PRACTICE EXAM 22: LIVING ENVIRONMENT REGENTS SIMULATION

Time Allowed: 3 hours | Total Points: 85 | Passing: 65 scaled | Mastery: 85 scaled

PART A — CORE CONTENT MULTIPLE CHOICE (30 Questions, 30 Points)

Answer all questions in this part.

1. All living things, from bacteria to humans, are organized into structural units that perform life processes. This basic unit of life is the

A. cell, the smallest unit capable of life functions

B. atom, the building block of all matter

C. tissue, a group of similar cells working together

D. organ system, multiple organs working together

2. Water has a high specific heat capacity, meaning it requires a large amount of energy to change its temperature. This property helps living organisms by

A. providing the energy needed for active transport

B. dissolving nutrients for transport in the blood

C. acting as a lubricant in joint cavities

D. moderating temperature changes in their bodies

3. Carbohydrates such as glucose serve as a primary source of energy for cells because they

A. form the structural components of cell membranes

B. can be broken down to release energy for ATP production

C. carry genetic information from one generation to the next

D. catalyze chemical reactions inside the cell

4. Enzymes speed up chemical reactions in living organisms by

A. providing energy that the reaction would not otherwise have

B. permanently combining with the products of the reaction

C. lowering the activation energy needed for the reaction

D. raising the temperature of the surrounding cellular environment

5. The cellular organelle that breaks down toxic substances such as hydrogen peroxide and certain fatty acids is called the

A. peroxisome containing oxidative enzymes

B. ribosome where proteins are assembled

C. mitochondrion that produces cellular ATP

D. nucleus that contains the genetic material

6. Oxygen moves from the air sacs of the lungs into the surrounding capillaries by

A. active transport that requires ATP energy

B. simple diffusion from higher to lower concentration

C. endocytosis bringing oxygen into the cells

D. exocytosis releasing oxygen from the cells

7. The process by which a sequence of amino acids is assembled at a ribosome based on the order of codons in mRNA is called

A. transcription of DNA into mRNA

B. replication of DNA before cell division

C. mutation of the original DNA sequence

D. translation of mRNA into a protein

8. A type of RNA that is a key structural component of the ribosomes themselves is called

A. messenger RNA (mRNA) carrying genetic instructions

B. transfer RNA (tRNA) carrying individual amino acids

C. ribosomal RNA (rRNA) forming part of the ribosome

D. DNA acting as the template for all RNA types

9. A point mutation that changes one base in a gene's coding sequence, resulting in a codon that codes for a different amino acid, is called

A. a silent mutation with no protein change

B. a missense mutation producing one different amino acid

C. a nonsense mutation creating a stop codon

D. a frameshift mutation shifting the entire reading frame

10. During which phase of meiosis does crossing over between homologous chromosomes occur?

A. Prophase I, when homologous chromosomes pair up

B. Metaphase II, when chromatids align at the equator

C. Anaphase I, when homologs separate to opposite poles

D. Telophase II, when daughter cells form completely

11. In a Punnett square cross between two heterozygous parents (Aa × Aa) for a trait showing complete dominance, the expected genotypic ratio of offspring is

A. 1:1, with equal numbers of each genotype

B. 9:3:3:1, the classic dihybrid ratio

C. 1:2:1, with two heterozygous and one of each homozygous

D. 3:1, with three dominant phenotypes to one recessive

12. In a pedigree chart, a horizontal line connecting two individuals indicates

A. a mating relationship between two individuals

B. that the two individuals are identical twins

C. a parent-child relationship between them

D. a sibling relationship between brothers and sisters

13. X-linked recessive disorders are more commonly expressed in males than in females because

A. males have stronger expression of all genetic disorders

B. females produce more offspring than males do typically

C. the Y chromosome carries the same recessive alleles

D. males have only one X chromosome with no second copy to mask recessive alleles

14. Scientists can transfer a useful gene from one organism into the DNA of another organism. This process is called

A. natural selection of beneficial alleles

B. genetic engineering using recombinant DNA techniques

C. mutation creating new genetic variation

D. cloning to produce identical genetic copies

15. Jean-Baptiste Lamarck proposed that giraffes have long necks because their ancestors stretched their necks to reach high leaves and passed this acquired trait to offspring. Modern biology rejects this idea because

A. giraffes have never had short ancestors in their evolutionary past

B. necks cannot be stretched by behavior in any organism

C. all giraffes alive today have necks of identical length

D. acquired traits developed during an individual's lifetime are not heritable

16. In a sexually reproducing population, the major source of new combinations of alleles that natural selection can act on is

A. cellular respiration releasing energy from glucose

B. photosynthesis producing oxygen as a byproduct

C. meiosis and fertilization shuffling allele combinations

D. binary fission of single-celled organisms

17. Vestigial structures, such as the small pelvic bones found in whales, are best understood as

A. reduced remnants of structures that were functional in ancestors

B. newly evolved structures developing for future use

C. structures unique to whales that have no evolutionary history

D. structures that develop only during embryonic stages of whales

18. When a population of squirrels becomes divided by the formation of a deep canyon, and the two groups eventually become unable to interbreed, the result is

A. an immediate mass extinction of both groups

B. the formation of two separate species through speciation

C. a return to the original ancestor species over time

D. the disappearance of all genetic variation in both groups

19. Some species in the fossil record show long periods of little change followed by short bursts of rapid evolutionary change. This pattern is described as

A. gradualism, with slow continuous change over time

B. coevolution between predator and prey species

C. convergent evolution toward similar adaptations

D. punctuated equilibrium with stasis broken by rapid change

20. A cactus with a deep root system and a thick waxy stem that stores water is adapted for survival in a desert. These adaptations are best classified as

A. behavioral adaptations learned during the cactus's lifetime

B. acquired traits developed in response to drought conditions

C. structural adaptations inherited from previous generations

D. physiological responses occurring only during a drought

21. Two species of birds compete for the same insect prey in the same forest. According to the principle of competitive exclusion, the most likely long-term outcome is that

A. both species continue to coexist with identical populations

B. one species will eventually exclude the other from the area

C. the two species will merge into a single new species

D. both species will go extinct in the forest simultaneously

22. The maximum number of individuals of a species that an environment can support indefinitely is called the environment's

A. biotic potential of the species

B. niche occupied by the species

C. trophic level of the species

D. carrying capacity for that species

23. A field that was previously farmland is abandoned. Grasses grow first, followed by shrubs and eventually trees over many decades. This is an example of

A. secondary succession on land with existing soil

B. primary succession on bare exposed rock

C. competitive exclusion of all plant species

D. mass extinction of all native vegetation

24. Coral reefs are among the most biodiverse ecosystems on Earth. The reefs themselves are built by

A. seaweed forming dense underwater forests

B. fish constructing protective structures from sand

C. coral animals secreting calcium carbonate skeletons

D. plants growing underwater in tropical seas

25. Some bacteria can break down petroleum and other pollutants in contaminated soil and water. The use of organisms to clean up environmental pollution is called

A. eutrophication of polluted water bodies

B. genetic engineering of resistant species

C. acid rain treatment of damaged ecosystems

D. bioremediation using organisms to remove pollution

26. When a large continuous forest is divided into smaller isolated patches by roads, housing, and farmland, the resulting decrease in habitat connectivity is called

A. ecological succession to a new community

B. habitat fragmentation reducing connectivity

C. carrying capacity of the new patches

D. genetic drift within isolated populations

27. To help wildlife move safely between separated habitat patches, conservationists sometimes build

A. wildlife corridors connecting habitat patches

B. tall walls preventing all animal movement

C. agricultural fields between protected areas

D. urban developments throughout the region

28. Which of the following agricultural practices is most likely to reduce soil erosion on a hillside farm?

A. Plowing the soil along the direction of the slope

B. Removing all natural vegetation from the slope

C. Planting crops along the contour lines of the slope

D. Leaving the soil bare between growing seasons

29. The thinning of the ozone layer in Earth's stratosphere has been caused primarily by

A. carbon dioxide released from cellular respiration

B. methane released from animal digestive processes

C. nitrogen gas released by soil bacteria

D. chlorofluorocarbons (CFCs) released by industrial chemicals

30. Acid rain is formed when certain pollutants in the atmosphere dissolve in water vapor. The pollutants most responsible for acid rain are

A. sulfur and nitrogen oxides from burning fossil fuels

B. chlorofluorocarbons from refrigerator leaks

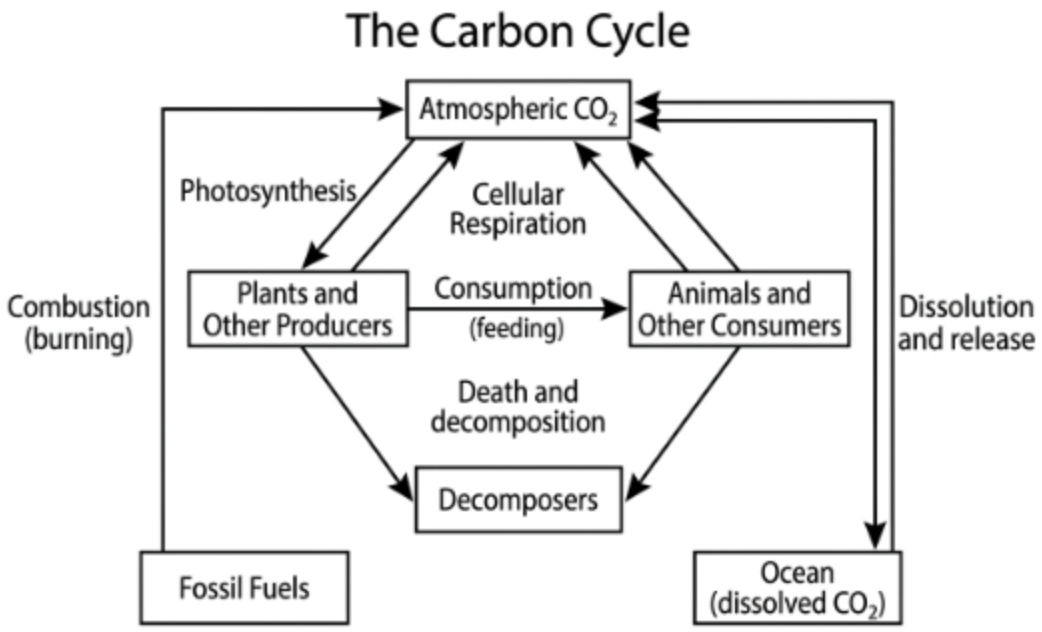
C. carbon monoxide from incomplete combustion

D. methane from natural gas extraction

PART B-1 — DATA-BASED MULTIPLE CHOICE (13 Questions, 13 Points)

Answer all questions in this part. Base your answers to questions 31–34 on the diagram below and on your knowledge of biology.

31. A student examines a diagram showing the major processes of the carbon cycle.



Based on the diagram, the process that removes carbon dioxide from the atmosphere and incorporates it into organic compounds in producers is

A. cellular respiration releasing carbon dioxide

B. photosynthesis fixing atmospheric carbon dioxide

C. combustion of buried fossil fuels into the air

D. death and decomposition of dead organisms

32. Based on the same diagram, the process that returns carbon dioxide from living organisms back to the atmosphere is

A. photosynthesis by green plants and algae

B. dissolution of CO_2 into the ocean's water

C. cellular respiration by living organisms

D. fossilization of dead organisms in rock

33. Based on the same diagram, the burning of coal, oil, and natural gas is shown as

A. combustion adding CO_2 to the atmosphere

B. photosynthesis removing CO_2 from the air

C. respiration converting glucose into CO_2

D. decomposition of dead organisms in soil

34. Based on the same diagram, an increase in the burning of fossil fuels would most directly cause

A. an immediate decrease in oxygen in the atmosphere

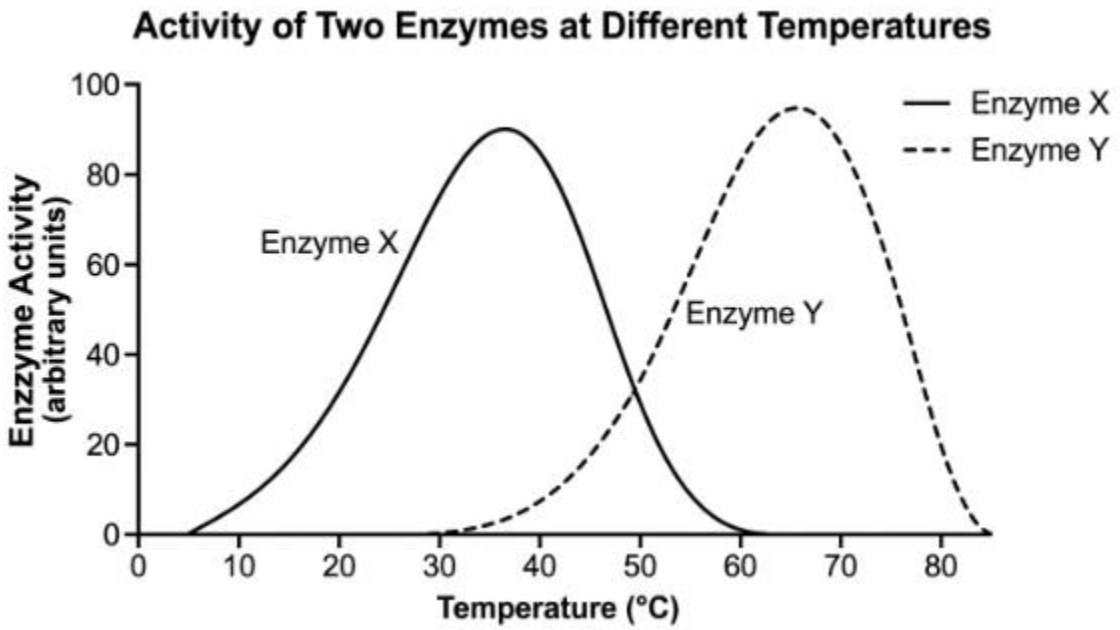
B. a sharp drop in the number of producers on Earth

C. an increase in the productivity of marine ecosystems

D. an increase in atmospheric carbon dioxide concentrations

Base your answers to questions 35–37 on the graph below and on your knowledge of biology.

35. A student examines a graph showing the activity of two enzymes (Enzyme X and Enzyme Y) at different temperatures.



Based on the graph, the optimum temperature for Enzyme X is approximately

A. 37 degrees Celsius, near typical human body temperature

B. 50 degrees Celsius, at a high environmental temperature

C. 70 degrees Celsius, at a hot environmental temperature

D. 90 degrees Celsius, near the boiling point of water

36. Based on the same graph, Enzyme Y is most likely to come from an organism that lives in

A. an environment that is constantly cold and icy

B. a typical mammalian body at normal temperatures

C. a hot spring or volcanic vent with very high temperatures

D. a moderate temperature environment such as a forest

37. Based on the same graph, both enzymes show decreased activity at temperatures above their optimum because

A. enzymes use less ATP at higher temperatures

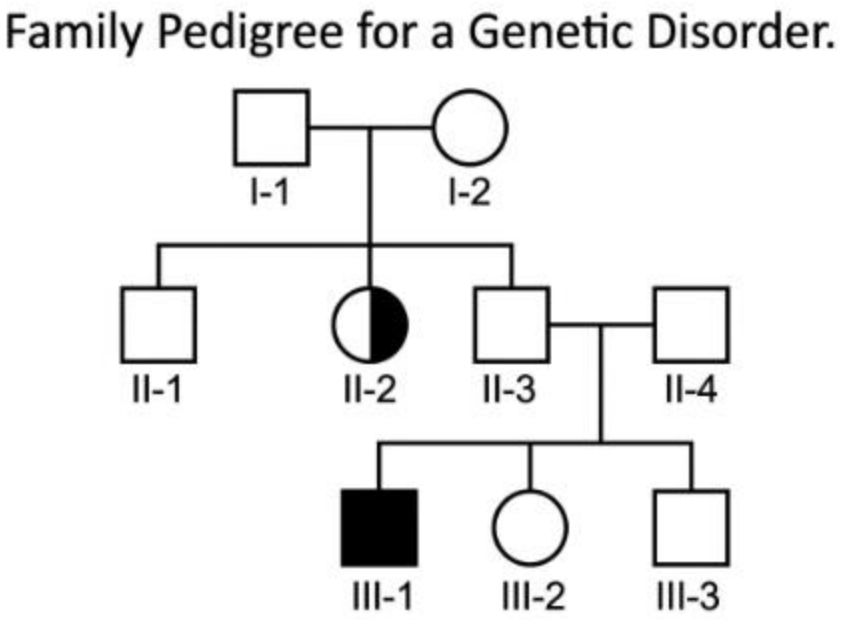
B. substrate concentration decreases at higher temperatures

C. enzymes work better in the absence of any heat at all

D. high temperatures denature the enzymes, changing their shape

Base your answers to questions 38–40 on the pedigree below and on your knowledge of biology.

38. A student examines a pedigree chart following the inheritance of a genetic disorder through three generations of a family.



Based on the pedigree shown, the pattern of inheritance is most consistent with

A. an autosomal dominant disorder

B. a sex-linked recessive disorder

C. an autosomal recessive disorder always

D. a sex-linked dominant disorder

39. Based on the same pedigree, individual II-2 (the half-filled circle in Generation II) is most accurately described as

A. an affected female showing the full disorder

B. an unaffected male with no recessive allele

C. an unaffected female carrier of the recessive allele

D. an affected male unable to have children

40. Based on the same pedigree, the probability that the next son born to parents II-2 and II-4 will be affected by the disorder is

A. 50% probability of being affected

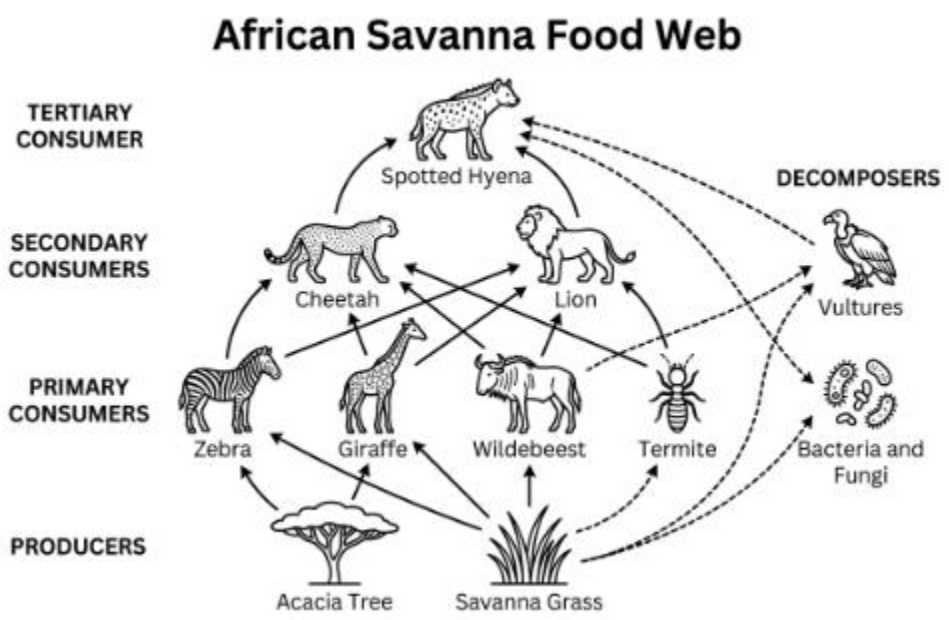
B. 0% probability of being affected

C. 25% probability of being affected

D. 100% probability of being affected

Base your answers to questions 41–43 on the food web below and on your knowledge of biology.

41. A student examines a food web of an African savanna ecosystem.



Based on the African savanna food web shown, the zebra that feeds on grass is best classified as

A. a tertiary consumer at the top of the food web

B. a producer at the base of the food web

C. a decomposer that breaks down dead matter

D. a primary consumer that eats producers

42. Based on the same savanna food web, if a severe drought killed most of the savanna grass, the population most directly affected first would be

A. the lions and other top predators

B. the zebras and wildebeests that eat the grass

C. the vultures and other decomposers

D. the acacia trees that produce different food

43. Based on the same food web, if the savanna grass contains 10,000 units of energy, approximately how much energy reaches the lion at its trophic level?

A. 100 units of energy reach the lion

B. 10,000 units of energy reach the lion

C. 1,000 units of energy reach the lion

D. 1 unit of energy reaches the lion

PART B-2 — MIXED FORMAT (12 Questions, 12 Points)

Answer all questions in this part.

44. In an experiment testing how different concentrations of salt affect the growth rate of bacteria, the dependent variable is

A. the concentration of salt added to the bacteria culture

B. the temperature at which the bacteria were grown

C. the growth rate measured in each culture

D. the type of bacteria used in the experiment

45. In an experiment to test whether a new fertilizer increases tomato plant growth, the control group should be plants that

A. receive twice the recommended dose of fertilizer

B. are grown in a different greenhouse from the others

C. are watered with a special solution containing minerals

D. receive no fertilizer but are otherwise treated identically

46. Ecologists studying plant populations on a meadow placed several 1-square-meter frames at random locations and counted the plants in each. This method is called

A. quadrat sampling for estimating plant populations

B. mark-and-recapture for animal populations

C. visual estimation from a single viewpoint

D. total population counting of every plant present

47. A young plant growing on a windowsill bends toward the window over several days. This response to light direction is called

A. gravitropism, growth in response to gravity

B. phototropism, growth in response to light direction

C. thigmotropism, growth in response to touch

D. hydrotropism, growth in response to moisture

48. The muscle tissue that lines internal organs such as the stomach and intestines and is not under conscious control is called

A. skeletal muscle attached to bones

B. cardiac muscle of the heart wall

C. nervous tissue that transmits signals

D. smooth muscle of internal organs

49. The muscle tissue found only in the walls of the heart, allowing it to contract continuously throughout life without conscious control, is called

A. skeletal muscle attached to bones for movement

B. smooth muscle lining the digestive tract organs

C. cardiac muscle of the heart wall

D. connective muscle of the joint capsules

50. In addition to providing structural support, bones contribute to homeostasis by

A. filtering urea and other wastes from the blood

B. producing red blood cells inside the bone marrow

C. producing antibodies against invading pathogens

D. regulating body temperature through sweating

51. Blood vessels that carry oxygen-rich blood AWAY from the heart at high pressure are called

A. arteries with thick muscular walls

B. veins with thin walls and one-way valves

C. capillaries with very thin permeable walls

D. lymph vessels carrying interstitial fluid

52. During a stressful or frightening situation, the body releases a hormone that increases heart rate, breathing rate, and energy availability for a "fight or flight" response. This hormone is

A. insulin released by the pancreas after eating

B. estrogen released by the female ovaries

C. adrenaline (epinephrine) from the adrenal glands

D. thyroxine released by the thyroid gland

53. The part of the human brain responsible for conscious thought, voluntary movement, and processing sensory information is the

A. cerebellum, which coordinates body balance and movement

B. medulla, which controls breathing and heart rate

C. spinal cord, which carries signals between brain and limbs

D. cerebrum, the largest part of the brain

54. The part of the brain that coordinates balance and the smooth movement of muscles is the

A. cerebrum, the main thinking part of the brain

B. cerebellum, located behind and below the cerebrum

C. medulla oblongata, which controls heart rate

D. spinal cord, which connects the brain to body

55. Neurons that carry signals from sensory organs (such as the skin or eyes) toward the central nervous system are called

A. sensory neurons (afferent neurons)

B. motor neurons (efferent neurons)

C. interneurons within the central nervous system

D. mirror neurons involved in social learning

PART C — EXTENDED CONSTRUCTED RESPONSE (17 Questions, 17 Points)

Answer all questions in this part.

56. During intense exercise when muscle cells run out of oxygen, they continue to produce ATP by

A. aerobic respiration in the mitochondria

B. photosynthesis using sunlight as energy

C. protein synthesis at the cellular ribosomes

D. lactic acid fermentation in the cytoplasm

57. The buildup of lactic acid in muscle cells during heavy exercise

A. provides extra energy for prolonged muscle activity

B. has no effect on muscle function or sensation

C. contributes to muscle fatigue and soreness

D. converts directly into glucose for additional energy

58. In the overall equation for photosynthesis, the substances that enter the reaction (the reactants) are

A. glucose and oxygen produced as outputs

B. carbon dioxide and water, plus light energy

C. ATP and ADP cycling through the chloroplast

D. amino acids and proteins from cellular reserves

59. The folded inner membrane of the mitochondrion, called the cristae, is important because it

A. surrounds the entire mitochondrion as an outer boundary

B. contains the DNA needed for genetic information storage

C. holds the ribosomes that build all cellular proteins

D. provides increased surface area for electron transport chains

60. During DNA replication, new nucleotides are added to the growing strand by base pairing with the template strand. This means the new strand is

A. complementary to the template strand

B. identical to the template strand

C. composed entirely of unmatched bases

D. constructed in the absence of any template

61. A mutation that occurs in a skin cell of an adult human

A. will be passed to all of that person's offspring

B. immediately spreads to all other body cells

C. cannot be passed to the person's offspring

D. is always corrected by the body's enzymes

62. Over many generations, a population of bacteria exposed to a particular antibiotic shows an increase in the proportion of individuals resistant to that antibiotic. This change in the population is best explained by

A. all bacteria evolving resistance during their lifetimes

B. natural selection favoring bacteria with resistance alleles

C. random changes occurring without any selection pressure

D. coevolution between the antibiotic and the bacteria

63. Scientists have determined that bacteria-like fossils are found in rocks approximately 3.5 billion years old. This finding supports the conclusion that

A. complex multicellular life appeared on Earth very early

B. life forms have not changed at all since Earth formed

C. animals were the first organisms to evolve on Earth

D. life on Earth has existed for billions of years

64. Two species of warblers feed on insects in the same trees but at different heights — one feeds in the upper branches and one in the lower branches. This separation allows the two species to coexist by

A. partitioning the available resources between themselves

B. competing for the exact same insects at all times

C. forming a mutualistic relationship that benefits both

D. completely avoiding contact with each other at all times

65. Cleaner fish swim into the mouths of larger fish to remove parasites from the larger fish's teeth and gills. The cleaner fish gets food and the larger fish gets clean teeth. This relationship is best described as

A. parasitism that harms the larger fish

B. competition for limited food resources

C. mutualism benefiting both fish species

D. predation by one fish on the other

66. Two different species of birds that perform very similar roles in two different ecosystems on different continents are best described as occupying

A. the same physical habitat in both ecosystems

B. completely different niches without overlap

C. the same physical location on both continents

D. similar ecological niches in different ecosystems

67. In a population, the equation for population growth includes births and deaths as well as

A. mutations occurring in the genetic material

B. immigration into and emigration out of the area

C. the average age of individuals in the population

D. the dominant phenotypes expressed in the population

68. When a person eats a large meal, blood sugar levels rise. The pancreas responds by releasing insulin, which causes body cells to absorb glucose, lowering blood sugar back to normal. This response is an example of

A. negative feedback restoring blood sugar to normal levels

B. positive feedback amplifying the initial rise in blood sugar

C. an allergic reaction to the food consumed

D. a learned behavior to control blood sugar levels

69. In Type 1 diabetes, the body's own immune system destroys the insulin-producing cells of the pancreas. As a result, people with Type 1 diabetes

A. produce too much insulin, lowering blood sugar dangerously

B. respond normally to natural insulin in their bodies

C. need to consume more sugar to compensate for the loss

D. must take insulin injections to regulate blood sugar levels

70. During early human embryonic development, the cells that form the inner mass of the blastocyst eventually develop into

A. only the placenta that supplies the embryo

B. all of the tissues and organs of the embryo

C. the wall of the mother's uterus during pregnancy

D. only nervous tissue without any other organs

71. Stem cells in adult bone marrow can develop into different types of blood cells but not into nerve or muscle cells. These adult stem cells are best described as

A. totipotent, able to become any type of cell

B. unipotent, able to become only one type of cell

C. multipotent, able to become several types of related cells

D. nonpotent, unable to develop into any cells

72. Antibodies produced by the immune system are highly specific because

A. each antibody binds to all foreign substances equally

B. all antibodies have identical structures throughout the body

C. antibodies are produced by all body cells in equal amounts

D. each antibody binds only to one specific antigen

PART D — LABORATORY PRACTICAL (13 Questions, 13 Points)

Answer all questions in this part.

73. In the Beaks of Finches simulation, the variation in beak shape (represented by different tools given to students) is meant to model

A. genetic variation that already exists in a finch population

B. learned behaviors that develop in finches over time

C. acquired traits passed from finch parents to offspring

D. random environmental damage to bird beaks over time

74. In the Making Connections laboratory, the rise in pulse rate during squeezing of the clothespin demonstrates that the body's pulse rate is

A. completely unrelated to the body's energy demands

B. controlled entirely by the conscious thoughts of a person

C. responsive to changes in the body's energy demands

D. permanently fixed at a single value for all activities

75. In the Relationships and Biodiversity laboratory, students perform multiple tests to determine which related species shares the most molecular and structural similarities with a hypothetical valuable species (Botana curus). The species sharing the MOST similarities is most likely to also share

A. the exact same physical location on Earth's surface

B. similar biochemical pathways, including the chemical of interest

C. all environmental adaptations of the original species

D. only physical appearance and color patterns visible externally

76. In the Diffusion Through a Membrane laboratory, before placing dialysis tubing into water, the contents of the tubing are tested to establish

A. the future results of the diffusion experiment

B. the maximum amount of starch the tubing can hold

C. how the experiment will turn out in the end

D. a baseline (starting condition) before diffusion occurs

77. As the magnification of a compound microscope is increased from low power to high power, the field of view becomes

A. larger and brighter, with more area visible

B. larger but darker, with less detail visible

C. smaller and darker, with less area visible

D. completely dark without any visible specimen

78. When measuring temperature data during an experiment, a student uses a thermometer marked in tenths of a degree Celsius. The most appropriate way to record a reading is

A. to the nearest tenth of a degree, matching the instrument's precision

B. as a whole number ignoring the decimal markings

C. to the nearest hundredth of a degree using estimation

D. as a range of two whole numbers above and below

79. A scientist wants to estimate the average size of fish in a large lake. To get a representative sample, the scientist should

A. measure only the largest fish caught from the lake

B. randomly catch fish from several different locations in the lake

C. measure only the fish caught near the shoreline

D. measure only the fish caught from a single deep area

80. A study in which scientists watch wild gorillas in their natural habitat and record their behavior, without manipulating any variables, is best described as

A. a controlled experiment with manipulated variables

B. a model that simplifies the gorilla's behaviors

C. an observational study without variable manipulation

D. a survey based on the opinions of other scientists

81. In an experiment, the average growth of plants given fertilizer is only slightly greater than the average growth of plants without fertilizer. To determine whether the fertilizer made a real difference, the scientist should

A. simply assume the difference was caused by the fertilizer

B. ignore the difference and consider the fertilizer ineffective

C. report only the data showing the positive effect of fertilizer

D. repeat the experiment with more plants and analyze the data

82. In the Relationships and Biodiversity laboratory, paper chromatography is used to separate plant pigments. After the experiment, scientists can identify each pigment by

A. counting the number of pigments produced by the plant

B. measuring how far each pigment traveled up the paper

C. checking the temperature at which the pigments separated

D. weighing the entire chromatography paper after drying

83. A student conducts an experiment but realizes afterward that the room temperature changed significantly during the trial, possibly affecting the results. This represents

A. an uncontrolled variable that may have affected the results

B. a successful control of all important variables

C. a normal part of every well-designed experiment

D. evidence that the experiment was definitely successful

84. After an experiment, a student's data shows clear support for the original hypothesis. The most appropriate next step is to

A. immediately assume the hypothesis is universally true

B. ignore any data points that disagree with the hypothesis

C. report the results and consider further testing for confirmation

D. change the hypothesis to match other experiments' results

85. In a biology laboratory, a student should wash their hands thoroughly

A. only when working with paint or art supplies

B. before and after working with biological materials

C. only at the very beginning of the day's work

D. only when reminded to do so by the instructor

Practice Exam 22 — Answer Key and Explanations

1. A — The cell is the smallest structural and functional unit of life, capable of carrying out all the basic life processes on its own. Cell theory states that all living things are composed of one or more cells; atoms are non-living building blocks, while tissues and organ systems are higher levels of organization made up of cells.

2. D — Water's high specific heat means it absorbs or releases substantial heat with only small temperature changes. This stabilizes internal body temperature against environmental fluctuations and protects enzymes and other heat-sensitive molecules from being denatured by sudden swings.

3. B — Glucose is the primary fuel cells use to make ATP, mainly through cellular respiration in the mitochondria. The energy stored in glucose's chemical bonds is released step by step and captured in the high-energy phosphate bonds of ATP, which then powers cellular work.

4. C — Enzymes are biological catalysts that lower the activation energy — the energy barrier — required for a reaction to occur. By binding substrates in the active site, they bring reactants into the correct orientation and stabilize the transition state, allowing reactions to proceed quickly at body temperature.

5. A — Peroxisomes are membrane-bound organelles packed with oxidative enzymes that break down toxic compounds, including hydrogen peroxide (using catalase) and very long-chain fatty acids. Their detoxification role protects the cell from oxidative damage that would otherwise harm membranes, proteins, and DNA.

6. B — Simple diffusion moves substances from high concentration to low concentration without requiring energy or transport proteins. Oxygen is small and nonpolar, so it crosses the alveolar membrane easily, moving down its gradient from the air sacs into the blood.

7. D — Translation is the process at the ribosome where the codons of an mRNA strand are read in sequence and matched with tRNAs carrying specific amino acids. The amino acids are then joined by peptide bonds, building the protein one residue at a time.

8. C — Ribosomal RNA (rRNA) combines with proteins to form the two subunits of the ribosome itself, providing both structural support and catalytic activity for peptide bond formation. Without rRNA there would be no ribosome — and therefore no protein synthesis.

9. B — A missense mutation substitutes one base for another in a codon such that the new codon specifies a different amino acid. The resulting protein has one altered amino acid, which may or may not affect its function — sickle cell anemia is a classic missense example.

10. A — Crossing over occurs during prophase I of meiosis, when homologous chromosomes pair up tightly as tetrads and exchange segments of DNA. This recombination creates new allele combinations on each chromosome, contributing to the genetic variation seen in gametes.

11. C — A monohybrid cross between two heterozygotes (Aa × Aa) gives a Punnett square with AA, Aa, Aa, and aa — a genotypic ratio of 1:2:1. The phenotypic ratio with complete dominance is 3:1, but the question asks specifically about genotypes.

12. A — In standard pedigree notation, a horizontal line drawn directly between two individuals at the same generation represents a mating (or marriage) relationship. The vertical line dropping from this couple to the next generation then indicates their offspring.

13. D — Males are XY and have only a single X chromosome. If they inherit a recessive allele on that X, there is no second X to mask it, so they express the disorder; females (XX) need two copies of the recessive allele to be affected, which is statistically much less likely.

14. B — Genetic engineering uses recombinant DNA techniques — restriction enzymes, DNA ligase, plasmid vectors — to cut a gene from one organism and insert it into another's DNA. This is how human insulin is now produced in bacteria, providing a reliable medical supply.

15. D — Modern genetics shows that only changes to DNA in gametes can be passed to offspring. Lamarck's idea fails because stretching a neck is a somatic change that does not alter sperm or egg DNA — natural selection on existing inherited variation, not acquired traits, drives evolution.

16. C — Meiosis (through independent assortment and crossing over) and the random fusion of gametes at fertilization shuffle alleles into countless new combinations every generation. This recombination is the single largest source of the genetic variation that natural selection acts upon.

17. A — Vestigial structures are reduced, often non-functional, remnants of structures that were fully functional in ancestors. The whale's tiny pelvic bones are inherited from four-legged terrestrial ancestors; their presence is direct evidence of common ancestry and evolutionary change.

18. B — When a population is split by a geographic barrier and gene flow is blocked, the two groups accumulate independent mutations and respond to different selection pressures. Over time, the populations become so different they can no longer interbreed — the definition of speciation (allopatric speciation).

19. D — Punctuated equilibrium describes the fossil pattern of long periods of stasis ("equilibrium") interrupted by short bursts of rapid morphological change ("punctuation"). Proposed by Eldredge and Gould, it contrasts with the strict gradualism of slow, steady change over time.

20. C — Deep roots and water-storing waxy stems are physical (structural) features of the cactus body, encoded in its genes and inherited from previous generations. Structural adaptations like these arise through natural selection over many generations, not within a single lifetime.

21. B — The competitive exclusion principle (Gause's principle) states that two species cannot occupy the same niche indefinitely; the better competitor will eventually drive the other to extinction or force it to shift niches. In stable environments, one species typically prevails for the contested resources.

22. D — Carrying capacity is the maximum population size that the available resources (food, water, space, shelter) can sustain over the long term. Once a population reaches this limit, density-dependent factors stabilize growth around the carrying capacity rather than allowing continued expansion.

23. A — Secondary succession occurs on land where soil and some organisms remain after a disturbance, such as abandoned farmland. Because the soil is already in place, succession proceeds much faster than primary succession on bare rock, with grasses giving way to shrubs and then forest.

24. C — Coral reefs are built by tiny coral animals (cnidarians called polyps) that secrete hard calcium carbonate exoskeletons around themselves. Over thousands of years, the accumulated skeletons form the massive reef structure that supports one of the most diverse ecosystems on Earth.

25. D — Bioremediation is the use of living organisms — usually bacteria, fungi, or sometimes plants — to break down or remove environmental pollutants. After oil spills, for example, hydrocarbon-eating bacteria can be deployed to consume the petroleum and return the area to a healthier state.

26. B — Habitat fragmentation occurs when large continuous habitats are broken into smaller, isolated patches by human activity. Fragmentation reduces gene flow between populations, limits home ranges of large species, and increases edge effects, all of which threaten biodiversity.

27. A — Wildlife corridors are strips of natural habitat (or specially built overpasses/tunnels) that physically reconnect fragmented patches. They allow animals to migrate, find mates, and recolonize areas, restoring gene flow and ecosystem function across the broken landscape.

28. C — Contour plowing — planting crops along the lines of equal elevation rather than up and down the slope — creates ridges that act as small dams to slow water runoff. Less runoff means less topsoil washed away, preserving soil fertility and reducing sediment pollution downstream.

29. D — Chlorofluorocarbons (CFCs), once used widely in refrigerants and aerosol propellants, drift up to the stratosphere where UV light frees chlorine atoms that catalytically destroy ozone molecules. The Montreal Protocol of 1987 banned CFCs, and the ozone layer is slowly recovering.

30. A — Burning coal and oil releases sulfur dioxide (SO_2) and nitrogen oxides (NO_x) into the atmosphere, where they react with water to form sulfuric and nitric acids. These acids fall as acid rain, damaging forests, acidifying lakes, and corroding buildings far from the original pollution source.

PART B-1 — DATA-BASED MULTIPLE CHOICE (Questions 31–43)

31. B — Photosynthesis is the process in which producers use atmospheric CO_2, water, and light energy to build organic compounds such as glucose. The diagram's arrow from "Atmospheric CO_2" down to "Plants and Other Producers" labeled "Photosynthesis" represents this carbon-fixing step at the base of the cycle.

32. C — Cellular respiration breaks down organic compounds in living cells and releases CO_2 as a waste product back to the atmosphere. The diagram shows respiration arrows running upward from producers, consumers, and decomposers back to atmospheric CO_2, completing the biological side of the cycle.

33. A — Combustion — the burning of fossil fuels — releases the carbon stored in coal, oil, and natural gas as CO_2 in the atmosphere. The diagram shows this as an arrow from "Fossil Fuels" up to "Atmospheric CO_2," labeled "Combustion."

34. D — Burning fossil fuels adds CO_2 to the atmosphere faster than natural processes can remove it, raising atmospheric CO_2 concentrations. This is the basic mechanism behind the observed rise in CO_2 over the past two centuries and the primary driver of anthropogenic climate change.

35. A — Reading the solid curve labeled "Enzyme X," activity rises to a peak at 37 °C, then drops off sharply at higher temperatures. 37 °C is normal human body temperature, suggesting Enzyme X comes from a mammal — most enzymes in our cells have evolved to peak at this temperature.

36. C — Enzyme Y peaks at 70 °C, far above any normal mammalian environment. Such heat tolerance is characteristic of thermophilic organisms (like the bacterium Thermus aquaticus) that live in hot springs, deep-sea vents, and other extreme high-temperature habitats.

37. D — Above the optimum temperature, the kinetic energy disrupts the hydrogen bonds and other weak interactions that hold the enzyme in its precise three-dimensional shape. The active site loses its specific geometry — the enzyme is denatured — so substrate can no longer bind and activity falls.

38. B — The pattern shows an affected male with a carrier mother and unaffected father — classic sex-linked recessive inheritance. The disorder appears in males of generation III but not in females, and the affected son inherited the recessive allele on the X chromosome from his carrier mother.

39. C — A half-filled circle in pedigree notation denotes a phenotypically unaffected female who carries one copy of the recessive allele on one of her X chromosomes. Her other X carries the dominant normal allele, which masks the recessive in her own phenotype but can be passed to her offspring.

40. A — A carrier mother (X^BX^b) crossed with an unaffected father (X^BY) produces sons who inherit Y from the father and either X^B or X^b from the mother — a 50/50 split. Half the sons are predicted to be affected (X^bY), so the probability for any one son is 50%.

41. D — Primary consumers are organisms that feed directly on producers (autotrophs). The zebra eats savanna grass, which is a producer, placing the zebra at the second trophic level as a primary consumer (herbivore).

42. B — The animals that feed most directly on savanna grass — the zebras and wildebeests — would be the first to suffer from its loss, since grass is their primary food source. Higher-level predators feel the effects only after the herbivore base collapses.

43. A — Energy transfer between trophic levels is roughly 10%, so 10,000 units of producer energy yields about 1,000 units at the primary consumer level (zebra) and about 100 units at the secondary consumer level (lion). This rapid energy loss is why higher trophic levels support fewer individuals.

PART B-2 — MIXED FORMAT (Questions 44–55)

44. C — The dependent variable is the outcome the experimenter measures in response to changes in the independent variable. Salt concentration is what is being manipulated, so bacterial growth rate — what is being measured — is the dependent variable.

45. D — A control group is identical to the experimental group in every way except for the independent variable being tested. Untreated plants (no fertilizer) grown under the same light, water, and soil conditions provide the baseline against which fertilized plants can be compared.

46. A — Quadrat sampling uses a frame of known area, placed randomly within a habitat, to count or estimate the abundance of organisms in each frame. Averaging across many quadrats and scaling up gives an estimate of total population size for the entire area.

47. B — Phototropism is the directional growth of a plant toward or away from light, driven by uneven distribution of the hormone auxin in the stem. Auxin accumulates on the shaded side, causing cells there to elongate more, which bends the stem toward the light source.

48. D — Smooth muscle is non-striated, involuntary muscle tissue found in the walls of hollow internal organs such as the stomach, intestines, blood vessels, and bladder. It produces slow, sustained contractions — like peristalsis — that move material through these organs without conscious control.

49. C — Cardiac muscle is striated, involuntary muscle found only in the wall of the heart. Its cells are connected by intercalated discs that allow rapid, coordinated electrical signaling, enabling the heart to contract rhythmically and continuously throughout life.

50. B — Red bone marrow contains hematopoietic stem cells that produce red blood cells, white blood cells, and platelets — a process called hematopoiesis. By generating the body's blood cells, bones contribute directly to oxygen transport, immune defense, and clotting.

51. A — Arteries carry oxygenated blood (except the pulmonary artery) away from the heart under high pressure generated by ventricular contraction. Their thick, elastic, muscular walls withstand and smooth out the pulsing pressure that ejects blood from the heart.

52. C — Adrenaline (also called epinephrine) is released by the adrenal medulla atop each kidney in response to acute stress signals from the sympathetic nervous system. It increases heart rate, dilates airways, and mobilizes glucose to prepare the body for fight or flight.

53. D — The cerebrum is the largest part of the brain and is responsible for higher-order functions such as conscious thought, learning, memory, voluntary movement, and sensory interpretation. Its outer layer (cerebral cortex) is where most "thinking" actually happens.

54. B — The cerebellum, sitting behind and below the cerebrum, coordinates voluntary movements, posture, and balance by fine-tuning motor commands from the cerebrum. Damage to the cerebellum produces clumsy, uncoordinated movements (ataxia), even though strength remains normal.

55. A — Sensory (afferent) neurons carry signals from sensory receptors in the skin, eyes, ears, and other organs toward the central nervous system. The CNS interprets these incoming signals and decides on a response, which it sends out through motor (efferent) neurons.

PART C – EXTENDED CONSTRUCTED RESPONSE (Questions 56–72)

56. D — When oxygen runs short during intense exercise, muscle cells switch from aerobic respiration to lactic acid fermentation in the cytoplasm. This anaerobic pathway regenerates the NAD^+ needed to

continue glycolysis, producing 2 ATP per glucose — much less than aerobic respiration, but enough to keep contracting briefly.

57. C — Lactic acid accumulating in working muscle cells lowers the local pH and interferes with normal muscle contraction, contributing to the burning sensation and fatigue felt during heavy exercise. Once blood flow restores oxygen, lactic acid is gradually converted back to pyruvate or shipped to the liver for processing.

58. B — The overall equation for photosynthesis is $6\ CO_2 + 6\ H_2O + \text{light energy} \rightarrow C_6H_{12}O_6 + 6\ O_2$. Carbon dioxide and water are the reactants entering the reaction, light supplies the energy, and glucose and oxygen are the products that come out.

59. D — The inner mitochondrial membrane is folded into cristae to provide a large surface area packed with electron transport chain proteins and ATP synthase. More surface area means more ETC complexes, more proton pumping, and more ATP — which is why metabolically active cells have mitochondria with many densely packed cristae.

60. A — DNA replication is semiconservative: each parent strand serves as a template, and base-pairing rules (A–T, G–C) dictate that the new strand has the complementary sequence rather than an identical one. The result is two daughter molecules, each with one old strand and one new complementary strand.

61. C — Mutations in body (somatic) cells affect only the individual in whom they occur; they cannot be transmitted to offspring because they are not present in eggs or sperm. Only mutations in germline cells — the cells that give rise to gametes — can be inherited by the next generation.

62. B — Antibiotic resistance evolves by natural selection: random pre-existing mutations make a few bacteria resistant, the antibiotic kills the sensitive ones, and the resistant survivors reproduce. Over generations, the resistant allele becomes much more common in the population.

63. D — Fossils of bacteria-like organisms dated to 3.5 billion years ago are direct evidence that life appeared early in Earth's roughly 4.6-billion-year history. The deep antiquity of microbial life shows how long evolution has had to produce the diversity seen today.

64. A — When two species use the same general resource but in different ways (different heights, times, or food sizes), they partition the resource and reduce direct competition. This niche differentiation allows them to coexist in the same habitat indefinitely.

65. C — Mutualism is a symbiotic relationship in which both partners benefit. The cleaner fish gets a reliable meal of parasites, and the larger fish gets parasite removal that improves its health — a textbook example of mutualism.

66. D — A niche is the role an organism plays in its ecosystem — what it eats, where it lives, when it is active, how it interacts. Two species living on different continents but performing the same general role occupy similar niches in their respective ecosystems, often the result of convergent evolution.

67. B — Population change over time = (births + immigration) − (deaths + emigration). Immigration adds individuals from outside, while emigration removes individuals, so both must be included alongside births and deaths to predict population growth accurately.

68. A — Negative feedback is a self-correcting response in which the body counteracts a change to return a variable to its set point. Insulin lowers high blood glucose back toward normal — the opposite direction of the initial change — which is the defining feature of negative feedback in homeostasis.

69. D — Without functioning beta cells, the pancreas cannot make insulin, so blood sugar cannot be regulated naturally. People with Type 1 diabetes must receive insulin by injection or pump to allow cells to take up glucose and to prevent dangerous hyperglycemia.

70. B — The inner cell mass of the blastocyst contains pluripotent embryonic stem cells that go on to form all three germ layers — ectoderm, mesoderm, and endoderm — and ultimately every tissue and organ of the embryo. The outer trophoblast layer, by contrast, forms the placenta.

71. C — Multipotent stem cells can differentiate into several related cell types within a specific lineage. Bone marrow stem cells produce all blood cell types — red cells, white cells, platelets — but cannot become unrelated tissue types like neurons or muscle, distinguishing them from pluripotent and totipotent cells.

72. D — Each antibody has a unique shape at its antigen-binding sites that recognizes one specific antigen, much like a lock fits one key. This specificity ensures targeted immune responses against particular pathogens without attacking harmless or self molecules.

PART D – LABORATORY PRACTICAL (Questions 73–85)

73. A — In the Beaks of Finches lab, different tools (forks, spoons, tweezers) represent the natural variation in beak shape that already exists within a finch population. The simulation demonstrates that natural selection acts on this pre-existing genetic variation, not on traits acquired during a bird's lifetime.

74. C — Squeezing a clothespin repeatedly increases the muscles' demand for ATP and therefore oxygen. The pulse rate rises to deliver more oxygenated blood to the working muscles — direct evidence that the cardiovascular system responds dynamically to the body's changing energy needs.

75. B — Closely related species share more recent common ancestors and therefore tend to share similar biochemistry, including metabolic pathways that produce particular chemicals. Identifying the most molecularly similar relative of Botana curus is the most reliable way to find another species likely to make the same valuable compound.

76. D — Initial tests on the contents of the dialysis tubing and the surrounding beaker establish baseline data — what substances are present and where — before diffusion begins. Without this starting point, students cannot determine which molecules moved across the membrane during the experiment.

77. C — As magnification increases, the area of the specimen visible (field of view) shrinks, and less light reaches the eye, making the field appear darker. This is why students must center the specimen and adjust the light source carefully before switching to high power.

78. A — Measurements should be recorded to the smallest division marked on the instrument — its precision. Recording temperature to the nearest tenth of a degree matches the thermometer's capability and preserves the available accuracy without overstating or understating it.

79. B — A representative sample requires random selection from across the entire study area, not just one location or one size class. Random sampling from several locations in the lake reduces bias and yields an average fish size that reflects the whole population.

80. C — An observational study describes the behavior or characteristics of subjects in their natural setting without the researcher manipulating any variables. Field studies of wild gorillas are classic observational research — they reveal natural behaviors but cannot establish cause-and-effect as strongly as a controlled experiment.

81. D — Small differences between groups may be due to random variation rather than a real effect of the treatment. Repeating the experiment with more plants increases statistical power and, combined with analysis of the data, helps determine whether the difference is genuine or just chance.

82. B — In paper chromatography, each pigment travels a characteristic distance based on its solubility in the solvent and its attraction to the paper. Calculating the Rf value (distance pigment moved ÷ distance solvent moved) gives a reproducible identifier that distinguishes one pigment from another.

83. A — Any variable other than the independent variable that changes during an experiment and could affect the outcome is an uncontrolled variable. A drifting room temperature can influence biological processes, and failing to keep it constant weakens any conclusions drawn from the results.

84. C — Supporting data is not proof — a single experiment with positive results should be reported and then retested by others to confirm the findings. Replication and continued testing are essential to scientific reliability and to ruling out chance or unique experimental conditions.

85. B — Washing hands before lab work prevents contamination of materials and experiments, and washing after handles the reverse — protecting the student from any biological agents handled during the lab. Both steps are basic biosafety practice in any biology laboratory.