer: B ( $58^\circ$ )**

The three acute angles measure  $37^\circ$ ,  $69^\circ$ , and  $58^\circ$ . Comparing distances from  $60^\circ$ :  $37^\circ$  is  $23^\circ$  away,  $69^\circ$  is  $9^\circ$  away, and  $58^\circ$  is  $2^\circ$  away. Angle  $58^\circ$  is closest to  $60^\circ$ .

**12. Correct Answer: D ( $161^\circ$ )**

The five angles measure  $112^\circ$ ,  $84^\circ$ ,  $49^\circ$ ,  $161^\circ$ , and  $73^\circ$ . Comparing all measurements,  $161^\circ$  is the largest angle.

**13. Correct Answer: A ( $21^\circ$ )**

The four angles measure  $21^\circ$ ,  $98^\circ$ ,  $71^\circ$ , and  $139^\circ$ . Comparing distances from  $20^\circ$ :  $21^\circ$  is only  $1^\circ$  away,  $71^\circ$  is  $51^\circ$  away,  $98^\circ$  is  $78^\circ$  away, and  $139^\circ$  is  $119^\circ$  away. Angle  $21^\circ$  is closest to  $20^\circ$ .

**14. Correct Answer: C ( $114^\circ$ )**

Obtuse angles measure between  $90^\circ$  and  $180^\circ$ . From the three angles ( $114^\circ$ ,  $43^\circ$ ,  $82^\circ$ ), only  $114^\circ$  is obtuse. Additionally,  $114^\circ$  is less than  $120^\circ$ , satisfying both conditions. Angles  $43^\circ$  and  $82^\circ$  are both acute.

**15. Correct Answer: B ( $34^\circ$ ,  $61^\circ$ ,  $79^\circ$ )**

The five angles measure  $34^\circ$ ,  $103^\circ$ ,  $61^\circ$ ,  $147^\circ$ , and  $79^\circ$ . Ordering all angles from smallest to largest:  $34^\circ$ ,  $61^\circ$ ,  $79^\circ$ ,  $103^\circ$ ,  $147^\circ$ . The three smallest angles in order are  $34^\circ$ ,  $61^\circ$ ,  $79^\circ$ .

## APERTURES (Questions 16-30)

### 16. Correct Answer: D (A rectangle 9 cm × 11 cm)

A rectangular prism measuring 5 cm × 9 cm × 11 cm has three possible face orientations. The largest face measures 9 cm × 11 cm. This rectangular aperture would accommodate the largest face when properly oriented.

### 17. Correct Answer: C (A circle with at least 9 cm diameter)

When a cylinder with diameter 9 cm is oriented with its circular end forward, the cross-section presented is circular with 9 cm diameter. The aperture must be a circle with at least 9 cm diameter to allow passage.

### 18. Correct Answer: A (A square 9 cm × 9 cm or larger)

A pyramid with a square base measuring 9 cm × 9 cm requires a square aperture of at least 9 cm × 9 cm to accommodate the base when oriented base-first.

### 19. Correct Answer: D (8 cm × 8 cm)

A cube measuring 8 cm on each side, when oriented face-first, presents a square cross-section of 8 cm × 8 cm. This is the exact size needed for the smallest square aperture through which it can pass.

### 20. Correct Answer: B (An equilateral triangle 7 cm sides)

A triangular prism with an equilateral triangular base measuring 7 cm on each side, when entering triangle-first, requires an aperture matching that triangular shape with 7 cm sides.

### 21. Correct Answer: C (A rectangle 7 cm × 10 cm or larger)

An L-shaped object with overall dimensions of 7 cm wide and 10 cm tall requires a rectangular aperture of at least 7 cm × 10 cm to accommodate the entire object's profile when passing through.

### 22. Correct Answer: A (A circle with at least 12 cm diameter)

A sphere with a 12 cm diameter requires a circular aperture of at least 12 cm diameter to pass through, regardless of orientation, since a sphere presents the same circular profile from any angle.

### 23. Correct Answer: A (A rectangle 7 cm × 9 cm)

A rectangular block measuring 7 cm × 9 cm × 5 cm, when oriented with the 7 cm × 9 cm face forward, requires a rectangular aperture of at least 7 cm × 9 cm to pass through.

### 24. Correct Answer: B (A hexagon approximately 7 cm across)

A hexagonal prism with a 7 cm wide hexagonal base, when entering hexagon-first, requires an aperture that matches the hexagonal shape, approximately 7 cm across at its widest point.

### 25. Correct Answer: D (A rectangle 11 cm × 13 cm)

A T-shaped object with overall dimensions of 11 cm wide and 13 cm tall requires a rectangular aperture of at least 11 cm × 13 cm to accommodate the entire T profile when passing through face-first.

**26. Correct Answer: A (An ellipse or rectangle 8 cm × 11 cm)**

An ellipsoid measuring 8 cm × 11 cm × 6 cm, when oriented with the 8 cm × 11 cm face forward, requires an elliptical or rectangular aperture of approximately 8 cm × 11 cm.

**27. Correct Answer: C (A square 9 cm × 9 cm or larger)**

A cross-shaped object with arms extending 9 cm in each direction requires a square aperture of at least 9 cm × 9 cm to accommodate the full width and height of the cross profile when entering face-first.

**28. Correct Answer: D (A circle with at least 11 cm diameter)**

A cone with a base diameter of 11 cm, when oriented base-first, presents a circular cross-section of 11 cm diameter. The aperture must be a circle with at least 11 cm diameter.

**29. Correct Answer: B (A rounded rectangle approximately 7 cm × 9 cm)**

A rectangular block measuring 7 cm × 9 cm × 13 cm with 2 cm radius curves on the ends requires a rounded rectangular aperture of approximately 7 cm × 9 cm to accommodate the curved end profile.

**30. Correct Answer: A (A rectangle 8 cm × 6 cm)**

An irregular object with maximum dimensions of 8 cm × 10 cm × 6 cm, when oriented with its smallest face (8 cm × 6 cm) forward, requires a rectangular aperture of at least 8 cm × 6 cm.

**ORTHOGRAPHIC PROJECTIONS (Questions 31-45)**

**31. Correct Answer: C (A cylinder)**

A cylinder shows circles in both the top and end views (looking along and perpendicular to the axis) and a rectangle in the front view (side profile). This combination uniquely identifies a cylinder oriented horizontally.

**32. Correct Answer: D (A rectangular prism)**

A square top view combined with rectangular front and end views (where the rectangles are different dimensions than the square) indicates a rectangular prism (box shape) with three different dimensions for length, width, and height.

**33. Correct Answer: B (Front view only)**

In a stepped object with two distinct levels, the front view (elevation) shows both levels as steps or tiers most clearly, displaying the height differences between the two levels in a side profile.

**34. Correct Answer: C (A triangular prism)**

A triangular top view combined with a rectangular front view and triangular end view indicates a triangular prism with the triangular cross-section visible in the top and end views, and the length shown in the front view.

**35. Correct Answer: A (A hexagonal prism)**

Hexagonal top and end views combined with a rectangular front view indicates a hexagonal prism—an object with a uniform hexagonal cross-section throughout its length.

**36. Correct Answer: D (A hollow rectangular frame)**

Nested squares in the top view and nested rectangles in the front and end views indicate a hollow rectangular structure—essentially a rectangular frame or box with walls but empty inside, not solid.

**37. Correct Answer: B (A cross-shaped prism)**

A cross-shaped top view, rectangular front view, and cross-shaped end view indicates a three-dimensional object with a uniform cross-shaped cross-section throughout its length—a cross-shaped prism.

**38. Correct Answer: A (A cylinder with slot or hole)**

A circle with a line through it in two views, combined with a rectangle with a line in the third view, suggests a cylindrical object with a slot, groove, or rectangular feature cut through it.

**39. Correct Answer: C (A T-shaped prism)**

T-shaped top and end views combined with a rectangular front view indicates a three-dimensional object with a uniform T-shaped cross-section throughout its length—a T-shaped prism or beam.

**40. Correct Answer: D (Four cubes in a row)**

Four squares in a row in the top view, a long rectangle in the front view, and a square in the end view suggests four cube-like units arranged in a linear row.

**41. Correct Answer: B (An octagonal prism)**

Octagonal top and end views combined with a rectangular front view indicates an octagonal prism—an object with a uniform octagonal cross-section throughout its length.

**42. Correct Answer: C (An elliptical cylinder)**

An oval (ellipse) in the top and end views combined with a rectangular front view indicates an elliptical cylinder—a cylinder with an elliptical rather than circular cross-section.

**43. Correct Answer: A (A pentagonal prism)**

Pentagonal top and end views combined with a rectangular front view indicates a pentagonal prism—an object with a uniform pentagonal cross-section throughout its length.

**44. Correct Answer: D (Two cylinders stacked)**

Two circles in the top view, two rectangles in the front view (showing two separate rectangular sections), and a circle in the end view suggests two cylindrical objects stacked vertically one on top of the other.

**45. Correct Answer: B (An L-shaped prism)**

L-shaped top and end views combined with a rectangular front view indicates a three-dimensional object with a uniform L-shaped cross-section throughout its length—an L-shaped prism or beam.

**CUBE COUNTING (Questions 46-60)**

**46. Correct Answer: A (16)**

A structure with 4 layers arranged  $2 \times 2 \times 4$  contains: 2 cubes wide  $\times$  2 cubes deep  $\times$  4 cubes high = 16 total cubes. Multiply the three dimensions to find the total count.

**47. Correct Answer: C (56)**

In a  $4 \times 4 \times 4$  cube structure containing 64 total cubes, only the interior cubes ( $2 \times 2 \times 2 = 8$  cubes) have no faces exposed. Therefore, cubes on the surface =  $64 - 8 = 56$  cubes with at least one face exposed.

**48. Correct Answer: A (30)**

A  $2 \times 3 \times 5$  structure contains: 2 cubes  $\times$  3 cubes  $\times$  5 cubes = 30 total cubes. Multiply the three dimensions to find the total count.

**49. Correct Answer: D (8)**

In a  $6 \times 6 \times 6$  cube, cubes with exactly three painted faces are corner cubes. Any rectangular prism has exactly 8 corners (vertices), so there are 8 corner cubes with three painted faces.

**50. Correct Answer: B (40)**

With 5 layers and 8 cubes per layer arranged  $2 \times 4$ : Total cubes = 5 layers  $\times$  8 cubes per layer = 40 cubes. Alternatively,  $2 \times 4 \times 5 = 40$  cubes.

**51. Correct Answer: A (8)**

Any rectangular prism has exactly 8 corners (vertices). In a  $2 \times 3 \times 4$  structure, there are 8 corner cubes where three edges meet.

**52. Correct Answer: C (120)**

A structure 6 cubes high  $\times$  5 cubes wide  $\times$  4 cubes deep contains:  $6 \times 5 \times 4 = 120$  total cubes. Multiply the three dimensions to find the total count.

**53. Correct Answer: D (14)**

An L-shaped structure with 8 cubes on one arm and 7 on the other, sharing 1 corner cube: Total =  $8 + 7 - 1 = 14$  cubes. Subtract the shared corner cube to avoid counting it twice.

**54. Correct Answer: B (20)**

In a  $6 \times 6 \times 1$  flat structure, cubes with exactly two painted faces are the perimeter cubes excluding corners. Perimeter cubes =  $6 + 6 + 6 + 6 - 4$  corners =  $24 - 4 = 20$  cubes with two painted faces.

**55. Correct Answer: C (15)**

A staircase structure with 3 cubes on first step, 5 on second, and 7 on third contains:  $3 + 5 + 7 = 15$  total cubes. This is the sum of the arithmetic sequence.

**56. Correct Answer: D (8)**

Any rectangular prism has exactly 8 corners (vertices). In a  $5 \times 6 \times 7$  structure, there are 8 corner cubes where three faces meet at each corner position.

**57. Correct Answer: A (6)**

In an  $8 \times 1 \times 1$  structure (8 cubes in a row), the 2 end cubes have 5 faces painted, and the 6 middle cubes have exactly 4 faces painted (top, bottom, front, back—not the two sides touching adjacent cubes).

**58. Correct Answer: C (35)**

Bottom layer:  $5 \times 5 = 25$  cubes. Next layer:  $3 \times 3 = 9$  cubes. Top layer: 1 cube. Total =  $25 + 9 + 1 = 35$  cubes in this pyramid structure.

**59. Correct Answer: B (124)**

A  $5 \times 5 \times 5$  cube contains 125 total cubes. With one corner cube removed:  $125 - 1 = 124$  cubes remain.

**60. Correct Answer: B (11)**

A plus-shaped structure with 6 cubes for vertical arm and 6 cubes for horizontal arm, sharing 1 center cube: Total =  $6 + 6 - 1 = 11$  cubes. The center cube where the arms intersect is counted only once.

## Biology

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**1. Correct Answer: A (Protein synthesis)**

The primary function of ribosomes is protein synthesis. Ribosomes are the cellular machinery where translation occurs—they read messenger RNA (mRNA) sequences and assemble amino acids in the correct order to build proteins. Ribosomes can be found free-floating in the cytoplasm or attached to the endoplasmic reticulum.

**2. Correct Answer: D (Lysosome)**

Lysosomes are membrane-bound organelles containing digestive enzymes (hydrolases) that break down cellular waste, damaged organelles, macromolecules, and foreign materials. They function as the cell's recycling center and waste disposal system, digesting materials through enzymatic breakdown.

**3. Correct Answer: C (Anaphase)**

During anaphase of mitosis, the sister chromatids separate and move to opposite poles of the cell. The spindle fibers shorten, pulling the chromatids apart. This ensures that each daughter cell will receive an identical set of chromosomes.

**4. Correct Answer: B (Active transport)**

Active transport is the only type of cellular transport that requires energy (ATP) to move substances across a cell membrane. It moves molecules against their concentration gradient, from areas of low concentration to areas of high concentration, which cannot occur passively.

**5. Correct Answer: D (Brings amino acids to the ribosome)**

Transfer RNA (tRNA) functions during translation by carrying specific amino acids to the ribosome. Each tRNA has an anticodon that matches a codon on the mRNA, ensuring that amino acids are added to the growing protein chain in the correct sequence specified by the mRNA.

**6. Correct Answer: A (23)**

Human gametes (sex cells—sperm and egg) contain 23 chromosomes, which is the haploid number ( $n = 23$ ). This is half the number found in somatic (body) cells, which contain 46 chromosomes (diploid,  $2n = 46$ ). When gametes unite during fertilization, the diploid number is restored.

**7. Correct Answer: C (Guanine)**

In DNA structure, the base pairing rules are specific: cytosine (C) pairs with guanine (G), and adenine (A) pairs with thymine (T). These complementary base pairs are held together by hydrogen bonds—three bonds between C and G, and two bonds between A and T.

**8. Correct Answer: B (Incomplete dominance)**

Incomplete dominance is an inheritance pattern where neither allele is completely dominant, resulting in an intermediate phenotype in heterozygotes. For example, when a red flower is crossed with a white flower, the heterozygous offspring are pink—a blend of the two parental phenotypes.

**9. Correct Answer: A (Prophase I)**

Crossing over (genetic recombination) occurs during prophase I of meiosis. During this phase, homologous chromosomes pair up (synapsis) and exchange genetic material at points called chiasmata. This creates genetic variation in gametes by producing new combinations of alleles.

**10. Correct Answer: D (Red blood cells)**

Red blood cells (erythrocytes) are the blood component responsible for transporting oxygen throughout the body. They contain hemoglobin, a protein that binds to oxygen in the lungs and releases it to tissues. Red blood cells also help transport some carbon dioxide back to the lungs.

**11. Correct Answer: C (Water absorption and feces formation)**

The primary function of the large intestine is to absorb water and electrolytes from undigested material and to form and store feces until elimination. The large intestine also houses beneficial bacteria that ferment remaining carbohydrates and synthesize certain vitamins.

**12. Correct Answer: B (Ligaments)**

Ligaments are strong, fibrous connective tissues that connect bones to other bones at joints. They provide stability to joints while allowing appropriate movement. Tendons, in contrast, connect muscles to bones. Both are composed primarily of collagen fibers.

**13. Correct Answer: D (9:3:3:1)**

In a dihybrid cross between two heterozygous parents ( $AaBb \times AaBb$ ), the phenotypic ratio is 9:3:3:1. This represents: 9 with both dominant traits, 3 with first dominant and second recessive, 3 with first recessive and second dominant, and 1 with both recessive traits.

**14. Correct Answer: A (Meiosis)**

Meiosis is the specialized cell division process that reduces chromosome number from diploid ( $2n$ ) to haploid ( $n$ ). It involves two successive divisions (meiosis I and II) and produces four haploid gametes from one diploid cell. This reduction is essential for sexual reproduction.

**15. Correct Answer: B (mRNA)**

Messenger RNA (mRNA) carries genetic information from DNA in the nucleus to ribosomes in the cytoplasm. During transcription, DNA is copied into mRNA, which then leaves the nucleus through nuclear pores and serves as the template for protein synthesis during translation.

**16. Correct Answer: C (Platelets)**

Platelets (thrombocytes) are the blood component primarily responsible for blood clotting (coagulation). When a blood vessel is injured, platelets adhere to the damaged site, aggregate together, and release chemicals that trigger the coagulation cascade, forming a clot to stop bleeding.

**17. Correct Answer: D (Smooth muscle)**

Smooth muscle tissue is found in the walls of hollow organs such as the stomach, intestines, blood vessels, bladder, and uterus. It is involuntary (not under conscious control) and contracts slowly and rhythmically to move substances through organs or regulate blood vessel diameter.

**18. Correct Answer: D (Protein)**

Translation is the process by which ribosomes synthesize proteins using mRNA as a template. The ribosome reads the mRNA codons and assembles amino acids in the specified sequence to create a polypeptide chain (protein). The end product of translation is always a protein or polypeptide.

**19. Correct Answer: B (Nucleus)**

The nucleus is the membrane-bound organelle that contains the cell's genetic material (DNA organized into chromosomes). The nucleus controls cellular activities by regulating gene expression and serves as the site of DNA replication and transcription. It is the defining feature of eukaryotic cells.

**20. Correct Answer: C (Break down bone)**

Osteoclasts are large, multinucleated bone cells responsible for breaking down (resorbing) bone tissue. They secrete acids and enzymes that dissolve the mineral matrix and digest the organic components, creating small cavities on bone surfaces. This contrasts with osteoblasts, which build new bone.

**21. Correct Answer: A (Cannot reproduce independently)**

Viruses differ fundamentally from bacteria because viruses cannot reproduce independently—they require host cells to replicate. Viruses are acellular (lack cellular structure), consisting only of genetic material (DNA or RNA) enclosed in a protein coat. They must hijack a host cell's machinery to reproduce.

**22. Correct Answer: D (Carbon dioxide and water)**

During cellular respiration, glucose is broken down to produce ATP (energy), with carbon dioxide and water as byproducts. The complete equation is:  $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + ATP$ . Carbon dioxide is expelled through the respiratory system, and water is used or excreted by the body.

**23. Correct Answer: B (Endocrine system)**

The endocrine system regulates body functions through chemical messengers called hormones. Endocrine glands (such as the pituitary, thyroid, adrenal glands, and pancreas) secrete hormones directly into the bloodstream, which then travel to target organs to regulate processes like metabolism, growth, and reproduction.

**24. Correct Answer: A (ATGC)**

Following complementary base pairing rules for DNA: A pairs with T, T pairs with A, C pairs with G, and G pairs with C. Therefore, if one DNA strand is TACG, the complementary DNA strand is ATGC. The two strands run antiparallel and are held together by hydrogen bonds.

**25. Correct Answer: B (Artery)**

Arteries are blood vessels that carry blood away from the heart to the body's tissues. Most arteries carry oxygenated blood (except pulmonary arteries which carry deoxygenated blood to the lungs). Arteries have thick, muscular, elastic walls to withstand high pressure from the heart's pumping action.

**26. Correct Answer: C (Lipid synthesis)**

The smooth endoplasmic reticulum (smooth ER) is primarily responsible for lipid synthesis, including phospholipids and steroids. It also detoxifies drugs and poisons, stores calcium ions, and metabolizes carbohydrates. Unlike rough ER, smooth ER lacks ribosomes on its surface.

**27. Correct Answer: A (Genotype)**

Genotype refers to the genetic makeup of an organism—the specific alleles an individual possesses for particular genes. This contrasts with phenotype, which refers to the observable physical or biochemical characteristics that result from the interaction of genotype with the environment.

**28. Correct Answer: D (S phase)**

DNA replication occurs during the S phase (synthesis phase) of interphase in the cell cycle. During this phase, the cell duplicates its entire genome so that each daughter cell will receive a complete copy of the genetic material during cell division. The S phase occurs between G1 and G2 phases.

**29. Correct Answer: C (Brain, spinal cord, and nerves)**

The main components of the nervous system are the brain, spinal cord, and nerves. The brain and spinal cord constitute the central nervous system (CNS), while nerves throughout the body make up the peripheral nervous system (PNS). Together, they coordinate responses to stimuli and control body functions.

**30. Correct Answer: B (Lack a membrane-bound nucleus)**

Prokaryotic cells (bacteria and archaea) differ from eukaryotic cells primarily by lacking a membrane-bound nucleus. Their DNA is located in a nucleoid region rather than enclosed in a nuclear envelope. Prokaryotes also lack other membrane-bound organelles like mitochondria, endoplasmic reticulum, and Golgi apparatus.

## General Chemistry

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**1. Correct Answer: A (Atomic number)**

The atomic number is defined as the number of protons in an atom's nucleus. This number uniquely identifies each element—every atom with 6 protons is carbon, every atom with 8 protons is oxygen, etc. The atomic number determines the element's identity and its position on the periodic table.

**2. Correct Answer: D (Electron)**

Electrons are subatomic particles located outside the nucleus in electron shells or orbitals. They carry a negative charge (-1) and have negligible mass compared to protons and neutrons. Protons and neutrons are located inside the nucleus, making them nucleons.

**3. Correct Answer: B (Covalent bond)**

A covalent bond forms when atoms share electrons. This type of bonding typically occurs between nonmetal atoms. Each atom contributes electrons to form shared pairs that hold the atoms together. Examples include  $\text{H}_2$ ,  $\text{O}_2$ ,  $\text{H}_2\text{O}$ , and  $\text{CO}_2$ .

**4. Correct Answer: C (18)**

The third energy level (shell) can hold a maximum of 18 electrons, calculated using the formula  $2n^2$  where  $n$  is the shell number. For the third shell:  $2(3)^2 = 2(9) = 18$  electrons maximum.

**5. Correct Answer: A (Carbon dioxide and water)**

When a hydrocarbon undergoes complete combustion (burns in sufficient oxygen), it produces carbon dioxide ( $\text{CO}_2$ ) and water ( $\text{H}_2\text{O}$ ). The general equation is:  $\text{Hydrocarbon} + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$ . For example:  $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$ .

**6. Correct Answer: D (44 g/mol)**

The molar mass of carbon dioxide ( $\text{CO}_2$ ) is calculated by adding the atomic masses: 1 carbon atom (12 g/mol) + 2 oxygen atoms ( $2 \times 16 \text{ g/mol} = 32 \text{ g/mol}$ ) = 44 g/mol total.

**7. Correct Answer: C (11)**

The pH scale ranges from 0 to 14, with pH 7 being neutral. Basic (alkaline) solutions have pH values greater than 7. Among the options, pH 11 indicates a basic solution. pH 3 and 6 are acidic, while pH 7 is neutral.

**8. Correct Answer: B (2)**

In the balanced equation  $2\text{Na} + \text{Cl}_2 \rightarrow 2\text{NaCl}$ , the coefficient of Na is 2. This coefficient indicates that 2 atoms of sodium react with 1 molecule of chlorine gas to produce 2 formula units of sodium chloride.

**9. Correct Answer: A (Isotopes)**

Isotopes are atoms of the same element that have the same number of protons (same atomic number) but different numbers of neutrons, resulting in different mass numbers. For example, carbon-12 and carbon-14 are isotopes, both with 6 protons but 6 and 8 neutrons respectively.

**10. Correct Answer: D (Pressure increases)**

According to Boyle's Law, at constant temperature, pressure and volume are inversely proportional ( $P_1V_1 = P_2V_2$ ). When volume decreases, pressure increases proportionally. This explains why compressing a gas in a container increases its pressure.

**11. Correct Answer: C (A covalent bond forms)**

When electrons are shared between two atoms, a covalent bond forms. This type of bonding typically occurs between nonmetal atoms, where each atom contributes electrons to form shared pairs. The sharing allows atoms to fill their valence shells and achieve stability.

**12. Correct Answer: B (4 moles)**

To calculate moles, divide mass by molar mass:  $\text{moles} = 72 \text{ g} \div 18 \text{ g/mol} = 4 \text{ moles}$ . This shows that 72 grams of water contains 4 moles of  $\text{H}_2\text{O}$  molecules.

**13. Correct Answer: D (Moles)**

The mole is the SI unit for measuring the amount of substance in chemistry. One mole contains Avogadro's number ( $6.022 \times 10^{23}$ ) of particles, whether atoms, molecules, or formula units. This unit connects the microscopic scale to the macroscopic scale.

**14. Correct Answer: A (Taste bitter and feel slippery)**

Bases have characteristic properties including tasting bitter and feeling slippery (like soap). They also turn red litmus paper blue and have pH values greater than 7. Acids, in contrast, taste sour, turn blue litmus paper red, and have pH less than 7.

**15. Correct Answer: C (Liquid)**

Liquids have particles that are close together (giving them definite volume) but can move past each other (allowing them to take the shape of their container). Solids have particles in fixed positions (definite shape and volume), while gases have particles far apart (no definite shape or volume).

**16. Correct Answer: D (By sharing electrons)**

In covalent bonds, atoms achieve stability by sharing electrons rather than transferring them completely. Each atom contributes electrons to form shared pairs that hold the atoms together. This sharing allows atoms to fill their valence shells and achieve a stable electron configuration.

**17. Correct Answer: B (21)**

The formula  $3\text{H}_2\text{SO}_4$  represents 3 molecules of sulfuric acid. Each  $\text{H}_2\text{SO}_4$  contains 2 H atoms, 1 S atom, and 4 O atoms = 7 atoms per molecule. Therefore:  $3 \text{ molecules} \times 7 \text{ atoms per molecule} = 21 \text{ total atoms}$ .

**18. Correct Answer: C (7)**

A neutral solution at  $25^\circ\text{C}$  has a pH of exactly 7. At this pH, the concentration of hydrogen ions ( $\text{H}^+$ ) equals the concentration of hydroxide ions ( $\text{OH}^-$ ), resulting in neither acidic nor basic properties. Solutions with  $\text{pH} < 7$  are acidic;  $\text{pH} > 7$  are basic.

**19. Correct Answer: A (Group 1)**

The alkali metals are located in Group 1 of the periodic table and include lithium, sodium, potassium, rubidium, cesium, and francium. These highly reactive metals have 1 valence electron and readily form +1 ions. They must be stored under oil to prevent reactions with air and moisture.

**20. Correct Answer: A (Synthesis)**

The reaction  $A + B \rightarrow AB$  represents a synthesis (or combination) reaction, where two or more simpler substances combine to form a more complex compound. This is the opposite of a decomposition reaction ( $AB \rightarrow A + B$ ). An example is  $2H_2 + O_2 \rightarrow 2H_2O$ .

**21. Correct Answer: B (100 times)**

The pH scale is logarithmic with base 10. Each unit represents a 10-fold difference in hydrogen ion concentration. A difference of 2 pH units represents  $10^2 = 100$ -fold difference. A solution with pH 3 has 100 times more  $H^+$  ions than a solution with pH 5.

**22. Correct Answer: C (Neutral (no charge))**

Neutrons are subatomic particles that carry no electrical charge—they are electrically neutral. They are located in the nucleus along with protons. Neutrons contribute to atomic mass but do not affect the element's identity or chemical properties directly.

**23. Correct Answer: A (1)**

Elements in Group 1 (the alkali metals) have 1 valence electron in their outermost energy level. This includes lithium, sodium, potassium, rubidium, cesium, and francium. Because they need to lose only one electron to achieve a stable electron configuration, alkali metals are highly reactive.

**24. Correct Answer: D (Atoms are rearranged)**

According to the Law of Conservation of Mass, during chemical reactions, atoms are neither created nor destroyed—they are simply rearranged as existing bonds break and new bonds form. The total mass of reactants equals the total mass of products, and the number and type of atoms remain constant.

**25. Correct Answer: B (2 M)**

Using the dilution formula  $M_1V_1 = M_2V_2$ :  $(6\text{ M})(20\text{ mL}) = M_2(60\text{ mL})$ . Solving:  $120 = 60M_2$ , so  $M_2 = 2\text{ M}$ . Diluting from 20 mL to 60 mL (3-fold dilution) reduces the concentration from 6 M to 2 M.

**26. Correct Answer: C ( $OH^-$  ions)**

According to the Arrhenius definition, bases are substances that release hydroxide ions ( $OH^-$ ) when dissolved in water. For example, NaOH dissociates to produce  $Na^+$  and  $OH^-$  ions. Acids, in contrast, release  $H^+$  ions in water.

**27. Correct Answer: D ( $6.022 \times 10^{23}$ )**

Avogadro's number is  $6.022 \times 10^{23}$ , representing the number of particles (atoms, molecules, or formula units) in one mole of any substance. This fundamental constant allows chemists to convert between particle count and moles, connecting microscopic and macroscopic scales.

**28. Correct Answer: A (Volume increases)**

According to Charles's Law, at constant pressure, the volume of a gas is directly proportional to its absolute temperature in Kelvin ( $V_1/T_1 = V_2/T_2$ ). When temperature increases, gas molecules move faster and require more space, causing volume to increase proportionally.

**29. Correct Answer: C (7)**

A neutral atom has equal numbers of protons and electrons, making the overall charge zero. Nitrogen has an atomic number of 7, meaning it has 7 protons. Therefore, a neutral nitrogen atom also has 7 electrons to balance the positive charge of the protons.

**30. Correct Answer: B (Pressure decreases)**

According to Gay-Lussac's Law (part of the Combined Gas Law), at constant volume, the pressure of a gas is directly proportional to its absolute temperature. When temperature decreases, gas molecules move slower and collide with container walls less frequently and less forcefully, causing pressure to decrease.