PRACTICE EXAM 10: 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. Which of the following is necessary for all living organisms to maintain life?

A. Movement of the entire body from place to place

B. Reproduction during every life stage of the organism

C. Photosynthesis as the primary means of producing food

D. The transformation of energy to carry out life processes

2. The basic unit of structure and function in all living organisms is

A. the cell

B. the organ

C. the tissue

D. the molecule

3. Which cell organelle is the site of photosynthesis in plant cells?

A. The mitochondrion

B. The ribosome

C. The chloroplast

D. The lysosome

4. Carbohydrates, lipids, proteins, and nucleic acids are the four major classes of

A. inorganic compounds found only in living cells

B. organic compounds that make up living organisms

C. minerals required for normal cellular function

D. elements essential for biological activity

5. The movement of water across a selectively permeable membrane from an area of higher concentration to lower concentration is called

A. osmosis

B. active transport

C. endocytosis

D. phagocytosis

6. The three-dimensional shape of an enzyme determines

A. the temperature at which it forms

B. the rate at which it is digested

C. the location where it is manufactured

D. the specific substrate to which it binds

7. During photosynthesis, the energy of sunlight is used to convert carbon dioxide and water into

A. nitrogen and oxygen

B. glucose and oxygen

C. proteins and carbon dioxide

D. lipids and hydrogen

8. Aerobic cellular respiration uses oxygen to break down glucose and release energy in the form of

A. heat alone with no chemical product formed

B. ATP, with carbon dioxide and water as byproducts

C. starch, which stores energy inside the cell

D. light, which is emitted by the mitochondria

9. The two strands of a DNA double helix are held together by

A. covalent bonds between adjacent sugars

B. ionic bonds between phosphate groups

C. hydrogen bonds between complementary bases

D. peptide bonds between nucleotide bases

10. The information that determines an organism's inherited traits is stored in the sequence of

A. nitrogenous bases in DNA

B. amino acids in cellular proteins

C. sugars in long carbohydrate chains

D. lipids in the plasma membrane

11. A sequence of three bases on an mRNA molecule that codes for one amino acid is called

A. a gene

B. a chromosome

C. a nucleotide

D. a codon

12. Which of the following is most likely to introduce new alleles into a population over many generations?

A. The destruction of body cells by ultraviolet light

B. Direct chemical damage to mature skin cells

C. Random mutations that occur during DNA replication in sex cells

D. The gradual loss of unused genes from a single chromosome

13. Meiosis differs from mitosis in that meiosis produces

A. two diploid daughter cells identical to the parent

B. four haploid daughter cells with new combinations of alleles

C. two cells that immediately fuse to form a zygote

D. eight haploid cells that are genetically identical to one another

14. Fertilization in sexually reproducing organisms restores the diploid chromosome number by

A. combining the haploid chromosomes from an egg and a sperm

B. duplicating the chromosomes of the female gamete only

C. activating extra chromosomes already present in body cells

D. removing duplicate chromosomes from the developing zygote

15. In humans, the gene for brown eyes (B) is dominant over the gene for blue eyes (b). If both parents are heterozygous (Bb), what is the probability that their child will have blue eyes?

A. 0%

B. 100%

C. 25%

D. 75%

16. Vestigial structures, such as the small hip bones found in some whales, provide evidence that whales

A. are still actively evolving toward a land-dwelling lifestyle

B. were created in their present form with all features intact

C. share no evolutionary relationship with any land mammals

D. evolved from ancestors that lived on land

17. In a population of moths, dark-colored individuals become much more common after pollution darkens the bark of trees in their habitat. This change is best explained by

A. moths choosing to darken their wing color to match the environment

B. natural selection favoring dark moths that were less visible to predators

C. the pollution chemically changing the wings of light moths to dark

D. moths migrating from polluted regions to find lighter-colored trees

18. Two organisms are considered members of the same species if they can

A. interbreed under natural conditions and produce fertile offspring

B. live in the same general habitat throughout their lives

C. eat similar foods at the same trophic level in the ecosystem

D. be observed to look almost identical to each other in appearance

19. Which of the following represents the largest level of biological organization?

A. Population

B. Community

C. Organism

D. Biosphere

20. In a food chain, the greatest amount of available energy is found at the level of the

A. tertiary consumers at the top

B. secondary consumers in the middle

C. producers at the base

D. decomposers in the soil

21. Plants remove carbon dioxide from the atmosphere during the process of

A. photosynthesis

B. respiration

C. transpiration

D. decomposition

22. Which process returns liquid water to the atmosphere as water vapor?

A. Precipitation in the form of rain or snow

B. Runoff into rivers, lakes, and oceans

C. Evaporation from oceans and transpiration from plants

D. Infiltration of water into the soil profile

23. Which of the following is an example of homeostasis in the human body?

A. The continuous growth of hair throughout a person's life

B. The maintenance of blood glucose within a narrow concentration range

C. The development of new bone tissue during childhood

D. The replacement of skin cells after a minor scrape or injury

24. White blood cells called lymphocytes recognize and respond to specific pathogens by

A. engulfing all foreign material in an indiscriminate way

B. producing high body temperatures to kill the pathogens

C. releasing acid that dissolves the pathogen's outer layer

D. producing antibodies that bind to specific antigens

25. Hormones are chemical messengers that are produced by glands and

A. travel through the bloodstream to reach target cells

B. travel through nerve cells to deliver electrical signals

C. remain inside the gland where they are first produced

D. are excreted from the body before reaching target tissues

26. A reflex action, such as quickly pulling a hand away from a hot surface, involves

A. a conscious decision made by the cerebral cortex

B. a rapid response coordinated through the spinal cord

C. the release of hormones from the adrenal glands only

D. a slow chemical signal that travels through the bloodstream

27. The digestion of food begins in the mouth, where enzymes in saliva start to break down

A. proteins into amino acids

B. fats into smaller fatty acids

C. nucleic acids into nucleotides

D. starches into smaller sugars

28. The chamber of the human heart that pumps oxygenated blood to the body is the

A. right atrium

B. right ventricle

C. left ventricle

D. left atrium

29. Gas exchange between the air and the blood in the human lungs occurs primarily in the

A. alveoli

B. bronchi

C. trachea

D. pharynx

30. In a mutualistic relationship between two species,

A. one species benefits while the other is harmed

B. both species benefit from the interaction

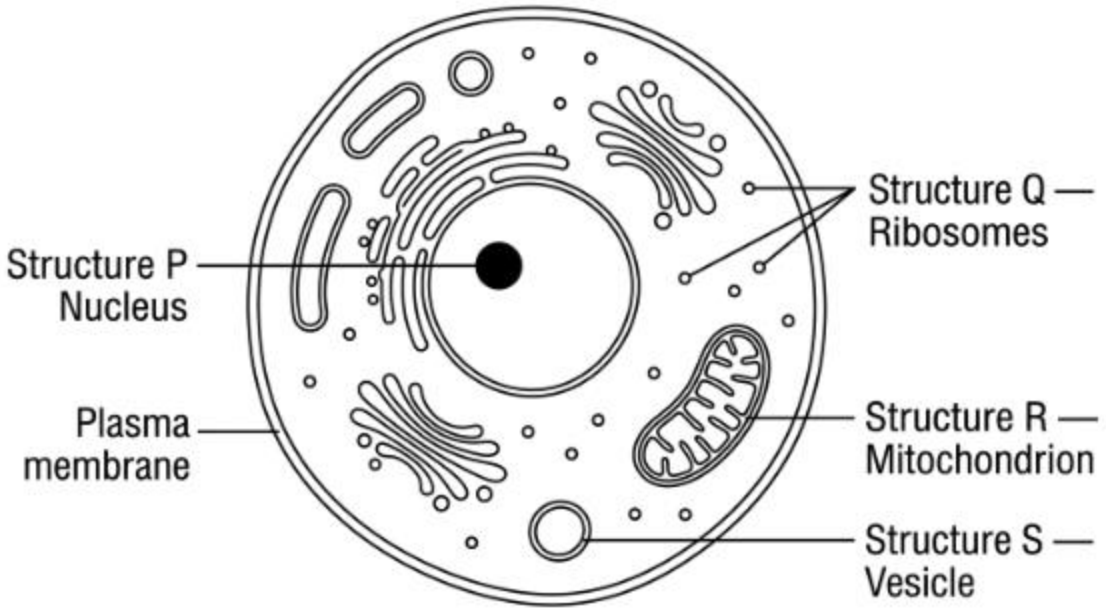
C. one species benefits while the other is unaffected

D. both species are harmed by the prolonged contact

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 labeled diagram of an animal cell with four structures identified.



Based on the diagram, which structure is the site of protein synthesis?

A. Structure P

B. Structure Q

C. Structure R

D. Structure S

32. Referring to the same diagram, which structure functions as the primary site of ATP production?

A. Structure P

B. Structure Q

C. Structure S

D. Structure R

33. Referring to the same diagram, the structure most directly involved in regulating gene expression is

A. Structure P

B. Structure Q

C. Structure R

D. Structure S

34. Referring to the same diagram, the cell shown can be identified as an animal cell rather than a plant cell because it lacks

A. mitochondria and ribosomes

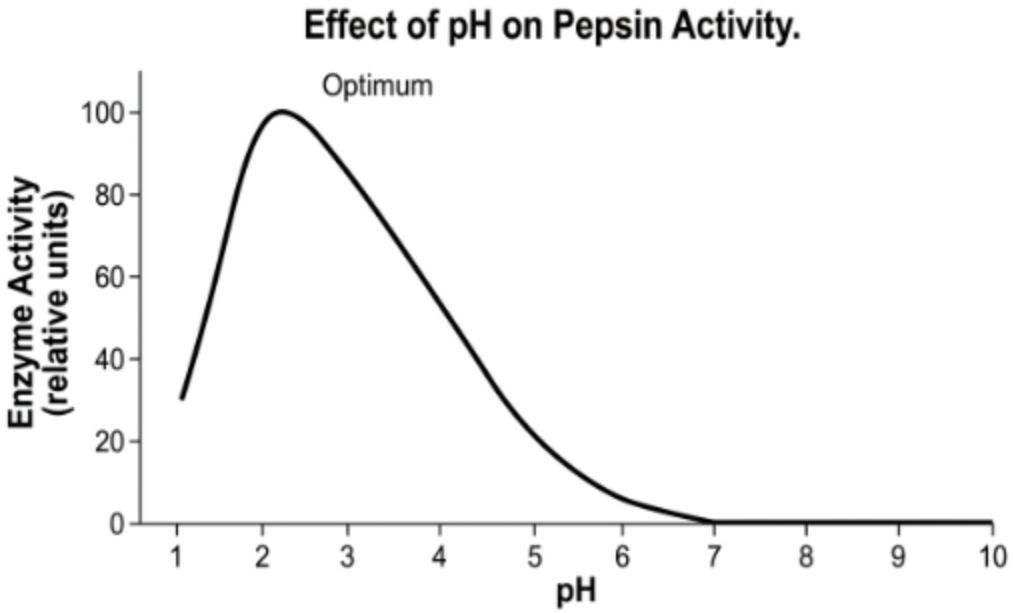
B. a cell wall and chloroplasts

C. a nucleus and vesicles

D. a plasma membrane and cytoplasm

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

35. A scientist measures the activity of the stomach enzyme pepsin at different pH values.



Based on the graph, pepsin is most active at a pH of approximately

A. 7

B. 5

C. 4

D. 2

36. Based on the same graph, which statement best explains why pepsin functions effectively in the human stomach?

A. The stomach maintains a high temperature that activates pepsin

B. The stomach lining absorbs all of the pepsin during digestion

C. The stomach environment is highly acidic, matching the enzyme's optimal pH

D. The stomach contains additional enzymes that boost pepsin activity

37. Based on the same graph, if pepsin were placed in the slightly basic environment of the small intestine (pH 8), the enzyme would

A. show almost no activity because the pH is far from its optimum

B. function at maximum activity due to the alkaline environment present

C. break down much more rapidly than at any acidic pH level

D. produce twice as much product as it does inside the stomach

Base your answers to questions 38-40 on the data table below and on your knowledge of biology.

38. A scientist measured the population size of a bacterial culture in a closed container over 12 hours.

| Time (hours) | Population Size |

|---|---|

| 0 | 100 |

| 2 | 200 |

| 4 | 400 |

| 6 | 800 |

| 8 | 1,500 |

| 10 | 1,900 |

| 12 | 2,000 |

Based on the data, the bacterial population shows characteristics of exponential growth from

A. hour 0 to hour 2 only

B. hour 8 to hour 12 only

C. hour 0 to hour 6 approximately

D. hour 10 to hour 12 only

39. Based on the same data, the slowing of population growth after hour 8 is best explained by

A. genetic mutations preventing further cell division entirely

B. an increase in the rate of bacterial reproduction over time

C. limiting factors such as nutrient depletion or waste accumulation

D. the arrival of a competing bacterial species in the container

40. Based on the same data, the carrying capacity of the container is closest to

A. 2,000

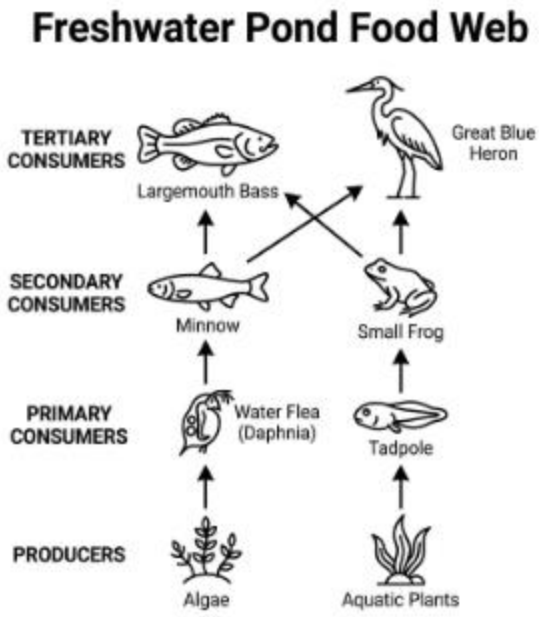
B. 1,500

C. 800

D. 200

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

41. A student examines a food web diagram for a freshwater pond ecosystem.



Based on the food web, which organisms function as producers?

A. Water Flea and Tadpole

B. Minnow and Small Frog

C. Largemouth Bass and Great Blue Heron

D. Algae and Aquatic Plants

42. Based on the same food web, if all the algae were removed from the pond, the most direct effect would be a decline in the population of

A. Tadpoles, because they feed directly on algae throughout life

B. Water Fleas, because algae are their primary food source

C. Largemouth Bass, because they consume algae through filter feeding

D. Great Blue Herons, because herons eat algae as part of their diet

43. Based on the same food web, the Largemouth Bass and Great Blue Heron may be considered competitors because they

A. feed on the same secondary consumer species in the pond

B. occupy completely different trophic levels in the same ecosystem

C. produce offspring that always share the same food sources

D. require entirely different habitats within the same pond environment

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

Answer all questions in this part.

44. A student wonders whether the amount of sunlight a bean plant receives affects the number of leaves it produces. In an experiment to test this question, the number of leaves on each plant would be the

A. independent variable

B. controlled variable

C. hypothesis being tested

D. dependent variable

45. In the same experiment, which of the following should be kept constant to ensure that any difference in leaf production is caused only by sunlight?

A. The number of hours of sunlight each plant receives daily

B. The number of leaves counted at the end of the experiment

C. The amount of water and type of soil given to each plant

D. The day on which the experiment first begins for plants

46. A graph showing the relationship between two variables clearly demonstrates a positive correlation. This means that as one variable increases,

A. the other variable decreases

B. the other variable also increases

C. the other variable remains exactly the same

D. the two variables become completely unrelated

47. A characteristic that is influenced by both genetics and the environment, such as human height, is best described as

A. a polygenic trait affected by environmental factors

B. a trait controlled by a single dominant allele only

C. a sex-linked recessive characteristic of low frequency

D. a trait determined solely by environmental conditions

48. DNA fingerprinting is a technique that can be used to

A. predict the geographic origin of any sample with certainty

B. determine the age of an organism from a single tissue sample

C. test for the presence of all human diseases simultaneously

D. identify an individual based on patterns in their DNA

49. Sickle-cell anemia is caused by a mutation in a single gene that codes for

A. an enzyme involved in protein digestion

B. the hemoglobin protein found in red blood cells

C. a hormone that regulates blood glucose levels

D. an antibody used in the immune response system

50. Comparisons of embryonic development in different vertebrate species reveal striking similarities during the early stages of development. This observation provides evidence for

A. the independent origin of each vertebrate species

B. the rapid evolution of species in modern environments

C. the descent of vertebrate species from a common ancestor

D. the absence of any evolutionary change in vertebrate species

51. A scientist alters a bacterial cell by inserting a human gene that codes for insulin. This procedure is best described as

A. genetic engineering used to produce a useful protein

B. natural selection of insulin-producing bacterial strains

C. asexual reproduction in a controlled laboratory environment

D. random mutation guided by specific laboratory conditions

52. In humans, biological sex is determined by which combination of chromosomes?

A. Two X chromosomes in males and one X in females

B. A pair of autosomes inherited from both parents

C. One X chromosome inherited only from the mother

D. The combination XX in females and XY in males

53. Cancer is best described as a disease that results from

A. inherited microscopic parasites that invade cell tissues

B. uncontrolled cell division caused by mutations in regulatory genes

C. an attack on body cells by foreign antibody molecules

D. a deficiency of vitamins and minerals in the diet over time

54. The structure in a flowering plant that is most directly involved in producing male gametes is the

A. anther

B. ovary

C. stigma

D. petal

55. Which of the following best describes biodiversity within an ecosystem?

A. The total mass of all living organisms found in the area

B. The number of food chains linking producers to top predators

C. The variety of species and the genetic differences among them

D. The amount of energy stored in the producers at the base level

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

Answer all questions in this part.

56. A person who has been jogging for several minutes begins to sweat heavily. The sweating response is best understood as

A. an attempt by the body to remove excess waste products from the blood

B. a method of conserving heat in cold environmental conditions outside

C. a side effect of increased muscle activity that has no useful purpose

D. a negative feedback mechanism that helps cool the body and maintain temperature

57. The reason a person typically does not get the same strain of the flu twice in the same season is that

A. all flu viruses are completely destroyed by stomach acid before causing illness

B. memory B and T cells produced during the first infection respond rapidly to the same antigens

C. the human body permanently develops resistance to all viral pathogens after one infection

D. all flu viruses naturally die off within a few weeks of entering a host body

58. A man with type A blood and a woman with type B blood have a child with type O blood. The best explanation for this outcome is that

A. both parents are heterozygous, each carrying one recessive O allele

B. the child's blood type changed shortly after birth due to environmental factors

C. one of the parents was incorrectly identified as the biological parent of the child

D. the type O allele appeared as a new mutation in the child during early development

59. Two populations of squirrels become separated when a large river forms between their habitats. Over many generations, the two populations evolve into distinct species. This pattern of speciation is best classified as

A. convergent evolution producing similar traits from different ancestors

B. coevolution where two species evolve traits in response to one another

C. directional selection favoring one extreme phenotype only over time

D. geographic isolation leading to reproductive isolation and divergence

60. A pond becomes contaminated with a pesticide at a low concentration. Years later, scientists find that fish-eating birds at the top of the food web have dangerously high levels of the pesticide in their tissues. This phenomenon is best explained by

A. the birds intentionally seeking out contaminated fish to consume

B. a chemical reaction inside the birds that creates new pesticide molecules

C. biomagnification, in which the pesticide becomes increasingly concentrated at higher trophic levels

D. the pesticide acting only on warm-blooded animals at the top of the food web

61. Deforestation contributes to climate change primarily because

A. cutting down trees increases the amount of nitrogen released into the soil

B. trees absorb carbon dioxide, and removing them allows more CO_2 to remain in the atmosphere

C. burning forests releases large amounts of free oxygen into the surrounding air

D. clearing land reduces the number of herbivores that produce greenhouse gases

62. Hemophilia is a sex-linked recessive disorder carried on the X chromosome. The disorder appears far more often in males than in females because

A. males have only one X chromosome, so a single recessive allele produces the disorder

B. males inherit two X chromosomes, one from each biological parent at conception

C. the gene for hemophilia is found only on the Y chromosome that males inherit

D. female hormones prevent the disorder from ever being expressed in any female

63. A volcanic island that has just formed in the ocean undergoes primary succession. The first organisms to colonize the new bare rock will most likely be

A. flowering plants requiring deep nutrient-rich soil to anchor their roots firmly

B. small herbivorous mammals seeking shelter on the newly exposed land mass

C. lichens and mosses that can survive harsh conditions and help form soil

D. large carnivorous animals seeking new territory free from competition with other species

64. The kidneys play a central role in maintaining homeostasis by

A. producing red blood cells that carry oxygen to tissues throughout the body

B. secreting digestive enzymes that break down food in the small intestine

C. storing energy in the form of glycogen for later use by working muscles

D. filtering waste products from the blood and regulating water balance

65. A change in the order of amino acids in a protein may result in

A. a protein with a different shape and altered or lost function

B. an immediate change in the sequence of DNA bases in every cell

C. a new chromosome being inserted into the cell's nucleus

D. a duplication of the gene that originally coded for the protein

66. During cell division, the genetic material is copied so that

A. the parent cell is destroyed after the division is fully complete

B. each daughter cell receives a complete and identical set of chromosomes

C. each daughter cell receives a different set of chromosomes from the parent

D. half of the genetic material is permanently lost during the division process

67. Photosynthesis and cellular respiration are complementary processes because

A. both processes occur exclusively inside chloroplasts in plant cells

B. both processes require direct sunlight to produce useful energy for cells

C. the products of one process serve as the reactants of the other process

D. both processes produce identical waste products that are released as gases

68. A scientist studying a genetic disease uses a technique that separates DNA fragments by size using an electric current passed through a gel. This technique is called

A. polymerase chain reaction

B. genetic recombination

C. selective breeding

D. gel electrophoresis

69. Asexual reproduction in organisms such as hydras and starfish produces offspring that are

A. genetically identical to the single parent organism

B. always larger and stronger than the parent organism

C. produced through the fusion of two separate sex cells

D. genetically varied due to recombination between chromosomes

70. During an experiment, a student observes results that do not match the original hypothesis. The most appropriate next step for the student is to

A. modify the recorded data so that the results match the hypothesis exactly

B. report the actual results and consider revising the hypothesis based on the evidence

C. eliminate any data points that conflict with the original hypothesis statement

D. repeat the experiment until the desired hypothesis-supporting results occur

71. Fossils found in lower (older) rock layers tend to differ significantly from those found in upper (younger) layers. This observation supports the conclusion that

A. fossils are randomly distributed throughout rock layers without any clear pattern

B. older fossils represent organisms that were more complex than modern species

C. all species on Earth appeared simultaneously and have not changed since that time

D. species have changed gradually over long periods of geological time

72. Sustainable use of natural resources is best described as a practice that

A. uses resources as quickly as possible to maximize short-term economic gain

B. relies entirely on imported resources from outside the local ecosystem

C. meets present needs without compromising the ability of future generations to meet theirs

D. prevents all human use of natural resources within a particular region

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

Answer all questions in this part.

73. In the Diffusion Through a Membrane laboratory, students place a dialysis bag containing starch and glucose into a beaker of water with Lugol's iodine. The dialysis tubing functions as a model of

A. a selectively permeable cell membrane that allows some molecules to pass

B. a fully impermeable cell wall that blocks all molecular movement entirely

C. a chloroplast actively converting light energy into chemical bonds

D. a ribosome assembling new proteins from individual amino acid components

74. After the experiment described in question 73 runs for thirty minutes, Benedict's solution is added to a sample of the water from the beaker, and the mixture is heated. A color change to orange-red indicates that

A. starch from the bag has diffused into the surrounding water

B. glucose from the bag has diffused into the surrounding water

C. the iodine in the beaker reacted directly with the dialysis tubing

D. carbon dioxide has been released into the surrounding water solution

75. In the Beaks of Finches simulation, students use various tools (such as tweezers, clothespins, and chopsticks) to pick up seeds during repeated rounds. The simulation models the process of

A. genetic drift caused by random changes in small populations

B. mutation introducing new alleles into a population over time

C. asexual reproduction producing identical offspring in finch populations

D. natural selection favoring beak shapes best suited to available food

76. A student uses a compound light microscope with a 10× eyepiece and a 40× objective lens. The total magnification of the specimen being viewed is

A. 4×

B. 50×

C. 400×

D. 4,000×

77. When viewing a specimen under a compound light microscope, the student should always begin focusing using

A. the lowest-power objective lens and the coarse adjustment knob

B. the highest-power objective lens and the coarse adjustment knob

C. the lowest-power objective lens and the fine adjustment knob only

D. the highest-power objective lens and the fine adjustment knob only

78. When preparing a wet-mount slide of an onion epidermis cell, the coverslip should be lowered onto the specimen at an angle in order to

A. prevent the iodine stain from oxidizing in the surrounding air

B. minimize the formation of air bubbles trapped under the coverslip

C. allow the specimen to fully absorb the surrounding water droplet

D. protect the high-power objective lens from accidental contact damage

79. In the Relationships and Biodiversity laboratory, students use multiple lines of evidence (structural, biochemical, and genetic) to determine relatedness because

A. molecular evidence is the only valid form of comparison in any taxonomic work

B. structural evidence alone is sufficient to confirm any evolutionary relationship

C. evolutionary relationships cannot be inferred from biochemical comparisons at all

D. using multiple independent lines of evidence produces stronger and more reliable conclusions

80. In the Making Connections laboratory, students measure the relationship between exercise and pulse rate. The hypothesis being tested would best be written as

A. Pulse rate is something that varies a lot from person to person each day

B. Some kinds of exercise might possibly have some effect on body functions

C. If a person exercises, then pulse rate will increase due to greater oxygen demand

D. Pulse rate may be measured easily by counting heartbeats at the wrist

81. The chemical indicator bromothymol blue is commonly used in biology laboratories to detect the presence of

A. carbon dioxide dissolved in solution

B. starch present in plant tissue samples

C. proteins present in animal tissue samples

D. lipids stored within fatty plant seeds

82. A student is preparing to heat a small quantity of liquid in a test tube. The safest procedure is to

A. seal the test tube with a rubber stopper before placing it over the flame

B. point the open end of the test tube away from herself and others while heating

C. point the open end of the test tube toward herself while observing the reaction

D. hold the test tube horizontally directly above the flame for the duration of heating

83. To read the volume of a liquid in a graduated cylinder accurately, a student should

A. read the measurement at the top of the curved liquid surface from above

B. shake the graduated cylinder gently to flatten the liquid surface first

C. estimate the value by viewing the cylinder from across the laboratory bench

D. read the measurement at the bottom of the curved meniscus at eye level

84. A dichotomous key is a tool used by biologists to

A. measure the genetic distance between two related populations of organisms

B. predict the appearance of offspring produced by two parent organisms

C. identify an unknown organism by using a series of paired contrasting statements

D. arrange organisms into a phylogenetic tree based on amino acid sequences

85. A student completes an experiment testing the effect of light color on plant growth. To strengthen the validity of her conclusions, she should

A. discard the data from any plant that grew in an unexpected direction

B. report only the results that confirmed her initial hypothesis statement

C. repeat the experiment multiple times to confirm that the results are consistent

D. change several variables at once to save time during future investigations

EXPLAINED ANSWER KEY – PRACTICE EXAM 10

1. D — The transformation of energy to carry out life processes is a universal characteristic of all living organisms. Whether through photosynthesis, cellular respiration, or chemosynthesis, every living thing must capture and transform energy to maintain its life functions. Movement, reproduction at every life stage, and photosynthesis are not universal traits.

2. A — The cell is recognized as the basic unit of structure and function in all living organisms, a principle established by the cell theory. Tissues and organs are higher levels of organization that exist only in multicellular organisms, and molecules are smaller subunits that are not themselves alive.

3. C — The chloroplast is the organelle in plant cells that contains chlorophyll and is the site of photosynthesis. Mitochondria carry out cellular respiration, ribosomes synthesize proteins, and lysosomes break down cellular waste — none capture light energy.

4. B — Carbohydrates, lipids, proteins, and nucleic acids are the four major classes of organic compounds (carbon-containing molecules) that make up living organisms. They are not inorganic, not minerals, and not elements — they are large biomolecules built primarily from carbon, hydrogen, and oxygen.

5. A — Osmosis is the specific term for the diffusion of water across a selectively permeable membrane from higher water concentration to lower water concentration. Active transport requires ATP and moves substances against the gradient, while endocytosis and phagocytosis involve membrane folding to bring in larger particles.

6. D — An enzyme's three-dimensional shape, specifically the shape of its active site, determines which substrate molecules can bind (the lock-and-key model). This structural specificity is why each enzyme catalyzes only a particular reaction, and why denaturation destroys enzyme function.

7. B — Photosynthesis uses light energy to combine carbon dioxide and water, producing glucose (the energy-storing sugar) and releasing oxygen as a byproduct. This process is the foundation of nearly all food chains because it converts solar energy into chemical energy stored in glucose.

8. B — Aerobic cellular respiration breaks down glucose using oxygen to release energy in the form of ATP, with carbon dioxide and water released as waste products. The overall equation is $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + ATP$, making ATP the usable energy currency of the cell.

9. C — The two strands of the DNA double helix are held together by hydrogen bonds between complementary nitrogenous bases (A pairs with T, G pairs with C). These bonds are weak enough to allow strands to separate during replication but strong enough collectively to keep the double helix stable.

10. A — Inherited traits are determined by the specific sequence of nitrogenous bases (adenine, thymine, guanine, cytosine) in DNA. This sequence is read in triplets during protein synthesis to determine the amino acid sequence of proteins, which in turn produces the observable traits of an organism.

11. D — A codon is a sequence of three consecutive bases on an mRNA molecule that specifies one amino acid during translation. A gene is a larger DNA sequence coding for a complete protein, a chromosome contains many genes, and a nucleotide is a single base unit — not three.

12. C — Random mutations occurring during DNA replication in sex cells (gametes) introduce new alleles that can be passed to offspring and become subject to natural selection. Mutations in body cells are not heritable, and damage to body cells does not introduce alleles into the population gene pool.

13. B — Meiosis produces four haploid daughter cells (gametes), each with half the parent's chromosome number and with new allele combinations due to crossing over and independent assortment. Mitosis produces two diploid identical cells, so the distinguishing feature of meiosis is the production of genetically varied haploid cells.

14. A — Fertilization restores the diploid (2n) chromosome number by combining the haploid (n) chromosome set from the sperm with the haploid set from the egg. This is the mechanism that joins genetic contributions from both parents to form a unique zygote.

15. C — In a Bb × Bb cross, the predicted offspring ratio is 1 BB : 2 Bb : 1 bb, meaning 25% of offspring will be homozygous recessive (bb) and therefore have blue eyes. This 1:2:1 genotype ratio underlies the classic 3:1 dominant-to-recessive phenotype ratio in monohybrid crosses.

16. D — Vestigial structures are reduced, nonfunctional remnants of features that were fully developed and functional in ancestral species. The small hip bones in whales indicate that whales descended from four-legged land-dwelling mammals, providing strong evidence for evolutionary descent with modification.

17. B — In industrial melanism, pollution darkened tree bark, which made light moths more visible to predators and gave dark moths a survival advantage. Natural selection then increased the frequency of the dark allele in the population — moths did not choose, change, or migrate in this process.

18. A — The biological species concept defines members of the same species as organisms that can interbreed under natural conditions and produce fertile offspring. Shared habitat, similar diet, or physical resemblance can occur between different species and are therefore not reliable indicators of species identity.

19. D — The biosphere encompasses all ecosystems on Earth and represents the highest, most inclusive level of biological organization. Populations exist within communities, communities within ecosystems, and all ecosystems together form the biosphere.

20. C — Energy decreases by roughly 90% at each trophic level (the 10% rule), so producers at the base of the food chain contain the greatest total energy. Higher trophic levels — primary, secondary, and tertiary consumers — receive progressively less of the energy originally captured by producers.

21. A — Photosynthesis is the process by which plants absorb atmospheric CO_2 and incorporate the carbon into glucose. Respiration releases CO_2, transpiration releases water vapor, and decomposition releases CO_2 during organic matter breakdown — none remove CO_2 from the air.

22. C — Liquid water returns to the atmosphere as water vapor through evaporation from open water surfaces and through transpiration from plant leaves. Precipitation, runoff, and infiltration all move water in the opposite direction.

23. B — Maintaining blood glucose within a narrow range through hormones such as insulin and glucagon is a classic example of homeostasis. The other options describe growth, development, or wound healing — processes that involve change rather than the maintenance of stable internal conditions.

24. D — B lymphocytes produce antibodies that bind specifically to antigens (unique molecules on pathogen surfaces) to mark them for destruction. This specificity is the defining feature of adaptive immunity, in contrast to nonspecific defenses such as phagocytosis or fever.

25. A — Endocrine hormones are released by glands directly into the bloodstream, which transports them throughout the body until they reach target cells with matching receptors. Nerve cells transmit electrical signals, but hormones are chemical messengers that travel through the circulatory system.

26. B — A reflex arc is processed at the level of the spinal cord, allowing a rapid protective response without waiting for signals to reach the brain. This shortcut explains why a hand withdraws from a hot surface before the person consciously feels the pain.

27. D — Salivary amylase, secreted in the mouth, begins the chemical digestion of starch by breaking it down into smaller sugars such as maltose. Protein digestion begins in the stomach, and fat and nucleic acid digestion begin in the small intestine.

28. C — The left ventricle is the thick-walled chamber that pumps oxygenated blood through the aorta to the entire body. The right ventricle pumps deoxygenated blood to the lungs; the atria receive blood rather than pumping it to the body systemically.

29. A — Alveoli are the tiny thin-walled air sacs at the ends of the bronchioles, and they are the site where oxygen and carbon dioxide diffuse between the air and the blood capillaries. The bronchi, trachea, and pharynx conduct air but do not exchange gases.

30. B — In mutualism, both species derive benefit from the interaction, such as the bee–flower relationship in which bees gain nectar and flowers achieve pollination. Commensalism benefits only one species, parasitism harms one, and competition harms both.

31. B — Ribosomes (Structure Q) are the cellular machines that assemble amino acids into proteins by reading mRNA codons. The nucleus stores genetic information, the mitochondrion produces ATP, and a vesicle stores or transports materials — none synthesize proteins themselves.

32. D — The mitochondrion (Structure R) is the powerhouse of the cell, where most ATP is produced through aerobic cellular respiration on the folded inner membrane (cristae). The other labeled structures play no direct role in ATP synthesis.

33. A — The nucleus (Structure P) contains the cell's DNA and is where transcription occurs, making it the primary site for regulating gene expression. Ribosomes and mitochondria carry out downstream processes, but the decision of which genes to transcribe takes place in the nucleus.

34. B — Animal cells lack a cell wall and chloroplasts, which are defining features of plant cells. Both plant and animal cells possess nuclei, ribosomes, mitochondria, vesicles, a plasma membrane, and cytoplasm, so those structures cannot be used to distinguish them.

35. D — The graph shows enzyme activity peaking sharply at pH 2, identifying the optimum pH for pepsin. This matches the highly acidic environment of the stomach, where pepsin functions in protein digestion.

36. C — The human stomach maintains a strongly acidic environment (approximately pH 1.5–2) due to the secretion of hydrochloric acid, which matches pepsin's optimum pH. This pairing of organ environment and enzyme optimum is a common adaptation in the digestive system.

37. A — At pH 8, the graph shows enzyme activity at essentially zero because the pH is far above pepsin's optimum and disrupts the ionic interactions that maintain active-site shape. As a result, pepsin is functionally inactive in the alkaline small intestine, where other enzymes such as trypsin take over.

38. C — Between hours 0 and 6, the population doubles every 2 hours (100 → 200 → 400 → 800), the defining pattern of exponential growth. After hour 6, growth slows substantially as the population approaches the container's carrying capacity.

39. C — In a closed container with finite resources, growth slows when limiting factors such as nutrient depletion and accumulation of metabolic waste begin to restrict reproduction. This produces the leveling-off (logistic) portion of the growth curve.

40. A — The population levels off at approximately 2,000 individuals, indicating that the container's carrying capacity (the maximum sustainable population size) is near that value. Above this density, deaths balance births and the population stops increasing.

41. D — In the food web, only algae and aquatic plants synthesize their own food through photosynthesis, making them the producers. All other organisms shown are consumers that obtain energy by eating other organisms.

42. B — Water Fleas (Daphnia) feed directly on algae according to the food web, so removing algae would most immediately reduce the water flea population. Tadpoles feed on aquatic plants rather than algae, and the bass and heron are several trophic levels removed.

43. A — The Largemouth Bass and the Great Blue Heron both prey on Minnows and Small Frogs, the same two secondary consumer species. When two species depend on the same food resource, they are considered ecological competitors.

44. D — The dependent variable is the outcome being measured — in this case, the number of leaves produced — because it is hypothesized to depend on the independent variable. The amount of sunlight is the independent variable that the experimenter changes deliberately.

45. C — Controlled variables are factors that must be held constant so they do not confound the effect of the independent variable. Keeping water and soil identical for all plants ensures that any difference in leaf production can be attributed to sunlight alone.

46. B — A positive correlation describes a relationship in which two variables change together in the same direction: as one increases, the other also increases. A negative correlation would describe variables moving in opposite directions.

47. A — Polygenic traits are controlled by multiple genes and are typically further influenced by environmental factors such as nutrition. Height is a textbook example, with adult stature reflecting both inherited genetic potential and developmental conditions during growth.

48. D — DNA fingerprinting compares unique patterns of repeated and variable DNA sequences to identify the individual a sample came from. It cannot reliably determine age, screen for all diseases, or pinpoint geographic origin with certainty.

49. B — Sickle-cell anemia is caused by a single base substitution in the gene coding for the beta chain of hemoglobin, the oxygen-carrying protein in red blood cells. The resulting abnormal hemoglobin (HbS) causes red blood cells to become sickle-shaped under low-oxygen conditions.

50. C — Striking similarities in vertebrate embryonic development (pharyngeal arches, post-anal tails, similar early body plans) indicate that vertebrates inherited these developmental features from a shared common ancestor. This embryological evidence is a major line of support for evolution.

51. A — Inserting a human gene into a bacterial cell to produce a desired protein (such as insulin) is a defining example of genetic engineering, also called recombinant DNA technology. This is exactly how human insulin is now produced for diabetic patients worldwide.

52. D — In humans, females have two X chromosomes (XX) and males have one X and one Y chromosome (XY). The presence of the Y chromosome, with its SRY gene, triggers male development; its absence results in female development.

53. B — Cancer arises when mutations accumulate in genes that normally regulate the cell cycle (proto-oncogenes and tumor suppressor genes), allowing cells to divide without normal restraints. The uncontrolled cell division produces tumors, which may invade surrounding tissues and metastasize.

54. A — In a flowering plant, the anther is the part of the stamen that produces and contains pollen grains, the male gametophytes that carry the male gametes. The ovary and stigma are female reproductive structures, and petals primarily attract pollinators.

55. C — Biodiversity refers to the variety of living organisms at multiple levels: the number of different species in an area and the genetic differences both within and among those species. Total biomass and energy storage describe ecosystem productivity, not biodiversity itself.

56. D — Sweating is a negative feedback response: rising body temperature triggers the hypothalamus to activate sweat glands, evaporation removes heat, and temperature returns toward the set point. This mechanism maintains homeostasis of core body temperature during exercise.

57. B — After the first infection, memory B and T lymphocytes specific to that flu strain remain in the body and mount a rapid, robust response if the same antigens are encountered again. This is the basis of adaptive immunological memory and the reason vaccines work.

58. A — Type A blood (genotype I^A i) and Type B blood (I^B i) can each carry one recessive O allele. When both heterozygous parents pass their i allele to the child, the child is genotype ii and expresses type O blood — demonstrating recessive inheritance through carrier parents.

59. D — When a physical barrier such as a new river separates a population, the two groups cannot exchange genes and over generations they accumulate different mutations and adaptations until they can no longer interbreed. This process — geographic isolation leading to reproductive isolation — is called allopatric speciation.

60. C — Biomagnification occurs when a persistent pollutant accumulates in organisms and becomes more concentrated at each higher trophic level because predators consume many contaminated prey. Top predators therefore accumulate the highest tissue concentrations, often reaching toxic levels even when environmental concentrations are low.

61. B — Trees act as carbon sinks by absorbing CO_2 during photosynthesis and storing carbon in their biomass. Removing forests both releases stored carbon (especially when wood is burned) and reduces the planet's capacity to absorb future emissions, raising atmospheric CO_2 and contributing to climate change.

62. A — Because hemophilia is X-linked recessive, males (XY) need only one copy of the recessive allele on their single X chromosome to express the disorder. Females (XX) typically need two copies, which is far less likely, so the disorder appears much more often in males.

63. C — Lichens and mosses are the classic pioneer species of primary succession on bare rock because they tolerate harsh conditions and can extract nutrients from rock surfaces. Their activity breaks down rock and adds organic matter, gradually forming soil that allows later successional species to colonize.

64. D — The kidneys filter wastes such as urea from the blood and regulate water and electrolyte balance to maintain homeostasis of body fluids. Red blood cell production occurs primarily in bone marrow, digestive enzymes come from the pancreas and digestive tract, and glycogen is stored mainly in liver and muscle.

65. A — A protein's function depends on its three-dimensional shape, which is determined by its amino acid sequence. Changing even one amino acid can disrupt folding and produce a protein with reduced, altered, or absent function — as seen in sickle-cell disease.

66. B — During cell division, DNA replication ensures that the genetic material is duplicated so that each daughter cell receives a complete and identical set of chromosomes. This faithful distribution preserves genetic continuity in mitotically dividing tissues.

67. C — The products of photosynthesis (glucose and oxygen) are the reactants of cellular respiration, and the products of respiration (carbon dioxide and water) are the reactants of photosynthesis. This complementary cycling supports the continuous flow of energy and matter through ecosystems.

68. D — Gel electrophoresis uses an electric current to drive DNA fragments through a porous gel, separating them by size because smaller fragments migrate faster than larger ones. This is a standard technique in DNA fingerprinting, paternity testing, and genetic disease research.

69. A — Asexual reproduction produces offspring from a single parent through mitosis, so the offspring inherit an identical copy of the parent's genetic material. The lack of genetic variation in asexual reproduction is its principal evolutionary disadvantage in changing environments.

70. B — Sound scientific practice requires reporting data accurately and using the evidence to evaluate and, when appropriate, revise the hypothesis. Modifying data or discarding inconvenient results violates research integrity and prevents the experiment from advancing scientific understanding.

71. D — The systematic differences between fossils in older and younger rock layers show that the kinds of organisms living on Earth have changed gradually over geological time. This pattern of change in the fossil record is one of the strongest lines of evidence supporting evolution.

72. C — The widely accepted definition of sustainability is the use of resources in a way that meets present needs without compromising the ability of future generations to meet their own needs. This concept balances current human use with long-term ecological and societal viability.

73. A — Dialysis tubing has microscopic pores that allow small molecules (water, glucose, iodine) to pass while blocking larger molecules such as starch, behaving like a selectively permeable membrane. This makes it a useful classroom model for studying diffusion across cell membranes.

74. B — A positive Benedict's test (color change to orange-red after heating) indicates the presence of reducing sugars such as glucose. Detecting glucose in the surrounding water shows that glucose molecules diffused through the dialysis tubing, while starch (too large) remained inside.

75. D — In the Beaks of Finches simulation, different tools represent variations in beak shape, and the tools that capture more seeds represent finches better adapted to the food supply. The simulation illustrates how differential reproductive success based on inherited variation — the core mechanism of natural selection — drives evolutionary change.

76. C — Total magnification of a compound microscope is calculated by multiplying the eyepiece (ocular) magnification by the objective lens magnification: $10 \times 40 = 400\times$. This combined magnification determines how large the specimen appears to the observer.

77. A — Standard microscope procedure is to begin with the lowest-power objective (which provides the widest field of view) and the coarse adjustment knob to bring the specimen into rough focus. Using the coarse knob with higher-power objectives can damage the slide or the lens.

78. B — Lowering the coverslip onto the specimen at an angle pushes air ahead of it out of the liquid drop, minimizing the formation of trapped air bubbles. Air bubbles obstruct light and appear as dark circles that obscure the specimen under the microscope.

79. D — Modern taxonomy and evolutionary biology use multiple independent lines of evidence — structural anatomy, biochemistry, and DNA sequences — because consistent findings across different methods produce more reliable and well-supported conclusions about relatedness. Any single line of evidence can be misleading on its own.

80. C — A well-formed scientific hypothesis follows an "if–then–because" structure that identifies the independent variable, predicts the outcome, and provides a reasoned explanation. The version stating that pulse rate will increase with exercise because of greater oxygen demand meets all three criteria.

81. A — Bromothymol blue is a pH indicator that turns from blue to yellow as a solution becomes more acidic. Because dissolved carbon dioxide forms carbonic acid in water, bromothymol blue is routinely used in biology labs to detect CO_2, such as in tests for cellular respiration.

82. B — The open end of a heated test tube must always be pointed away from the experimenter and from other people because the contents can boil violently and spray outward. This is a fundamental laboratory safety rule for any heating procedure.

83. D — Liquids in a graduated cylinder form a curved surface called the meniscus, and the correct reading is taken at the bottom of the meniscus with the eye level with the liquid surface. Reading from above or below introduces parallax error.

84. C — A dichotomous key consists of a series of paired, contrasting statements that progressively narrow down the identity of an unknown organism. At each step, the user selects the statement that best matches the specimen, eventually arriving at a species identification.

85. C — Repeating an experiment multiple times tests whether the results are consistent and reproducible, which strengthens the validity of any conclusions drawn from the data. A single trial cannot distinguish a real effect from random variation, so replication is essential to sound experimental design.