

PRACTICE EXAM 23: 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. The four main classes of biological macromolecules include carbohydrates, lipids, nucleic acids, and
 - A. cellulose found in plant cell walls
 - B. carbon dioxide released by respiration
 - C. water present in all living tissues
 - D. proteins built from amino acids

2. The cellular organelle responsible for breaking down old or damaged cell parts is the
 - A. ribosome that builds new proteins
 - B. lysosome that digests cellular waste
 - C. centrosome that organizes spindle fibers
 - D. peroxisome that detoxifies hydrogen peroxide

3. An enzyme's active site is the specific region where
 - A. the enzyme molecule is denatured by extreme heat
 - B. the cell stores excess ATP for later use

C. substrate molecules bind during a reaction

D. genetic information for the enzyme is stored

4. The movement of water across a selectively permeable membrane from an area of low solute concentration to an area of high solute concentration is called

A. osmosis driven by water's concentration gradient

B. active transport requiring cellular energy

C. exocytosis releasing material from the cell

D. endocytosis bringing material into the cell

5. The greatest number of ATP molecules per glucose molecule is produced during

A. glycolysis in the cytoplasm of the cell

B. fermentation in the absence of oxygen

C. the Krebs cycle in the mitochondrial matrix

D. the electron transport chain on the inner membrane

6. The light-dependent reactions of photosynthesis produce

A. ATP and NADPH for use in the Calvin cycle

B. glucose and water for use by the plant

C. carbon dioxide and oxygen released as waste

D. carbon dioxide and water absorbed from the air

7. In a starch molecule, the building block units that are joined together by chemical bonds are

A. amino acids linked by peptide bonds

B. glucose molecules linked by glycosidic bonds

- C. fatty acids linked by ester bonds
- D. nucleotides linked by phosphodiester bonds

8. During DNA replication, the original DNA molecule serves as the template for producing two new DNA molecules. Each new molecule contains

- A. only newly synthesized strands of DNA
- B. only strands from the original DNA molecule
- C. one original strand and one newly made strand
- D. two new strands and no original strand at all

9. The genetic code in DNA is read in groups of three nitrogen bases. Each group of three bases is called

- A. a codon that codes for one amino acid
- B. a gene that codes for an entire protein
- C. an exon that codes for the start of a gene
- D. an intron that codes for non-coding regions

10. A mutation that occurs in a body cell of an adult human will most likely

- A. be passed to all of the person's future offspring
- B. be expressed in every cell of the person's body
- C. be passed to half of the person's future offspring
- D. affect only the person in whom the mutation occurred

11. In a cross between two parents with the genotypes Aa and aa, the offspring are expected to be

- A. 100% homozygous dominant for the gene
- B. 50% heterozygous and 50% homozygous recessive

- C. 75% heterozygous and 25% homozygous recessive
- D. 100% heterozygous for the gene tested

12. In humans, color blindness is a sex-linked recessive trait. A father with normal vision and a mother who is a carrier will have what percentage of their sons being color-blind?

- A. 0% of their sons being color-blind
- B. 25% of their sons being color-blind
- C. 50% of their sons being color-blind
- D. 100% of their sons being color-blind

13. Meiosis differs from mitosis in that meiosis produces

- A. four genetically different haploid cells
- B. two genetically identical diploid cells
- C. four identical cells with twice the chromosomes
- D. only one daughter cell with extra chromosomes

14. Sexual reproduction differs from asexual reproduction in that sexual reproduction

- A. produces offspring identical to one parent organism
- B. requires fewer biological resources to occur
- C. proceeds more quickly than asexual reproduction
- D. produces genetic variation among the offspring

15. Darwin's theory of natural selection differs from Lamarck's theory of evolution in that Darwin proposed that

- A. acquired traits are passed on to offspring

- B. variations within a species exist before selection acts on them
- C. individuals can will themselves to change physically
- D. environments cause specific mutations in DNA to occur

16. The development of mimicry, where one species evolves to resemble another, often involves mutual evolutionary change between predator and prey species over time. This pattern is called

- A. allopatric speciation due to geographic separation
- B. directional selection toward one extreme of the trait
- C. coevolution between two interacting species
- D. genetic drift in a small isolated population

17. Two populations of squirrels become geographically isolated by the formation of a deep canyon. Over many generations, the populations evolve into separate species that can no longer interbreed. This process is called

- A. convergent evolution of two unrelated species
- B. coevolution between predator and prey species
- C. artificial selection performed by human breeders
- D. allopatric speciation due to geographic isolation

18. The fact that all living organisms — from bacteria to plants to animals — use ATP as the energy currency of cells supports the idea that

- A. ATP was independently invented by each lineage
- B. ATP is the only molecule that can store energy
- C. all living things share a common evolutionary origin
- D. ATP cannot be produced by any other type of molecule

19. A coral reef ecosystem contains many species of fish, invertebrates, plants, and microorganisms that interact with one another and with their environment. Together, all of these populations of different species form

- A. a population of related coral reef species
- B. a community of interacting species
- C. a single species adapted to the coral reef
- D. the biosphere of Earth in one location

20. A primary consumer in a food chain typically obtains energy by

- A. eating producers such as plants or algae
- B. eating secondary consumers higher in the chain
- C. absorbing sunlight directly from the sun
- D. decomposing dead organisms in the soil

21. The clownfish lives among the venomous tentacles of the sea anemone. The clownfish gains protection from predators, while the anemone receives food scraps and parasite removal. This relationship is best described as

- A. parasitism, in which the clownfish harms the anemone
- B. commensalism, in which only the clownfish benefits
- C. mutualism, in which both species benefit from the interaction
- D. predation, in which the anemone consumes the clownfish

22. The growth of a population of rabbits in a meadow is most likely limited by

- A. the temperature of the air during summer months
- B. the gravity affecting the rabbits' movements
- C. the time of day when the rabbits are most active

D. the availability of food, water, and shelter

23. In a process of primary succession, the first species to colonize bare rock are typically

A. tall hardwood trees that produce many seeds

B. lichens and mosses able to grow on bare rock

C. herbivores such as deer that graze on plants

D. fungi that decompose dead plant material rapidly

24. In a temperate forest ecosystem, the role of converting dead plant and animal material into simpler compounds is filled by

A. decomposers such as bacteria and fungi

B. producers such as the dominant tree species

C. primary consumers such as deer and rabbits

D. secondary consumers such as foxes and owls

25. Carbon enters the food web of an ecosystem primarily through the process of

A. respiration carried out by all living organisms

B. decomposition of dead matter by bacteria

C. photosynthesis carried out by green plants

D. combustion of fossil fuels by human industries

26. A national park is created to protect a population of bald eagles from human disturbance. The most direct way the park benefits the eagle population is by

A. preserving the natural habitat the eagles need to survive

B. introducing new predators that compete with the eagles

- C. removing all of the prey species the eagles depend on
- D. exposing the eagles to a wider variety of new diseases

27. The use of certain types of refrigerants and aerosol propellants in the late 20th century led to a noticeable thinning of the ozone layer because these chemicals contain

- A. nitrogen compounds that combine with the ozone gas
- B. carbon dioxide molecules that absorb heat in the atmosphere
- C. methane molecules that contribute to global warming directly
- D. chlorine atoms that catalyze the breakdown of ozone

28. The pancreas helps regulate blood glucose levels by releasing two hormones with opposing effects. These two hormones are

- A. estrogen and progesterone, controlling reproduction
- B. insulin and glucagon, controlling blood glucose levels
- C. thyroxine and calcitonin, controlling metabolic rate
- D. adrenaline and cortisol, controlling stress response

29. The structures that carry nerve impulses away from the cell body of a neuron toward another neuron or target cell are called

- A. axons extending from the neuron's cell body
- B. dendrites receiving signals from other neurons
- C. ribosomes producing the neuron's proteins
- D. mitochondria producing the neuron's energy

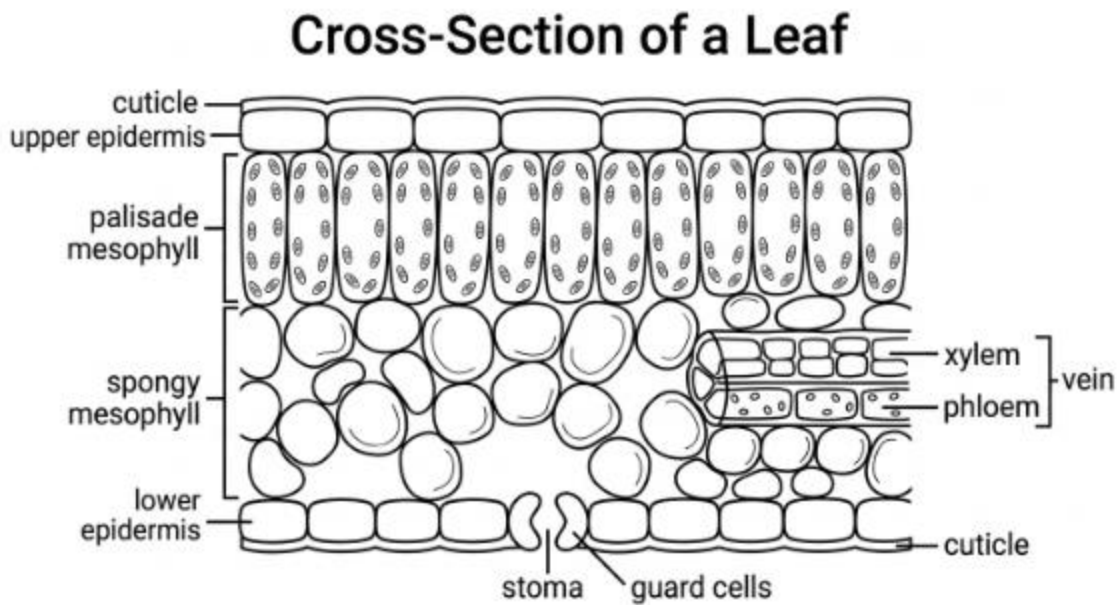
30. The pancreas produces the hormone insulin in response to

- A. low blood glucose levels after long periods of fasting
- B. high body temperature during strenuous exercise
- C. high blood glucose levels following a carbohydrate-rich meal
- D. low blood oxygen levels at very high altitudes

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 cross-section of a typical green leaf.



In the diagram, the layer that contains the largest number of chloroplasts and carries out most of the photosynthesis is the

- A. cuticle on the upper and lower surfaces of the leaf
- B. spongy mesophyll layer with many air spaces between cells
- C. lower epidermis containing the stomata for gas exchange

D. palisade mesophyll layer with tightly packed columnar cells

32. Referring to the same diagram, the small opening surrounded by two guard cells (the stoma) functions to

- A. produce sugars during photosynthesis directly
- B. transport water from the roots to the leaves
- C. provide structural support for the leaf to remain rigid
- D. allow gases to enter and exit the leaf for photosynthesis and respiration

33. Referring to the same diagram, the function of the cuticle layer on the upper and lower surfaces of the leaf is to

- A. reduce water loss from the leaf surface to the air
- B. transport water from the roots up to the leaf
- C. carry out the bulk of photosynthesis for the plant
- D. produce the seeds that will form new plants

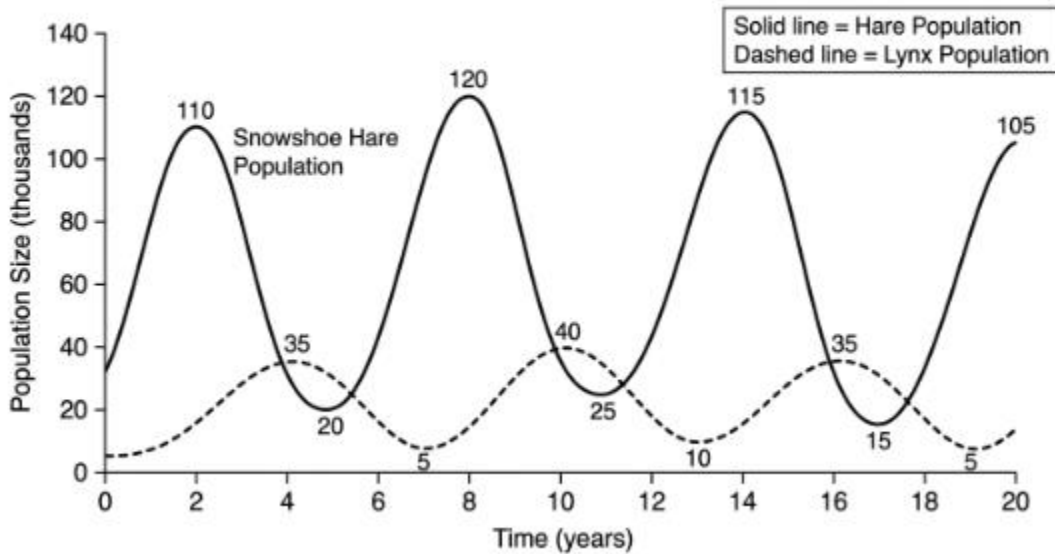
34. Referring to the same diagram, the xylem in the vein of the leaf functions to

- A. transport sugars produced by photosynthesis to other plant parts
- B. open and close the stomata at different times of day
- C. transport water and dissolved minerals from the roots to the leaf
- D. produce new cells for plant growth throughout the year

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

35. A student examines a graph showing population sizes of snowshoe hares and Canadian lynx in a forest over a 20-year period.

Figure PQ-2 Snowshoe Hare and Canadian Lynx Population Cycles



Based on the graph, the relationship between the populations of hares and lynx is best described as

- A. completely unrelated to one another over the years
- B. cyclical, with the lynx population following the hare population
- C. directly proportional with both populations rising together always
- D. inversely proportional with both populations always opposite

36. Based on the same graph, the lynx population peaks occur

- A. before the hare population peaks each cycle
- B. at exactly the same time as the hare peaks
- C. simultaneously with the lowest hare populations
- D. after the hare population peaks each cycle

37. Based on the same graph, the most likely explanation for the decrease in the lynx population following its peak is

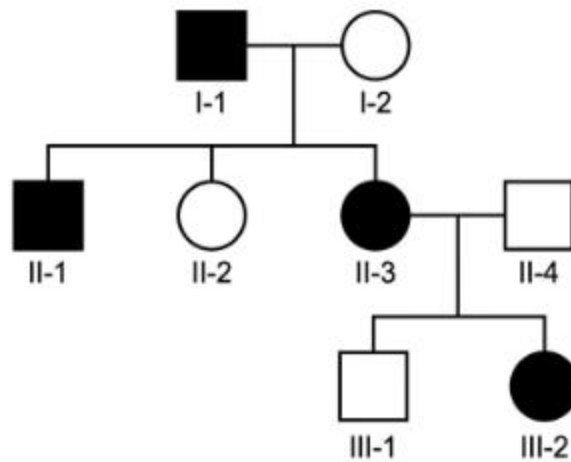
- A. a decrease in the hare population reduces food for lynx

- B. the lynx population has reached its biotic potential
- C. lynx are unable to reproduce after their peak year
- D. the hares actively hunt and kill the lynx in the area

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

38. A pedigree shows the inheritance of Huntington's disease, an autosomal dominant disorder, in a family.

Pedigree of Huntington's Disease (Autosomal Dominant)



Filled = affected with Huntington's disease; Unfilled = unaffected; Square = male; Circle = female.

Based on the pedigree, an unaffected individual (such as I-2) must have the genotype

- A. Hh, with one normal and one disease allele
- B. hh, with two normal recessive alleles
- C. HH, with two dominant disease alleles
- D. either HH or Hh, depending on the parents

39. Based on the same pedigree, if the affected male I-1 has the genotype Hh, the probability that any child of his with an unaffected partner (hh) will be affected is

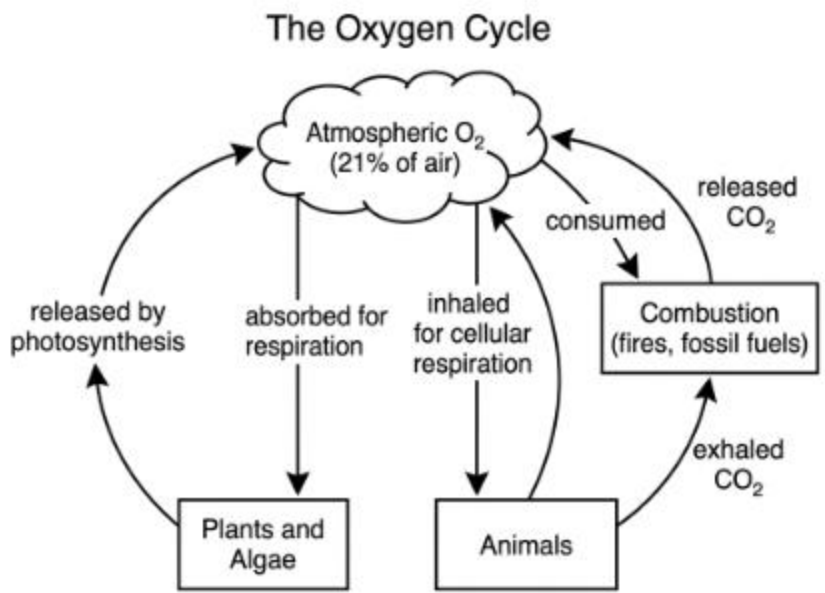
- A. 0% probability of being affected
- B. 25% probability of being affected
- C. 50% probability of being affected
- D. 100% probability of being affected

40. Based on the same pedigree, Huntington's disease is unusual among genetic disorders because the dominant allele

- A. provides a survival advantage to those who carry it
- B. is recessive and only seen in homozygous individuals
- C. requires both parents to be affected for transmission
- D. causes a serious disease rather than being protective

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

41. A student examines a diagram of the oxygen cycle in an ecosystem.



Based on the diagram, the main source of atmospheric oxygen is

- A. photosynthesis carried out by plants and algae
- B. respiration carried out by animals and plants
- C. combustion of fossil fuels in human industry
- D. evaporation from oceans and large lakes globally

42. Based on the same diagram, the main process that removes oxygen from the atmosphere is

- A. photosynthesis carried out by green plants
- B. evaporation from large bodies of water
- C. cellular respiration carried out by all organisms
- D. condensation of water vapor into liquid water

43. Based on the same diagram, the process of combustion

- A. releases only oxygen into the atmosphere quickly
- B. consumes oxygen while releasing carbon dioxide into the atmosphere
- C. produces nitrogen gas in the atmosphere from underground
- D. releases ozone into the upper atmosphere indirectly

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

Answer all questions in this part.

44. The smallest unit of length commonly used in measuring objects viewed through a compound light microscope is the

- A. centimeter for measuring large samples in lab
- B. millimeter for measuring medium-sized samples in lab

- C. nanometer for measuring atoms only at very small scale
- D. micrometer for measuring small cells under the lens

45. A student wishes to test whether the rate of photosynthesis is affected by the color of light reaching the plant. The independent variable in this experiment is

- A. the color of light shone on the plant being tested
- B. the rate of photosynthesis measured by the student
- C. the temperature of the room during the experiment
- D. the species of plant used in the experiment

46. The probability that a child of two heterozygous parents ($Aa \times Aa$) will be heterozygous for the trait is

- A. 25% chance of being heterozygous
- B. 50% chance of being heterozygous
- C. 75% chance of being heterozygous
- D. 100% chance of being heterozygous

47. In a DNA sample, the percentage of cytosine bases is 22%. According to Chargaff's rules, the percentage of adenine in the same sample is

- A. 22% of the bases are adenine
- B. 56% of the bases are adenine
- C. 28% of the bases are adenine
- D. 44% of the bases are adenine

48. Gel electrophoresis is a laboratory technique used to

- A. amplify small samples of DNA into large quantities
- B. produce many copies of a specific protein in a cell
- C. translate a sequence of mRNA into a polypeptide chain
- D. separate fragments of DNA based on their size

49. A scientist wishes to study how the introduction of an invasive species affects native plant populations in a forest. The best approach would be to

- A. ignore the situation and let nature take its course
- B. compare native plant populations in invaded and non-invaded areas
- C. remove all native plants from the invaded area for testing
- D. add more invasive species to compare the rates of spread

50. A small, isolated population of an endangered species is more vulnerable to extinction than a larger population because of

- A. reduced genetic diversity and inbreeding effects
- B. greater genetic variation that complicates breeding
- C. larger food supplies that attract more predators
- D. wider geographic distribution of the species' range

51. A scientist observes that as the size of a bird's population in an area increases, the average territory size per bird decreases. This relationship between population size and territory size is best described as

- A. directly proportional with both increasing together
- B. exponential with rapidly accelerating change over time
- C. logarithmic with rapidly decelerating change over time
- D. inversely proportional with one increasing while the other decreases

52. Methods used to preserve biodiversity in agricultural settings include

- A. planting only a single high-yield crop variety year after year
- B. clearing all native vegetation from farm fields completely
- C. crop rotation and the preservation of seed banks
- D. heavy use of pesticides on all growing crops every season

53. A region that has experienced extensive deforestation may also experience

- A. increased soil erosion and reduced rainfall in the area
- B. greater biodiversity due to the removal of trees
- C. lower temperatures because of less plant respiration
- D. higher water tables because trees no longer absorb water

54. The biome characterized by hot temperatures, low rainfall (less than 25 cm per year), and plants adapted for water conservation such as cacti is the

- A. tropical rainforest with high rainfall year-round
- B. desert with hot temperatures and very little rainfall
- C. temperate deciduous forest with seasonal leaf loss
- D. arctic tundra with permafrost and short cold summers

55. Ocean acidification, caused largely by increased atmospheric CO₂ dissolving in seawater, threatens marine ecosystems by

- A. raising sea levels and flooding the coastal regions
- B. increasing ocean temperatures to dangerous levels
- C. polluting ocean water with chemical contaminants
- D. dissolving the calcium carbonate shells of marine organisms

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

Answer all questions in this part.

56. The organ that develops during pregnancy and serves as the site of exchange of nutrients, oxygen, and wastes between the maternal and fetal blood is the

- A. uterus, where the fetus is implanted and grows
- B. amniotic sac, which surrounds the fetus with protective fluid
- C. placenta, where maternal and fetal blood vessels meet
- D. umbilical cord, which provides a transport passage to the fetus

57. After completing meiosis, the four daughter cells in humans each contain

- A. 23 chromosomes, half the parent cell number
- B. 46 chromosomes, the same as the parent cell
- C. 92 chromosomes, twice the parent cell number
- D. only one chromosome regardless of species

58. A characteristic that is controlled by genes located on the X chromosome is described as

- A. an autosomal dominant trait inherited equally
- B. an autosomal recessive trait inherited equally
- C. a polygenic trait controlled by many genes together
- D. a sex-linked trait carried on the X chromosome

59. The flow of genetic information in cells generally follows the pattern

- A. protein → mRNA → DNA → tRNA in the cytoplasm

- B. DNA → mRNA → protein at the ribosome
- C. mRNA → DNA → tRNA → protein in the nucleus
- D. protein → DNA → mRNA → tRNA in the nucleus

60. Two species of dolphins separated by an ocean for many generations have developed different body sizes and feeding habits. This change over time is best described as

- A. convergent evolution producing similar traits independently
- B. coevolution between two interacting species over time
- C. divergent evolution from a common ancestor
- D. artificial selection guided by human breeders

61. A small group of birds from a mainland population colonizes a remote island. Over generations, the island population becomes genetically different from the mainland population. The most likely reason for this difference is

- A. the founder effect with limited genetic variation in the colonizers
- B. directional selection toward one extreme of the trait
- C. stabilizing selection toward an intermediate trait
- D. convergent evolution producing similar traits to other birds

62. A population of bacteria is exposed to a particular antibiotic, killing most but not all of the bacteria. The few survivors reproduce, producing a population in which most bacteria are now resistant. The reason most survivors were resistant is that they

- A. learned to resist the antibiotic during the exposure
- B. mutated specifically in response to the antibiotic
- C. were transformed by chemicals in the environment
- D. already had resistance genes before the exposure

63. A keystone species in a kelp forest is the sea otter. If sea otters are removed from the ecosystem, the most likely result is

- A. an increase in the kelp population due to less competition
- B. no significant change in the kelp forest ecosystem at all
- C. a decrease in the kelp population due to increased sea urchin grazing
- D. an immediate increase in sea urchin predators in the area

64. The total amount of available energy that reaches the third trophic level in a food chain, starting from 10,000 units of energy in producers, is approximately

- A. 1,000 units of available energy at the third level
- B. 100 units of available energy at the third level
- C. 10 units of available energy at the third level
- D. 1 unit of available energy at the third level

65. The hormone responsible for the development of secondary male characteristics during puberty is

- A. estrogen, secreted by the ovaries
- B. progesterone, supporting pregnancy maintenance
- C. testosterone, secreted by the testes
- D. insulin, regulating blood glucose levels

66. The function of red blood cells (erythrocytes) is to

- A. fight infections by attacking foreign pathogens directly
- B. produce antibodies against specific antigens
- C. clot the blood at the site of an injury
- D. transport oxygen from the lungs to body tissues

67. Capillaries are the smallest blood vessels in the body and are the site where

- A. blood is pumped out of the heart at high pressure
- B. exchange of materials with tissues takes place
- C. blood is filtered by the kidneys to remove waste
- D. the bloodstream becomes oxygenated by the lungs

68. Bile produced by the liver helps in the digestion of

- A. proteins by breaking them into amino acids
- B. carbohydrates by breaking them into simple sugars
- C. fats by emulsifying them into smaller droplets
- D. nucleic acids by breaking them into nucleotides

69. The autonomic nervous system controls

- A. involuntary functions such as digestion and heart rate
- B. voluntary movements such as walking and writing
- C. conscious sensations such as touch and pain
- D. higher-level thought such as making decisions

70. The hormone aldosterone, produced by the adrenal glands, helps regulate the body's

- A. blood glucose levels in response to meals
- B. body temperature during heavy exercise
- C. heart rate during stressful situations
- D. balance of sodium and water in the blood

71. Antibodies are produced by

- A. red blood cells circulating in the bloodstream
- B. platelets responsible for blood clotting
- C. specialized white blood cells called B cells
- D. nerve cells transmitting electrical signals

72. Vaccines provide protection against disease by

- A. introducing weakened or inactive pathogens to stimulate immunity
- B. directly killing pathogens already present in the body
- C. providing extra nutrients to support natural healing
- D. lowering the body temperature to halt pathogen growth

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

Answer all questions in this part.

73. In the Beaks of Finches laboratory, the variation in tool types used by different students simulates

- A. learned behaviors that change during a lifetime
- B. inherited variation in beak shape within a population
- C. environmental factors that affect food availability
- D. random changes in genetic material across generations

74. In the Diffusion Through a Membrane laboratory, water moves into a dialysis tube containing concentrated sugar solution placed in distilled water. This movement of water is best explained by

- A. active transport requiring energy from ATP

- B. exocytosis releasing materials from the dialysis tube
- C. endocytosis bringing materials into the dialysis tube
- D. osmosis moving water down its concentration gradient

75. The Relationships and Biodiversity laboratory provides evidence to determine evolutionary relationships among species. Two species with the most similar amino acid sequences in a particular protein are likely to

- A. live in the same geographic area together
- B. compete for the same resources directly
- C. share a more recent common ancestor
- D. have the same number of chromosomes in their cells

76. In the Making Connections laboratory, students typically measure their pulse rate

- A. before, during, and after a period of physical activity
- B. only at the very beginning of the experiment
- C. only at the very end of the experiment session
- D. while drinking different amounts of water

77. A student observes a tiny organism through a compound light microscope at a magnification of 100x. To see the organism in greater detail, the student should

- A. decrease the magnification by switching to a lower-power objective
- B. increase the magnification by switching to a higher-power objective
- C. remove the slide and view it without the microscope
- D. add more iodine stain to make the cell more visible

78. When using a Bunsen burner in a biology laboratory, a student should

- A. wear loose, flowing clothing to be more comfortable
- B. point the open flame at the nearest classmate to share heat
- C. light the burner and walk away from it briefly to set up
- D. tie back long hair and keep flammable materials away

79. In the Beaks of Finches laboratory, students who fail to gather enough food during a round are considered to have

- A. successfully reproduced with all of their original traits
- B. moved to a different habitat in the next round
- C. failed to survive and not passed on their traits
- D. won the simulation against the other students

80. When using a triple-beam balance in a biology laboratory to measure mass, the unit of measurement is

- A. grams used for measuring small objects
- B. millimeters used for measuring length of objects
- C. milliliters used for measuring the liquid volume
- D. degrees Celsius used for measuring temperature

81. A student's experimental procedure includes the step "Place 10 mL of distilled water in a graduated cylinder." This step represents a

- A. dependent variable being measured in the experiment
- B. controlled variable kept the same in all trials
- C. independent variable being manipulated by the student
- D. random variable that cannot be controlled in the lab

82. When a student is reading a numerical value on a graduated cylinder, the volume should be read

- A. at the top of the liquid surface where it touches the cylinder wall
- B. at any point on the liquid surface near the top mark
- C. at the highest point of the curved meniscus
- D. at the bottom of the curved meniscus at eye level

83. In a biology laboratory, the most accurate way for a student to handle a spill of a hazardous chemical is to

- A. immediately inform the teacher and follow safety procedures
- B. quickly wipe up the spill with bare hands and paper towels
- C. ignore the spill and continue with the planned experiment
- D. add water to the spill to dilute the chemical before cleanup

84. A scientist studying enzyme activity records data showing that the enzyme works best at 37°C. To present this information clearly, the scientist should create

- A. a circle graph showing only percentages of the data
- B. a bar graph comparing two unrelated categories
- C. a line graph showing reaction rate versus temperature
- D. a flowchart of the steps in the experiment

85. The Beaks of Finches laboratory simulates natural selection by demonstrating that

- A. all organisms within a species are genetically identical
- B. organisms with advantageous traits survive and reproduce more often
- C. environments do not affect which traits are selected for
- D. natural selection works only on plants, not on animals

ANSWER KEY WITH EXPLANATIONS – Practice Exam 23

- 1. D** — Proteins are the fourth class of biological macromolecules, built from amino acids linked by peptide bonds. Cellulose is a specific carbohydrate, CO₂ is a small inorganic molecule, and water is not classified as a macromolecule — only proteins complete the list with carbohydrates, lipids, and nucleic acids. Proteins serve structural, catalytic, transport, and signaling roles in cells.
- 2. B** — Lysosomes are membrane-bound organelles filled with digestive enzymes that break down old, damaged, or unwanted cellular components in a process called autophagy. Without lysosomes, cells would accumulate damaged organelles and waste. Lysosomal storage diseases such as Tay-Sachs result when these enzymes fail to function.
- 3. C** — The active site is a specific pocket or cleft on an enzyme where the substrate binds, allowing catalysis to occur. The substrate fits the active site like a key fits a lock, ensuring enzyme specificity. Any change that distorts the active site — heat, pH, inhibitors — disrupts enzyme function.
- 4. A** — Osmosis is the diffusion of water across a selectively permeable membrane from low solute (high water) to high solute (low water). The water moves down its own concentration gradient and requires no ATP. Cells rely on osmosis to balance water levels with their surroundings.
- 5. D** — The electron transport chain on the inner mitochondrial membrane produces about 32–34 ATP per glucose, far more than glycolysis (2 ATP) or the Krebs cycle (2 ATP). Oxygen acts as the final electron acceptor here, which is why aerobic respiration is far more efficient than anaerobic fermentation. ATP synthase couples proton flow to ATP synthesis.
- 6. A** — Light-dependent reactions split water and use captured light energy to produce ATP and NADPH. These energy carriers then power the Calvin cycle, which fixes CO₂ into glucose. Glucose itself is the final product of photosynthesis as a whole, not of the light reactions specifically.
- 7. B** — Starch is a polysaccharide built from glucose monomers joined by glycosidic bonds. Amino acids form proteins, fatty acids form lipids, and nucleotides form nucleic acids — only glucose forms starch. Starch is the major energy-storage carbohydrate in plants.
- 8. C** — DNA replication is semi-conservative: each new molecule contains one original (parental) strand and one newly synthesized strand. This was demonstrated by the Meselson-Stahl experiment using nitrogen isotopes. Semi-conservative replication ensures accurate inheritance of genetic information.
- 9. A** — A codon is a sequence of three mRNA bases that specifies one amino acid in a polypeptide chain. With 64 possible codons and only 20 amino acids, multiple codons can code for the same amino acid. The genetic code also includes start and stop codons that mark the boundaries of a protein-coding sequence.
- 10. D** — Somatic (body cell) mutations affect only the individual in whom they occur because they are not present in the gametes. Only germline mutations in egg or sperm cells can be inherited by offspring. This is why most cancer-causing mutations remain confined to the individual.

- 11. B** — In a test cross $Aa \times aa$, the heterozygous parent contributes A or a in equal proportions while the homozygous recessive parent contributes only a. The offspring are therefore 50% Aa and 50% aa. This 1:1 ratio is the diagnostic outcome of a test cross.
- 12. C** — A carrier mother ($X^N X^n$) passes X^N or X^n to her sons with equal probability, and sons receive Y from the father. Half of sons therefore inherit $X^n Y$ and are color-blind. This is the classic pattern of X-linked recessive inheritance from a carrier mother to her sons.
- 13. A** — Meiosis involves two divisions and produces four haploid daughter cells that are genetically different from one another due to crossing over and independent assortment. Mitosis, by contrast, produces two diploid identical daughter cells. The variation generated by meiosis is essential for sexual reproduction and evolution.
- 14. D** — Sexual reproduction combines genetic material from two parents and generates new combinations through independent assortment, crossing over, and random fertilization. This produces offspring genetically different from both parents and from one another. The resulting variation is the raw material on which natural selection acts.
- 15. B** — Darwin proposed that variation exists within populations before selection acts on it, and that individuals with favorable variations are more likely to survive and reproduce. Lamarck's idea that acquired characteristics could be inherited has been disproven by modern genetics. Darwin's framework, combined with genetics, forms the modern synthesis of evolution.
- 16. C** — Coevolution describes reciprocal evolutionary change between two interacting species, in which each acts as a selective force on the other. Predator-prey, host-parasite, and mimicry relationships are classic examples. Mimicry between palatable and unpalatable species evolves through coevolutionary pressure from shared predators.
- 17. D** — Allopatric speciation is the formation of new species through geographic isolation, where a physical barrier prevents gene flow between populations. Over many generations, different selection pressures and genetic drift drive the populations apart until they can no longer interbreed. This is the most common mode of speciation in most animal groups.
- 18. C** — The universal use of ATP as cellular energy currency, like the universal genetic code and shared metabolic pathways, points to a single common ancestor of all life on Earth. Independent origins would likely have produced different energy molecules. Biochemical universality is a cornerstone of evidence for common descent.
- 19. B** — A community consists of all interacting populations of different species in a defined area. A population is one species, an ecosystem includes both community and abiotic environment, and the biosphere encompasses all of Earth's life. Community ecology focuses on inter-species interactions.
- 20. A** — Primary consumers are herbivores that feed directly on producers such as plants and algae, occupying the second trophic level. They transfer about 10% of producer energy upward to higher consumers. Most of the energy at each trophic level is lost as metabolic heat or used in life processes.

- 21. C** — In mutualism, both partners benefit from the relationship. The clownfish gains protection from predators within the anemone's stinging tentacles, and the anemone gains food and parasite removal. The clownfish's mucus coating prevents the anemone from stinging it.
- 22. D** — Limiting factors are environmental conditions that restrict population growth. For rabbits, food, water, and shelter are the primary limiting resources, and a shortage of any of them slows or stops population growth. Population size cannot exceed what the environment can supply.
- 23. B** — Lichens and mosses are classic pioneer species in primary succession because they can grow on bare rock and slowly break it down, contributing organic matter to form the first thin layer of soil. Larger plants cannot colonize until soil has developed. This is why succession after volcanic eruptions or glacial retreat begins with lichens.
- 24. A** — Decomposers — primarily bacteria and fungi — break down dead organic matter into simpler compounds, recycling nutrients back into the soil for use by producers. Without decomposers, nutrients would remain locked in dead matter and ecosystems would collapse. They are essential to nutrient cycling.
- 25. C** — Photosynthesis fixes atmospheric CO₂ into organic carbon (glucose), which producers incorporate into their tissues. When consumers eat producers, this fixed carbon enters the food web. Photosynthesis is the main route by which atmospheric carbon enters biological systems.
- 26. A** — Protecting natural habitat is the single most effective conservation strategy because habitat loss is the leading cause of species decline. A protected park preserves the eagles' nesting sites, hunting territory, and prey base. Habitat protection also benefits many other species that share the ecosystem.
- 27. D** — Chlorofluorocarbons (CFCs) release chlorine atoms when UV light breaks them apart in the upper atmosphere. Each chlorine atom can catalyze the destruction of thousands of ozone molecules. This chemistry led to the international Montreal Protocol that has phased out CFC use globally.
- 28. B** — Insulin lowers blood glucose by signaling cells to take up sugar, while glucagon raises blood glucose by signaling the liver to release stored glycogen. Together they form the negative feedback system that maintains blood glucose homeostasis. Diabetes mellitus results when this system fails.
- 29. A** — Axons are long projections of the neuron that carry electrical signals away from the cell body toward the synapse, where they communicate with the next cell. Dendrites receive incoming signals. This polarized structure (dendrites in, axon out) is fundamental to how the nervous system processes information.
- 30. C** — When blood glucose rises after a carbohydrate-rich meal, the pancreatic beta cells secrete insulin to signal muscle, fat, and liver cells to absorb glucose from the blood. This brings blood sugar back to baseline. People with type 1 diabetes cannot produce insulin and require external supplementation.
- 31. B** — The spongy mesophyll layer contains chloroplasts and contributes to photosynthesis, with air spaces allowing CO₂ to diffuse to chloroplast-containing cells. However, the palisade mesophyll layer (option D) is generally considered the primary photosynthetic site due to its tightly packed columnar cells

and high chloroplast density just below the upper epidermis. Standard botany teaching identifies the palisade layer as containing the largest number of chloroplasts.

32. D — The stoma is the opening that allows gases to enter and exit the leaf, providing CO₂ for photosynthesis and releasing O₂. Guard cells flanking the stoma open and close it in response to environmental conditions such as light and water availability. Without stomata, gas exchange could not occur in leaves.

33. A — The cuticle is a waxy layer secreted by the epidermis that minimizes water loss through evaporation from the leaf surface. This is especially important in dry conditions where water conservation is critical. The cuticle does not contain chloroplasts and does not transport substances.

34. C — Xylem is a vascular tissue made of dead, hollow cells that transports water and dissolved minerals upward from the roots to the rest of the plant. Phloem, by contrast, transports sugars from photosynthetic leaves to other tissues. Together xylem and phloem form the plant's vascular system.

35. B — The graph shows the hare and lynx populations rising and falling in linked cycles, with the lynx peaks occurring after the hare peaks. This cyclical pattern is a classic predator-prey relationship driven by feedback between the two populations. The pattern has been documented in trapping records for over a century.

36. D — Lynx peaks consistently follow hare peaks because the predator population can only grow after its food source has increased. As hare numbers rise, lynx reproduction succeeds; once hare numbers fall, lynx populations decline. This delayed response is a hallmark of predator-prey cycling.

37. A — Lynx depend on hares as their primary food source. When the hare population drops, food becomes scarce and lynx face starvation, reduced reproduction, and increased mortality. The lynx population therefore declines in response to its prey's decline.

38. B — Huntington's disease is autosomal dominant, so unaffected individuals must lack the dominant disease allele entirely. This means their genotype is homozygous recessive (hh) for the normal allele. Even one copy of the disease allele (H) would cause the disease.

39. C — A Hh × hh cross produces offspring that are 50% Hh (affected) and 50% hh (unaffected). Each child therefore has a 50% chance of inheriting the disease allele from the affected parent. This is the characteristic transmission pattern for autosomal dominant disorders.

40. D — Most dominant alleles in populations are either neutral or beneficial because dominant disease alleles tend to be removed by selection. Huntington's disease is unusual because its dominant allele causes a serious disorder yet persists — symptoms appear after typical reproductive age, allowing the allele to be passed to children before its harmful effects appear.

41. A — Photosynthesis by plants, algae, and cyanobacteria is the source of essentially all atmospheric oxygen, releasing O₂ as a byproduct of splitting water during the light reactions. Before oxygenic photosynthesis evolved, Earth's atmosphere had little free oxygen. Continued plant and algal photosynthesis maintains the modern atmosphere's oxygen levels.

42. C — Cellular respiration in essentially all aerobic organisms (animals, plants, fungi, many bacteria) consumes oxygen to break down glucose for ATP. This is the main biological process that removes atmospheric oxygen. Combustion also consumes oxygen but is secondary in scale compared to respiration globally.

43. B — Combustion uses O_2 to oxidize carbon-containing fuels, releasing CO_2 as a major product. This applies to natural fires, fossil fuel burning, and engine combustion. The CO_2 released contributes to atmospheric greenhouse gas levels.

44. D — The micrometer (μm , equal to 10^{-6} meter) is the standard unit for measuring objects viewed under a compound light microscope. Cells typically range from 1 μm (bacteria) to 100 μm (large eukaryotic cells). Centimeters and millimeters are too large, while nanometers are below the optical resolution limit.

45. A — The independent variable is the variable the experimenter deliberately changes — here, the color of light used. The rate of photosynthesis is the dependent variable that responds to changes in the light color. Other factors like temperature and species are kept constant as controls.

46. B — In an $Aa \times Aa$ cross, the offspring genotype ratio is 1 AA : 2 Aa : 1 aa , so 2 out of 4 (50%) are heterozygous Aa . This 50% heterozygous outcome is a standard result of crossing two heterozygotes. The remaining 50% are split equally between the two homozygous genotypes.

47. C — By Chargaff's rules, C pairs with G (so $G = 22\%$) and A pairs with T. If $C + G = 44\%$, then $A + T = 56\%$, and since $A = T$, each must equal 28%. This base-pairing arithmetic is a common Regents calculation.

48. D — Gel electrophoresis separates DNA fragments by size by applying an electric field across a porous gel. Smaller fragments migrate farther than larger ones, producing a pattern of bands that allows comparison of samples. This technique is central to DNA fingerprinting, paternity testing, and forensic analysis.

49. B — Comparing native plant populations in invaded and non-invaded areas provides a controlled scientific test of the invasive species' effects. The non-invaded area serves as the control. Ignoring, removing native plants, or adding more invasive species would not produce sound scientific data.

50. A — Small populations have less genetic diversity, and inbreeding among closely related individuals increases the expression of harmful recessive alleles. These genetic problems reduce fitness and resilience to environmental change, making small populations more vulnerable to extinction. This principle is central to conservation genetics.

51. D — When a bird population increases, more individuals must share the same total area, so each bird's territory becomes smaller. As one variable rises, the other falls — the definition of inverse proportionality. This relationship is well-documented in territorial bird species.

52. C — Crop rotation reduces soil nutrient depletion and pest buildup, while seed banks preserve crop genetic diversity for future use. Both practices help maintain agricultural biodiversity against ecological challenges. Monoculture and clearing of native vegetation reduce biodiversity rather than preserving it.

53. A — Trees stabilize soil with their roots and contribute to rainfall through transpiration and atmospheric moisture cycling. Removing forest cover increases erosion (especially from rainstorms) and reduces local rainfall. This is one reason deforestation has serious regional climate consequences.

54. B — Deserts are defined by very low precipitation (under 25 cm/year) and often hot temperatures. Plants like cacti show classic adaptations: thick stems that store water, reduced leaves (spines), and CAM photosynthesis that minimizes water loss. Rainforests, deciduous forests, and tundras differ markedly in these characteristics.

55. D — Dissolved CO₂ forms carbonic acid, lowering ocean pH. The acidic water dissolves calcium carbonate shells of corals, mollusks, and many plankton species, threatening these organisms and the food webs that depend on them. Ocean acidification is a major consequence of rising atmospheric CO₂.

56. C — The placenta is the temporary organ that forms during pregnancy and contains intermingled maternal and fetal blood vessels, where nutrient, gas, and waste exchange occurs. The umbilical cord is the conduit that connects the fetus to the placenta but is not the site of exchange. Without a properly functioning placenta, the fetus cannot develop.

57. A — Meiosis halves the chromosome number, producing four haploid daughter cells with 23 chromosomes each (in humans). Meiosis I separates homologous chromosomes; meiosis II separates sister chromatids. The haploid count is essential so that fertilization can restore the diploid 46 chromosomes.

58. D — Genes located on the X chromosome produce sex-linked inheritance patterns. Because males (XY) have only one X chromosome, recessive X-linked traits are expressed more often in males than in females. Color blindness, hemophilia, and Duchenne muscular dystrophy are well-known examples.

59. B — The central dogma of molecular biology states that genetic information flows from DNA → mRNA (transcription) → protein (translation). DNA serves as the master template stored in the nucleus, mRNA carries the coded message to the cytoplasm, and ribosomes assemble the protein from amino acids.

60. C — Divergent evolution occurs when one ancestral species gives rise to two or more species that become progressively more different over time. Geographic separation, like an ocean between dolphin populations, removes gene flow and allows divergence. This contrasts with convergent evolution, where unrelated species evolve similar traits.

61. A — The founder effect occurs when a small group establishes a new population from a much larger source, carrying only a small, non-random sample of the original gene pool. The resulting population may differ markedly from the source population due to this limited genetic representation. This effect is important in island biogeography and conservation genetics.

62. D — Resistance alleles arose by random mutation before the antibiotic was applied, and a few bacteria already carried them. When the antibiotic killed susceptible bacteria, the pre-existing resistant variants

survived and reproduced, increasing their frequency. Antibiotics select for, but do not cause, resistance mutations.

63. C — Sea otters control sea urchin populations through predation, and sea urchins eat kelp. Removing otters allows urchin populations to explode, leading to severe overgrazing of kelp and the collapse of kelp forest ecosystems. This is the classic trophic cascade example illustrating keystone species.

64. B — Each trophic level retains about 10% of the energy from the level below. Starting from 10,000 units at the producer level, primary consumers receive 1,000, and secondary consumers (third trophic level) receive 100. This is the basis of the energy pyramid and the reason food chains are typically short.

65. C — Testosterone, produced by the testes, drives the development of male secondary sexual characteristics during puberty: deepening voice, facial hair, muscle development, and reproductive organ maturation. Estrogen and progesterone drive female secondary characteristics, and insulin regulates blood glucose. Testosterone is the primary male sex hormone.

66. D — Red blood cells contain hemoglobin, which binds oxygen in the lungs and releases it in body tissues. This transport function is the cell's defining role. White blood cells fight infection, B cells produce antibodies, and platelets handle clotting — only red blood cells transport oxygen.

67. B — Capillaries have walls only one cell thick, allowing gases, nutrients, and wastes to diffuse easily between blood and surrounding tissues. This thin-walled design is essential for the exchange function of the circulatory system. Arteries and veins transport blood; only capillaries perform tissue exchange.

68. C — Bile, made in the liver and stored in the gallbladder, contains bile salts that emulsify large fat globules into smaller droplets. This increases the surface area available for lipase enzymes to digest fats. Without bile, fat digestion would be slow and incomplete.

69. A — The autonomic nervous system controls involuntary functions such as heart rate, digestion, breathing, and blood pressure. It includes the sympathetic (fight-or-flight) and parasympathetic (rest-and-digest) divisions. Voluntary movement is controlled by the somatic nervous system, not the autonomic.

70. D — Aldosterone acts on the kidneys to promote sodium reabsorption, which leads to water retention through osmotic effects. This raises blood volume and pressure and maintains body fluid balance. Aldosterone deficiency (Addison's disease) leads to dangerously low blood pressure and electrolyte imbalances.

71. C — Antibodies are Y-shaped proteins produced by plasma cells, which are differentiated B lymphocytes (B cells). Each antibody binds specifically to one antigen, marking pathogens for destruction. B cells are part of the adaptive immune response and are activated when they encounter specific pathogens.

72. A — Vaccines contain weakened, killed, or fragment versions of a pathogen, exposing the immune system to antigens without causing disease. The immune system responds by producing memory cells that enable a rapid, strong response if the actual pathogen is later encountered. Vaccination has dramatically reduced once-common infectious diseases.

73. B — Different "beak" tools in the Beaks of Finches lab represent the inherited variation in beak shape that exists within a real bird population. Some tools work better than others for certain food types, just as some real beaks are better suited for specific seeds or insects. This variation is the raw material on which natural selection acts.

74. D — Water moves into the dialysis tube because the sugar solution inside is more concentrated in solute than the surrounding distilled water. Water flows down its own concentration gradient through the selectively permeable membrane — the definition of osmosis. The sugar molecules themselves cannot pass through the tubing's small pores.

75. C — Species with the most similar amino acid sequences in homologous proteins have had less time to accumulate mutations since their last common ancestor. Greater similarity therefore indicates closer evolutionary relationship. This protein-comparison method is one of the molecular evidence types used in modern taxonomy.

76. A — Measuring pulse rate before, during, and after exercise allows students to track how the cardiovascular system responds to physical activity. This time-series approach captures the full picture of the body's homeostatic response. Single-point measurements would miss the dynamic adjustment.

77. B — Higher-power objective lenses magnify the image more, allowing greater detail to be resolved. The total magnification equals the eyepiece magnification multiplied by the objective magnification. Switching from a 10x to a 40x objective increases total magnification fourfold.

78. D — Tying back long hair and keeping flammable materials away from the burner prevent fires, burns, and other serious accidents. Loose clothing, pointing flames at others, and leaving an unattended burner are all dangerous practices. Lab safety rules around open flames are non-negotiable.

79. C — In the simulation, students who collect insufficient food represent finches that did not survive to reproduce, so their "beak" traits are not passed to the next round. This models natural selection's elimination of less-fit phenotypes from the gene pool. The surviving students pass their tools (representing inherited traits) to the next generation.

80. A — A triple-beam balance measures mass in grams by comparing the unknown sample to known weights along three sliding beams. Millimeters measure length, milliliters measure volume, and degrees Celsius measure temperature — none of these are mass units. The gram is the standard SI mass unit in biology labs.

81. B — Distilled water is used as a standard solvent in the experiment and is kept the same across all trials, making it a controlled variable. Controlled variables ensure that any observed differences in results can be attributed to the variable being tested, not to other factors. Identifying these variables is a key part of experimental design.

82. D — A liquid in a graduated cylinder forms a curved surface (meniscus) due to surface tension. Volume should be read at the bottom of the meniscus with the eye at the same level as the liquid to avoid parallax error. Reading at the top or side introduces inaccuracy.

83. A — Hazardous chemical spills must be reported immediately to the teacher, who can determine the appropriate response and supervise safe cleanup. Wiping with bare hands, ignoring the spill, or adding water without knowing what's spilled can cause serious harm. Standard lab safety protocol requires teacher notification first.

84. C — A line graph displays continuous data showing how one variable (reaction rate) changes in response to another (temperature). The shape of the line reveals the optimum temperature and how activity falls off on either side. Line graphs are the standard for continuous-data relationships.

85. B — The Beaks of Finches simulation demonstrates the central principle of natural selection: individuals with advantageous traits (better-suited "beaks") collect more food, survive, and pass those traits to the next generation. Over time, the population's average traits shift toward those most useful in the current environment. This is the engine of adaptive evolution.