

PRACTICE EXAM 7: LIFE SCIENCE: BIOLOGY SIMULATION (50 QUESTIONS)

Instructions: . Each question is independent. Select the one best answer for each item.

1. Which of the following best describes the role of ATP in living cells?
 - A. ATP serves as the primary genetic material that stores hereditary information
 - B. ATP is a structural protein that gives the cell membrane its rigid outer shape
 - C. ATP is a long-term energy storage molecule found mostly in human fat tissue
 - D. ATP transfers chemical energy to power cellular processes such as active transport
2. Which organelle is the primary site of cellular respiration in eukaryotic cells?
 - A. The ribosome, where amino acids are linked into polypeptide chains during translation
 - B. The mitochondrion, where glucose is broken down to produce ATP energy in cells
 - C. The chloroplast, where light energy is converted into stored chemical bond energy
 - D. The vacuole, where water and dissolved materials are stored within the cell body
3. A particular type of cellular transport moves molecules against their concentration gradient and requires the input of ATP. This process is best described as:
 - A. Active transport, which uses energy to move particles from low to high concentration
 - B. Simple diffusion, in which particles move randomly until they reach concentration equilibrium
 - C. Osmosis, in which water moves freely across a selectively permeable cell membrane
 - D. Facilitated diffusion, in which carrier proteins assist particles without using any ATP
4. Oxygen enters a single-celled amoeba directly from the surrounding pond water. This movement is best explained by which process?
 - A. Active transport, which pumps oxygen molecules across the cell membrane using ATP
 - B. Endocytosis, in which oxygen is engulfed in small vesicles formed by the cell membrane
 - C. Diffusion, in which oxygen moves from higher to lower concentration across the membrane
 - D. Exocytosis, in which oxygen vesicles fuse with the membrane and release contents outward
5. Which of the following structures is found in plant cells but not in animal cells?

- A. A cell membrane composed of a phospholipid bilayer with embedded transport proteins
- B. Mitochondria that generate ATP through the process of aerobic cellular respiration
- C. Ribosomes that synthesize proteins from messenger RNA in the cytoplasm of the cell
- D. A rigid cell wall made primarily of cellulose surrounding the outside of the cell membrane

6. Enzymes increase the rate of chemical reactions in cells primarily by:

- A. Lowering the activation energy required for the reaction to proceed in the cell
- B. Providing the chemical energy that drives the reaction forward to its completion
- C. Increasing the temperature within the cell to speed up overall molecular motion
- D. Permanently bonding to the substrate molecules to form a stable final product

7. In a plant cell, photosynthesis takes place primarily within which structure?

- A. The mitochondria, which produce ATP for use in the plant cell's daily metabolism
- B. The nucleus, which contains the DNA that codes for all of the plant's enzymes
- C. The chloroplasts, which contain chlorophyll that captures light energy from the sun
- D. The cell wall, which provides structural support and physical protection to the plant

8. The overall chemical equation for photosynthesis is best summarized as:

- A. Glucose + oxygen → carbon dioxide + water + ATP energy released to the cell
- B. Carbon dioxide + water → glucose + oxygen, using light energy from the sun
- C. Glucose + carbon dioxide → starch + oxygen released into the atmosphere outside
- D. Water + oxygen → carbon dioxide + glucose during the dark reactions in the cell

9. During aerobic cellular respiration, the primary fuel molecule that is broken down is:

- A. Glucose, a six-carbon sugar produced by photosynthesis or obtained from the diet
- B. Carbon dioxide, a waste product released by both plants and animal cells daily
- C. Oxygen, an atmospheric gas required as the final electron acceptor in the process
- D. Water, a small molecule used to provide hydrogen atoms to the electron carriers

10. A yeast cell placed in a sealed container with sugar but no oxygen will most likely:

- A. Stop all metabolic activity within seconds and die from the lack of available oxygen
- B. Increase its rate of aerobic respiration by switching over to anaerobic enzymes alone
- C. Begin to photosynthesize by using glucose as a substitute source of light energy
- D. Carry out fermentation, producing carbon dioxide and ethanol from the available sugar

11. The nucleotide bases of DNA pair according to which specific rule?

- A. Adenine pairs with guanine, and cytosine pairs with thymine across the double helix
- B. Adenine pairs with cytosine, and guanine pairs with thymine across the double helix
- C. Adenine pairs with thymine, and guanine pairs with cytosine across the double helix
- D. Adenine pairs with uracil, and guanine pairs with thymine across the double helix

- 12.** Before a cell divides by mitosis, the DNA in the nucleus must first undergo:
- A. Translation, in which messenger RNA is used to build polypeptide chains at ribosomes
 - B. Replication, producing two identical copies of each chromosome before cell division begins
 - C. Transcription, in which a single-stranded RNA copy is made from a portion of the DNA
 - D. Mutation, in which the nucleotide sequence is permanently altered by intracellular enzymes
- 13.** Which structural feature distinguishes a molecule of RNA from a molecule of DNA?
- A. RNA contains the nitrogen base thymine, while DNA contains the nitrogen base uracil
 - B. RNA contains the sugar ribose, while DNA contains the slightly different sugar deoxyribose
 - C. RNA contains phosphate groups, while DNA contains only nitrogen base groups in its backbone
 - D. RNA always exists as a double helix, while DNA exists only as a single strand inside cells
- 14.** A messenger RNA codon consists of how many nucleotides?
- A. One nucleotide, which alone specifies which amino acid is added to the growing chain
 - B. Two nucleotides, which together code for one specific amino acid during translation
 - C. Four nucleotides, matching the four DNA bases used during gene transcription steps
 - D. Three nucleotides, which together specify a single amino acid during the translation process
- 15.** A change in the nucleotide sequence of a gene is best classified as:
- A. A mutation, which may or may not result in an altered protein product in the cell
 - B. A translation, which converts the codons of messenger RNA into a polypeptide chain
 - C. A replication, which copies the gene exactly during the S phase of the cell cycle
 - D. A transcription, which copies the DNA sequence into a complementary strand of mRNA
- 16.** In humans, somatic (body) cells normally contain how many chromosomes?
- A. 23 single chromosomes, one inherited from each parent during the process of fertilization
 - B. 92 chromosomes arranged into 46 separate homologous pairs in each diploid body cell
 - C. 46 chromosomes arranged into 23 homologous pairs in each diploid somatic body cell
 - D. 12 chromosomes organized into 6 distinct pairs found in every typical somatic body cell
- 17.** In a multicellular organism, mitosis is essential primarily for:
- A. Producing haploid gametes for use in sexual reproduction between two adult parents
 - B. Generating genetic variation among the offspring produced in the next generation
 - C. Reducing the chromosome number from diploid to haploid during the formation of gametes
 - D. Growth of the organism, repair of damaged tissues, and replacement of old worn-out cells
- 18.** Meiosis differs from mitosis in that meiosis:
- A. Produces four genetically unique haploid gametes with half the parent's chromosome number
 - B. Produces two diploid daughter cells that are genetically identical to the original parent cell

- C. Occurs in the body's somatic cells throughout the entire life span of the organism's body
- D. Does not involve the replication of DNA molecules before the cell division process begins

19. In sexual reproduction, the fusion of a sperm and an egg restores the diploid chromosome number through a process called:

- A. Mitosis, in which one parent cell divides to form two genetically identical daughter cells
- B. Fertilization, in which two haploid gametes unite to form a single diploid zygote cell
- C. Meiosis, in which homologous chromosomes are separated into different gamete cells
- D. Replication, in which DNA molecules are copied exactly before any cell division occurs

20. In humans, the sex of an offspring is determined by which factor?

- A. The combination of dominant and recessive autosomal alleles inherited from both parents
- B. The single X chromosome contributed by the mother during the formation of the egg cell
- C. The sex chromosome (X or Y) contributed by the father at the moment of fertilization
- D. The genotype of the maternal grandmother, passed through the egg cell to all offspring

21. Two parents who are both heterozygous for a trait ($Aa \times Aa$) have offspring. What proportion of the offspring is expected to be homozygous recessive (aa)?

- A. About 75 percent of the offspring under standard Mendelian inheritance rules and patterns
- B. About 50 percent of the offspring under standard Mendelian inheritance rules and patterns
- C. About 25 percent of the offspring under standard Mendelian inheritance rules and patterns
- D. About 100 percent of the offspring under standard Mendelian inheritance rules and patterns

22. In pea plants, the allele for purple flowers (P) is dominant over the allele for white flowers (p). A pea plant with the genotype Pp will most likely have:

- A. Purple flowers, because the dominant P allele masks the expression of the recessive p allele
- B. White flowers, because the recessive p allele is always expressed in heterozygous plants
- C. A mixture of purple and white flowers on the same plant due to the blending of the traits
- D. Pink flowers, because the two alleles blend evenly together to produce an intermediate color

23. Hemophilia is a sex-linked recessive disorder carried on the X chromosome. A father with hemophilia and a mother who is not a carrier will produce children with which expected pattern?

- A. All daughters with hemophilia and all sons completely unaffected by the disorder's symptoms
- B. Half of the daughters affected and half of the sons unaffected by the disorder in the family
- C. All sons with hemophilia and all daughters expressing the disorder in roughly equal numbers
- D. All daughters as carriers and all sons unaffected because they inherit a Y from the father

24. A pedigree chart is most useful to a genetic counselor for which of the following purposes?

- A. Determining the exact nucleotide sequence of a specific patient's gene of clinical interest
- B. Tracking how a trait is inherited through several generations of a single extended family

- C. Producing a high-resolution image of all the chromosomes inside a single human body cell
- D. Measuring the rate at which random mutations occur in human germline reproductive cells

25. The peppered moth population in industrial England shifted from mostly light-colored to mostly dark-colored as tree bark darkened with soot. This change is best explained by:

- A. Natural selection, with dark moths surviving and reproducing more successfully on dark bark
- B. Spontaneous generation of dark-colored moths directly from the soot deposited on tree bark
- C. Inheritance of acquired darkening that each moth developed during its own lifetime experience
- D. Conscious choice by light-colored moths to physically become darker over their adult lifetimes

26. Which of the following provides the strongest direct evidence that humans, chimpanzees, and gorillas share a recent common ancestor?

- A. All three species can survive in tropical climates with abundant rainfall and varied food sources
- B. All three species use their hands to grasp and manipulate small objects in their natural habitats
- C. All three species are roughly similar in their average adult body weight when measured in the wild
- D. All three species share a very high percentage of their DNA nucleotide sequences in common genes

27. The original source of genetic variation upon which natural selection acts is:

- A. Conscious adaptations made by individual organisms during their own lifetimes as they encounter challenges
- B. Random mutations in DNA, combined with the reshuffling of alleles during meiosis and sexual reproduction
- C. The constant, predictable expression of every gene in every individual organism in a given population
- D. Environmental signals that directly change the DNA of body cells in adult organisms during their lifetimes

28. A desert plant has a thick, waxy coating on its leaves. This feature is best described as:

- A. A symbiotic relationship between the plant and the desert soil bacteria community at its roots
- B. A behavioral response developed by the individual plant during its own lifetime in the desert
- C. An adaptation that reduces water loss and helps the plant survive in arid environmental conditions
- D. A mutation that has appeared only within the last single generation of this desert plant species

29. In the modern classification system, organisms are grouped from most general to most specific in the order:

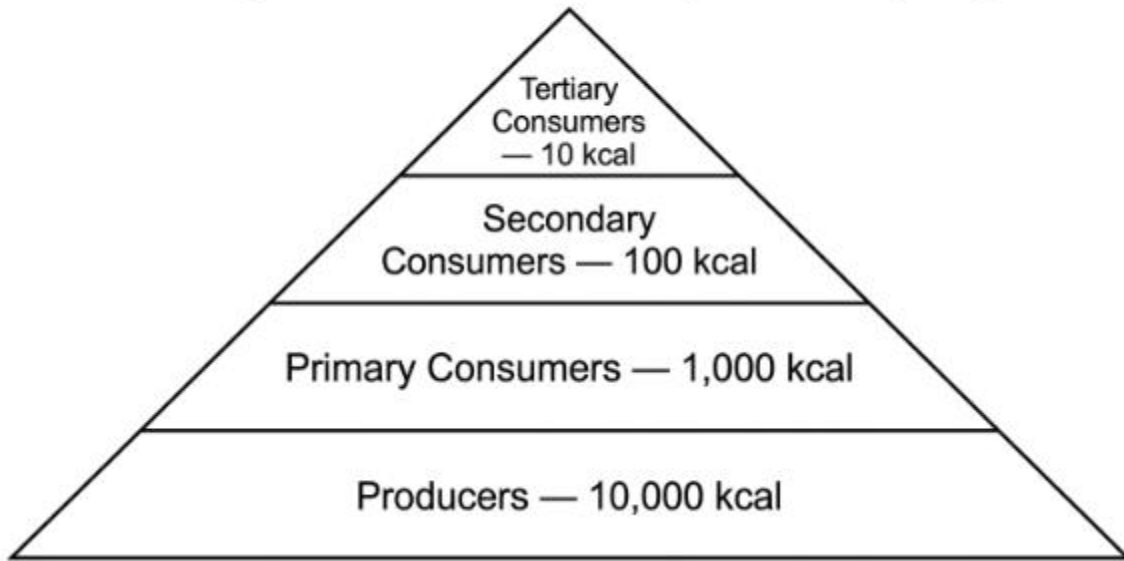
- A. Species, genus, family, order, class, phylum, kingdom, domain in the standard grouping system
- B. Domain, kingdom, phylum, class, order, family, genus, species in the standard grouping system
- C. Kingdom, domain, family, phylum, order, class, genus, species in the standard grouping system
- D. Genus, species, family, phylum, class, order, kingdom, domain in the standard grouping system

30. In a typical terrestrial food web, the producers obtain energy directly from:

- A. Sunlight, which is captured by chlorophyll molecules and converted into stored chemical energy
- B. Decomposing organic matter, which they absorb through their extensive underground root systems
- C. Other producer organisms that pass usable chemical energy along through interconnected root systems
- D. Cellular respiration, which they use as their primary source of usable chemical cellular energy

31. The energy pyramid below shows the approximate amount of energy available at each trophic level in a forest ecosystem.

Energy Available at Each Trophic Level (kcal).



Based on the pyramid, approximately what percentage of the energy at each level is passed on to the next trophic level above it?

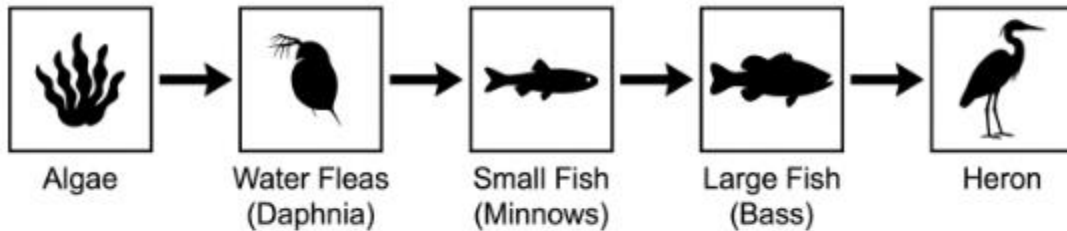
- A. About 100 percent, since all energy is conserved and passed directly upward in any food chain
- B. About 50 percent, since half of all energy is converted into predator body tissue at each step upward
- C. About 25 percent, since the rest is stored in the reproductive cells and gametes of those organisms
- D. About 10 percent, since most of the energy is lost as heat through respiration at each trophic level

32. Bacteria and fungi that break down dead organisms and return nutrients to the soil are best classified as:

- A. Producers, which build complex organic compounds using energy directly from sunlight each day
- B. Primary consumers, which eat producers as their main source of stored chemical energy from plants
- C. Decomposers, which break down dead organic material and recycle nutrients back into the soil
- D. Apex predators, which sit at the top of the food chain and have no natural predators of their own

33. A food chain in a freshwater pond is shown below.

Freshwater Pond Food Chain



In the food chain shown above, what does each arrow most directly represent?

- A. The direction of energy flow from one organism to the next organism in the food chain
- B. The direction of nutrient cycling among the four different organism types in the food chain
- C. The migration path that each species follows during a typical seasonal annual life cycle
- D. The order in which each species first evolved within this freshwater pond habitat over time

34. Plants, algae, and other producers remove carbon dioxide from the atmosphere primarily through which process?

- A. Cellular respiration, which converts glucose into carbon dioxide and water for energy production
- B. Decomposition, which breaks down dead organic material into simpler chemical compounds again
- C. Photosynthesis, which uses carbon dioxide and water to build glucose with energy from sunlight
- D. Nitrogen fixation, which converts atmospheric nitrogen gas into ammonia for plant root uptake

35. Which group of organisms is most essential for converting atmospheric nitrogen gas into a form usable by plants?

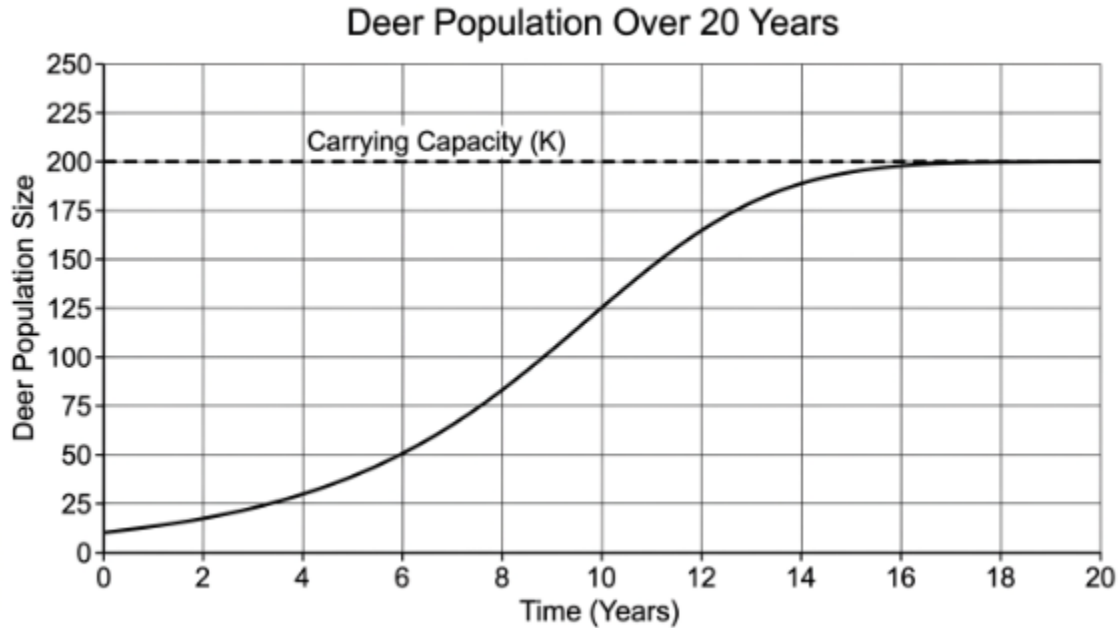
- A. Decomposing fungi, which break down dead plant and animal material in the surrounding soil
- B. Nitrogen-fixing bacteria, which live in the root nodules of legumes and in the surrounding soil
- C. Herbivorous insects, which eat plants and release nitrogen back into the soil through their waste
- D. Photosynthetic algae, which produce oxygen and release nitrogen gas through their green leaves

36. After a glacier retreats from an area of bare rock, lichens and mosses are typically the first organisms to colonize the area. This process is best classified as:

- A. Secondary succession, which begins in a disturbed area where soil is already present beforehand
- B. Convergent evolution, in which unrelated species independently evolve similar physical traits

- C. Ecological niche partitioning, which divides resources among similar species in a shared habitat
- D. Primary succession, which begins on bare rock or other surfaces with no existing soil present

37. The graph below shows the size of a deer population over time in a forest preserve.



At approximately which time interval was the deer population growing at its fastest rate?

- A. Between years 6 and 12, where the curve rises most steeply across the graphed time interval
- B. Between years 0 and 4, when the population was small and resources were essentially unlimited
- C. Between years 16 and 20, after the population has leveled off at its long-term stable size
- D. Between years 12 and 16, where the curve begins to flatten out as it nears carrying capacity

38. A limiting factor in an ecosystem is best defined as:

- A. Any environmental factor that increases the rate of reproduction in a population over time
- B. Any environmental factor that restricts the size or growth of a population in an ecosystem
- C. The total number of producer species available to all of the consumers in a given ecosystem
- D. The total amount of solar energy that reaches the ecosystem during one complete calendar year

39. Maintaining biodiversity in an ecosystem is important because biodiversity:

- A. Reduces the total number of producer species and simplifies the structure of the local food web
- B. Eliminates direct competition between species and allows one dominant species to flourish alone
- C. Allows ecosystems to function with only one species at each level of the food pyramid efficiently
- D. Increases ecosystem stability and the capacity to recover from environmental disturbances over time

40. The role of a species in its ecosystem — including how it obtains food, what it eats, and where it lives — is best described as the species':

- A. Habitat, which refers only to the geographic area where the species commonly lives in nature
- B. Population, which refers to the total number of individuals of the species living in a single area
- C. Niche, which describes the species' overall functional role within its ecological community
- D. Adaptation, which is any inherited trait that helps the species survive in its surrounding environment

41. A tick attached to a deer feeds on the deer's blood, harming the deer in the process. This type of relationship is best classified as:

- A. Mutualism, in which both organisms in the relationship clearly benefit from the close interaction
- B. Commensalism, in which one organism benefits and the other is neither helped nor harmed in any way
- C. Parasitism, in which one organism benefits directly at the expense of the other organism involved
- D. Competition, in which two organisms struggle for the same limited resources in their shared habitat

42. Homeostasis in living organisms is best defined as:

- A. The maintenance of a relatively stable internal environment despite changing external conditions
- B. The complete cessation of all metabolic activity during prolonged periods of environmental stress
- C. The process by which organisms reproduce sexually to produce genetically varied offspring populations
- D. The progressive aging of cells and tissues that naturally occurs over the lifespan of the organism

43. When body temperature rises above the normal set point, sweat glands release sweat that cools the body. This response is best classified as:

- A. A positive feedback loop, which amplifies the original change and moves the body further from set point
- B. A negative feedback loop, which reverses the original change and restores the body to normal conditions
- C. A direct hormone response, which permanently changes the body's normal target temperature value over time
- D. A reflex arc response, which bypasses the brain to produce an immediate involuntary muscle contraction

44. Which structure carries signals from one neuron to the next neuron at a synapse?

- A. The nucleus, which contains the genetic material that controls the daily activities of the cell
- B. The mitochondrion, which produces ATP to power the cell's many metabolic processes every day
- C. The cell wall, which surrounds the neuron and provides physical structural support to it directly
- D. Neurotransmitters, which are chemical messengers released across the synaptic cleft to the next neuron

45. Which type of blood vessel returns blood from the body's tissues back to the heart?

- A. Arteries, which carry blood away from the heart and toward the body's various organs and tissues
- B. Capillaries, which connect arterioles to venules and allow exchange of materials across thin walls

- C. Veins, which return blood toward the heart from the body's tissues at a relatively low pressure
- D. Lymphatic vessels, which collect tissue fluid and eventually return it to the bloodstream slowly

46. Gas exchange in the human lungs occurs primarily across the thin walls of which structures?

- A. The alveoli, tiny air sacs surrounded by capillaries located deep within each lobe of the lungs
- B. The bronchi, large airways that branch off the trachea and carry air into each of the two lungs
- C. The diaphragm, the dome-shaped muscle below the lungs that controls breathing movements directly
- D. The pharynx, the upper region of the airway shared by both the digestive and respiratory systems

47. Most chemical digestion and absorption of nutrients in humans takes place in which organ?

- A. The stomach, where strong acid and the enzyme pepsin begin the chemical breakdown of dietary protein
- B. The small intestine, where enzymes finish digestion and villi absorb nutrients into the bloodstream
- C. The large intestine, where water is reabsorbed and solid waste is formed before excretion from the body
- D. The esophagus, a muscular tube that transports swallowed food from the mouth down to the stomach

48. White blood cells help defend the body from infection primarily by:

- A. Carrying oxygen from the lungs to the body's tissues through the systemic circulatory system
- B. Producing the digestive enzymes needed to break down dietary food in the small intestine each day
- C. Releasing hormones that regulate the body's normal blood glucose levels in the hours after meals
- D. Recognizing foreign pathogens, producing antibodies, and engulfing invading microorganisms directly

49. The hormone insulin lowers blood glucose levels primarily by:

- A. Stimulating body cells to take up glucose from the bloodstream and store it as glycogen in liver
- B. Stimulating the breakdown of glycogen in the liver to release more glucose into the bloodstream
- C. Stimulating the kidneys to filter out and excrete excess glucose into the urine each day directly
- D. Stimulating the pancreas to produce additional new glucose during long periods of human fasting

50. The process by which a single fertilized egg cell (zygote) develops into a multicellular embryo with many specialized cell types involves:

- A. A single round of meiosis followed by random recombination of the offspring's inherited chromosomes
- B. Repeated rounds of mitosis along with the differentiation of cells into many specialized tissue types
- C. The fusion of multiple sperm cells with the egg to produce additional genetic material in the embryo
- D. The complete loss of all genetic material from each cell as the embryo's tissues continue to develop

Practice Exam 7: Life Science: Biology Simulation – Answer Key with Explanations

1. D — ATP transfers chemical energy to power cellular processes such as active transport. The terminal phosphate bond of ATP releases usable energy when broken, which drives muscle contraction, protein synthesis, active transport, and other endergonic reactions. ATP is the cell's primary energy currency, not a genetic, structural, or long-term storage molecule.

2. B — The mitochondrion, where glucose is broken down to produce ATP energy in cells. Aerobic respiration occurs in the mitochondrial matrix and inner membrane, where the Krebs cycle and electron transport chain generate most of the cell's ATP. This is why cells with high energy demand, such as muscle and nerve cells, contain especially large numbers of mitochondria.

3. A — Active transport, which uses energy to move particles from low to high concentration. Active transport relies on carrier proteins powered by ATP to pump particles against the concentration gradient, unlike passive processes that move particles down their gradient. The sodium-potassium pump in nerve cells is a classic example of this energy-requiring transport.

4. C — Diffusion, in which oxygen moves from higher to lower concentration across the membrane. Pond water contains a higher concentration of dissolved oxygen than the amoeba's cytoplasm, so oxygen passively crosses the membrane down its concentration gradient. No ATP is needed because the molecule is small, nonpolar, and moves with the gradient.

5. D — A rigid cell wall made primarily of cellulose surrounding the outside of the cell membrane. The cellulose cell wall provides structural support, protects against bursting in hypotonic conditions, and gives plant tissues their rigidity. Animal cells lack this feature and instead rely on the extracellular matrix and cytoskeleton for structural support.

6. A — Lowering the activation energy required for the reaction to proceed in the cell. Enzymes bind substrates at their active sites and stabilize the transition state, reducing the energy barrier that must be overcome for a reaction to occur. The enzyme itself is not consumed and can catalyze the same reaction repeatedly.

7. C — The chloroplasts, which contain chlorophyll that captures light energy from the sun. Chlorophyll in the thylakoid membranes absorbs photons to drive the light reactions, and the resulting ATP and NADPH power glucose synthesis in the stroma. Only plant and algal cells contain chloroplasts, which is why these organisms function as the primary producers of most ecosystems.

8. B — Carbon dioxide + water → glucose + oxygen, using light energy from the sun. Photosynthesis combines six molecules of CO₂ and six of H₂O, powered by light, to produce one glucose molecule and six O₂. This equation is essentially the reverse of cellular respiration and explains why plants are net consumers of CO₂ and producers of atmospheric oxygen.

- 9. A** — Glucose, a six-carbon sugar produced by photosynthesis or obtained from the diet. Glucose is oxidized through glycolysis, the Krebs cycle, and the electron transport chain to release energy stored in its chemical bonds. Oxygen is the final electron acceptor in this process, not the fuel itself.
- 10. D** — Carry out fermentation, producing carbon dioxide and ethanol from the available sugar. Yeast switches to anaerobic fermentation when oxygen is absent, regenerating NAD^+ so that glycolysis can continue producing small amounts of ATP. This same process is the basis of bread rising and alcoholic beverage production.
- 11. C** — Adenine pairs with thymine, and guanine pairs with cytosine across the double helix. A–T base pairs form two hydrogen bonds and G–C base pairs form three, and this complementarity is what allows accurate DNA replication. These pairing rules ensure that each new strand carries the same genetic information as the original.
- 12. B** — Replication, producing two identical copies of each chromosome before cell division begins. During the S phase of interphase, DNA polymerase synthesizes a complementary strand on each parental strand, producing two identical sister chromatids per chromosome. Without replication, daughter cells would inherit only half of the parent's genetic material.
- 13. B** — RNA contains the sugar ribose, while DNA contains the slightly different sugar deoxyribose. RNA also uses uracil in place of thymine and is typically single-stranded, while DNA is double-stranded. The presence of the extra hydroxyl group on ribose makes RNA less chemically stable than DNA, which suits its role as a short-lived genetic messenger.
- 14. D** — Three nucleotides, which together specify a single amino acid during the translation process. The triplet nature of the genetic code allows $4^3 = 64$ possible codons, which is more than enough to encode all 20 amino acids plus start and stop signals. This is why a deletion or insertion of one nucleotide produces a frameshift that disrupts every downstream codon.
- 15. A** — A mutation, which may or may not result in an altered protein product in the cell. Mutations include base substitutions, insertions, and deletions, and they can be silent, missense, nonsense, or frameshift in effect. Mutations are the original source of all new genetic variation in a population.
- 16. C** — 46 chromosomes arranged into 23 homologous pairs in each diploid somatic body cell. Each pair consists of one chromosome inherited from each parent, including 22 pairs of autosomes and one pair of sex chromosomes. Gametes are haploid and carry only 23 single chromosomes, which is restored to 46 at fertilization.
- 17. D** — Growth of the organism, repair of damaged tissues, and replacement of old worn-out cells. Mitosis produces two genetically identical diploid daughter cells, which is exactly what is needed for body growth, wound healing, and routine cell turnover. Meiosis, by contrast, is reserved for producing gametes with reduced chromosome number.
- 18. A** — Produces four genetically unique haploid gametes with half the parent's chromosome number. Meiosis includes two sequential divisions and incorporates crossing over and independent assortment,

generating extensive genetic variation. Reducing chromosome number to haploid is essential so that fertilization restores the correct diploid count.

19. B — Fertilization, in which two haploid gametes unite to form a single diploid zygote cell. The sperm and egg each contribute one set of chromosomes (n), and their fusion produces a $2n$ zygote. This combination of meiosis followed by fertilization is what maintains a constant chromosome number from generation to generation while creating genetic diversity.

20. C — The sex chromosome (X or Y) contributed by the father at the moment of fertilization. The mother always contributes an X, while the father contributes either an X (producing XX, female) or a Y (producing XY, male). This is why the father's gamete determines offspring sex in humans.

21. C — About 25 percent of the offspring under standard Mendelian inheritance rules and patterns. A monohybrid cross of two heterozygotes ($Aa \times Aa$) produces a 1:2:1 genotypic ratio of AA:Aa:aa, so one of every four offspring is predicted to be homozygous recessive. This is the same probability as the classic 3:1 phenotypic ratio's recessive portion.

22. A — Purple flowers, because the dominant P allele masks the expression of the recessive p allele. In complete dominance, a single dominant allele is sufficient to produce the dominant phenotype, so Pp and PP individuals appear identical. The recessive trait only appears in homozygous recessive (pp) individuals.

23. D — All daughters as carriers and all sons unaffected because they inherit a Y from the father. The affected father (X^hY) gives X^h to every daughter and Y to every son, while the non-carrier mother (X^HX^H) gives X^H to all children. Daughters therefore become X^HX^h carriers, and sons become X^HY and are unaffected because they receive no X from their father.

24. B — Tracking how a trait is inherited through several generations of a single extended family. Pedigree charts use standardized symbols to display affected and unaffected individuals across generations, revealing whether a trait is dominant, recessive, autosomal, or sex-linked. This information lets a counselor estimate the risk of an affected child in future pregnancies.

25. A — Natural selection, with dark moths surviving and reproducing more successfully on dark bark. Soot-darkened bark made light-colored moths more visible to predators, while dark moths were better camouflaged and survived to reproduce. Over generations, the heritable dark-color allele increased in frequency — a textbook example of differential reproductive success driving evolutionary change.

26. D — All three species share a very high percentage of their DNA nucleotide sequences in common genes. Shared DNA sequences provide direct molecular evidence of common ancestry because closely related species inherit recent shared mutations and gene arrangements. Behavioral and morphological similarities can also reflect ancestry, but DNA evidence is the most direct and quantitative.

27. B — Random mutations in DNA, combined with the reshuffling of alleles during meiosis and sexual reproduction. New alleles arise through mutation, and existing alleles are recombined into novel combinations through crossing over, independent assortment, and fertilization. Natural selection cannot act without this underlying variation, so the two processes together drive evolutionary change.

28. C — An adaptation that reduces water loss and helps the plant survive in arid environmental conditions. The waxy cuticle limits transpiration through the leaf surface, conserving precious water in dry climates. Such adaptations are heritable traits that have been favored by natural selection over many generations, not changes acquired by an individual plant.

29. B — Domain, kingdom, phylum, class, order, family, genus, species in the standard grouping system. This Linnaean hierarchy moves from the broadest grouping (domain) to the most specific (species), with each level containing all of the levels below it. Memory aids such as "Dear King Philip Came Over For Good Soup" are commonly used to recall the correct order.

30. A — Sunlight, which is captured by chlorophyll molecules and converted into stored chemical energy. Producers such as plants and algae are autotrophs that use photosynthesis to build glucose from CO₂ and water using light energy. This converted energy then becomes the foundation of the entire food web that supports the rest of the ecosystem.

31. D — About 10 percent, since most of the energy is lost as heat through respiration at each trophic level. The pyramid shows energy dropping by roughly a factor of ten between each level (10,000 → 1,000 → 100 → 10 kcal), reflecting the well-known 10% rule. The remaining 90% is dissipated as heat during cellular respiration or lost in undigested waste.

32. C — Decomposers, which break down dead organic material and recycle nutrients back into the soil. Decomposer bacteria and fungi release digestive enzymes that break complex organic molecules into simpler compounds, returning carbon, nitrogen, and other nutrients to the abiotic environment. Without decomposers, dead matter and locked-up nutrients would accumulate and cycles would halt.

33. A — The direction of energy flow from one organism to the next organism in the food chain. By convention, food-chain and food-web arrows always point from the organism being eaten to the organism doing the eating, tracing the path of energy and biomass. This is why arrows always run from producer toward higher-level consumers.

34. C — Photosynthesis, which uses carbon dioxide and water to build glucose with energy from sunlight. CO₂ is fixed into organic compounds during the light-independent (Calvin) reactions, which is the main way carbon enters the biotic portion of the carbon cycle. Cellular respiration and decomposition reverse the process by returning CO₂ to the atmosphere.

35. B — Nitrogen-fixing bacteria, which live in the root nodules of legumes and in the surrounding soil. These bacteria use the enzyme nitrogenase to convert atmospheric N₂ into ammonia, the first biologically usable form of nitrogen. Without this conversion, plants would have no access to the enormous reservoir of nitrogen in the atmosphere.

36. D — Primary succession, which begins on bare rock or other surfaces with no existing soil present. Lichens and mosses are classic pioneer species capable of colonizing bare rock, slowly building soil as they decompose. Secondary succession, by contrast, begins where soil and some life already remain after a disturbance.

37. A — Between years 6 and 12, where the curve rises most steeply across the graphed time interval. The steepest portion of a population curve indicates the fastest rate of change, which on a logistic curve occurs during the exponential phase between the lag and the leveling-off phases. Growth slows once the population approaches carrying capacity due to density-dependent limiting factors.

38. B — Any environmental factor that restricts the size or growth of a population in an ecosystem. Limiting factors include resources such as food, water, and space, as well as conditions such as temperature, disease, and predation. The most restrictive factor at any given time sets the upper limit on population size in that environment.

39. D — Increases ecosystem stability and the capacity to recover from environmental disturbances over time. Greater species diversity means more functional redundancy, so the loss of one species is less likely to collapse the system as a whole. Biodiverse ecosystems also tend to be more productive and better able to resist invasive species and disease.

40. C — Niche, which describes the species' overall functional role within its ecological community. A niche includes the species' food sources, habitat requirements, behaviors, and interactions with other species. Habitat refers only to physical location, so niche is the broader and more accurate term for the species' ecological "job."

41. C — Parasitism, in which one organism benefits directly at the expense of the other organism involved. The tick gains nutrition and a place to live, while the deer experiences blood loss, irritation, and possible disease transmission. This +/- relationship is the defining feature of parasitism and distinguishes it from mutualism and commensalism.

42. A — The maintenance of a relatively stable internal environment despite changing external conditions. Living organisms use feedback mechanisms to regulate variables such as temperature, pH, blood glucose, and water balance within narrow ranges. Disruption of homeostasis underlies many diseases and is often the trigger for clinical intervention.

43. B — A negative feedback loop, which reverses the original change and restores the body to normal conditions. Sweating opposes the rising body temperature by removing heat through evaporation, returning the body toward its set point. Most physiological control systems — blood glucose regulation, blood pressure, thermoregulation — rely on negative feedback to maintain homeostasis.

44. D — Neurotransmitters, which are chemical messengers released across the synaptic cleft to the next neuron. When an action potential reaches the axon terminal, vesicles release neurotransmitters that diffuse across the synapse and bind to receptors on the next neuron, triggering or inhibiting a new electrical signal. This chemical relay is what allows neurons to communicate across the small gap of the synapse.

45. C — Veins, which return blood toward the heart from the body's tissues at a relatively low pressure. Veins have thinner walls than arteries and contain one-way valves that prevent backflow, especially in the limbs. Blood pressure drops as blood moves through the capillaries, so additional structural features are needed to ensure venous return to the heart.

46. A — The alveoli, tiny air sacs surrounded by capillaries located deep within each lobe of the lungs. Their enormous combined surface area and extremely thin walls allow rapid diffusion of oxygen into the blood and carbon dioxide out of it. Damage to alveoli, as occurs in emphysema, dramatically impairs gas exchange and oxygen delivery to the body's tissues.

47. B — The small intestine, where enzymes finish digestion and villi absorb nutrients into the bloodstream. Pancreatic and intestinal enzymes complete the breakdown of carbohydrates, proteins, and fats, while finger-like villi and microvilli vastly expand the absorptive surface area. The vast majority of nutrient uptake into the circulatory system occurs in this organ.

48. D — Recognizing foreign pathogens, producing antibodies, and engulfing invading microorganisms directly. Different white blood cells specialize in different roles: phagocytes such as neutrophils and macrophages engulf microbes, while B lymphocytes produce specific antibodies. Together they form the cellular and chemical defenses that protect the body against infection.

49. A — Stimulating body cells to take up glucose from the bloodstream and store it as glycogen in liver. Insulin binds to receptors on liver, muscle, and fat cells, signaling increased glucose uptake and storage after meals. In type 1 diabetes, insufficient insulin production leaves blood glucose dangerously elevated, which is why exogenous insulin is required.

50. B — Repeated rounds of mitosis along with the differentiation of cells into many specialized tissue types. The zygote divides mitotically to produce billions of genetically identical cells, which then turn on different sets of genes to become muscle, nerve, skin, blood, and other specialized cell types. This combination of cell division and differentiation produces the complex multicellular body from a single starting cell.