

# PRACTICE EXAM 9: LIFE SCIENCE: BIOLOGY SIMULATION (50 QUESTIONS)

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**Instructions:** This simulation exam mirrors the format of the New York State Regents Examination in Life Science: Biology. Questions are organized into stimulus-based clusters. Read each cluster's stimulus completely before answering any questions in that set. Select the one best answer for each question.

*Base your answers to questions 1 through 5 on the information below and on your knowledge of biology.*

Meiosis is a specialized form of cell division that produces gametes used in sexual reproduction. It begins with a single diploid parent cell and proceeds through two consecutive divisions, meiosis I and meiosis II, without an intervening round of DNA replication. During prophase I, homologous chromosomes pair up and may exchange segments in a process called crossing over. Later, the homologous chromosomes separate independently of one another during anaphase I, and sister chromatids separate during anaphase II. The result is four daughter cells, each with half the chromosome number of the original parent cell and each carrying a unique combination of alleles.

1. What is the end result of meiosis starting from one parent cell?
  - A. Two genetically identical diploid daughter cells, just like the result of mitosis
  - B. Two haploid daughter cells with the same number of chromosomes as the parent cell
  - C. Four genetically identical diploid daughter cells from one original parent cell
  - D. Four genetically unique haploid daughter cells from one original parent cell
2. At what point during meiosis does crossing over typically occur?
  - A. During interphase, before the chromosomes have begun condensing into compact structures
  - B. During prophase I, when homologous chromosomes pair up and exchange genetic segments
  - C. During anaphase II, when sister chromatids separate to opposite poles of the cell
  - D. During telophase II, after the daughter nuclei have already begun to reform inside the cells

3. Why is meiosis essential for sexual reproduction in eukaryotic organisms?
- A. It produces genetically identical cells that can replace damaged body tissues efficiently
  - B. It produces extra copies of chromosomes that gradually increase organism size over time
  - C. It produces haploid gametes that combine during fertilization to restore the diploid number
  - D. It produces diploid cells that contain twice the genetic material of the original parent
4. If a parent organism has 24 chromosomes in its body cells, how many chromosomes will each gamete contain after meiosis?
- A. 12 chromosomes, exactly half the number found in the parent's normal body cells
  - B. 24 chromosomes, the same number found in the parent's normal body cells
  - C. 48 chromosomes, exactly twice the number found in the parent's normal body cells
  - D. 6 chromosomes, exactly one-quarter the number found in the parent's body cells
5. Which two mechanisms during meiosis most directly increase the genetic variation found in offspring?
- A. Mitosis of body cells and the chemical breakdown of DNA molecules during cell division
  - B. Crossing over during prophase I and independent assortment of homologous chromosomes
  - C. Replication of DNA during S phase and the repair of damaged genes by cellular enzymes
  - D. Active transport of chromosomes and the synthesis of new ribosomes in daughter cells

*Base your answers to questions 6 through 9 on the information below and on your knowledge of biology.*

A flower is the reproductive structure of a flowering plant. The diagram below shows a typical flower with its main parts labeled. The male parts (stamens) consist of an anther and a filament, while the female parts (the pistil) include the stigma, style, and ovary. The ovary contains one or more ovules, which house the egg cells. Many flowers depend on insects, birds, or other animals to transfer pollen between flowers of the same species during pollination.

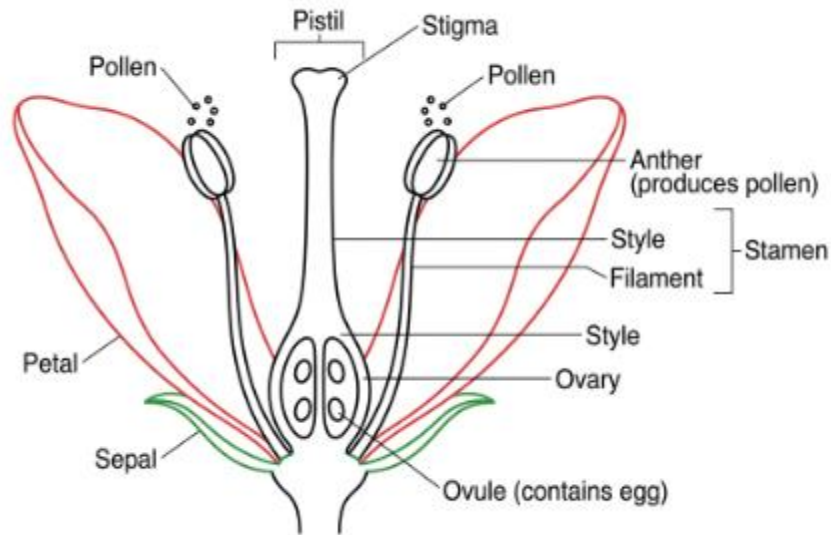


Figure PQ-1

6. Which structure in the flower produces pollen?

- A. The stigma, the sticky structure at the top of the female part of the flower
- B. The ovary, the structure that contains and protects the egg cells of the plant
- C. The petal, the colorful structure that attracts pollinators such as bees and birds
- D. The anther, the structure at the top of the stamen that produces pollen grains

7. Pollination is the transfer of pollen from one structure to another. Which transfer correctly describes pollination?

- A. From the anther of one flower to the stigma of a flower of the same plant species
- B. From the ovary of one flower to the stigma of a flower of the same plant species
- C. From the stigma of one flower to the ovary of a flower of the same plant species
- D. From the roots of one plant to the leaves of another plant of the same species

8. After pollination, a pollen grain grows a pollen tube down through the style. Where does the pollen tube ultimately deliver its sperm cells?

- A. To the petals, where the pollen tube delivers nutrients required for fruit growth
- B. To the leaves, where the pollen tube delivers sugars produced during photosynthesis
- C. To the egg in the ovule, where fertilization produces a zygote that develops into a seed
- D. To the stamen, where new pollen grains are produced for the next pollination event

9. What is the most likely advantage to a flowering plant of having brightly colored petals and producing sweet nectar?

- A. They allow the plant to absorb additional sunlight for photosynthesis throughout the day
- B. They attract animal pollinators that transfer pollen between flowers of the same species

- C. They store starch reserves that the plant uses during long periods of low sunlight
- D. They prevent herbivores from eating the leaves and stems of the flowering plant

*Base your answers to questions 10 through 14 on the information below and on your knowledge of biology.*

The endocrine system uses chemical messengers called hormones to coordinate activities throughout the body. Hormones are produced by endocrine glands and travel through the bloodstream to reach target cells. One of the most important roles of the endocrine system is regulating internal conditions through negative feedback. For example, when body temperature rises above the normal set point, the brain's hypothalamus triggers responses such as sweating and dilation of skin blood vessels to release heat. When body temperature falls below the set point, the hypothalamus triggers shivering and constriction of skin blood vessels to conserve heat. These responses act to restore body temperature to its normal range.

**10.** Which statement best defines a hormone?

- A. A chemical signal produced by an endocrine gland and transported through the bloodstream
- B. A type of nerve cell that carries electrical impulses between different regions of the brain
- C. A digestive enzyme produced by the stomach that breaks down proteins into amino acids
- D. A structural protein found in muscle tissue that contracts to produce body movement

**11.** How does endocrine signaling typically differ from nervous-system signaling?

- A. Endocrine signals travel along neurons, while nerve signals travel through the bloodstream
- B. Endocrine signals are faster than nerve impulses but reach fewer target cells over time
- C. Endocrine signals use electrical pulses, while nerve signals use chemical messengers entirely
- D. Endocrine signals travel through the blood and act more slowly, while nerve signals are rapid

**12.** When body temperature rises above the normal set point, the body responds by:

- A. Shivering to generate heat through rapid involuntary muscle contractions across the body
- B. Constricting blood vessels near the skin surface to reduce heat loss from the body
- C. Sweating, which absorbs heat from the body as the sweat evaporates from the skin
- D. Increasing the rate of cellular respiration to generate additional heat throughout the body

**13.** The shivering response triggered when body temperature falls below normal is best described as:

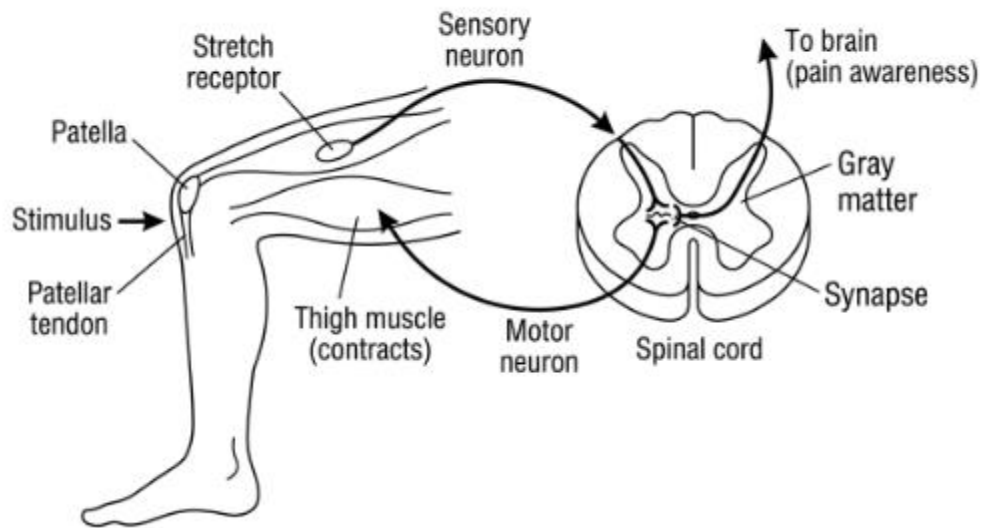
- A. A negative feedback response that reverses the original drop in the body's temperature
- B. A positive feedback response that amplifies the original drop in the body's temperature
- C. An example of homeostatic failure caused by overactive hormone-producing glands in the body
- D. A direct response of skin cells to cold rather than a coordinated body-wide nervous response

14. A specific hormone produces an effect in some cells but not in others. The most likely reason is that:
- A. The hormone is the only signal molecule the responsive cells encounter in the bloodstream
  - B. The responsive cells have receptor proteins that bind specifically to that hormone molecule
  - C. The responsive cells are located physically next to the gland that produced the hormone
  - D. The hormone is produced at a much higher concentration than any other hormone in the body

*Base your answers to questions 15 through 19 on the information below and on your knowledge of biology.*

A reflex is a rapid, involuntary response to a stimulus. The diagram below shows the pathway of a simple knee-jerk reflex. When a doctor taps the patellar tendon just below the kneecap, a stretch receptor in the thigh muscle is activated. The receptor sends a signal along a sensory neuron to the spinal cord. In the spinal cord, the signal is passed directly to a motor neuron, which carries the signal back to the thigh muscle, causing the muscle to contract and the lower leg to kick forward. The signal also reaches the brain, but the reflex response is already underway before conscious awareness occurs.

**Figure PQ-2**



15. In the knee-jerk reflex, the sensory neuron carries the signal from the stretch receptor directly to:
- A. The brain, where the response is consciously planned before being sent back down to the leg
  - B. The skin, where the receptor is located and processes the response by itself immediately
  - C. The muscle cells in the thigh, where the contraction occurs before any signal is processed
  - D. The spinal cord, where the signal is passed directly to a motor neuron without the brain

**16.** What is the main advantage of a reflex arc?

- A. It produces a slow, deliberate response that requires careful conscious thought from the brain
- B. It bypasses the spinal cord and sends signals directly from receptors to muscles in the body
- C. It produces a rapid, involuntary response that protects the body before conscious awareness
- D. It strengthens voluntary muscle movements over time through repeated practice and learning

**17.** Neurons communicate with other neurons across a small gap called:

- A. The axon, the long extension that carries the electrical signal away from the cell body
- B. The synapse, where neurotransmitter molecules carry the signal to the next neuron
- C. The dendrite, the short branched extension that receives signals from other neurons
- D. The myelin sheath, the insulating layer that increases the speed of the nerve impulse

**18.** What is the role of the motor neuron in this reflex arc?

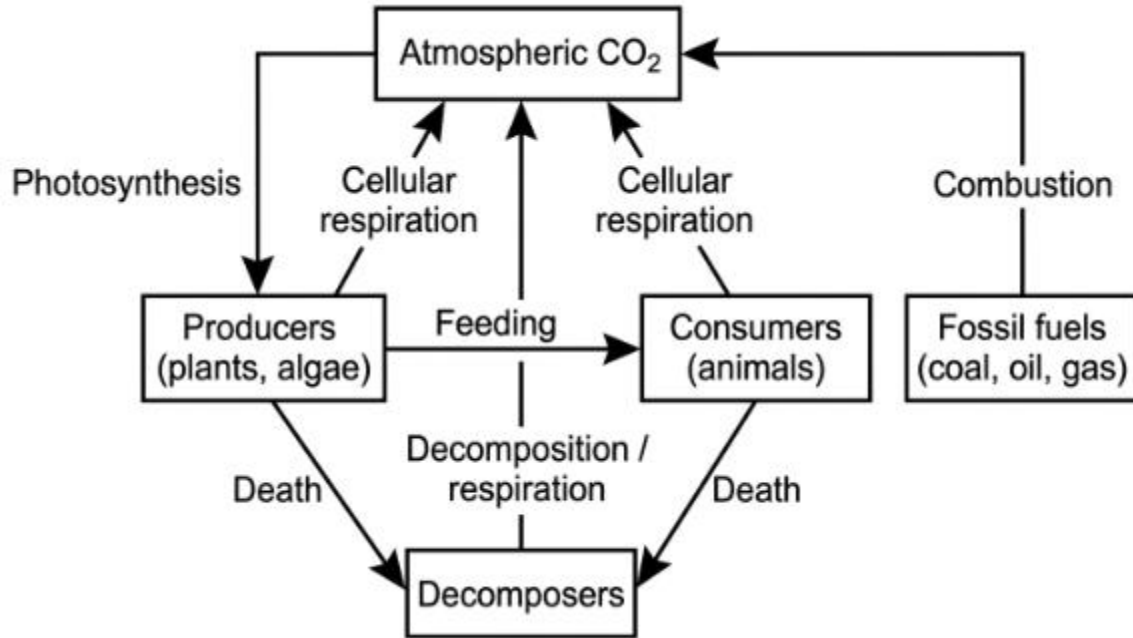
- A. It carries the signal from the spinal cord to a muscle or gland to produce the response
- B. It carries the signal from a sensory receptor to the spinal cord for further processing
- C. It interprets the meaning of the sensory information arriving at the brain for awareness
- D. It destroys damaged tissue and releases inflammatory chemicals at the site of injury

**19.** A person touches a hot stove and pulls their hand away before they consciously feel the pain. This sequence occurs because:

- A. The brain processes the pain signal much faster than the reflex arc completes its response
- B. The pain signal travels through the spinal cord only after the reflex response has finished
- C. The reflex arc completes its response through the spinal cord before the brain processes pain
- D. The reflex arc and the conscious pain processing occur at the same time but in different organs

*Base your answers to questions 20 through 24 on the information below and on your knowledge of biology.*

Carbon is constantly cycled between the atmosphere, living organisms, the oceans, and Earth's solid surface. The diagram below shows the major paths of the carbon cycle. Producers absorb carbon dioxide from the atmosphere during photosynthesis and incorporate carbon into organic compounds such as glucose. Consumers obtain carbon by eating producers or other consumers. Cellular respiration in living organisms returns carbon to the atmosphere as CO<sub>2</sub>. Decomposers break down dead organisms and release additional CO<sub>2</sub>. Combustion of fossil fuels and biomass also returns stored carbon to the atmosphere.



**20.** Producers move carbon from the atmosphere into living organisms through which process?

- A. Cellular respiration, which converts oxygen into stored carbohydrate molecules in cells
- B. Decomposition, which breaks dead material directly into atmospheric carbon dioxide gas
- C. Combustion, which burns plant material to release carbon dioxide into the atmosphere
- D. Photosynthesis, which converts atmospheric CO<sub>2</sub> into organic compounds such as glucose

**21.** When an animal eats a plant and then performs cellular respiration, the carbon originally found in the plant material is:

- A. Released back into the atmosphere as CO<sub>2</sub> produced by the animal's cellular respiration
- B. Stored in the animal's bones for many millions of years before being released slowly
- C. Converted directly into nitrogen gas that escapes through the lungs of the animal
- D. Transferred to the animal's chloroplasts where it is used for further photosynthesis

**22.** Coal, oil, and natural gas are known as fossil fuels because they represent:

- A. Recently formed carbon compounds produced by living plants during the last several decades
- B. Carbon that was removed from the atmosphere millions of years ago and stored underground
- C. Carbon that is released continuously from active volcanic eruptions over the past century
- D. Atmospheric nitrogen that has been converted to a solid form by ancient soil bacteria

**23.** Decomposers play an important role in the carbon cycle by:

- A. Capturing carbon from the air and storing it permanently in their cellular structures
- B. Producing oxygen as they break down dead organic matter on the forest floor over time
- C. Converting carbon dioxide into nitrogen compounds that plants can absorb through their roots
- D. Breaking down dead organisms and releasing CO<sub>2</sub> back to the atmosphere through respiration

24. How does the large-scale burning of fossil fuels affect the atmospheric CO<sub>2</sub> concentration?

- A. It removes CO<sub>2</sub> from the atmosphere by converting it into solid carbon deposits underground
- B. It has no measurable effect on atmospheric CO<sub>2</sub> levels because the carbon is fully recycled
- C. It adds CO<sub>2</sub> to the atmosphere that had been stored underground for millions of years
- D. It transforms atmospheric CO<sub>2</sub> into harmless water vapor that quickly leaves the atmosphere

*Base your answers to questions 25 through 29 on the information below and on your knowledge of biology.*

A farmer applies large amounts of nitrogen and phosphorus fertilizer to crops planted in fields next to a small pond. After several heavy rainstorms, much of the fertilizer washes off the fields and into the pond. Within a few weeks, a thick layer of green algae forms on the pond surface. Several weeks later, large numbers of dead fish are observed along the shoreline. Researchers studying the pond record the changes shown in the table below.

Time	Observation
Week 0 (before runoff)	Clear water; healthy fish population; moderate plant growth
Week 2 (after runoff)	Heavy algal bloom covers the surface of the pond
Week 5	Dead algae sinking to the bottom; bacterial decomposition accelerates
Week 6	Dissolved oxygen drops sharply; large fish die-off observed at shore

25. What is the most direct cause of the algal bloom observed at Week 2?

- A. A rapid increase in algae and aquatic plant growth because of the added fertilizer nutrients
- B. The immediate death of all fish in the pond from direct contact with the fertilizer chemicals
- C. A sudden rise in dissolved oxygen because the fertilizer contains free oxygen molecules
- D. A complete loss of aquatic plant life because the fertilizer is toxic to plant cells

26. Why did dissolved oxygen drop sharply between Week 5 and Week 6?

- A. The remaining algae stopped photosynthesizing entirely and began consuming oxygen for growth
- B. The fish themselves consumed all of the dissolved oxygen during their attempt to escape the pond
- C. Bacteria decomposing the dead algae consumed large amounts of oxygen during respiration
- D. The fertilizer chemicals reacted with the oxygen molecules and converted them into water

27. What is the most likely effect of reduced dissolved oxygen on the pond's fish population?

- A. Fish populations grow rapidly because lower oxygen levels reduce competition for available food
- B. Fish populations decline or die because most fish species require dissolved oxygen to survive

- C. Fish populations remain unchanged because fish can use atmospheric oxygen instead of dissolved
- D. Fish populations evolve gills within several days that can extract oxygen from the pond sediment

**28.** The overall process by which nutrient pollution leads to oxygen depletion in a body of water is called:

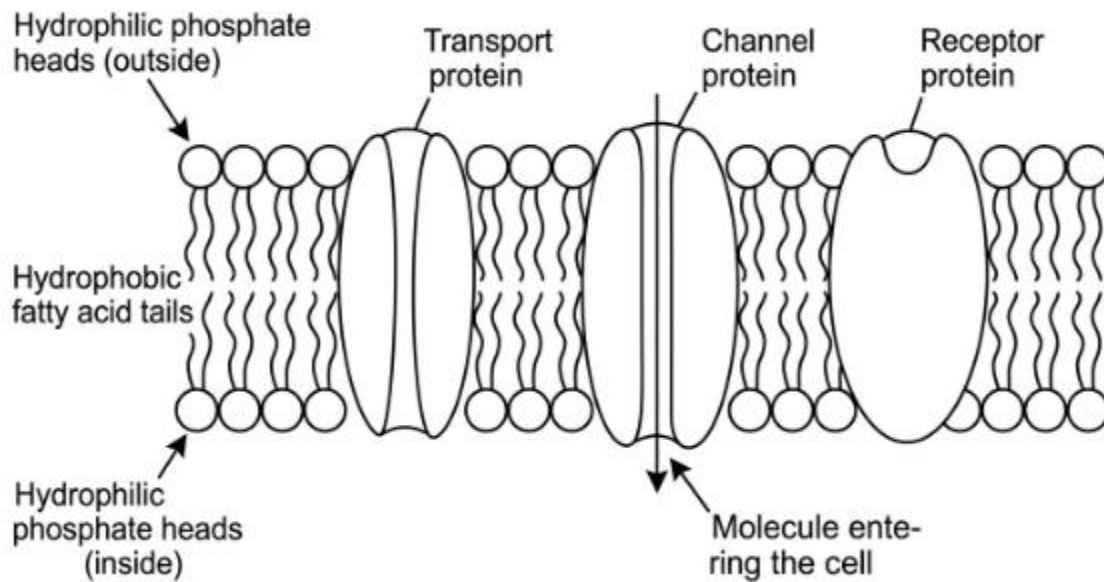
- A. Acidification, in which dissolved carbon dioxide lowers the pH of the surrounding water body
- B. Biomagnification, in which toxic substances accumulate at the top of the food chain over time
- C. Desertification, in which fertile land is gradually converted into dry, unproductive desert habitat
- D. Eutrophication, in which excess nutrients drive overgrowth and subsequent oxygen depletion

**29.** Which farming practice would most directly reduce eutrophication in nearby ponds?

- A. Increasing the amount of fertilizer applied so crops can absorb it before it runs off the field
- B. Removing all natural vegetation from buffer zones to make farming easier on flat sloping land
- C. Applying only the amount of fertilizer crops can use and maintaining vegetated buffer strips
- D. Replacing organic fertilizers with synthetic ones that dissolve quickly in surface water flow

*Base your answers to questions 30 through 35 on the information below and on your knowledge of biology.*

The cell membrane controls what enters and leaves a cell. Its main structural component is a phospholipid bilayer, in which two layers of phospholipid molecules orient themselves with their hydrophilic ("water-loving") phosphate heads facing the watery environment outside and inside the cell, and their hydrophobic ("water-fearing") fatty acid tails facing each other in the interior of the membrane. Embedded throughout the bilayer are proteins that function as channels, pumps, receptors, and identification markers. This arrangement is called the fluid mosaic model. The diagram below shows a small section of the cell membrane.



**30.** Which statement best describes the basic structural component of the cell membrane?

- A. A phospholipid bilayer, with hydrophilic heads facing outward and hydrophobic tails facing inward
- B. A single layer of cholesterol molecules that wraps around the cell and provides structural rigidity
- C. A solid sheet of protein that completely encloses the cell with no openings whatsoever
- D. A double layer of carbohydrate molecules that blocks all substances from entering the cell

**31.** Which molecules can most easily cross the phospholipid bilayer through simple diffusion?

- A. Large, charged ions such as sodium and potassium, which fit between adjacent phospholipids
- B. Large polar molecules such as glucose, which are strongly attracted to the hydrophilic heads
- C. Charged amino acid molecules, which interact with the polar surface of the cell membrane
- D. Small, nonpolar molecules such as oxygen and carbon dioxide, which dissolve in the lipid layer

**32.** How does facilitated diffusion differ from simple diffusion?

- A. Facilitated diffusion requires the use of ATP to move particles against a concentration gradient
- B. Facilitated diffusion uses transport proteins to help molecules pass through the cell membrane
- C. Facilitated diffusion always moves particles from low to high concentration without any help
- D. Facilitated diffusion takes place only in plant cells, not in animal cells of any kind in nature

**33.** Active transport differs from diffusion in which essential way?

- A. Active transport requires energy from ATP because particles move against the concentration gradient
- B. Active transport moves particles down their concentration gradient without any use of cellular energy
- C. Active transport occurs only through the phospholipid bilayer without help from any membrane protein
- D. Active transport moves only water molecules, while diffusion moves all other substances in cells

**34.** A nerve cell uses the sodium-potassium pump to move sodium ions out of the cell and potassium ions into the cell. This process is best classified as:

- A. Simple diffusion, since both ions are moving down their concentration gradients passively
- B. Facilitated diffusion, since transport proteins allow the ions to pass through the cell membrane
- C. Active transport, since ATP is used to move both ions against their concentration gradients
- D. Osmosis, since water molecules follow the sodium and potassium across the cell membrane

**35.** A large protein molecule must be brought into a cell, but it is far too big to fit through any membrane channel. The cell most likely uses which process?

- A. Active transport through the sodium-potassium pump, which can handle large molecules normally
- B. Simple diffusion through the phospholipid bilayer using the hydrophobic interior of the membrane
- C. Facilitated diffusion through a specific protein channel large enough to accommodate the molecule
- D. Endocytosis, in which the cell membrane folds inward and engulfs the molecule inside a vesicle

*Base your answers to questions 36 through 40 on the information below and on your knowledge of biology.*

In snapdragons, flower color is determined by a single gene with two alleles. Plants with two red alleles (RR) have red flowers. Plants with two white alleles (rr) have white flowers. Plants with one red allele and one white allele (Rr) have pink flowers — an intermediate color between red and white. This inheritance pattern is called incomplete dominance.

**36.** A red snapdragon (RR) is crossed with a white snapdragon (rr). What is the expected phenotype of all the offspring of this cross?

- A. All offspring will be red, because red is completely dominant over white in snapdragons
- B. All offspring will be pink, an intermediate color between the two parental phenotypes
- C. All offspring will be white, because white is completely dominant over red in snapdragons
- D. Half of the offspring will be red and half will be white in a one-to-one phenotypic ratio

**37.** What distinguishes incomplete dominance from complete dominance?

- A. One allele is fully dominant and the other allele is fully recessive in the offspring phenotype
- B. Both alleles are expressed fully and produce two separate traits in the same individual
- C. Neither allele is fully dominant, so the heterozygote shows a blended intermediate phenotype
- D. The heterozygote shows only one of the two parental phenotypes selected randomly each generation

**38.** Two pink snapdragons (Rr × Rr) are crossed. What is the expected phenotypic ratio of the offspring?

- A. 1 red : 2 pink : 1 white, because heterozygous offspring show the intermediate pink phenotype
- B. 3 red : 1 white, because red is dominant over white in the snapdragon plant population
- C. 1 red : 1 white, because the two alleles separate evenly in a typical monohybrid cross
- D. All pink offspring, because two pink parents always produce only pink children in this cross

**39.** Incomplete dominance differs from codominance because:

- A. Incomplete dominance involves three alleles, while codominance involves only two alleles
- B. Incomplete dominance produces a blended intermediate, while codominance shows both traits fully
- C. Incomplete dominance occurs only in plants, while codominance occurs only in animals
- D. Incomplete dominance never produces heterozygotes, while codominance always does so

**40.** A pink snapdragon (Rr) is crossed with a white snapdragon (rr). What is the probability that any single offspring of this cross will have pink flowers?

- A. 0%, because pink and white parents cannot produce any pink offspring in this cross
- B. 25%, because only one in four offspring will inherit the R allele needed for pink color
- C. 75%, because most offspring will inherit at least one R allele in a typical monohybrid cross
- D. 50%, because the pink (Rr) parent passes the R allele to half of the offspring with white parent

*Base your answers to questions 41 through 45 on the information below and on your knowledge of biology.*

Multiple independent lines of evidence support the theory that all living organisms share common ancestors and that species change over time. Comparative anatomy reveals that the forelimbs of many vertebrates contain the same basic set of bones, even though those limbs are now used for very different functions. Embryology shows that the early embryos of many distantly related vertebrates pass through similar developmental stages. Comparisons of DNA sequences between species reveal patterns of similarity and difference that reflect evolutionary relationships. Some species retain vestigial structures — reduced or non-functional remnants of organs that performed important functions in their ancestors.

**41.** The forelimbs of humans, whales, bats, and cats all contain the same basic arrangement of bones, even though those limbs are used very differently. Such structures are best classified as:

- A. Vestigial structures, which are remnants of organs that no longer perform their original function
- B. Analogous structures, which evolved independently to perform the same function in unrelated species
- C. Homologous structures, which share a common evolutionary origin despite different current functions
- D. Convergent structures, which are produced when two unrelated species adapt to the same environment

**42.** The wings of a bird and the wings of an insect both function in flight but have very different internal structures and very different evolutionary origins. These wings are best classified as:

- A. Analogous structures, which evolved independently to perform similar functions in different lineages
- B. Homologous structures, which share a recent common ancestor with the same internal body plan
- C. Vestigial structures, which have lost their original function during recent evolutionary history
- D. Embryonic structures, which appear only during the very early stages of development in animals

**43.** Why do comparisons of DNA sequences between species provide useful evidence for evolution?

- A. All species have exactly the same DNA sequence, proving they all share a single common ancestor
- B. Species with more recent common ancestors should have completely different DNA sequences overall
- C. DNA sequence comparisons are far less reliable than fossil evidence for studying species ancestry
- D. Species with more recent common ancestors generally have more similar DNA sequences overall

**44.** The early embryos of fish, chickens, and humans show striking similarities, including features such as pharyngeal arches and similar body shapes. The most likely explanation is that:

- A. Embryos of all vertebrates are exposed to the same environment during their developmental period
- B. These species share a common ancestor that passed down similar early developmental processes
- C. The embryos of different vertebrate species can interbreed to produce hybrid embryos in nature
- D. Modern vertebrates independently developed identical embryos through convergent evolution recently

**45.** A vestigial structure such as the human appendix or the pelvic bones of whales supports the theory of evolution because it suggests that:

- A. The structure once had a function in a common ancestor but is now reduced or non-functional
- B. The structure has never had any function in any species across all of evolutionary time on Earth
- C. Humans and whales developed all of their body structures completely independently of one another
- D. The structure was deliberately designed to disappear gradually over many human generations

*Base your answers to questions 46 through 50 on the information below and on your knowledge of biology.*

Human activities have caused significant changes to ecosystems and have driven many species toward extinction. In response, engineers, ecologists, and policy makers have developed a range of conservation strategies. These include replacing fossil-fuel energy with renewable sources such as solar and wind power, creating wildlife corridors to connect fragmented habitats, and establishing protected areas that conserve the habitat of endangered species. Each strategy involves trade-offs among ecological benefit, cost, land use, and social impact.

- 46.** Solar panels and wind turbines reduce greenhouse gas emissions because:
- A. They absorb carbon dioxide directly from the atmosphere as they generate clean electric power
  - B. They produce more oxygen than they consume during the generation of electric power for use
  - C. They generate electricity without burning fossil fuels, avoiding the release of CO<sub>2</sub> to the air
  - D. They destroy existing greenhouse gases in the atmosphere upon contact with metal rotor blades
- 47.** One ecological concern associated with large-scale wind energy installations is that:
- A. The turbines release large amounts of carbon dioxide when their blades rotate at high speed
  - B. Wind turbines can injure or kill birds and bats that fly near the rotating turbine blades
  - C. The turbines deplete the atmosphere of oxygen needed by other organisms in the area
  - D. The turbines drain groundwater from the surrounding soil, affecting nearby vegetation
- 48.** Compared with fossil fuels, biofuels made from plants are often considered more sustainable because:
- A. Biofuels release no carbon dioxide at all when they are burned for energy in motor vehicles
  - B. Biofuels can be produced indoors without using any land, water, or soil resources at all
  - C. Biofuels generate ten times more energy per gallon than gasoline or diesel fuel produced today
  - D. The plants used to make biofuels remove CO<sub>2</sub> from the atmosphere during their normal growth
- 49.** When evaluating the trade-offs of an engineered conservation solution such as a wildlife corridor, scientists must consider:
- A. Only the cost of the project in U.S. dollars over the next single calendar year of construction
  - B. Only the number of new species created by the project within the affected ecosystem each year
  - C. Effectiveness, cost, land use, impact on local communities, and benefit to target wildlife species
  - D. Only the visual appeal of the corridor as seen from a major nearby highway or major paved road
- 50.** A protected area established to conserve an endangered species is most likely to succeed in the long term if it:
- A. Is large enough to support a healthy breeding population and is connected to other suitable habitats
  - B. Excludes all human activity completely, including scientific research and monitoring efforts on site
  - C. Contains only the single endangered species and excludes all other plant and animal species nearby
  - D. Is located in a region with extreme climate conditions that very few other organisms can tolerate

## Practice Exam 9 – Full Explained Answer Key

- 1. D** — Meiosis consists of two consecutive divisions following a single round of DNA replication, producing four daughter cells from one parent cell. Each daughter cell has half the chromosome number (haploid) and a unique combination of alleles due to crossing over and independent assortment. This contrasts with mitosis, which yields two identical diploid cells.
- 2. B** — Crossing over takes place during prophase I when homologous chromosomes pair up to form tetrads and physically exchange corresponding segments at points called chiasmata. This exchange reshuffles alleles between maternal and paternal chromosomes. It is a major source of genetic variation in sexually reproducing organisms.
- 3. C** — Meiosis cuts the chromosome number in half so that when two gametes fuse during fertilization, the resulting zygote has the correct diploid number. Without this halving, chromosome number would double every generation. Halving and recombining is the genetic foundation of sexual reproduction.
- 4. A** — Meiosis halves the chromosome number from diploid to haploid, so a parent with 24 chromosomes in its body cells produces gametes with 12 chromosomes each. Fertilization restores the diploid number to 24 in the resulting zygote. This pattern holds for every sexually reproducing species.
- 5. B** — Crossing over (in prophase I) shuffles alleles between homologous chromosomes, and independent assortment (in metaphase I) determines which homolog of each pair enters which gamete. Together these two events produce enormous variability in gamete genotypes. They are the two main meiotic sources of genetic diversity.
- 6. D** — The anther sits at the tip of each stamen and produces pollen grains, which contain the male gametes (sperm cells) of the flowering plant. The filament simply supports the anther in position. Without functional anthers, pollination and seed production cannot occur.
- 7. A** — Pollination is defined as the transfer of pollen from the anther (male part) to a stigma (female part), typically of a flower of the same species. The pollen does not yet contact the egg; that requires a subsequent pollen tube. This distinction between pollination and fertilization is fundamental to plant reproduction.
- 8. C** — After landing on the stigma, the pollen grain grows a pollen tube down through the style to the ovary, delivering sperm cells to an egg inside an ovule. Fertilization there produces a zygote that develops within the ovule into a seed. The ovule then matures into the seed coat, and the surrounding ovary often becomes a fruit.
- 9. B** — Brightly colored petals serve as visual signals and nectar serves as a food reward, both of which attract animal pollinators such as bees, butterflies, and hummingbirds. As these animals move between flowers in search of nectar, they incidentally transfer pollen. This co-evolved relationship is a classic example of mutualism.
- 10. A** — A hormone is a chemical messenger produced by an endocrine gland, released into the bloodstream, and delivered to distant target cells that respond to it. This definition distinguishes hormones

from neurotransmitters, digestive enzymes, and structural proteins. Hormones provide the body's slow, system-wide coordination.

**11. D** — Endocrine signals travel slowly through the bloodstream and can produce long-lasting, body-wide effects, while nervous signals travel as fast electrochemical impulses along neurons to specific targets. Each system is suited to different kinds of coordination. Together they form the body's two main communication networks.

**12. C** — When core temperature rises, the hypothalamus triggers sweating; as sweat evaporates from the skin, it carries heat energy away with it (evaporative cooling). Vasodilation of surface blood vessels also helps release heat. Both responses move temperature back toward the set point.

**13. A** — Shivering is triggered when temperature falls below the set point and generates heat that drives temperature back up, reversing the original deviation — the defining characteristic of negative feedback. Negative feedback maintains homeostasis by opposing change. Positive feedback would instead amplify the deviation.

**14. B** — A target cell responds to a particular hormone only if it expresses the matching receptor protein, which binds that hormone with high specificity and initiates a cellular response. Cells lacking the receptor ignore the hormone even though it reaches them through the bloodstream. Receptor specificity is the basis for selective hormone action.

**15. D** — In a simple reflex, the sensory neuron carries the signal from the stretch receptor straight to the spinal cord, where it synapses directly with a motor neuron. The brain is informed only afterward. This short pathway is what makes reflexes so fast.

**16. C** — The reflex arc is designed for speed: by routing the response through the spinal cord without first requiring conscious processing in the brain, the body can produce protective movements (like pulling a hand away from heat) before damage occurs. This involuntary, rapid response is the defining feature of a reflex.

**17. B** — A synapse is the small gap between the axon terminal of one neuron and the dendrite of the next, across which chemical neurotransmitters carry the signal. The arriving impulse causes vesicles to release neurotransmitter, which then binds receptors on the next neuron. Synapses are the principal sites of neural communication and modulation.

**18. A** — A motor neuron is an efferent neuron that carries signals away from the central nervous system to effectors such as skeletal muscles or glands, producing the actual response. In the reflex arc it conveys the spinal cord's command to the muscle. Without functioning motor neurons, the reflex cannot be executed.

**19. C** — The reflex arc completes its loop entirely within the spinal cord, allowing the hand to withdraw before the slower pathway that carries pain information up to the brain produces conscious awareness. This separation of automatic protective action from conscious sensation is the survival advantage of reflexes. It is why we feel pain only after we have already pulled away.

**20. D** — Photosynthesis is the process by which producers (plants, algae, and cyanobacteria) capture CO<sub>2</sub> from the atmosphere and combine it with water using light energy to synthesize glucose. This step pulls inorganic carbon into the food web. It is the main pathway for carbon entry from the atmosphere into living matter.

**21. A** — Cellular respiration oxidizes glucose back to CO<sub>2</sub> and water, releasing energy as ATP; the CO<sub>2</sub> produced is exhaled (in animals) into the atmosphere. The carbon atoms that entered the plant via photosynthesis are thereby returned to the atmospheric pool. This continual cycling balances carbon uptake and release in healthy ecosystems.

**22. B** — Coal, oil, and natural gas formed from the buried remains of organisms that lived hundreds of millions of years ago; their carbon was effectively removed from the atmospheric cycle and locked underground. Burning them now returns that ancient carbon to today's atmosphere. This is why fossil-fuel combustion is such a significant contributor to atmospheric CO<sub>2</sub> rise.

**23. D** — Decomposers carry out cellular respiration as they break down dead plants, dead animals, and waste, releasing the carbon stored in those organisms back into the atmosphere as CO<sub>2</sub>. Without decomposers, carbon would remain locked in dead biomass. This recycling step closes the carbon cycle in ecosystems.

**24. C** — Combustion of fossil fuels transfers carbon that had been buried for hundreds of millions of years into the atmosphere as CO<sub>2</sub> at a rate far faster than natural sinks can absorb it. The result is a net increase in atmospheric CO<sub>2</sub> since the Industrial Revolution. This excess CO<sub>2</sub> is the main driver of contemporary climate change.

**25. A** — Nitrogen and phosphorus are the primary limiting nutrients in most freshwater systems, so a sudden influx from fertilizer runoff allows algae populations to grow explosively. This rapid surface growth is observed as a green bloom. It is the first visible stage of eutrophication.

**26. C** — When the algal bloom dies and sinks, decomposer bacteria break down the dead biomass through aerobic respiration, consuming large amounts of dissolved oxygen in the process. The resulting oxygen depletion is called hypoxia. This is why oxygen drops sharply only after the bloom collapses.

**27. B** — Fish, like most aerobic aquatic organisms, depend on dissolved oxygen extracted across their gills to support cellular respiration. When dissolved oxygen falls below a critical threshold, fish suffocate and die in large numbers. Massive fish die-offs are the most familiar visible consequence of eutrophication.

**28. D** — Eutrophication is the technical term for the sequence in which excess nutrients fuel overgrowth of algae, decomposition of that biomass consumes oxygen, and aquatic life is harmed. It is among the most widespread forms of water pollution worldwide. Recognizing this term is essential for understanding nutrient management.

**29. C** — Matching fertilizer application to crop needs minimizes the surplus available for runoff, and vegetated buffer strips along waterways absorb and trap nutrients before they reach the water. Together

these practices reduce nutrient loading at the source. They are core components of agricultural best-management practices.

**30. A** — The cell membrane is built around a phospholipid bilayer whose polar (hydrophilic) phosphate heads face the watery environments on both sides and whose nonpolar (hydrophobic) fatty acid tails face inward toward each other. This arrangement is energetically stable in water. It also creates the membrane's selective barrier to charged and polar substances.

**31. D** — Small nonpolar molecules such as  $O_2$  and  $CO_2$  readily dissolve in the hydrophobic interior of the bilayer and diffuse across it without assistance. Charged ions and large polar molecules cannot cross unaided because the fatty acid tails repel them. This selective permeability is fundamental to membrane function.

**32. B** — Facilitated diffusion still moves substances down their concentration gradient (no ATP required), but it relies on membrane transport proteins (channels or carriers) to provide a path through the hydrophobic interior. This allows polar and charged molecules to cross. The defining feature is protein assistance with passive movement.

**33. A** — Active transport moves substances against their concentration gradient, which is energetically unfavorable; the energy required is supplied by ATP. Diffusion, by contrast, requires no energy because particles move down their gradient. This is why active transport is essential for maintaining concentration differences across membranes.

**34. C** — The sodium-potassium pump uses energy from ATP to move  $Na^+$  out of and  $K^+$  into the cell, in each case moving the ion against its concentration gradient. This is the textbook example of primary active transport. It establishes the electrochemical gradient required for nerve impulse generation.

**35. D** — Endocytosis enables a cell to engulf large molecules or particles by folding a portion of its plasma membrane around the material and pinching off a vesicle containing it. This bulk-transport mechanism handles substances too large for any channel or carrier. The reverse process, exocytosis, releases large molecules from the cell.

**36. B** — In incomplete dominance the heterozygote ( $Rr$ ) shows a phenotype intermediate between the two homozygotes, so an  $RR \times rr$  cross produces all  $Rr$  offspring with pink flowers. Neither allele fully masks the other. Pink is therefore the visible expression of the heterozygous condition.

**37. C** — In incomplete dominance neither allele is fully dominant, so the heterozygote shows a blended phenotype between the two homozygous extremes. This contrasts with complete dominance, where the heterozygote is indistinguishable from one homozygote. Snapdragons are the classic textbook example.

**38. A** — An  $Rr \times Rr$  cross produces offspring in the genotypic ratio 1  $RR$  : 2  $Rr$  : 1  $rr$ ; because heterozygotes are pink, the phenotypic ratio is 1 red : 2 pink : 1 white. The phenotypic and genotypic ratios are identical under incomplete dominance. This is a hallmark Punnett-square outcome to recognize on the exam.

**39. B** — In incomplete dominance the heterozygote shows a single blended intermediate phenotype, while in codominance both alleles are expressed simultaneously and produce distinguishable separate traits (as with type AB blood). Both involve two alleles. The key distinction is "blended" versus "both expressed fully."

**40. D** — An  $Rr \times rr$  cross produces gametes  $R$  and  $r$  from the pink parent and only  $r$  from the white parent, yielding  $Rr$  (pink) and  $rr$  (white) offspring in a 1:1 ratio. Therefore 50 percent of offspring are expected to be pink. This is a classic test-cross outcome.

**41. C** — Homologous structures share the same underlying anatomical plan because they were inherited from a common ancestor, even when their current functions differ. The shared bone arrangement in vertebrate forelimbs (humerus, radius, ulna, carpals) reveals this shared ancestry. Homology is among the strongest forms of evidence for evolution.

**42. A** — Analogous structures perform similar functions but arose independently in lineages without a recent common ancestor, often through convergent evolution to similar environmental challenges. Bird wings (modified forelimbs) and insect wings (cuticular outgrowths) share function but not internal structure. Their similarity is therefore not evidence of close ancestry.

**43. D** — DNA accumulates mutations over time, so the longer two lineages have been separated, the more their sequences diverge. Closely related species share more sequence similarity than distantly related ones. Molecular phylogenies rely directly on this principle.

**44. B** — Shared early embryological features such as pharyngeal arches and tail buds reflect a developmental program inherited from a common vertebrate ancestor. Modifications later in development produce the very different adult forms. This pattern is a core piece of evidence for descent with modification.

**45. A** — A vestigial structure makes evolutionary sense as the reduced remnant of an organ that was fully functional in an ancestor but is no longer useful in the descendant. The human appendix and the pelvic bones of whales fit this description. Their presence is difficult to explain without an evolutionary history.

**46. C** — Solar panels and wind turbines convert sunlight or wind directly into electricity through physical processes that release no  $CO_2$ . By displacing fossil-fuel combustion in the power grid, they prevent additional greenhouse-gas emissions. This is the central climate benefit of these renewable technologies.

**47. B** — Spinning turbine blades strike birds and bats that fly into the rotor swept area, causing significant wildlife mortality, especially among migratory species. This is a well-documented ecological cost of wind energy. Modern siting, design changes, and detection-based shutdowns aim to reduce these impacts.

**48. D** — Biofuel crops absorb  $CO_2$  from the atmosphere during photosynthesis as they grow, and burning the biofuel re-releases roughly that same carbon — keeping the carbon already in active circulation rather than adding ancient fossil carbon. This partial carbon-neutrality is the sustainability argument for biofuels. Land-use change and fertilizer use can still reduce that benefit substantially.

**49. C** — Engineered conservation projects must be evaluated across multiple dimensions: how well the project achieves its ecological goal, what it costs, what land it requires, how it affects nearby human communities, and how it benefits the target species. Optimizing any one factor in isolation leads to poor outcomes. Systems-level analysis is the hallmark of sound conservation engineering.

**50. A** — Long-term species survival requires populations large enough to maintain genetic diversity and recover from disturbance, and habitat connectivity that allows migration, dispersal, and gene flow between populations. Reserves that are too small or too isolated tend to lose species over time. Reserve size and connectivity are therefore central to modern conservation design.