PRACTICE EXAM 14: LIFE SCIENCE: BIOLOGY SIMULATION (50 QUESTIONS)

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.

A biology class investigated the effect of size on diffusion using cubes of agar that contained the indicator phenolphthalein, which turns bright pink in basic solutions. Students cut the agar into three different cube sizes and placed each cube into the same dilute sodium hydroxide (NaOH) solution. After 10 minutes, students cut each cube in half and recorded how far the pink color had penetrated from the surface, and what percentage of the cube's volume had turned pink. The class data are shown below.

Cube Size (cm)	Surface Area (cm^2)	Volume (cm^3)	SA : V Ratio	% Volume Pink
1 × 1 × 1	6	1	6 : 1	100%
2 × 2 × 2	24	8	3 : 1	65%
3 × 3 × 3	54	27	2 : 1	33%

1. The pink color in the agar shows where:

A. The NaOH solution has diffused into the cube and reacted with the indicator
B. The phenolphthalein has been broken down by the surrounding water in the dish
C. The agar has begun to dissolve into the sodium hydroxide solution outside it
D. The cube has converted the NaOH into water and salt during the experiment

2. As cube size increased, the percentage of the cube turning pink decreased. The best explanation is:

A. Larger cubes contain less agar to react with the NaOH solution
B. The NaOH solution loses its strength when placed near a larger cube
C. The surface area to volume ratio decreases as cube size increases
D. Larger cubes produce a chemical that blocks NaOH from entering them

3. The agar cubes serve as a model for which biological principle?

A. Larger cells use ATP more efficiently than smaller cells of the same shape
B. Smaller cells exchange materials with their surroundings more efficiently
C. Larger cells have a higher concentration of organelles for their size
D. Smaller cells require more nutrients per unit volume than larger cells

4. If the experiment were repeated with a 4 × 4 × 4 cm cube, which prediction would be most reasonable?

A. The cube would turn 100% pink within the same 10-minute period
B. The cube would turn the same percentage pink as the 3 × 3 × 3 cube
C. The cube would not turn pink at all because of its larger size
D. The cube would turn less than 33% pink in the same time period

5. This model helps explain why most cells must divide before becoming too large. As a cell grows, its volume increases faster than its surface area, and the cell cannot efficiently:

A. Exchange enough materials across the membrane to support its needs
B. Produce enough cell wall material to keep up with rapid growth
C. Replace its DNA, which is consumed during normal cell activity
D. Take in carbon dioxide for use in cellular respiration in the mitochondria

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

Salivary amylase is an enzyme produced in the human mouth that begins the chemical digestion of starch. To investigate the activity of salivary amylase, a class set up four test tubes. Each tube contained the same volume of starch solution but was kept at a different temperature. A few drops of salivary amylase were added to each tube, and after 15 minutes students tested each tube for the presence of remaining starch using iodine solution, which turns blue-black when starch is present. The class results are shown below.

Tube	Temperature (°C)	Iodine Result After 15 minutes
1	5	Strong blue-black color
2	25	Moderate blue-black color
3	37	No color change (clear)
4	80	Strong blue-black color

6. The most likely reason that Tube 3 showed no iodine color change is that:

A. The starch in Tube 3 was destroyed by the higher temperature alone
B. Salivary amylase broke down the starch most completely at 37°C

C. The iodine solution stopped working when warmed above 30°C
D. The starch was carried out of Tube 3 by evaporation during the test

7. The strong color in Tube 4 (80°C) is best explained by:

A. The starch became thicker at higher temperatures and resisted digestion
B. The iodine was activated more strongly at 80°C than at lower temperatures
C. Salivary amylase was denatured at 80°C and could not break down the starch
D. The salivary amylase converted the starch into more starch at high temperatures

8. Salivary amylase has an optimal temperature near 37°C because:

A. All enzymes function best between 60°C and 80°C in living organisms
B. The mouth is exposed to extreme cold during normal food intake
C. Salivary amylase is produced inside the cells of the small intestine
D. 37°C matches normal human body temperature, where the enzyme is active

9. The starch in Tube 3 has most likely been broken down into:

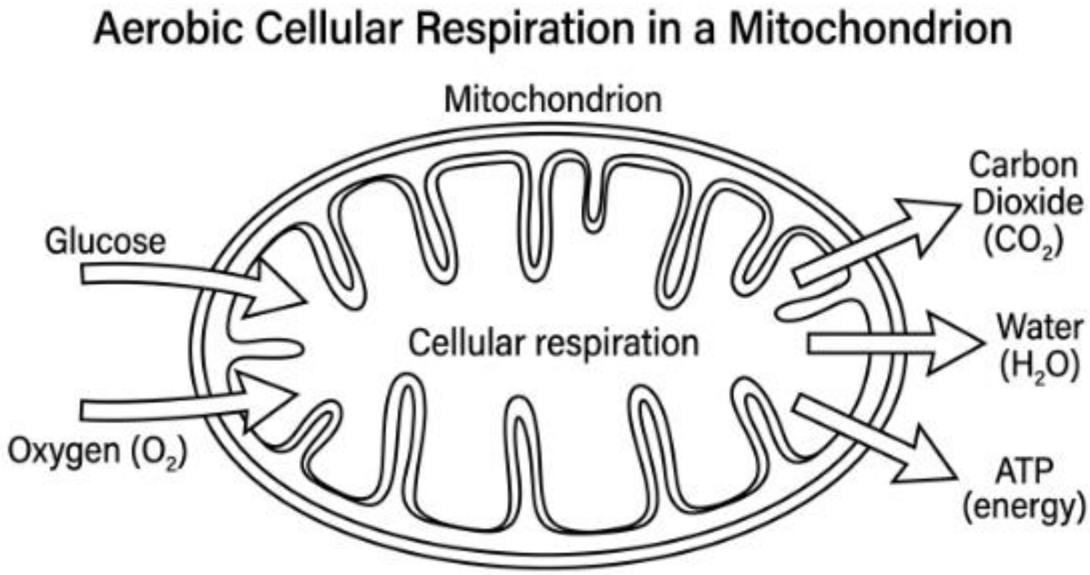
A. Maltose and other smaller sugars that no longer react with iodine
B. Amino acids and short peptides that are easily absorbed by the body
C. Fatty acids and glycerol released from the long carbohydrate chain
D. Nucleotides that can be reassembled into a new starch molecule later

10. Salivary amylase is best classified as a:

A. Storage molecule that holds energy for the cells of the mouth
B. Biological catalyst that speeds up the breakdown of starch
C. Substrate that is consumed during the digestion of starch
D. Structural protein that gives shape to the cells of the tongue

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

Mitochondria are organelles found in nearly all eukaryotic cells. Inside the mitochondria, glucose and oxygen are used to produce ATP, the molecule that powers most cellular activities. The diagram below shows the major inputs and outputs of aerobic cellular respiration in a mitochondrion.



11. According to the diagram, the two main inputs of aerobic cellular respiration are:

A. Carbon dioxide and water, taken in from the cytoplasm of the cell
B. ATP and oxygen, both produced by chloroplasts in plant cells
C. Carbon dioxide and ATP, supplied by the surrounding cells of the body
D. Glucose and oxygen, supplied by digestion and breathing

12. The ATP produced inside the mitochondria is used by the cell to:

A. Build new mitochondria during the rapid growth of the cell
B. Convert oxygen into carbon dioxide and water as waste products
C. Power activities such as muscle contraction and active transport
D. Replace the cell wall when it becomes damaged by normal use

13. The waste products of aerobic respiration shown in the diagram are:

A. Carbon dioxide and water, which leave the cell or are used elsewhere
B. Glucose and oxygen, which are stored back into the mitochondrion
C. Amino acids and peptides, which are reused by the cell's ribosomes
D. Starch and cellulose, which are produced inside the mitochondria

14. A cell that needs a great deal of energy, such as a heart muscle cell, would be expected to contain:

A. Few mitochondria but a large amount of stored glucose for use
B. A large number of mitochondria compared with most other cells
C. No mitochondria, since heart muscle cells use only fermentation
D. One large mitochondrion that produces all the cell's energy

15. The overall equation that best summarizes aerobic cellular respiration is:

A. carbon dioxide + water → glucose + oxygen + ATP
B. glucose + carbon dioxide → oxygen + water + ATP
C. oxygen + water → glucose + carbon dioxide + ATP
D. glucose + oxygen → carbon dioxide + water + ATP

Base your answers to questions 16 through 19 on the information below and on your knowledge of biology.

The human body maintains a stable internal temperature of approximately 37°C despite changes in the surrounding environment. When body temperature begins to rise above this set point — for example, during exercise or in hot weather — the body responds through sweating and the widening (dilation) of blood vessels near the skin's surface, which release heat to the environment. When body temperature begins to fall — for example, in cold weather — the body responds through shivering and the narrowing (constriction) of blood vessels near the skin, which conserve heat.

16. The maintenance of a stable internal body temperature is best described as an example of:

A. Homeostasis, the maintenance of a stable internal environment
B. Active transport, the movement of materials using ATP energy
C. Convergent evolution, in which unrelated species develop similar traits
D. Photosynthesis, in which light energy is converted into chemical energy

17. Sweating helps cool the body because:

A. Sweat carries excess sodium ions out through the openings in the skin
B. Sweat produces a chemical reaction that absorbs heat from the muscles
C. The evaporation of sweat from the skin's surface removes heat from the body
D. Sweat insulates the body from outside temperatures by forming a layer

18. The dilation of blood vessels near the skin's surface in hot weather and their constriction in cold weather is an example of:

A. Positive feedback, which amplifies an initial change in body temperature
B. Negative feedback, which returns body temperature toward its set point
C. Acquired adaptation, in which the body chooses how to react each time
D. Mutation, which changes the genes for temperature control in each cell

19. Shivering helps warm the body in cold weather because:

A. The motion of shivering signals the body to release stored sugar to muscles
B. Shivering produces a hormone that increases the body's metabolic rate

C. The shivering motion brings blood vessels closer to the skin to absorb heat
D. Rapid muscle contractions during shivering release heat as a byproduct

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

In a particular plant species, the allele for purple flowers (P) is dominant over the allele for white flowers (p), and the allele for tall stems (T) is dominant over the allele for short stems (t). The two genes are located on different chromosomes and are inherited independently. A scientist crosses two plants that are heterozygous for both traits (PpTt × PpTt) and produces a large number of offspring.

20. A plant with the genotype PpTt shows which phenotype?

A. Purple flowers and tall stems, because both dominant alleles are present
B. White flowers and short stems, because the recessive alleles dominate
C. Purple flowers and short stems, because P is on the same chromosome as t
D. White flowers and tall stems, because Tt always masks the Pp genotype

21. The expected phenotypic ratio of the offspring from the PpTt × PpTt cross is:

A. 1 : 2 : 1, the standard ratio of a single heterozygous cross
B. 1 : 1 : 1 : 1, the standard ratio of a test cross between two genes
C. 9 : 3 : 3 : 1, the standard dihybrid ratio for two independent genes
D. 3 : 1, the standard ratio of a heterozygous cross for one gene only

22. One of the offspring of this cross has white flowers and short stems. The genotype of this plant must be:

A. PpTt, since both dominant alleles must be present in the genotype
B. pptt, since both traits require homozygous recessive genotypes
C. PPTT, since both traits must be homozygous dominant in expression
D. PpTT, since at least one dominant allele is required for each trait

23. The independent inheritance of the flower color gene and the stem height gene illustrates which principle?

A. Codominance, in which two alleles are fully expressed at the same time
B. Incomplete dominance, in which the heterozygote shows a blended trait
C. Sex linkage, in which the gene is carried on the X chromosome
D. Independent assortment, in which gene pairs separate independently during meiosis

24. The genotypes PpTt and ppTT differ in which way?

A. PpTt is heterozygous for both genes, while ppTT is homozygous for both
B. PpTt is homozygous for both genes, while ppTT is heterozygous for both
C. PpTt expresses only the recessive traits, while ppTT expresses both dominants
D. PpTt is found only in females, while ppTT is found only in males

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

In snapdragons, flower color is determined by a single gene with two alleles. Plants homozygous for the red allele (RR) produce red flowers, plants homozygous for the white allele (WW) produce white flowers, and plants that carry one of each allele (RW) produce pink flowers. A pink-flowered plant (RW) is crossed with another pink-flowered plant (RW), and the resulting offspring are studied.

25. The flower color pattern in snapdragons is best classified as an example of:

A. Codominance, in which both alleles are fully expressed at the same time
B. Complete dominance, in which one allele masks the expression of the other
C. Incomplete dominance, in which the heterozygote shows a blended phenotype
D. Sex linkage, in which the gene is carried on the X chromosome of the plant

26. The expected phenotypic ratio of the offspring from the RW × RW cross is:

A. 3 red : 1 white, the typical pattern of a heterozygous cross with dominance
B. 1 red : 2 pink : 1 white, reflecting the incomplete dominance pattern
C. 9 red : 3 pink : 3 white : 1 mixed, the typical dihybrid pattern
D. All pink flowers, because pink is the dominant flower color in snapdragons

27. The pink color of an RW plant is best explained by:

A. The R and W alleles each producing some pigment, combining to give pink
B. The R allele masking the W allele to produce a faded red color in flowers
C. Pink being a separate allele not described in the original genotype
D. The plant choosing to express both alleles equally at all times

28. If a pink-flowered snapdragon (RW) is crossed with a white-flowered snapdragon (WW), the expected phenotypic ratio of the offspring is:

A. All pink flowers, because pink masks white in this generation
B. All white flowers, because white is the dominant allele in this cross
C. 3 pink : 1 white, the typical ratio of a heterozygous test cross
D. 1 pink : 1 white, reflecting equal inheritance of each parent's allele

29. Incomplete dominance differs from complete dominance in that:

A. Incomplete dominance occurs only in plants, while complete dominance occurs only in animals
B. Incomplete dominance always produces all four blood types in human offspring
C. The heterozygote shows a blended phenotype rather than the dominant phenotype
D. Incomplete dominance requires three different alleles instead of two allele

Base your answers to questions 30 through 36 on the information below and on your knowledge of biology.

Before the Industrial Revolution in England, peppered moths were most commonly light-colored, which helped them blend in with the light-colored lichens growing on tree bark in unpolluted forests. A small number of dark-colored peppered moths also existed in the population. As coal-burning factories grew, soot darkened the tree bark and killed the lichens in many forests. Over several decades, the percentage of dark-colored peppered moths in these forests increased dramatically, while the percentage of light-colored moths decreased. After pollution controls were introduced in the mid-twentieth century, the trend began to reverse.

30. Before the Industrial Revolution, light-colored moths were more common because:

A. Light-colored moths reproduced more often than dark moths
B. Light-colored moths were better camouflaged from predators on light bark
C. Dark moths were less able to survive cold winters than light moths
D. Light moths produced a chemical that destroyed any dark moth eggs

31. During the period of heavy industrial pollution, the dark-colored variant became more common because:

A. Dark moths were better camouflaged against the soot-darkened tree bark
B. The pollution caused light moths to develop dark coloring during life
C. Dark moths could digest soot for nutrition while light moths could not
D. Light moths migrated away from polluted areas in very large numbers

32. The change in the proportion of dark and light moths over several decades is best classified as an example of:

A. Co-evolution between the moths and the trees they live on
B. Sexual selection, in which moths choose mates of their own color
C. Genetic drift, in which moth populations change purely by random chance
D. Natural selection, in which an inherited trait becomes more or less common

33. The dark color of some peppered moths was caused by:

A. The moths absorbing soot into their bodies during their lifetime
B. A change in behavior that caused moths to seek shaded areas of trees
C. A genetic mutation that produced an allele for dark pigment
D. A choice the moths made when they recognized the dark bark

34. When pollution controls reduced soot and the trees grew lighter again, the proportion of light-colored moths increased. This reversal supports the conclusion that:

A. Once an evolutionary change occurs, it can never reverse direction
B. Natural selection acts in whichever direction the environment favors
C. Air pollution permanently changed the moths' genes and their offspring
D. The moths were able to consciously match their color to the trees

35. The variation between light and dark moths in the original population most likely arose from:

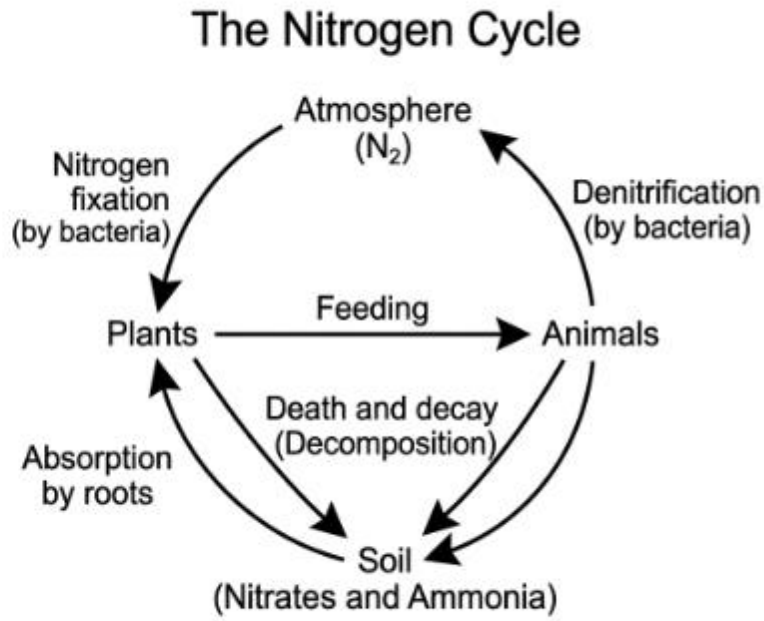
A. Random mutations in the gene controlling wing pigment
B. The moths choosing their color based on the bark color they preferred
C. The bark of the trees actively painting the moths each generation
D. A single moth in the population changing color during its lifetime

36. If a new and even more reflective bark covering appeared on the trees, the most likely outcome in the moth population would be:

A. The moth population would go extinct because no variation exists
B. The moths would all turn the same color as the new tree bark
C. The dark moths would replace the light moths within a few decades
D. Moths with coloring matching the new bark would become more common

Base your answers to questions 37 through 41 on the information below and on your knowledge of biology.

Nitrogen is an essential element in proteins and nucleic acids. Although the atmosphere is nearly 80% nitrogen gas (N_2), most living organisms cannot use this form directly. The nitrogen cycle moves nitrogen from the atmosphere into living organisms and back through several key processes. The diagram below shows the major steps of the nitrogen cycle.



37. According to the diagram, nitrogen gas from the atmosphere is converted into a form that plants can use through which process?

A. Decomposition, by which fungi and bacteria break down dead organic matter
B. Photosynthesis, by which plants take in CO_2 and produce glucose
C. Nitrogen fixation, by which bacteria convert N_2 into usable nitrogen compounds
D. Denitrification, by which bacteria release nitrogen gas back into the air

38. Plants take up nitrogen from the soil mainly in the form of:

A. Nitrate (NO_3^-) and ammonia (NH_3), absorbed through their roots
B. Nitrogen gas (N_2), absorbed directly through their leaves
C. Proteins, absorbed directly from the bodies of dead animals
D. Carbon dioxide, absorbed through stomata in the leaf surface

39. Animals obtain the nitrogen they need by:

A. Absorbing nitrogen gas directly through their lungs and skin
B. Eating plants or other animals that contain nitrogen-rich proteins
C. Producing their own nitrogen compounds through photosynthesis
D. Breaking down water molecules during cellular respiration

40. Decomposers play a critical role in the nitrogen cycle because they:

A. Convert atmospheric nitrogen directly into plant proteins and DNA
B. Capture sunlight and use it to fix nitrogen gas in their own cells
C. Remove all the nitrogen from the soil and lock it permanently in rock
D. Break down dead organisms and return nitrogen compounds to the soil

41. The bacteria that carry out denitrification convert nitrate in the soil into:

A. Nitrogen gas (N_2), which returns to the atmosphere
B. Glucose, which is used by plants as a source of energy
C. Oxygen, which can be used by other living organisms
D. Carbon dioxide, which is released by all decomposers

Base your answers to questions 42 through 45 on the information below and on your knowledge of biology.

When a small population of organisms is introduced into a new environment with abundant resources, the population first grows slowly, then very rapidly. Over time, however, limiting factors such as food, water, space, and predators slow the rate of growth. The population eventually levels off near the carrying capacity of the environment. The graph below compares this typical pattern of population growth (Curve I) with another pattern (Curve II) in which growth continues at a rapid rate without leveling off.

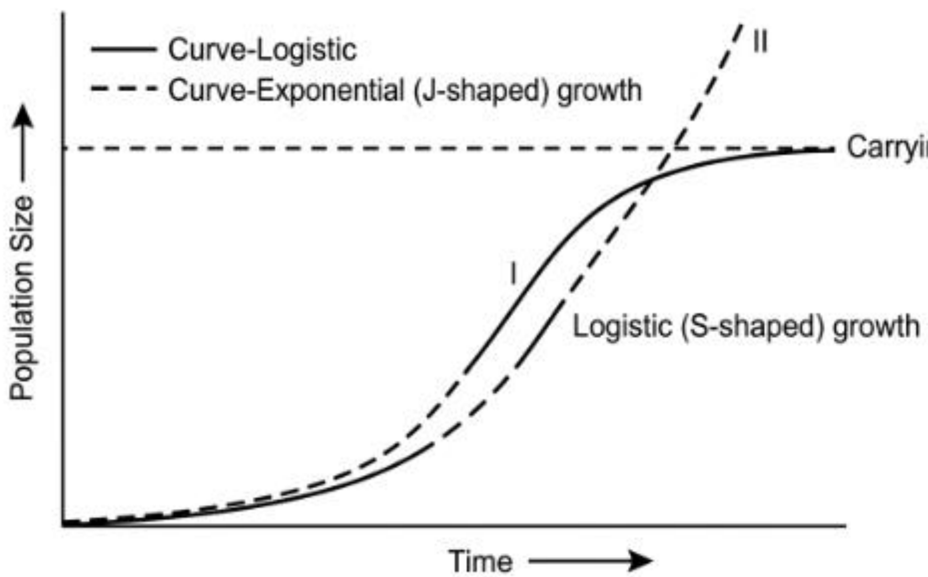


Figure PQ-3

42. The leveling off of Curve I near the dashed line is best explained by:

A. The population reaching the maximum number of births in one generation
B. The population reaching the minimum number of deaths in one generation
C. The population reaching the carrying capacity of its environment
D. The population beginning to evolve into a completely different species

43. Limiting factors that contribute to the leveling off in Curve I include:

A. The total mass of soil and rock in the surrounding ecosystem
B. The number of unrelated species living in distant ecosystems
C. The wavelength of sunlight reaching the deepest layers of soil
D. Availability of food, water, space, and the presence of predators

44. Curve II (exponential growth) does not level off because:

A. The population produces fewer offspring as time passes
B. Resources in the environment are unlimited in this scenario
C. The population's predators are eliminated by random events
D. The population's reproductive rate falls to zero over many generations

45. In nature, exponential growth typically continues only for a short period before:

A. Limiting factors slow growth and the curve transitions toward logistic growth
B. The population doubles in size every generation for many centuries
C. The population learns to control its own birth rate to stay exponential
D. The carrying capacity rises faster than the population for many decades

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

Tropical rainforests are among the most biodiverse ecosystems on Earth, supporting millions of species of plants, animals, and microorganisms. In recent decades, large areas of tropical rainforest have been cleared for agriculture, timber, mining, and infrastructure. This process is called deforestation. Conservation scientists and engineers are developing strategies to monitor deforestation and to protect remaining rainforest habitat.

46. Tropical rainforests are biodiversity hotspots because they contain:

A. Almost no plant species, but a high number of species of large mammals
B. A small number of plant species, with very high numbers of one fish species
C. A large variety of plant, animal, and microbial species in a small area
D. Mostly species that have already gone extinct in other parts of the world

47. A direct effect of deforestation on rainforest biodiversity is:

A. An immediate increase in the number of species in the cleared area
B. A rise in atmospheric oxygen levels caused by the loss of plants
C. A decrease in soil erosion caused by removing tree roots from the ground
D. A loss of habitat that drives many species toward decline and extinction

48. Deforestation also affects the global carbon cycle by:

A. Permanently removing all carbon from the atmosphere for many decades
B. Increasing the rate at which plants absorb CO_2 from the air during growth
C. Releasing stored carbon into the atmosphere when trees are cut and burned
D. Converting fossil fuels deep underground into living trees in cleared land

49. An engineering team is designing a system to monitor deforestation in real time. Which design feature would most directly support this goal?

A. A drilling rig that measures the depth of forest soils across the region
B. Satellite imagery that maps changes in forest cover over time
C. A high-resolution photograph taken once every fifty years at ground level
D. A single thermometer placed at the center of one rainforest tree

50. When comparing strategies to slow deforestation, which factor is most important to consider as a trade-off?

A. The brand of equipment used to record deforestation across regions
B. The aesthetic appearance of the technology installed for monitoring
C. The number of patents the conservation team has filed in the past year
D. The balance among effectiveness, cost, ecological impact, and feasibility

Practice Exam 14 — Full Answer Key with Explanations

1. A — Phenolphthalein turns pink in basic conditions, so wherever the agar has been reached by the NaOH solution, the indicator changes color. The pink region therefore traces how far the base has diffused inward from the cube's surface. The unreacted center stays clear.

2. C — As cube size grows, volume increases as the cube of the side length while surface area increases only as the square, so the SA:V ratio drops from 6:1 to 3:1 to 2:1. Less surface area per unit volume means less membrane to admit NaOH, leaving more of the interior unreached in the same 10 minutes. This is a basic geometric scaling effect.

3. B — Smaller cubes (and smaller cells) have higher SA:V ratios, so each unit of volume has more surface available for exchange with the surroundings. This is why most cells stay small or divide before getting too large to feed themselves. The agar cube models cell-size limits on diffusion.

4. D — A 4×4×4 cube has SA = 96 cm^2 and V = 64 cm^3, giving an SA:V ratio of 1.5:1 — lower than the 3×3×3 cube. With proportionally less surface area, NaOH penetrates a smaller fraction of the interior in 10 minutes. The trend predicts less than 33% pink.

5. A — As a cell grows, its volume rises faster than its surface area, so the SA:V ratio shrinks and the membrane can no longer move enough nutrients in or wastes out. Without sufficient exchange, the cell cannot maintain its metabolism. This is the central reason cells must divide before growing too large.

6. B — At 37°C, salivary amylase is at its optimal temperature and works fastest, fully breaking down the starch before iodine is added. With no starch left, no blue-black color forms. The result confirms 37°C as the enzyme's best operating temperature.

7. C — At 80°C, heat disrupts the hydrogen bonds and other interactions that maintain salivary amylase's three-dimensional shape, distorting its active site. The denatured enzyme can no longer bind starch, so the starch remains and iodine reacts strongly. High-temperature denaturation is typically irreversible.

8. D — Enzymes evolve to function best at the conditions in which they normally operate. Salivary amylase is produced in the mouth and acts at normal body temperature, so its optimum matches 37°C. Human enzymes generally have body-temperature optima for this reason.

9. A — Salivary amylase breaks long starch chains into the disaccharide maltose and shorter dextrins. Iodine forms its blue-black color only with long, coiled starch (amylose), so after digestion no color appears. The iodine test therefore detects whether starch breakdown has occurred.

10. B — A catalyst increases the rate of a reaction without being consumed by it, and salivary amylase repeatedly breaks down starch molecules while remaining unchanged itself. All enzymes are biological catalysts. This is why a small amount of amylase can digest a large amount of starch.

11. D — The diagram shows two arrows entering the mitochondrion: glucose (the fuel molecule) and oxygen (the final electron acceptor). Both are required for aerobic respiration to produce ATP efficiently. Without either, the cell cannot complete the full pathway.

12. C — ATP carries chemical energy in a form cells can quickly use to power muscle contraction, active transport, synthesis of macromolecules, and nerve impulse transmission. Energy is released when ATP's terminal phosphate bond is broken. ATP is the universal energy currency of cells.

13. A — The diagram identifies carbon dioxide and water as the two waste products leaving the mitochondrion. CO_2 diffuses out of the cell and is exhaled by the body, while water joins the cell's water pool. These are the byproducts of fully oxidizing glucose.

14. B — More mitochondria provide more sites for ATP production to match the high energy demands of continuously contracting cells. Heart muscle cells, which never rest, contain especially large numbers of mitochondria. Mitochondrial abundance generally tracks a cell's energy needs.

15. D — The standard aerobic respiration equation is $C_6H_{12}O_6 + 6\ O_2 \rightarrow 6\ CO_2 + 6\ H_2O$ + ATP. Glucose and oxygen are the reactants; carbon dioxide, water, and ATP are the products. Option D correctly shows the inputs, outputs, and direction.

16. A — Homeostasis is the maintenance of stable internal conditions (such as temperature, pH, blood sugar, and water balance) despite changes in the external environment. Body temperature regulation is one of the clearest examples in humans. Stable internal conditions are essential for enzyme function and cell survival.

17. C — Sweat absorbs heat from the body as it evaporates from the skin surface, carrying that heat into the air. This evaporative cooling is the body's main way to dump excess heat. It is most effective in dry air, less so when humidity is high.

18. B — Negative feedback reverses a deviation from a set point and restores balance. Dilating vessels when too hot releases heat, and constricting them when too cold conserves heat, both returning body temperature toward 37°C. Most homeostatic systems in the body work by negative feedback.

19. D — Skeletal muscle contractions release heat as a byproduct of cellular respiration. Shivering produces rapid, repeated contractions, generating extra heat that helps warm the body. This is why shivering is one of the body's main responses to cold.

20. A — Both flower color and stem height show complete dominance, so a single dominant allele expresses the dominant trait. PpTt has at least one P and at least one T, so the plant shows purple flowers and tall stems. The recessive alleles are masked.

21. C — A cross between two dihybrid heterozygotes (PpTt × PpTt) gives the classic 9:3:3:1 phenotypic ratio when the two genes are on separate chromosomes. This ratio reflects independent assortment during meiosis. It is the textbook Mendelian outcome for two independent dominant-recessive genes.

22. B — Each recessive trait requires a homozygous recessive genotype because one dominant allele would mask it. White flowers require pp and short stems require tt, giving pptt. This is the only possible double-recessive genotype.

23. D — Independent assortment is Mendel's principle that alleles of different gene pairs separate independently during meiosis. This produces every possible combination of gametes when genes are on different chromosomes. It is why the dihybrid 9:3:3:1 ratio appears.

24. A — PpTt has one dominant and one recessive allele at each gene, making it heterozygous for both. ppTT has two identical alleles at each gene (homozygous recessive for one, homozygous dominant for the other). The genotypes differ in zygosity and produce different phenotypes.

25. C — Incomplete dominance occurs when the heterozygote (RW) shows a phenotype intermediate between the two homozygotes — pink, between red and white. Neither allele fully masks the other. This pattern produces a 1:2:1 phenotypic ratio in heterozygous crosses.

26. B — In incomplete dominance, the genotypic ratio of an RW × RW cross (1 RR : 2 RW : 1 WW) is also the phenotypic ratio: 1 red : 2 pink : 1 white. Each genotype produces a unique phenotype because no allele is masked. This is the defining ratio of incomplete dominance.

27. A — Each R allele directs the production of some red pigment, while the W allele produces little or none. In a heterozygote, the smaller amount of red pigment mixes with the white background to produce pink. This biochemical "blend" is the basis of incomplete dominance.

28. D — An RW parent produces gametes carrying R or W in equal numbers; a WW parent produces only W gametes. Offspring genotypes are therefore 1/2 RW (pink) and 1/2 WW (white). The expected phenotypic ratio is 1 pink : 1 white.

29. C — In complete dominance, the heterozygote looks identical to the homozygous dominant. In incomplete dominance, the heterozygote shows a phenotype intermediate between the two homozygotes — a blended trait. This intermediate appearance is the key distinction.

30. B — In unpolluted forests, light-colored bark and lichens made light moths hard for bird predators to see, while dark moths stood out and were eaten more often. Better camouflage gave light moths higher survival and reproductive success. Selection therefore favored the light variant.

31. A — When soot darkened the bark, dark moths now blended in better than light moths and escaped predation more often. They reproduced more and passed on the dark coloration. The camouflage advantage shifted from light to dark.

32. D — Natural selection occurs when individuals with favorable heritable traits survive and reproduce more than others, shifting trait frequencies over generations. The change in peppered moth coloration matches this pattern exactly. The peppered moth is one of the most-cited examples of natural selection in action.

33. C — The dark coloration arose from a genetic mutation in the gene controlling wing pigment, present at low frequency in the population before industrialization. Selection later raised its frequency. Mutation provides the new variation on which selection acts.

34. B — When bark lightened again, selection again favored light moths, and their frequency rose. This shows that natural selection has no fixed direction — it favors whichever trait suits current conditions. The reversal confirms that the environment drives the direction of selection.

35. A — Genetic variation in populations originates from random mutations in DNA, which produce new alleles such as the dark-pigment allele. Mutations occur regardless of need; selection then acts on whatever variation exists. Without preexisting variation, selection has nothing to work on.

36. D — Natural selection would favor whichever color matches the new bark, raising the frequency of well-camouflaged moths over generations. The specific color that succeeds depends on the bark's appearance. This is the same principle that explains both the rise of the dark variant and its later decline.

37. C — Nitrogen fixation is the process by which certain bacteria convert atmospheric N_2 into ammonia and other usable nitrogen compounds. This makes nitrogen available to plants, which cannot use N_2 directly. Without nitrogen fixation, nitrogen could not enter the living part of the ecosystem.

38. A — Plant roots absorb soil nitrogen mainly as nitrate (NO_3^-) and ammonium / ammonia (NH_4^+ / NH_3). These ions are taken up and used to build amino acids, proteins, and nucleic acids. Plants cannot absorb N_2 directly.

39. B — Animals cannot fix nitrogen themselves, so they obtain it by consuming plants or other animals that already contain nitrogen-rich proteins. The amino acids released during digestion are then used to build the animal's own proteins. Feeding is therefore the main step that transfers nitrogen up the food chain.

40. D — Decomposers break down dead plants, animals, and waste, returning the nitrogen they contained to the soil as ammonia and nitrate. Producers can then reabsorb these compounds. Without decomposition, nitrogen would remain locked in dead matter and be unavailable to the ecosystem.

41. A — Denitrifying bacteria convert soil nitrate (NO_3^-) into nitrogen gas (N_2), which returns to the atmosphere. This step balances nitrogen fixation and completes the cycle. Denitrification typically occurs under low-oxygen conditions such as waterlogged soils.

42. C — Carrying capacity is the maximum population size an environment can support given its resources. When a growing population approaches this limit, birth and death rates equalize and the population levels off. This produces the S-shape of logistic growth.

43. D — Limiting factors include any environmental resources or pressures that restrict population growth: food, water, space, shelter, and predators. As populations grow, these factors become scarcer or more intense per individual. They drive the slowdown that defines logistic growth.

44. B — True exponential growth requires unlimited resources so every individual can reproduce at the maximum rate without competing. In Curve II's scenario, nothing limits the population. In nature, this is rare and short-lived.

45. A — In real ecosystems, limiting factors inevitably become important as populations expand. Food, space, or predation slow the growth rate, and the curve bends toward an S-shape. Pure exponential growth eventually shifts to logistic growth.

46. C — Tropical rainforests contain extraordinary numbers of plant, animal, and microbial species packed into a relatively small global area. This is why they are called biodiversity hotspots. Many of these species exist nowhere else on Earth.

47. D — Clearing forest destroys the habitat countless species depend on for food, shelter, and reproduction. With no place to live, many populations decline, and species with small or specialized ranges go extinct. Habitat loss is the leading cause of species extinction worldwide.

48. C — Trees store large amounts of carbon in their wood and leaves. When forests are cut and burned (or left to decay), that stored carbon is released to the atmosphere as CO_2. Deforestation therefore contributes significantly to rising atmospheric CO_2 and climate change.

49. B — Satellites can repeatedly image the same forest regions, and changes in forest cover can be mapped by comparing images over time. This provides large-scale, real-time monitoring of deforestation. The other options lack the spatial or temporal coverage required.

50. D — Engineering and conservation decisions involve weighing how well a strategy works, what it costs, how it affects ecosystems, and whether it can be implemented at scale. A strong design balances all four criteria. Considering trade-offs is the foundation of sound environmental decision-making.