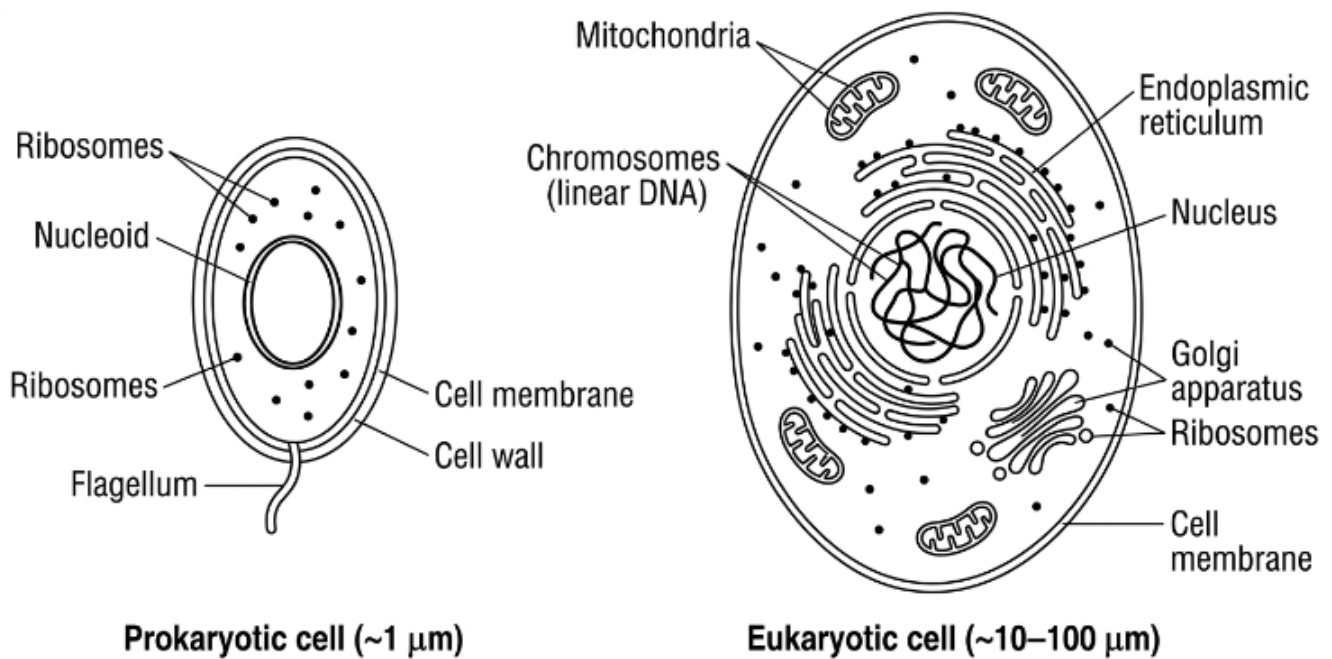


PRACTICE EXAM 32: LIFE SCIENCE: BIOLOGY SIMULATION (50 QUESTIONS)

Instructions: This simulation exam mirrors the format of the New York State Regents Examination in Life Science: Biology and emphasizes comparative judgment between two scenarios, assertion-reason pairs, and multi-step cause-and-effect chain reasoning. Read each stimulus and any accompanying diagram carefully before answering the 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.

Two types of cells are commonly studied in introductory biology: prokaryotic cells (such as bacteria) and eukaryotic cells (such as those found in plants, animals, fungi, and protists). The diagram below compares key features of each cell type.



1. The most fundamental structural difference between the two cell types shown is:
 - A. Eukaryotic cells contain a membrane-bound nucleus that prokaryotic cells lack
 - B. Eukaryotic cells contain ribosomes while prokaryotic cells use other structures
 - C. Prokaryotic cells contain a cell membrane while eukaryotic cells lack one entirely
 - D. Prokaryotic cells contain DNA while eukaryotic cells use only RNA for genetic information

2. A student claims that prokaryotic cells must perform cellular respiration in mitochondria, just as eukaryotic cells do. This claim is best evaluated as:
 - A. Correct, because all living cells contain mitochondria for energy production
 - B. Correct, because bacteria evolved from mitochondria during early Earth history
 - C. Incorrect, because prokaryotic cells do not perform cellular respiration at all
 - D. Incorrect, because prokaryotic cells perform respiration across the cell membrane

3. Why does the size difference between the two cell types ($\sim 1 \mu\text{m}$ vs. $\sim 20 \mu\text{m}$) have significant biological consequences?
 - A. Smaller prokaryotic cells require larger amounts of DNA to function properly always
 - B. Larger eukaryotic cells have a low surface-to-volume ratio, requiring internal transport
 - C. Smaller prokaryotic cells contain more organelles per unit volume than eukaryotes
 - D. Larger eukaryotic cells require fewer ribosomes than prokaryotic cells typically contain

4. Which feature is shared by BOTH cell types as shown in the diagram?
 - A. A membrane-bound nucleus that houses the cell's DNA
 - B. Mitochondria for cellular respiration and energy production
 - C. Ribosomes that carry out the process of protein synthesis
 - D. An endoplasmic reticulum for protein folding and modification

5. The endosymbiotic theory proposes that mitochondria descended from free-living prokaryotic cells engulfed by an early eukaryote. Which observation from the diagram is most consistent with this theory?
 - A. Mitochondria are bean-shaped structures whose size is comparable to whole prokaryotic cells
 - B. Mitochondria contain membrane-bound nuclei similar to those of eukaryotic cells
 - C. Mitochondria are absent from eukaryotic cells but present in prokaryotic cells instead
 - D. Mitochondria are connected to the eukaryotic cell membrane on the outside surface

Base your answers to questions 6 through 10 on the information below and on your knowledge of biology.

Cells produce ATP through cellular respiration, which can occur with or without oxygen. The table below compares aerobic respiration (with oxygen) and anaerobic fermentation (without oxygen) in terms of inputs, products, and ATP yield.

| Feature | Aerobic Respiration | Anaerobic Fermentation |
|-----------------------|---|--|
| Oxygen required? | Yes | No |
| Starting molecule | Glucose | Glucose |
| Final products | CO ₂ , H ₂ O, ATP | Lactic acid (or ethanol + CO ₂), ATP |
| ATP yield per glucose | ~32 ATP | 2 ATP |
| Cellular location | Cytoplasm + mitochondria | Cytoplasm only |

6. A muscle cell engaged in heavy exercise begins to produce lactic acid. Which sequence best explains why?

- A. Oxygen supply lags demand → mitochondria can't process pyruvate → cells switch to fermentation
- B. Lactic acid is a normal product of aerobic respiration → exercise just increases this product
- C. Muscle cells permanently switch to fermentation during all exercise regardless of oxygen level
- D. Mitochondria stop working completely during heavy exercise and produce no ATP whatsoever

7. If a yeast cell and a human muscle cell both perform fermentation, the products differ because:

- A. Yeast cells use a different starting molecule than glucose during fermentation
- B. Yeast and muscle cells contain different enzymes that convert pyruvate to different end products
- C. Yeast cells do not produce any ATP during fermentation while muscle cells do produce some
- D. Yeast cells require oxygen for fermentation while muscle cells operate completely without it

8. The 16-fold higher ATP yield of aerobic respiration is best explained by:

- A. Aerobic respiration fully oxidizes glucose to CO₂, extracting energy at multiple stages further
- B. Aerobic respiration uses a smaller starting glucose molecule than fermentation requires
- C. Anaerobic fermentation extracts more energy per stage but operates in fewer stages overall
- D. Anaerobic fermentation breaks glucose into less stable byproducts that release energy slowly

9. A student makes the following assertion and reason. **Assertion:** Anaerobic fermentation is less efficient than aerobic respiration. **Reason:** Aerobic respiration fully breaks down glucose to carbon dioxide and water. Which best evaluates the statements?

- A. Both the assertion and the reason are correct, and the reason explains the assertion
- B. Both the assertion and the reason are correct, but the reason does not explain the assertion
- C. The assertion is correct but the reason is incorrect for this cellular process described
- D. Both the assertion and the reason are incorrect statements about cellular respiration processes

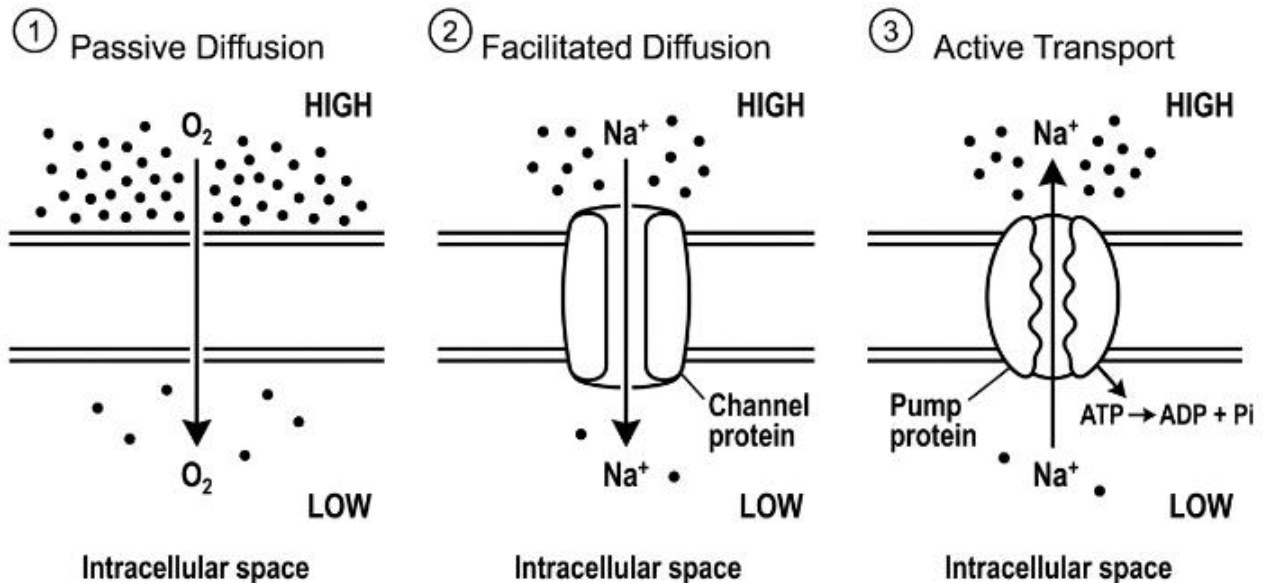
10. A bacterium living in deep ocean sediments where oxygen is absent must rely on which process to produce ATP?

- A. Aerobic respiration using dissolved CO₂ in place of oxygen as the final electron acceptor
- B. Photosynthesis using deep-sea geothermal light as the energy source for ATP production
- C. Mitochondrial respiration using the bacterium's own internal supply of stored oxygen
- D. Anaerobic fermentation or anaerobic respiration using molecules other than oxygen present

Base your answers to questions 11 through 15 on the information below and on your knowledge of biology.

Cells move materials across their cell membranes by several different mechanisms. The diagram below compares passive diffusion, facilitated diffusion (via a channel protein), and active transport (via a pump protein).

[Figure PQ-2]: Passive and Active Transport mechanisms compared



11. Which property of the oxygen molecule allows it to cross the membrane by passive diffusion without protein assistance?

- A. Oxygen molecules carry a strong positive electrical charge at the cell surface
- B. Oxygen molecules are larger than the gaps between phospholipid tails normally
- C. Oxygen molecules attach to channel proteins on the outside of the cell surface
- D. Oxygen molecules are small and nonpolar, so they slip through the lipid bilayer

12. The fundamental difference between facilitated diffusion (Panel 2) and active transport (Panel 3) is:

- A. Facilitated diffusion moves materials against gradient while active transport moves them down it
- B. Active transport requires ATP energy while facilitated diffusion does not require any energy expenditure
- C. Facilitated diffusion uses pump proteins while active transport uses channel proteins instead
- D. Only facilitated diffusion requires a protein embedded in the cell membrane structure

13. A nerve cell maintains a high concentration of K^+ inside and a high concentration of Na^+ outside the cell. Which sequence of events best explains how this gradient is established?

- A. Passive diffusion moves Na^+ in and K^+ out \rightarrow no energy required \rightarrow gradient builds spontaneously
- B. Na^+/K^+ pump uses ATP \rightarrow moves Na^+ out and K^+ in against gradients \rightarrow ion imbalance results
- C. Cell membrane permeable only to K^+ \rightarrow K^+ flows in passively \rightarrow Na^+ remains outside randomly
- D. Facilitated diffusion of both ions \rightarrow equal concentrations are reached \rightarrow the gradient stabilizes

14. An assertion and a reason are given. **Assertion:** A nerve cell at rest is in homeostasis but not at equilibrium with its surroundings. **Reason:** The cell must continuously expend energy to maintain its internal ion concentrations. Which best evaluates the statements?

- A. The assertion is correct but the reason does not explain why homeostasis differs from equilibrium
- B. The assertion is incorrect but the reason describes a real cellular process accurately
- C. Both the assertion and the reason are incorrect statements about cellular function overall
- D. Both the assertion and the reason are correct, and the reason explains the assertion

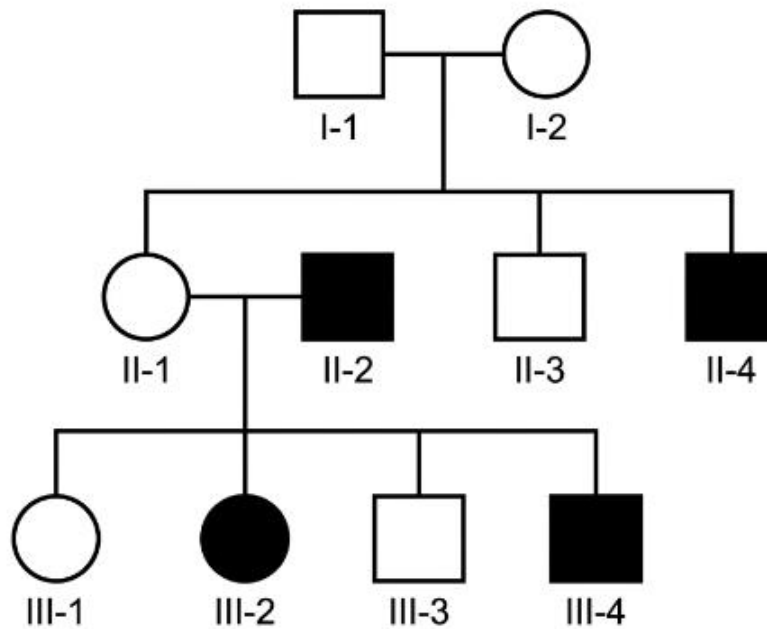
15. Which scenario would result in osmosis MOVING water OUT of a cell?

- A. The cell is placed in a solution with the same solute concentration as inside the cell
- B. The cell is placed in a solution with a much lower solute concentration than its interior
- C. The cell is placed in a solution with a much higher solute concentration than its interior
- D. The cell membrane becomes completely impermeable to all water molecules everywhere immediately

Base your answers to questions 16 through 20 on the information below and on your knowledge of biology.

Color blindness is a recessive trait caused by a defective allele on the X chromosome. A pedigree below shows the inheritance pattern in one family across three generations. Filled symbols indicate affected individuals; squares represent males and circles represent females.

Color Blindness Pedigree — Three Generations



16. Why are males more frequently affected by color blindness than females?

- A. Males inherit color vision genes from their mother only and never from their father
- B. Males have only one X chromosome, so a single defective allele produces the trait
- C. Females inherit color vision genes from their father only and never from their mother
- D. Females require three defective alleles for the trait to become visible in their phenotype

17. II-1 is described as an "unaffected carrier" of the color-blindness allele. This means she:

- A. Has two defective X-linked alleles but shows no symptoms of color blindness
- B. Has no defective alleles but can still transmit color blindness to her offspring
- C. Has one defective X-linked allele and one normal allele, masking the trait
- D. Has color blindness but does not yet show clinical symptoms of the condition

18. II-1 (carrier) and II-2 (affected) have a daughter, III-2, who is affected. The probability that any daughter of this couple is affected is:

- A. 50% — half the daughters will receive defective alleles from both parents
- B. 25% — only one quarter of daughters inherit two defective alleles from parents
- C. 75% — most daughters inherit at least one defective X allele from their father
- D. 100% — all daughters will inherit the defective allele and show color blindness

19. An assertion and a reason are given. **Assertion:** II-2 (affected father) cannot have passed his defective allele to III-3 (unaffected son). **Reason:** Sons inherit their X chromosome from their mother, not their father. Which best evaluates the statements?

- A. Both the assertion and the reason are correct, but the reason does not explain the assertion
- B. Both the assertion and the reason are correct, and the reason explains the assertion
- C. The assertion is correct but the reason describes the wrong chromosomal inheritance pattern
- D. The assertion is incorrect because sons can inherit X chromosomes from their fathers directly

20. Which is the most likely genotype of I-2 (unaffected female), given that one of her sons (II-4) shows color blindness?

- A. XX — homozygous affected, although she shows no symptoms outwardly
- B. XX* — heterozygous carrier with one defective allele transmitted to children
- C. XX — homozygous normal, with no defective allele available to transmit
- D. X*Y — sex chromosome anomaly that did not produce color blindness phenotype

Base your answers to questions 21 through 25 on the information below and on your knowledge of biology.

DNA replication occurs before every cell division to ensure that each daughter cell receives a complete copy of the genome. Errors during replication can introduce mutations, which may be repaired by cellular machinery or may persist and affect the resulting protein. Researchers are studying a particular DNA region where a single base-pair error has occurred.

21. During DNA replication, the original double-stranded DNA molecule:

- A. Unwinds and each strand serves as a template for building a new complementary strand
- B. Splits into individual nucleotides that reassemble into two new DNA molecules
- C. Is destroyed completely so two entirely new DNA molecules can be built from scratch
- D. Remains intact while two new DNA molecules are built next to it without templates

22. Which sequence best traces the cause-and-effect chain that produces a defective protein from a single DNA base error?

- A. DNA error → ribosome breaks down → no protein is produced from the gene anywhere
- B. DNA error → DNA replication stops permanently → all cell division fails completely
- C. DNA error → altered mRNA codon → altered amino acid → protein structure changed
- D. DNA error → ribosome refuses to translate → DNA is repaired immediately every time

23. A point mutation changes one DNA nucleotide from A to G in the coding region of a gene. The resulting mRNA codon would change correspondingly. Which is the most likely consequence of this change?

- A. The amino acid coded by that codon may or may not change, depending on the code
- B. The amino acid coded by that codon will always change, since every codon codes for one

- C. The protein's translation will always stop at this codon and produce a truncated protein
- D. The protein will always retain its original function because amino acid changes are very rare

24. A different cell has a mutation in its DNA repair machinery. Which long-term consequence is most likely?

- A. The cell will divide more rapidly to compensate for the repair deficiency over time
- B. The cell will produce more enzymes to replace the missing repair proteins quickly
- C. The cell will stop dividing and undergo apoptosis within a few hours of mutation
- D. The cell will accumulate mutations over time at a higher rate than normal cells

25. An assertion and a reason are given. **Assertion:** A mutation in a non-coding region of DNA might still affect the cell's function. **Reason:** Non-coding regions contain regulatory sequences that control whether and when genes are transcribed. Which best evaluates the statements?

- A. The assertion is correct but the reason describes coding regions, not non-coding regions
- B. The assertion is incorrect because non-coding DNA has no influence on gene expression
- C. Both the assertion and the reason are correct, and the reason explains the assertion
- D. Both the assertion and the reason are incorrect statements about DNA biology overall

Base your answers to questions 26 through 30 on the information below and on your knowledge of biology.

Two island bird species are studied to understand how natural selection has shaped their beaks. Species X eats hard seeds available year-round on its island; Species Y eats nectar and small insects from flowering plants. The data table compares their average beak measurements over 50 years.

| Measurement | Species X (year 1) | Species X (year 50) | Species Y (year 1) | Species Y (year 50) |
|------------------|--------------------|---------------------|--------------------|---------------------|
| Beak depth (mm) | 9.2 | 10.8 | 4.1 | 4.0 |
| Beak length (mm) | 11.5 | 11.6 | 14.3 | 16.2 |
| Population size | 1,200 | 1,400 | 900 | 850 |

26. The beak depth changes shown for Species X over 50 years are best explained by:

- A. Random variations unrelated to the seeds the birds eat from year to year
- B. Behavioral choices made consciously by each individual bird across its lifetime
- C. Climate change directly causing physical reshaping of beaks during the birds' adult lives
- D. Natural selection favoring individuals whose deeper beaks crack hard seeds more efficiently

27. The Species Y beak length increase is best explained by:

- A. The birds growing longer beaks during each year due to constant flower-feeding behavior
- B. Random chance producing longer-beaked individuals at a higher rate than shorter ones
- C. Population decline causing each remaining individual bird to develop longer beaks gradually
- D. Natural selection favoring longer beaks that reach nectar deep inside flowers more efficiently

28. The fact that Species X beak DEPTH changed substantially but Species Y beak depth did NOT change significantly is most directly explained by:

- A. Species Y lives on a different island that has no seeds available for the birds anywhere
- B. Species Y has been studied for a shorter total time period than Species X overall
- C. Beak depth provides little selective advantage for Species Y, which eats nectar and insects
- D. Species Y has stopped evolving entirely while Species X continues to evolve actively now

29. Which scenario would most likely cause the two species to evolve toward MORE similar beak shapes over time?

- A. The plant species producing nectar disappear and Species Y shifts to eating hard seeds instead
- B. A predator that hunts both species moves into the area and increases its predation pressure
- C. The two species merge into one interbreeding population with no genetic separation
- D. Climate conditions remain stable for both species and selection pressures do not change at all

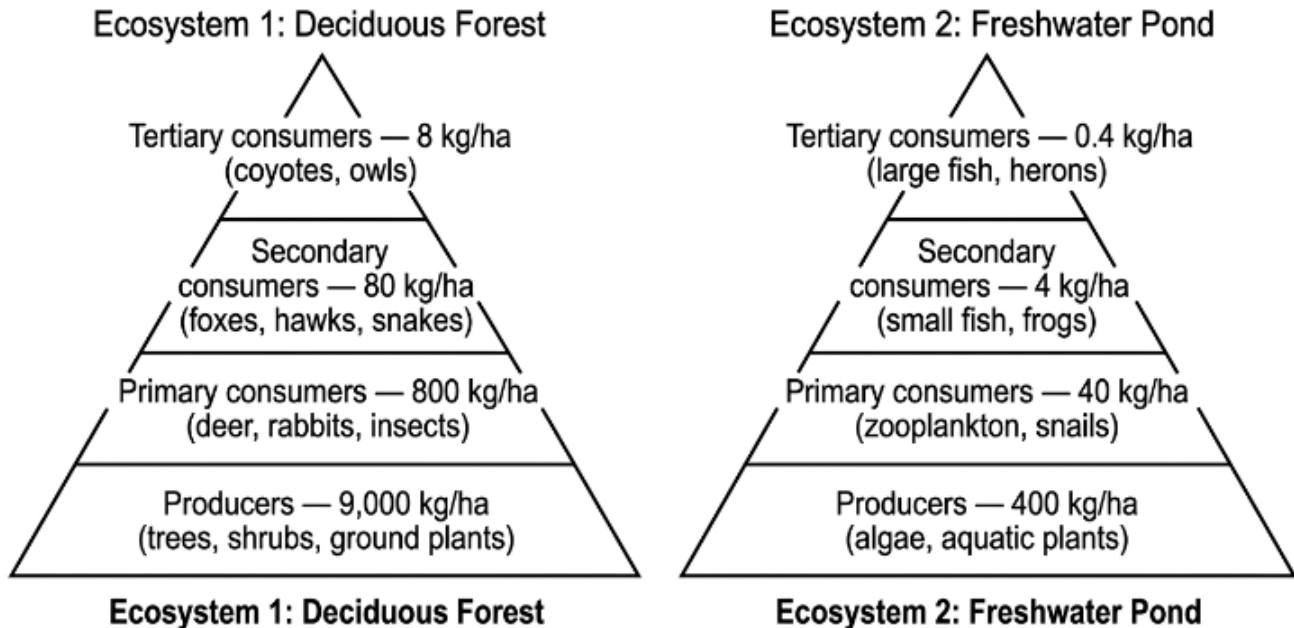
30. An assertion and a reason are given. **Assertion:** The beak changes in Species X across 50 years are an example of evolution. **Reason:** The frequency of certain beak depth alleles in the population shifted across generations. Which best evaluates the statements?

- A. The assertion is correct but the reason confuses individual change with population change
- B. The assertion is incorrect because 50 years is far too short for any evolution to occur
- C. Both the assertion and the reason are correct, and the reason explains the assertion
- D. The assertion is correct but the reason should mention individual lifetime change instead

Base your answers to questions 31 through 35 on the information below and on your knowledge of biology.

Two ecosystems are compared for their structure and energy flow. Ecosystem 1 is a temperate deciduous forest in upstate New York; Ecosystem 2 is a freshwater pond in the same region. The energy pyramid below shows comparative biomass at each trophic level in kilograms per hectare.

Biomass Pyramids — Forest vs. Pond Ecosystems



31. Both pyramids show the same approximate biomass ratio between trophic levels. This ratio of roughly 10:1 reflects:

- A. The fact that producers always outnumber consumers in every ecosystem regardless of conditions
- B. The migration patterns that move biomass between ecosystems on a regular seasonal basis
- C. The ~10% energy transfer efficiency between trophic levels (90% is lost as heat or used)
- D. The reproductive strategies of organisms at each level of the food chain consistently

32. The forest ecosystem has substantially more producer biomass (9,000 kg/ha) than the pond (400 kg/ha). The most likely reason is:

- A. Forest organisms are smaller than pond organisms on average across the entire ecosystem
- B. Trees and shrubs accumulate biomass over many years, while pond producers are short-lived
- C. Forest ecosystems contain no decomposers, so dead plant material accumulates indefinitely
- D. Pond ecosystems receive less sunlight than forest ecosystems throughout the entire year

33. A new top predator (a mountain lion) enters the forest ecosystem and feeds on deer, rabbits, and foxes. Which cause-and-effect chain best describes the likely consequences?

- A. Mountain lion arrives → producers decrease → entire ecosystem collapses immediately
- B. Mountain lion arrives → all primary consumers go extinct → no food for any predators left
- C. Mountain lion arrives → tertiary consumer biomass stays unchanged → no measurable effect at all
- D. Mountain lion arrives → primary consumer numbers decrease → producers may increase due to less browsing

34. The producer trophic level supports all other levels above it. Which observation is consistent with that role in BOTH ecosystems?

- A. Producer biomass is the smallest in both ecosystems shown in the pyramids above
- B. Producer biomass equals consumer biomass in both ecosystems shown in the pyramids
- C. Producer biomass is the largest at the base of both pyramids by a wide margin
- D. Producer biomass is the same in both ecosystems despite their very different sizes

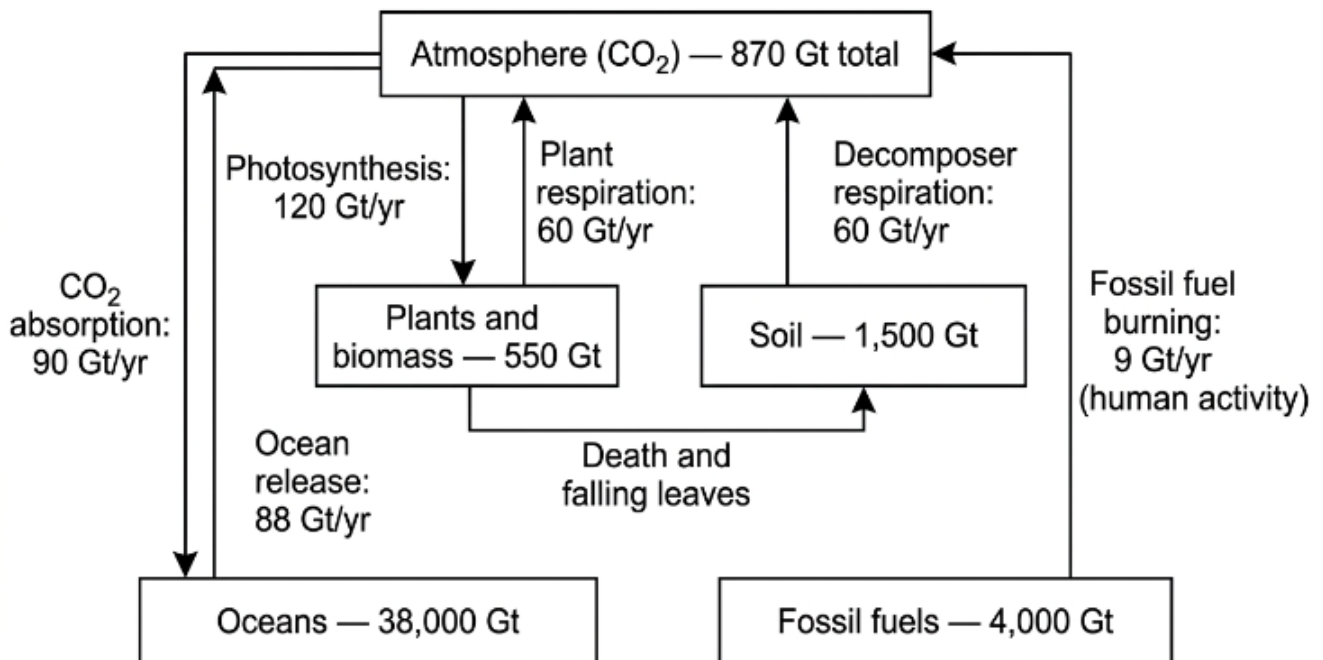
35. An assertion and a reason are given. **Assertion:** Removing all producers from an ecosystem would cause the entire pyramid to collapse. **Reason:** Producers are the only source of new biological energy entering the ecosystem through photosynthesis. Which best evaluates the statements?

- A. Both the assertion and the reason are correct, and the reason explains the assertion
- B. Both the assertion and the reason are correct, but the reason does not explain the assertion
- C. The assertion is correct but the reason ignores energy from decomposers and consumers
- D. The assertion is incorrect because consumers could survive on stored energy indefinitely

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

The carbon cycle moves carbon among the atmosphere, living organisms, soils, fossil fuel deposits, and oceans. The diagram below shows the major reservoirs and fluxes of the carbon cycle, with values in gigatons of carbon per year.

Major Reservoirs and Fluxes of the Global Carbon Cycle



36. The 9 Gt/yr of carbon released by fossil fuel burning enters the atmosphere primarily as:
- A. Methane gas (CH₄), released by incomplete combustion of fossil fuels primarily
 - B. Carbon monoxide (CO), released during the rapid burning process across the world
 - C. Solid carbon particles that settle out of the atmosphere within hours of release
 - D. Carbon dioxide (CO₂), released by complete combustion of carbon-containing fuels
37. The natural exchanges between the atmosphere and plants approximately balance (120 Gt down \approx 60 + 60 = 120 Gt up from plants and soil), and the atmosphere-ocean exchanges nearly balance (90 down \approx 88 up). The most direct reason atmospheric CO₂ is rising globally is:
- A. Photosynthesis has slowed in recent decades due to declining plant populations
 - B. Fossil fuel burning adds 9 Gt/yr that is not balanced by an equivalent natural removal
 - C. Decomposer respiration has accelerated in recent decades due to soil disturbance worldwide
 - D. Ocean release has increased in recent decades to over twice its previous documented rate
38. Trace the cause-and-effect chain of carbon moving from atmosphere to soil:
- A. Atmosphere \rightarrow ocean \rightarrow fossil fuels \rightarrow soil through normal flux pathways shown above
 - B. Atmosphere \rightarrow fossil fuels \rightarrow soil through deep underground geological transformations slowly
 - C. Atmosphere \rightarrow plants (photosynthesis) \rightarrow soil (death, decomposition of plant material)
 - D. Atmosphere \rightarrow soil directly through diffusion, bypassing any plant or animal life altogether
39. An assertion and a reason are given. **Assertion:** Planting more trees globally would reduce atmospheric CO₂ over time. **Reason:** Trees absorb CO₂ from the atmosphere during photosynthesis and store carbon in their biomass. Which best evaluates the statements?
- A. The assertion is incorrect because trees release more CO₂ than they absorb annually
 - B. The assertion is correct but the reason describes a process that does not occur in trees
 - C. Both the assertion and the reason are correct, but the reason does not explain the assertion
 - D. Both the assertion and the reason are correct, and the reason explains the assertion
40. The ocean contains by far the largest carbon reservoir (38,000 Gt). The most important biological process moving carbon from atmosphere into the ocean involves:
- A. Volcanic activity along the mid-ocean ridges, releasing carbon from oceanic plates upward
 - B. CO₂ dissolves in ocean surface waters and is absorbed by photosynthetic plankton there
 - C. Soil sediments washing into the ocean through rivers and underground groundwater flow
 - D. Fossil fuel deposits leaking carbon dioxide directly into the ocean from drilling activity

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

Two coastal communities are comparing impacts from rising sea levels. Community A is on a low-lying island in the Pacific Ocean with an average elevation of 3 meters above sea level. Community B is a mainland coastal town in North America with an average elevation of 50 meters above sea level. Both communities are monitoring sea level rise of approximately 3.5 mm per year and increased storm intensity from climate change.

41. Why is Community A at substantially higher risk from sea level rise than Community B?

- A. Community A is closer to the equator and therefore experiences warmer ocean water year-round
- B. Community A receives more rainfall than Community B does annually across all seasons
- C. Community A's low elevation means small absolute sea level changes affect a large land area
- D. Community A has fewer technological resources to study sea level rise than Community B has

42. An assertion and a reason are given. **Assertion:** Sea level rise affects coastal ecosystems even before complete flooding occurs. **Reason:** Saltwater intrusion changes the salinity of freshwater wetlands and coastal aquifers. Which best evaluates the statements?

- A. The assertion is incorrect because only complete flooding affects coastal ecosystems
- B. Both the assertion and the reason are correct, and the reason explains the assertion
- C. Both the assertion and the reason are correct, but the reason does not explain the assertion
- D. The assertion is correct but the reason describes river ecosystems, not coastal ones

43. If global temperatures continue to rise, what cause-and-effect chain best explains why sea level will continue rising?

- A. Higher temperatures → less rain → ocean water evaporates faster → sea level falls slowly
- B. Higher temperatures → more clouds → less ocean heating → sea level stays constant overall
- C. Higher temperatures → more biological activity → oceans absorb more carbon → sea level falls
- D. Higher temperatures → ice sheets melt + ocean water expands thermally → sea level rises here

44. Community A is considering adaptation strategies. Which strategy would address the ROOT cause of the threat rather than just its local effects?

- A. Reducing greenhouse gas emissions through international cooperation on climate policy
- B. Building taller seawalls along the coastline to keep rising water out of communities
- C. Raising homes on stilts to keep them above the rising water level over time
- D. Relocating residents to higher-elevation areas before flooding becomes severe locally

45. Both communities are experiencing increased storm intensity. Climate science attributes this to:

- A. Random year-to-year variation in storm patterns unrelated to global temperature changes
- B. Sun cycles producing more solar radiation reaching Earth's surface in recent years
- C. Warmer ocean surfaces transferring more energy and water vapor to developing storms
- D. Decreased ocean salinity from melting freshwater ice reducing storm energy substantially

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

A regional conservation board is evaluating two proposed engineering solutions to protect a declining native salamander population from habitat loss. The salamanders breed in vernal pools (temporary spring ponds) and migrate across roads to reach them.

Proposed Solution 1: Build a series of underpass tunnels at known salamander migration routes.
Proposed Solution 2: Acquire land surrounding the vernal pools to create a no-build buffer zone.

46. Why might Solution 2 provide more comprehensive protection than Solution 1?

- A. Solution 2 costs less per square meter of habitat than Solution 1 will cost overall
- B. Solution 2 addresses both road mortality and broader habitat protection beyond crossings
- C. Solution 2 is faster to implement than Solution 1 because it requires no construction
- D. Solution 2 requires no maintenance over time while Solution 1 will need regular cleaning

47. An assertion and a reason are given. **Assertion:** Solution 1 (tunnels) alone is not a complete conservation solution. **Reason:** Tunnels protect salamanders only during road crossings, not from habitat loss elsewhere. Which best evaluates the statements?

- A. The assertion is incorrect because tunnels fully protect salamander populations from all threats
- B. The assertion is correct but the reason describes irrelevant aspects of salamander biology overall
- C. Both the assertion and the reason are correct, but the reason does not explain the assertion
- D. Both the assertion and the reason are correct, and the reason explains the assertion

48. The board is also considering a combined approach (tunnels AND buffer zone). Which engineering principle supports combining the two solutions?

- A. Simpler is always better, so the cheapest single option should be selected from the proposals
- B. Innovative ideas are always best, so the newest engineering option should always be chosen
- C. Layered or redundant defenses protect against multiple threats and reduce overall failure risk
- D. Following precedent is always best, so the option used elsewhere should be selected directly

49. The board wants to evaluate which solution actually helps salamanders most. Which measurement would best assess effectiveness?

- A. Long-term monitoring of salamander population size and breeding success after implementation
- B. Counting how many salamanders cross the road within the first week of implementation
- C. Measuring the water quality in vernal pools before and after construction is complete
- D. Conducting a community survey about how residents feel about the conservation effort

50. An assertion and a reason are given. **Assertion:** Both solutions will require ongoing monitoring after implementation. **Reason:** Engineering solutions can have unintended consequences that emerge only over time. Which best evaluates the statements?

- A. Both the assertion and the reason are correct, and the reason explains the assertion
- B. The assertion is correct but the reason describes a problem only of agricultural projects
- C. Both the assertion and the reason are incorrect statements about conservation engineering practice
- D. The assertion is incorrect because well-designed solutions require no monitoring at all

Practice Exam 32: Full Answer Key with Explanations

1. A — The defining structural difference between prokaryotic and eukaryotic cells is the membrane-bound nucleus, which eukaryotes possess and prokaryotes lack. In prokaryotes the DNA sits freely in the cytoplasm in a region called the nucleoid, while in eukaryotes the linear chromosomes are enclosed within a double membrane. This nuclear compartmentalization enables the more complex gene regulation characteristic of eukaryotic life.

2. D — Prokaryotic cells DO perform cellular respiration, but they lack mitochondria entirely. Instead, their electron transport chain and ATP synthase are embedded directly in the cell membrane itself, accomplishing the same energetic work that mitochondria perform in eukaryotes. The endosymbiotic theory holds that mitochondria descended from prokaryotic ancestors, which is why the two processes are so similar at the molecular level.

3. B — As cells grow larger, volume increases as the cube of the radius while surface area increases only as the square — so the surface-area-to-volume ratio drops. Large eukaryotic cells therefore need internal membrane systems (ER, Golgi, vesicles) to compensate for the diminished relative surface area available for exchange with the environment. This is a fundamental geometric constraint shaping cell biology.

4. C — Ribosomes are present in BOTH prokaryotic and eukaryotic cells and carry out the same fundamental function: translating mRNA into protein. They differ slightly in size (70S in prokaryotes, 80S in eukaryotes) but are universal across all life. Nuclei, mitochondria, and the endoplasmic reticulum are eukaryotic features only.

5. A — Mitochondria are roughly bacterial in size and shape and contain their own circular DNA, their own ribosomes, and a double membrane — all hallmarks of free-living prokaryotic ancestors. The endosymbiotic theory holds that an early eukaryote engulfed a bacterium that then became a permanent organelle. The size and shape match shown in the diagram is consistent with this evolutionary origin.

6. A — During heavy exercise, oxygen delivery to muscle cells cannot keep up with the high ATP demand. Without sufficient oxygen, mitochondria cannot process incoming pyruvate through the citric acid cycle, so the cell switches to lactic acid fermentation in the cytoplasm to regenerate NAD^+ and continue producing ATP. This anaerobic backup is faster but yields far less ATP than aerobic respiration.

7. B — Both cells start fermentation with the same substrate (pyruvate) but possess different enzymes that direct pyruvate down different metabolic pathways. Yeast cells convert pyruvate to ethanol and CO₂, while muscle cells convert pyruvate to lactic acid. The end product depends entirely on the cell's enzymatic machinery, not on the starting molecule or the oxygen status.

8. A — Aerobic respiration completely oxidizes glucose to CO₂ and H₂O, extracting energy at glycolysis, the citric acid cycle, and the electron transport chain — multiple stages that capture many ATP per glucose. Fermentation only completes glycolysis, leaving most of the energy still locked in the partially-oxidized end product (lactic acid or ethanol). The ~32:2 ATP yield reflects this fundamental difference in completeness.

9. A — The assertion is correct: fermentation yields only 2 ATP per glucose while aerobic respiration yields about 32 ATP, making fermentation roughly 16-fold less efficient. The reason is also correct and directly explains the inefficiency — complete oxidation to CO₂ + H₂O extracts more energy than the partial breakdown of fermentation. This is the classic assertion-reason pattern where both are true and causally linked.

10. D — Without oxygen, aerobic respiration cannot proceed because there is no terminal electron acceptor for the electron transport chain. Bacteria in oxygen-free environments rely on anaerobic fermentation or anaerobic respiration, which uses molecules like sulfate or nitrate as alternate electron acceptors. These pathways are widespread among deep-sediment, deep-soil, and gut microbes.

11. D — The phospholipid bilayer's hydrophobic interior allows small nonpolar molecules like O₂, CO₂, and N₂ to pass freely without protein assistance. Charged or large polar molecules cannot dissolve in the lipid interior and require channel or carrier proteins to cross. This selective permeability is fundamental to cell membrane function.

12. B — Facilitated diffusion moves substances down their concentration gradient through a protein channel, which is passive and requires no energy input. Active transport moves substances against their gradient using a pump protein and requires ATP hydrolysis to drive the conformational change. Both use membrane proteins, but only active transport spends energy.

13. B — The Na⁺/K⁺ pump is the classic example of active transport in nerve cells: it uses ATP to move 3 Na⁺ out and 2 K⁺ in against both gradients, creating and maintaining the resting ionic imbalance. This stored electrochemical gradient is what nerve cells later use to fire action potentials. Without the pump, the gradients would dissipate within minutes.

14. D — The assertion is correct: homeostasis means maintaining an internal state different from the surroundings, which is fundamentally different from equilibrium (the state at which net change stops). The reason directly explains the assertion — maintaining ion gradients away from equilibrium requires continuous ATP-powered pumping. A cell at true equilibrium with its surroundings would be a dead cell.

15. C — Water moves by osmosis from regions of higher water concentration (lower solute) to regions of lower water concentration (higher solute). When a cell is placed in a hypertonic solution (higher solute outside than inside), water exits the cell. This causes plant cells to plasmolyze and animal cells to shrivel, both of which can be fatal.

16. B — Color blindness is X-linked recessive. Males (XY) have only one X chromosome, so a single defective allele on that X causes the trait — they have no second X to mask it. Females (XX) require both X chromosomes to carry the defective allele, which is far rarer in the population.

17. C — A carrier is a heterozygous female who carries one defective X-linked allele and one normal allele. The normal allele masks the defective one, so she shows no symptoms but can still pass the defective allele to half her offspring. Carrier status is the hallmark of recessive inheritance: variation hidden within a phenotypically normal individual.

18. A — The affected father (XY) *passes his only X (X)* to every daughter. The carrier mother (XX*) passes X to half her daughters and X* to the other half. So daughters are 50% XX (affected) and 50% XX* (carriers), giving a 50% probability that any daughter is affected. This affected-father × carrier-mother combination is the highest-risk pedigree for X-linked disease in daughters.

19. B — The assertion is correct: II-2 contributed only a Y chromosome to his sons, not an X, so he could not have transmitted his X-linked allele to any son including III-3. The reason directly explains why — sons inherit Y from father and X from mother. This is the fundamental rule of sex-linked inheritance: father-to-son transmission of X-linked traits is impossible.

20. B — I-2 must carry at least one X* allele because she produced an affected son (II-4) who inherited his X* from her (his Y came from I-1). She is phenotypically unaffected, so she cannot be XX. The only remaining genotype consistent with both facts is XX* — heterozygous carrier — which is exactly what a healthy mother of an affected son must be.

21. A — DNA replication is semiconservative: the double helix unwinds, the two strands separate, and each parent strand serves as a template for building a new complementary strand. Each daughter DNA molecule therefore contains one original and one new strand. This template-directed copying is what makes DNA replication so accurate.

22. C — A single DNA base change can produce an altered mRNA codon during transcription, which then specifies a different amino acid during translation, which alters the protein's primary structure and potentially its folding and function. Each step is causally linked to the next: DNA → mRNA → amino acid → protein structure. This is the central dogma applied to mutation consequences.

23. A — The genetic code is redundant: most amino acids are coded by multiple codons. A single base change might produce a silent mutation (same amino acid, no change to the protein) or a missense mutation (different amino acid, possible functional change). The outcome depends on which codon was originally there and which codon results from the change.

24. D — DNA repair machinery normally fixes most replication errors and DNA damage from radiation or chemicals. Without functional repair, every error and damaging event leaves a permanent mark, and mutations accumulate at a much higher rate over time. This is the basis for several human cancers — defective repair genes lead to genomic instability.

25. C — The assertion is correct: non-coding regions of DNA include promoters, enhancers, and other regulatory sequences that influence whether and when a gene is transcribed. The reason directly explains

why — a mutation in these regulatory regions can change gene expression even though the protein-coding sequence is intact. This is why "non-coding" does not mean "non-functional."

26. D — Hard seeds require strong, deep beaks to crack open. In a population with variable beak depth, individuals with deeper beaks crack more seeds and obtain more food, leading to better survival and reproduction. Over generations the average beak depth increases — exactly the 9.2 mm to 10.8 mm shift observed in Species X.

27. D — Nectar from deep flowers requires long, slender beaks to reach. Among Species Y individuals, those with longer beaks access more nectar, gaining a feeding advantage that translates into higher reproductive success. Over generations the average beak length increases — exactly the 14.3 mm to 16.2 mm shift observed.

28. C — Selection acts only on traits that affect survival and reproduction. Beak depth matters for cracking hard seeds (Species X's diet) but is irrelevant for sipping nectar and catching insects (Species Y's diet). With no selective advantage for deeper beaks in Species Y, beak depth remains essentially unchanged regardless of the variation present in the population.

29. A — If Species Y had to shift to eating hard seeds (the same diet as Species X), it would face the same selection pressures favoring deeper, stronger beaks, and would evolve toward Species X's beak shape. This is convergent evolution: similar selection pressures producing similar adaptations in distinct lineages. Sharing an ecological niche pulls phenotypes together.

30. C — The assertion is correct: beak depth changing across 50 years (many generations of these short-lived birds) is evolution. The reason directly explains why — evolution is defined as a change in allele frequencies within a population over generations, which is precisely what occurred. Individual beak depth does not change within a lifetime; allele frequencies shifted across generations.

31. C — About 90% of the energy at each trophic level is lost as metabolic heat or used for the organism's own life processes, leaving only about 10% available to be passed up to the next level. This is why biomass pyramids consistently show a roughly 10:1 ratio between adjacent levels. The pattern is universal across ecosystems and limits the number of trophic levels possible.

32. B — Trees and shrubs can live for decades or centuries, accumulating large amounts of woody biomass that persists year-round. Pond algae and aquatic plants typically have life spans measured in weeks and turn over rapidly, so even high productivity does not accumulate into a large standing biomass. The forest's massive biomass reflects long-term accumulation, not necessarily faster productivity.

33. D — A new top predator reduces the population of primary consumers (deer, rabbits) that browse on plants. With fewer browsers, plant biomass tends to increase — a phenomenon known as a trophic cascade. The Yellowstone wolf reintroduction is the most famous documented example, where wolf reintroduction reduced elk browsing and allowed willow and aspen to recover.

34. C — In both pyramids, producers occupy the widest base, supporting the smaller biomass at higher levels. This is the universal shape of an energy pyramid: producers must be most abundant because the

inefficient ~10% energy transfer at each step requires a much larger base to support smaller upper levels. The shape itself is the visible consequence of energy-flow inefficiency.

35. A — The assertion is correct: without producers, no new energy enters the ecosystem and the consumer levels would starve as their food sources fail. The reason directly explains why — producers are the only organisms that capture new energy through photosynthesis (or chemosynthesis in some ecosystems), and the rest of the food web depends on this input. Removing producers severs the foundation of every ecosystem.

36. D — Fossil fuels are reduced hydrocarbons composed largely of carbon and hydrogen. Complete combustion in oxygen-rich air converts these to $\text{CO}_2 + \text{H}_2\text{O}$ — releasing all stored carbon as carbon dioxide gas. The 9 Gt/yr human flux into the atmosphere is overwhelmingly CO_2 , which is why CO_2 is the primary anthropogenic greenhouse gas of concern.

37. B — The natural fluxes between atmosphere, plants, soil, and ocean are nearly balanced in steady-state, so they cannot account for the rising atmospheric CO_2 trend. The 9 Gt/yr from fossil fuel combustion adds new carbon that was previously locked underground, with no equivalent natural sink to remove it at that rate. Roughly half stays in the atmosphere, accounting for the steady rise in CO_2 concentration.

38. C — Carbon enters living systems when plants fix atmospheric CO_2 through photosynthesis, building carbohydrates and other organic compounds. When plants die or shed leaves, that organic carbon enters the soil, where decomposers gradually break it down. This atmosphere → plant → soil pathway is the dominant route by which atmospheric carbon enters terrestrial soils.

39. D — The assertion is correct: afforestation increases the rate at which atmospheric CO_2 is pulled out and stored. The reason directly explains why — trees fix CO_2 through photosynthesis and store the carbon as woody biomass that can persist for decades or centuries. This is why large-scale tree-planting is one component of many climate-mitigation strategies.

40. B — CO_2 dissolves in cold ocean surface waters where it can be taken up by phytoplankton during photosynthesis. The phytoplankton then sink (or are eaten and their carbon is excreted at depth), transporting carbon away from the surface — the so-called "biological pump." This combination of physical dissolution and biological uptake makes the ocean the largest active carbon sink on Earth.

41. C — A 3-meter elevation community sits very close to current sea level, so a sea level rise of even a fraction of a meter could submerge a large fraction of the land area. A 50-meter elevation community has the same absolute rise but most of its land remains far above water. Vulnerability to sea level rise is a function of elevation above current sea level, not latitude or technology.

42. B — The assertion is correct: coastal ecosystems suffer well before they go fully underwater, as salinity changes alter what species can survive in affected habitats. The reason directly explains the mechanism — saltwater pushes inland into freshwater wetlands and aquifers, raising salinity in zones that were previously brackish or freshwater and stressing organisms adapted to lower salinity. This indirect ecosystem impact often precedes any visible flooding.

43. D — Rising global temperatures cause two distinct contributions to sea level rise: land-based ice sheets and mountain glaciers melt (transferring water from land to ocean), and ocean water expands thermally as it warms (taking up more volume). Both effects operate simultaneously and add together to produce the observed rise. Thermal expansion currently accounts for roughly a third of total sea level rise.

44. A — Sea level rise is ultimately driven by human greenhouse gas emissions that warm the planet. Reducing emissions addresses the root cause — the warming itself — while seawalls, stilts, and relocation only adapt to the effects without slowing them. Effective climate response requires both root-cause action (mitigation) and effect-targeted action (adaptation), but only the former addresses the underlying driver.

45. C — Tropical storms and hurricanes draw their energy from warm ocean surface water through evaporation. Warmer sea surface temperatures provide more thermal energy and more water vapor to developing storms, intensifying their winds and rainfall. The observed trend toward more intense storms in recent decades is consistent with this thermodynamic mechanism.

46. B — Tunnels address only one specific threat — road mortality during migration — leaving the surrounding breeding habitat unprotected. A buffer zone preserves both the breeding pools themselves AND the upland forest where adult salamanders spend most of the year, plus it eliminates the road-crossing problem by removing the road from the protected area. Habitat protection is generally more comprehensive than infrastructure mitigation alone.

47. D — The assertion is correct: tunnels alone do not address habitat destruction beyond the road itself. The reason directly explains why — tunnels solve one specific threat (road crossings) but do nothing for the broader habitat loss that is driving the species' decline. Conservation typically requires addressing multiple threats simultaneously, which is why single-intervention strategies often fall short.

48. C — Combining tunnels and buffer zones provides protection against multiple threats — road mortality AND broader habitat loss — and reduces the risk that any single failure compromises the entire conservation outcome. Redundant or layered defenses are widely used in engineering (aviation safety, nuclear plant design) precisely because no single intervention is foolproof. This combined approach is consistent with sound engineering risk management.

49. A — The ultimate measure of conservation success is whether the target population is stable or growing over time. Long-term population data — counts of breeding adults, juvenile recruitment, and survival rates — directly tell you whether the intervention worked. Short-term observations and indirect measures (water quality, public opinion) do not reliably reflect biological success of conservation engineering.

50. A — The assertion is correct: monitoring is required after implementation of any conservation engineering project. The reason directly explains why — unintended consequences (predators using tunnels to ambush prey, buffer zones attracting unrelated invasive species) often emerge only over time and require adaptive management to address. Engineering projects in living ecosystems are never truly finished at construction.