PRACTICE EXAM 8 — QUESTIONS 1–50

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 medical research team monitored a healthy adult's blood glucose and insulin levels for four hours after the participant consumed a meal containing 75 grams of carbohydrates at time 0. Blood samples were drawn every 30 minutes. Blood glucose concentration rose from a baseline of about 90 mg/dL to a peak of about 145 mg/dL at 45 minutes, then gradually returned to baseline by hour 3. Insulin concentration in the blood rose shortly after glucose rose, peaked at approximately 60 minutes, and fell as glucose returned toward baseline.

1. What is the main scientific question this study is designed to answer?

A. Whether the participant's stomach can digest carbohydrates within 30 minutes
B. Whether insulin production can be increased through aerobic exercise alone
C. How the body regulates blood glucose concentration after carbohydrate ingestion
D. Whether all healthy adults respond identically to identical carbohydrate meals

2. Which gland secretes the insulin observed in the participant's bloodstream?

A. The adrenal gland, which sits on top of each kidney in the abdomen
B. The pancreas, which contains specialized beta cells within the islets
C. The thyroid gland, which is located in the front of the lower neck
D. The pituitary gland, which lies just beneath the brain inside the skull

3. The pattern in which rising glucose triggers insulin release, which then lowers glucose, is best classified as which type of mechanism?

A. Open-loop control, which proceeds without sensing the current output
B. Positive feedback, which amplifies the change away from the set point
C. Mechanical regulation, which depends only on direct physical forces
D. Negative feedback, which reverses a change to restore the set point

4. Insulin causes blood glucose concentration to fall primarily by:

A. Stimulating body cells to take up glucose from the blood for use or storage
B. Breaking glucose molecules into smaller undetectable units in the bloodstream
C. Causing the kidneys to filter the majority of blood glucose into the urine
D. Triggering the liver to release stored glycogen back into the bloodstream

5. A person whose pancreas cannot produce sufficient insulin would most likely:

A. Experience extremely low blood glucose levels after each meal is eaten
B. Experience persistently elevated blood glucose levels following each meal
C. Produce excessive amounts of glucagon to compensate for the deficit
D. Show no measurable changes in blood glucose throughout each day

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

A class investigated how temperature affects the rate at which salivary amylase breaks down starch. Equal volumes of 1% starch solution were placed in five test tubes and brought to 0°C, 20°C, 37°C, 60°C, and 90°C. The same volume of salivary amylase was added to each tube. Every 60 seconds, students removed a drop of each mixture and tested it with iodine solution, which turns blue-black in the presence of starch. The time required for the iodine test to remain colorless (indicating starch had been digested) was recorded. The results are shown below.

Temperature (°C)	Time to Complete Digestion (min)
0	No digestion observed after 30 min
20	12
37	3
60	No digestion observed after 30 min
90	No digestion observed after 30 min

6. Which conclusion is best supported by the data in the table?

A. Amylase functions optimally at temperatures below 0°C in this experiment
B. The rate of starch digestion is independent of temperature in the body
C. Amylase activity is highest at approximately human body temperature
D. Starch molecules denature at temperatures above 60°C in any solution

7. The failure of amylase to digest starch at 90°C is best explained by:

A. Denaturation of the enzyme, which alters the shape of the active site
B. The complete evaporation of starch molecules from the solution at 90°C
C. The conversion of amylase into a different enzyme that targets sugars
D. The formation of new ionic bonds that strengthen the enzyme structure

8. Why does the reaction proceed so slowly at 0°C compared with 37°C?

A. Cold temperatures permanently destroy the active site of the amylase enzyme
B. Starch molecules are completely absent from the solution at low temperatures
C. The iodine reagent does not function at low temperatures during testing
D. Low temperatures reduce molecular motion and limit enzyme-substrate collisions

9. The role of amylase in this reaction is best described as:

A. A substrate that is consumed and incorporated into the final products
B. A protein that increases the activation energy required for digestion
C. A biological catalyst that speeds up the breakdown of starch molecules
D. A simple sugar produced when starch is broken down by stomach acid

10. If the experiment were repeated using a higher concentration of amylase at 37°C, the most likely outcome would be:

A. Starch would be digested in less time than the original three minutes
B. Starch would be digested in approximately the same three minutes as before
C. Starch would be digested more slowly because the enzymes would compete
D. Starch would not be digested because the enzymes would inhibit each other

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

Students placed sprigs of *Elodea*, an aquatic plant, into four beakers of water containing the indicator bromothymol blue. Bromothymol blue turns yellow when dissolved carbon dioxide forms carbonic acid in the water, and turns blue when carbon dioxide is removed. Before the experiment, each student blew through a straw into each beaker until the solution turned yellow. The beakers were then set up as shown below and left for one hour. The final color was recorded.

Beaker	Setup	Initial Color	Final Color
1	*Elodea* in bright light	Yellow	Blue
2	*Elodea* in dim light	Yellow	Light green
3	*Elodea* wrapped in foil (dark)	Yellow	Yellow
4	No plant, bright light	Yellow	Yellow

11. The yellow color of the bromothymol blue solution at the start of the experiment indicates the presence of:

A. Dissolved oxygen, which is consumed during plant photosynthesis activity
B. Dissolved carbon dioxide, which forms carbonic acid in the water
C. Dissolved nitrogen, which inhibits photosynthesis in aquatic plant species
D. Dissolved glucose, which serves as a food source for the *Elodea* plant

12. Beaker 4 (no plant, bright light) was included in the experiment in order to:

A. Show that plants are not necessary for photosynthesis to take place
B. Demonstrate that bromothymol blue changes color in bright sunlight
C. Compare two different aquatic plant species under identical conditions
D. Serve as a control demonstrating the color change requires the *Elodea*

13. The color change in Beaker 1 from yellow to blue is best explained by:

A. *Elodea* consumed CO2 during photosynthesis, raising the pH of the water
B. *Elodea* released CO2 during cellular respiration, lowering the pH of water
C. The bright light caused the indicator to break down into a blue compound
D. The water evaporated, leaving behind concentrated blue bromothymol dye

14. In Beaker 3, where the *Elodea* was wrapped in foil, the color remained yellow because:

A. The *Elodea* consumed oxygen and released carbon dioxide as a waste product
B. The bromothymol blue cannot change color in the complete absence of light
C. Photosynthesis did not occur, and CO2 was not removed from the water
D. The *Elodea* died immediately after being wrapped in the aluminum foil

15. The most direct evidence in this experiment that photosynthesis requires light comes from comparing:

A. Beaker 1 with Beaker 4, since one contains a plant and the other does not
B. Beaker 1 with Beaker 3, since they differ only in the light condition
C. Beaker 2 with Beaker 4, since they show different degrees of color change
D. Beaker 3 with Beaker 4, since both retained their initial yellow color

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

Researchers studied lactic acid production in human leg muscles during exercise. Volunteers cycled on stationary bikes at progressively higher intensities while researchers measured oxygen consumption and

blood lactic acid concentration. As exercise intensity increased, oxygen consumption rose in proportion to effort up to approximately 70% of each volunteer's maximum capacity. Above that threshold, lactic acid concentration in the blood rose sharply while oxygen consumption increased only slightly.

16. The lactic acid accumulating in the volunteers' blood during high-intensity exercise is produced when:

A. Muscle cells perform anaerobic fermentation due to insufficient oxygen supply
B. Muscle cells convert excess oxygen into lactic acid for energy storage use
C. The liver synthesizes lactic acid from amino acids during periods of stress
D. The kidneys release lactic acid into the bloodstream during heavy exercise

17. Compared with aerobic cellular respiration, anaerobic fermentation in muscle cells produces:

A. More ATP per glucose, because fermentation skips inefficient cellular steps
B. Carbon dioxide and water exclusively, with no additional byproducts at all
C. More total chemical energy because no oxygen is required during the process
D. Less ATP per glucose, with lactic acid as a byproduct in human muscle tissue

18. The mitochondria are essential to aerobic respiration in muscle cells because they:

A. Synthesize glucose molecules from carbon dioxide and water in muscle cells
B. Store glycogen reserves that supply muscle cells during heavy exercise
C. Carry out the reactions that produce most of the cell's ATP using oxygen
D. Filter waste products such as lactic acid out of the bloodstream after exercise

19. After intense exercise, a person continues to breathe heavily for several minutes. This "oxygen debt" is best explained by the body's need to:

A. Cool the body temperature back down to normal resting levels quickly
B. Supply oxygen to convert accumulated lactic acid back into usable forms
C. Replace water lost as sweat during the exercise session that was completed
D. Synthesize new mitochondria within muscle cells after heavy exertion

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

Cystic fibrosis (CF) is a genetic disorder caused by mutations in the CFTR gene, which codes for a protein that transports chloride ions across cell membranes. The most common CF-causing mutation is a deletion of three nucleotides from the CFTR gene, resulting in the loss of a single amino acid

(phenylalanine) from the CFTR protein. The altered protein fails to fold correctly and is destroyed by the cell before it reaches the membrane. People with CF produce unusually thick mucus that clogs airways and digestive ducts. CF is inherited as an autosomal recessive trait.

20. The CFTR gene provides instructions for building a protein. The process of using a gene to produce a protein begins with:

A. Replication, which produces two identical DNA molecules in the cell nucleus
B. Translation, in which transfer RNA molecules carry amino acids to ribosomes
C. Fertilization, which combines two gametes to form a new organism's genome
D. Transcription, in which messenger RNA is synthesized using the DNA template

21. A deletion of three nucleotides from the CFTR gene results in the loss of exactly one amino acid from the protein because:

A. Each amino acid is coded by a single nucleotide along the mRNA strand
B. The ribosome skips one codon for every three nucleotides that are deleted
C. Each amino acid is specified by a sequence of three nucleotides called a codon
D. The three deleted nucleotides always coded for the amino acid phenylalanine

22. The malfunctioning CFTR protein cannot perform its normal function in the cell because:

A. The altered protein folds into an incorrect three-dimensional shape
B. The new protein is too small to span the thickness of the cell membrane
C. The cell completely fails to produce any CFTR protein from the altered gene
D. The chloride ions become too large to fit through the protein channel

23. A child with cystic fibrosis is born to two parents who do not have the disease. Which statement about the parents must be true?

A. Both parents are homozygous dominant for the normal CFTR allele
B. Each parent must carry at least one copy of the recessive CF allele
C. At least one parent must have the disease in an undiagnosed form
D. Both parents must have acquired the mutation during their own lifetimes

24. The deletion of three nucleotides from the CFTR gene is best classified as which type of mutation?

A. A whole-chromosome duplication occurring during normal cell division
B. A point mutation changing a single base from one nucleotide to another
C. A chromosomal translocation moving a section to a different chromosome
D. A small deletion mutation that removes nucleotides from a single gene

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

In humans, ABO blood type is controlled by a single gene with three alleles: I^A, I^B, and i. The I^A and I^B alleles are codominant with each other, and both are completely dominant over the i allele. A woman with blood type A and genotype I^A i has children with a man whose blood type is AB and whose genotype is I^A I^B.

25. What blood types are possible among the children of this couple?

A. Types A, B, and AB are all possible among the children of this couple
B. Only blood type AB is possible because both parents express the A allele
C. Only blood types A and B are possible; type AB cannot appear in offspring
D. Only blood type O is possible because the children inherit recessive alleles

26. What is the probability that any single child of this couple will have blood type B?

A. 0%, because neither parent has blood type B within the family
B. 12.5%, because one of every eight combinations produces blood type B
C. 25%, because one of every four combinations produces blood type B
D. 75%, because three of every four offspring will inherit the B allele

27. The fact that a person with genotype I^A I^B has blood type AB (expressing both A and B antigens) demonstrates which inheritance pattern?

A. Complete dominance, in which one allele completely masks the other allele
B. Incomplete dominance, in which the heterozygote shows a blended phenotype
C. Polygenic inheritance, in which multiple genes contribute to one trait
D. Codominance, in which both alleles are fully expressed in the heterozygote

28. The three alleles of the ABO blood-type gene (I^A, I^B, and i) are an example of:

A. Sex-linked traits, which are carried only on the X or Y chromosome
B. Multiple alleles, in which more than two alleles exist for a single gene
C. Polygenic inheritance, in which several genes control a single trait
D. Linked genes, which are inherited together on the same chromosome

29. A child of this couple has blood type AB. What is the genotype of this child?

A. I^A i, indicating the child carries the recessive blood-type allele
B. I^B i, indicating the child carries one recessive allele from the father
C. I^A I^B, indicating the child inherited one allele from each parent
D. ii, indicating the child is homozygous for the recessive i allele

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

Researchers studied the medium ground finch (*Geospiza fortis*) on Daphne Major Island in the Galápagos. During a severe drought in 1977, soft, small seeds became scarce while large, hard seeds remained available. Finches with larger, deeper beaks could crack the hard seeds, while finches with smaller beaks generally could not. Researchers measured average beak depth in the population before the drought, at the end of the drought, and in the next generation born after the drought. The data are shown below.

Time Point	Mean Beak Depth (mm)
Year 0 (before drought)	9.4
Year 1 (end of drought)	9.8
Year 2 (next generation)	10.2

30. During the 1977 drought, which finches were most likely to survive and reproduce?

A. Finches with larger, deeper beaks capable of cracking large, hard seeds
B. Finches with smaller, narrower beaks that could fit into tight crevices
C. Finches with the same average beak depth as the pre-drought population
D. Finches that migrated to a neighboring island for the entire dry season

31. The shift in average beak depth between Year 0 and Year 2 is best described as an example of:

A. Acquired characteristics passed from parents to offspring during the drought
B. Genetic engineering of the finch population by external research scientists
C. A random mutation in every surviving finch that produced larger beak depth
D. Natural selection acting on existing heritable variation in finch beak depth

32. Before the drought began, the finch population already contained finches with a range of beak sizes. This pre-existing variation is best explained by:

A. The drought itself, which produced new mutations in adult finches each year
B. Random mutations and sexual reproduction occurring in earlier generations
C. Finches deliberately choosing mates with beak sizes different from their own
D. Environmental pressures that taught individual finches to grow larger beaks

33. In order for the change in beak depth to be passed on to the next generation, the trait must be:

A. Heritable, meaning it can be transmitted genetically from parent to offspring
B. Acquired, meaning it develops only during an individual finch's lifetime
C. Learned, meaning each finch must observe other finches before adopting it
D. Reversible, meaning the population can return to its original beak size

34. If, in a later year, abundant rainfall once again made small, soft seeds the dominant food source, the most likely long-term result would be:

A. The finch population would go extinct because seeds would be too small to eat
B. All finches would immediately grow smaller beaks within a single dry season
C. Average beak depth in the population would remain permanently elevated
D. Average beak depth in the population might gradually decrease over generations

35. Which statement best distinguishes natural selection from genetic drift in this finch population?

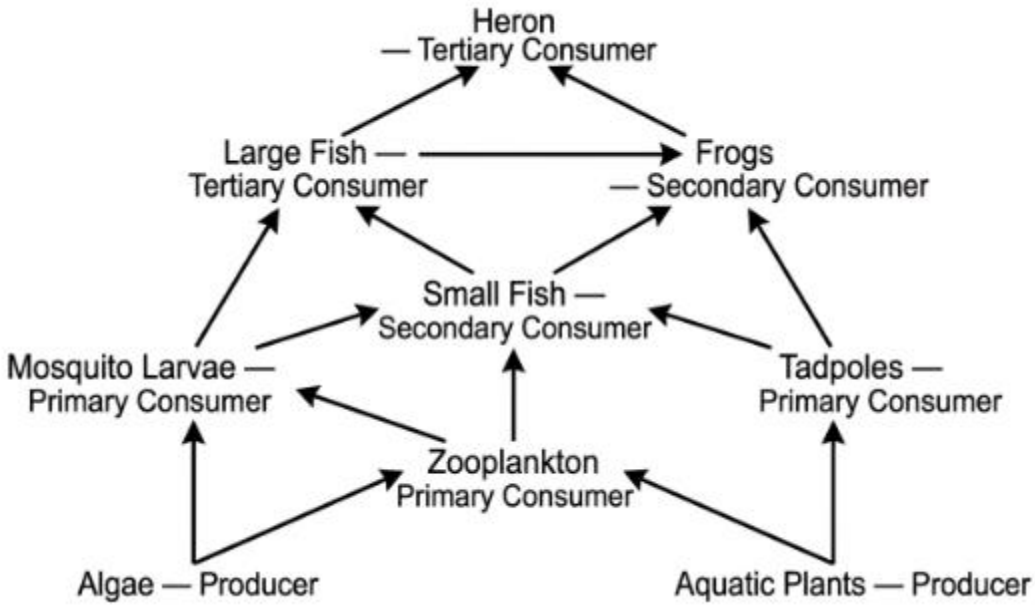
A. Genetic drift always produces larger and stronger individuals in each generation
B. Natural selection only operates in populations of less than fifty individuals
C. Natural selection favors traits that improve survival; drift is random change
D. Natural selection and genetic drift cannot both occur in the same population

36. Later research showed that beak depth in this finch species is influenced by several genes. This means that beak depth is best described as:

A. A simple Mendelian trait controlled by one gene with two distinct alleles
B. A polygenic trait, in which multiple genes contribute to the phenotype
C. A sex-linked trait carried only on the female finches' sex chromosomes
D. A maternal-effect trait determined entirely by the mother's environment

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

A simplified food web for a freshwater pond ecosystem is shown below. Arrows point from the organism being eaten to the organism that eats it, indicating the direction of energy transfer.



37. The algae and aquatic plants in this pond ecosystem are best classified as:

A. Producers, because they convert sunlight into chemical energy via photosynthesis
B. Primary consumers, because they feed on zooplankton at the bottom of the pond
C. Secondary consumers, because they consume small organisms within the water column
D. Decomposers, because they break down dead matter at the bottom of the pond

38. If a pesticide accidentally kills most of the mosquito larvae in this pond, the most immediate effect will be:

A. The algae will go extinct because they depend on mosquito larvae for nitrogen
B. The heron population will increase because more food becomes available to it
C. Small fish that feed on mosquito larvae will have reduced food availability
D. Zooplankton will be eliminated as the pesticide spreads through the entire pond

39. A scientist measures the total biomass at each trophic level of the pond food web. The expected pattern is that:

A. The top predators contain the largest total biomass within the pond ecosystem
B. Biomass is distributed approximately equally among all of the trophic levels
C. Biomass increases at each higher level because predators are larger than prey
D. Producers contain the largest total biomass, decreasing at each higher level

40. Approximately what percentage of the energy at one trophic level is typically transferred to the next higher level in a food web such as this one?

A. Approximately 100%, because energy cannot be created or destroyed in nature
B. Approximately 10%, because most consumed energy is lost as heat to surroundings

C. Approximately 50%, because half of the consumed material becomes new body tissue
D. Approximately 90%, because predators efficiently extract most of the prey's energy

41. Which group of organisms is not shown on the diagram but would be essential for recycling nutrients within this pond ecosystem?

A. Additional secondary consumers, which would help balance the predator populations
B. Larger apex predators, which would regulate the numbers of large fish in the pond
C. Decomposers such as bacteria and fungi, which break down dead organic material
D. New producer species, which would supply more solar energy to the pond system

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

A glacier in Alaska has been retreating since the late 1800s, exposing bare rock surfaces. Ecologists have monitored the colonization of life on the newly exposed rock for over a century. The first organisms to appear on the bare rock are lichens and mosses. Over the following decades, soil gradually develops as these pioneer organisms die and decompose. Eventually, small herbaceous plants and shrubs become established, followed by alder trees. After several centuries, a spruce forest dominates the area.

42. The pattern of community change described in this scenario is best classified as:

A. Primary succession, which begins on bare rock with no pre-existing soil layer
B. Secondary succession, which begins in a disturbed area where soil remains intact
C. Convergent evolution, in which unrelated species develop similar physical traits
D. Niche partitioning, which divides limited resources among similar competing species

43. Lichens are particularly well suited to be among the first organisms on bare glacial rock because they:

A. Reproduce more rapidly than any other land organism in the ecosystem
B. Provide habitat for large herbivores that would otherwise leave the area
C. Outcompete spruce trees for sunlight during the early years of succession
D. Can survive on bare rock and gradually contribute to the formation of soil

44. As the spruce forest becomes established, which of the following is most likely to occur?

A. The lichens will return to dominate the ground beneath the tall spruce canopy
B. The soil will become thinner because spruce trees absorb most of the nutrients
C. Many of the early pioneer species will decline due to shade and competition
D. The community will stop changing entirely once the first spruce tree appears

45. The mature spruce forest that develops at the end of this succession is best described as:

A. A pioneer community, which is the first stage that appears on newly bare ground
B. A climax community, which represents a stable, late-stage ecological community
C. A keystone species, which has a disproportionately large effect on its ecosystem
D. A trophic level, which describes one position in the flow of energy through life

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

The brown tree snake (*Boiga irregularis*) was accidentally introduced to the island of Guam in cargo shipments shortly after World War II. Guam had no native snake species, and its forest birds had evolved without snake predators. Within several decades of the snake's arrival, native forest bird populations on Guam collapsed, and many bird species were driven to extinction on the island. Ecosystems that lost their birds also experienced reductions in seed dispersal, sharp increases in spider populations, and changes in forest plant composition over time.

46. The brown tree snake on Guam is best classified as:

A. An invasive species, because it was introduced to a new ecosystem and caused harm
B. A native species, because it has now lived on Guam for many decades since arrival
C. A keystone species, because it stabilizes the populations of all other organisms
D. A producer species, because it converts solar energy into food for its own use

47. The collapse of native bird populations on Guam after the snake's arrival is best explained by the fact that:

A. The birds began directly competing with the snake for nesting sites in the trees
B. The snake produced a chemical that altered the genetic code of every bird species
C. Guam's birds had no evolutionary history with snakes and lacked effective defenses
D. The snake caused the average temperature of Guam's forests to increase substantially

48. The sharp increase in spider populations on Guam after the bird decline is best explained by:

A. The brown tree snake actively feeding spiders to support spider population growth
B. The spiders evolving a new genetic mutation that made them resistant to predation
C. A sudden increase in insect food sources following the destruction of all the birds
D. The removal of a major predator (birds) that had previously kept spider numbers down

49. The reduction in seed dispersal across Guam's forests after the bird decline is most likely to:

A. Increase the number of plant species in the forest within a single generation
B. Reduce the long-term diversity and distribution of plant species in the forest
C. Have no measurable effect on the composition of the forest plant community
D. Cause new bird species to colonize Guam from neighboring islands very quickly

50. When evaluating policies to reduce future invasive species introductions, which factor would be most important to consider as a trade-off?

A. The balance among effectiveness, cost, ecological impact, and feasibility of enforcement
B. The number of patents filed by biologists during the previous calendar year worldwide
C. The aesthetic appearance of inspection equipment used at the ports of entry
D. The amount of attention the issue receives in popular entertainment media

PRACTICE EXAM 8 – EXPLAINED ANSWER KEY (Q1–Q50)

1. C — The study tracks both blood glucose and insulin concentrations across four hours after a standardized carbohydrate meal. The variables being measured directly test how the body's hormonal system regulates blood glucose after carbohydrate intake. Quantifying this homeostatic response is the central purpose of the investigation.

2. B — The pancreas contains beta cells within the islets of Langerhans that secrete insulin in response to rising blood glucose. The adrenal, thyroid, and pituitary glands serve different endocrine functions and do not produce insulin. Recognizing the pancreas as the source of insulin is foundational for understanding diabetes and glucose homeostasis.

3. D — Negative feedback reverses a deviation from a set point to restore homeostasis. Rising glucose triggers insulin release, which lowers glucose; falling glucose then turns off insulin secretion — the textbook negative-feedback loop. This is the same general mechanism that controls body temperature, blood pH, and many other regulated physiological variables.

4. A — Insulin binds to receptors on body cells (especially muscle, fat, and liver) and signals them to take up glucose from the blood for use or storage as glycogen. This removal lowers blood glucose concentration directly. Without insulin signaling, glucose remains in the bloodstream because cellular uptake fails — the core defect in type 1 diabetes.

5. B — Without sufficient insulin, body cells cannot efficiently take up glucose from the blood, so glucose accumulates and remains elevated after meals. This is the defining feature of diabetes mellitus. Persistent hyperglycemia is what produces the long-term vascular, nerve, and organ damage seen in untreated diabetes.

6. C — The data show fastest digestion (3 minutes) at 37°C, with no detectable activity at either extreme. Human body temperature is approximately 37°C, which is the optimal temperature for human salivary amylase. Enzymes generally evolve to function best at the temperature of the organism that produces them.

7. A — At 90°C, heat disrupts the hydrogen bonds and weak interactions that maintain the enzyme's three-dimensional shape. Once the active site is distorted, the substrate (starch) can no longer bind, and catalysis stops. Denaturation is typically irreversible, which is why high heat permanently inactivates most enzymes.

8. D — Temperature determines the kinetic energy of molecules. At 0°C, both enzyme and substrate move slowly and collide infrequently, so very few enzyme-substrate complexes form. The enzyme is not damaged — activity simply resumes as temperature is raised back toward the optimum.

9. C — Amylase is a biological catalyst (enzyme) that speeds up the breakdown of starch into smaller sugars without being consumed in the reaction. Enzymes work by lowering the activation energy required for a reaction to proceed. This catalytic role is why a small amount of amylase can digest a large amount of starch.

10. A — Adding more enzyme provides more active sites available to bind substrate at the same time, increasing the overall rate of the reaction. As long as substrate is in excess, doubling enzyme concentration roughly doubles the reaction rate. This principle holds broadly for enzyme-catalyzed reactions whenever substrate is not the limiting factor.

11. B — Bromothymol blue turns yellow in acidic conditions, which occur when dissolved CO_2 forms carbonic acid in the water. Blowing through the straw introduced CO_2, lowering the pH and producing the initial yellow color. The indicator therefore acts as a real-time tracker of dissolved CO_2 levels in the experimental water.

12. D — A control isolates the variable being tested. Beaker 4 contains everything except the *Elodea*, so any color change must be caused by something other than the plant. Because the no-plant beaker stayed yellow, students can confidently attribute the color change in Beaker 1 to the *Elodea* itself.

13. A — In bright light, the *Elodea* photosynthesized actively, absorbing dissolved CO_2 from the water. As CO_2 was removed, carbonic acid decreased and the pH rose, returning the indicator from yellow to blue. The color shift directly visualizes CO_2 uptake during photosynthesis.

14. C — Photosynthesis requires light energy to drive the light-dependent reactions. With the beaker wrapped in foil, the *Elodea* could not photosynthesize, so CO_2 was not removed from the water and the indicator stayed yellow. This result confirms that light is an essential input to the photosynthetic reaction.

15. B — Beakers 1 and 3 differ only in light exposure — same plant, same water, same starting CO_2. The blue color in light and the yellow color in dark therefore isolate light as the variable responsible for the change. A well-controlled experimental comparison changes only one variable at a time.

16. A — When oxygen demand exceeds supply during intense exercise, muscle cells switch to anaerobic fermentation, converting pyruvate to lactic acid to regenerate the NAD^+ needed for glycolysis to continue. This allows ATP production to continue briefly without oxygen. The lactic acid then diffuses into the blood, where it can be measured.

17. D — Aerobic respiration yields roughly 36 ATP per glucose molecule by fully oxidizing it in the mitochondria. Anaerobic fermentation in muscle produces only about 2 ATP per glucose and leaves lactic acid as a byproduct. This is why anaerobic effort can only be sustained for short bursts before fatigue sets in.

18. C — The mitochondria house the electron transport chain and the citric acid cycle, which together generate the vast majority of cellular ATP when oxygen is available. Without functional mitochondria, cells must rely on glycolysis and fermentation, which produce far less energy. Muscle cells contain large numbers of mitochondria precisely because of their high energy demand.

19. B — During recovery, oxygen is needed to convert accumulated lactic acid back into pyruvate (and ultimately glucose in the liver via the Cori cycle) and to restore ATP and creatine phosphate stores. This continued elevated breathing repays the "oxygen debt." Heavy breathing only stops once metabolic balance is fully restored.

20. D — Transcription is the first step of gene expression: an mRNA copy of the DNA sequence is synthesized in the nucleus by RNA polymerase. The mRNA then travels to a ribosome, where translation builds the protein. Transcription must occur first because the ribosome cannot read DNA directly.

21. C — The genetic code is read in triplets called codons; each codon specifies one amino acid. Removing exactly three nucleotides eliminates one full codon, removing one amino acid while keeping the reading frame intact for the rest of the protein. This is why the CFTR deletion produces a protein missing exactly one phenylalanine residue.

22. A — A protein's function depends on its three-dimensional shape, which is determined by its amino acid sequence. Losing even one amino acid can disrupt folding, leaving the protein misshapen and nonfunctional. In CF, the misfolded CFTR is detected by cellular quality-control machinery and destroyed before it can reach the cell membrane.

23. B — Cystic fibrosis is autosomal recessive, so an affected child must inherit one recessive allele from each parent. Because neither parent has the disease, each parent must be a heterozygous carrier (one normal allele, one CF allele). Carrier screening uses this principle to identify at-risk couples before pregnancy.

24. D — The mutation removes three nucleotides from the gene's DNA sequence — a small deletion mutation, distinct from substitutions, insertions, or larger chromosomal changes. Because the deletion is a multiple of three, the reading frame downstream is preserved and only one amino acid is lost. Deletions that are not multiples of three would instead cause frameshift mutations.

25. A — A Punnett square of I^A i × I^A I^B yields four genotypes in equal proportion: I^A I^A (type A), I^A I^B (type AB), I^A i (type A), and I^B i (type B). The resulting phenotypes are types A, B, and AB. Type O is impossible because the father cannot contribute an i allele.

26. C — From the cross I^A i × I^A I^B, one of the four equally likely offspring genotypes is I^B i, which expresses blood type B. That outcome occurs in 1 of 4 combinations, giving a probability of 25%. Each birth is independent, so the 25% probability applies to every individual child of this couple.

27. D — Codominance occurs when both alleles in a heterozygote are fully and simultaneously expressed in the phenotype, rather than one masking the other. In type AB blood, both A and B antigens appear on the red blood cell surface. This differs from incomplete dominance, where the heterozygote shows a blended intermediate trait.

28. B — Multiple alleles refers to a single gene having more than two allele variants within a population. The ABO system has three (I^A, I^B, i), even though any one individual carries only two of them. Many traits — including coat color in rabbits and HLA types in humans — are governed by multiple-allele systems.

29. C — Type AB requires expression of both the A and B antigens, which only occurs in a person with one I^A and one I^B allele. The mother contributes I^A and the father contributes I^B (or vice versa), producing the I^A I^B genotype. A type AB phenotype with any other genotype is not biologically possible.

30. A — During the drought, the only abundant seeds were large and hard, requiring deep, strong beaks to crack. Finches with larger beaks could feed and survive; finches with smaller beaks largely starved. Survival was determined by an existing heritable trait — the textbook setup for natural selection.

31. D — Beak depth varies and is heritable, and the drought selectively favored finches with deeper beaks. Their surviving offspring inherited the deeper-beak alleles, shifting the population mean upward. This is natural selection acting on existing variation, not the creation of new traits in response to need.

32. B — Variation in populations arises from random mutation and from sexual reproduction's reshuffling of alleles through meiosis and fertilization. These processes generate the heritable differences on which selection can later act. The drought did not create the variation; it simply favored some of the variants that were already present.

33. A — Natural selection only acts on traits that are heritable — encoded in DNA and passed to offspring through gametes. Acquired traits, gained during an individual's lifetime through use, learning, or injury, are not transmitted genetically. Without heritability, no shift in population averages would persist across generations.

34. D — A reversal of selective pressure would favor finches with smaller, narrower beaks better suited to soft seeds, so the average beak depth in the population would gradually decline over generations. The change would not be immediate — selection works generation by generation. Beak depth in this species has in fact been observed to oscillate with rainfall patterns over multi-decade studies.

35. C — Natural selection is non-random: traits that improve survival and reproduction become more common because they help organisms succeed in their environment. Genetic drift, by contrast, is random change in allele frequencies due to chance events, and is especially strong in small populations. Both processes can occur simultaneously, but they differ fundamentally in directionality.

36. B — Polygenic traits are influenced by multiple genes acting together, producing continuous variation rather than discrete categories. Beak depth, like human height and skin color, shows a smooth range of values across the population because many genes each contribute small effects. This contrasts with Mendelian traits controlled by a single gene with clear dominant/recessive patterns.

37. A — Producers (autotrophs) capture energy from sunlight and convert it into chemical energy stored in organic molecules through photosynthesis. Algae and aquatic plants both perform photosynthesis,

forming the energy base of pond food webs. All higher trophic levels ultimately depend on this captured solar energy.

38. C — Mosquito larvae are prey for small fish in this food web. Removing them eliminates a major food source for small fish, which would experience reduced food availability and possible population decline. Such cascading effects are common when one species in a food web is suddenly reduced.

39. D — Because energy is lost as heat at each transfer between trophic levels, the biomass that can be supported decreases at each higher level. Producers therefore contain the most biomass, with each successive consumer level holding less. This is the classic ecological pyramid of biomass.

40. B — The "10% rule" describes the typical efficiency of energy transfer between trophic levels: only about 10% of the energy at one level is incorporated into the next. The remainder is lost as heat through respiration, used in metabolism, or excreted as waste. This inefficiency limits the number of trophic levels a food web can support.

41. C — Decomposers such as bacteria and fungi break down dead organisms and waste, releasing nutrients back into the water and sediment for producers to reuse. Without decomposers, nutrients would remain locked in dead organic matter and the system would eventually collapse. Decomposers complete the nutrient cycle that sustains the ecosystem.

42. A — Primary succession begins in a lifeless area where no soil exists — such as freshly exposed glacial rock, volcanic surfaces, or new islands. Hardy pioneers like lichens and mosses must first colonize the bare substrate and slowly build soil. This distinguishes it from secondary succession, which begins where soil already remains after a disturbance.

43. D — Lichens are symbiotic associations of fungi and algae (or cyanobacteria) capable of clinging to bare rock and obtaining minerals by slowly weathering it. As lichens die and decompose, their remains mix with weathered rock particles to form the earliest soil. This soil then supports the mosses, herbaceous plants, and shrubs that follow in succession.

44. C — As tall trees fill in the canopy, the forest floor becomes shaded and the soil chemistry changes. Many pioneer species require open sunlight and cannot reproduce under shaded, competitive conditions, so they decline. This community turnover is a defining feature of succession progressing toward a climax state.

45. B — A climax community is the relatively stable, self-sustaining assemblage of species that develops at the end of an ecological succession. The spruce forest persists because its dominant species can reproduce under its own conditions, unlike the earlier pioneer stages. Climax communities can still change, but they no longer undergo the rapid directional turnover characteristic of succession.

46. A — An invasive species is a non-native organism that establishes in a new ecosystem and causes ecological or economic harm. The brown tree snake fits this definition precisely on Guam: it was introduced by humans and has caused widespread biodiversity loss. Invasive species are one of the leading causes of extinction worldwide.

47. C — Guam's native birds evolved without snake predators and therefore lacked behavioral defenses, suitable nesting strategies, or warning responses to a stealthy nocturnal climber. The snake encountered prey populations that had no resistance to it. This pattern — naïve native species devastated by introduced predators — is common on isolated islands.

48. D — Birds had previously preyed heavily on spiders, keeping spider populations in check. Removing this major predator pressure allowed spider numbers to multiply without their main natural control. Such trophic cascades, where the loss of a predator dramatically alters lower levels, are well documented in ecosystems worldwide.

49. B — Many tropical plants depend on birds to disperse their seeds, often by eating fruits and depositing seeds at new locations. Without birds, seeds remain near the parent plant and fail to colonize new sites, narrowing the spatial distribution and reducing recruitment of new individuals over time. The long-term result is lower plant diversity and altered forest composition.

50. A — Effective environmental policy must balance multiple competing factors: how well the policy works, how much it costs, what side effects it has on ecosystems and human activities, and whether it can realistically be enforced. Focusing on only one factor — such as cost alone — produces poor outcomes. Trade-off analysis is therefore central to evidence-based environmental decision-making.