PRACTICE EXAM 8: 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 internal framework of protein fibers that gives a cell its shape and helps organize its contents is called the

A. cell wall surrounding plant cells

B. cytoskeleton inside the cell's cytoplasm

C. nuclear envelope around the DNA

D. plasma membrane forming the boundary

2. The cellular organelle that contains digestive enzymes used to break down worn-out cell parts and engulfed materials is the

A. ribosome assembling protein chains

B. mitochondrion releasing energy from food

C. centriole helping with cell division

D. lysosome digesting cellular debris

3. The movement of substances across a cell membrane from low concentration to high concentration requires

A. simple diffusion down a gradient

B. osmosis through aquaporin channels

C. active transport using energy from ATP

D. facilitated diffusion through channel proteins

4. Lipids serve many roles in living organisms, including

A. storing energy and forming cell membrane bilayers

B. carrying genetic information in chromosomes

C. catalyzing biochemical reactions inside cells

D. building rigid cell walls in plant tissues

5. Most enzymes that catalyze reactions in living cells are composed of

A. lipids arranged in a bilayer structure

B. nucleic acids carrying genetic instructions

C. carbohydrates linked into long chains

D. proteins folded into specific shapes

6. Water molecules stick to each other through hydrogen bonds, a property called cohesion. This property helps plants by

A. providing energy directly to leaf cells

B. allowing water to be pulled upward through xylem

C. dissolving the chlorophyll inside chloroplasts

D. lowering the freezing point of cell contents

7. In a DNA molecule, the nitrogen base guanine always pairs with

A. cytosine through three hydrogen bonds

B. adenine through two hydrogen bonds

C. thymine through two hydrogen bonds

D. uracil through two hydrogen bonds

8. During DNA replication, the enzyme that unwinds the double helix by breaking hydrogen bonds between the two strands is

A. RNA polymerase that builds mRNA

B. DNA polymerase that adds nucleotides

C. helicase that separates the two strands

D. ligase that joins DNA fragments together

9. In a eukaryotic cell, the assembly of amino acids into a polypeptide chain occurs at the

A. nucleus where DNA is stored

B. mitochondrion that produces most ATP

C. chloroplast that captures light energy

D. ribosome where translation takes place

10. During protein synthesis, the molecule that brings specific amino acids to the ribosome is

A. messenger RNA carrying the genetic code

B. transfer RNA carrying individual amino acids

C. ribosomal RNA forming the ribosome's structure

D. DNA serving as the original template

11. A mutation that adds or removes a single base from a gene's coding sequence, shifting how the entire downstream sequence is read, is called

A. a frameshift mutation affecting all later codons

B. a silent mutation with no protein change

C. a point mutation changing only one amino acid

D. a chromosomal mutation affecting many genes at once

12. In humans, a person who inherits an X chromosome from the mother and a Y chromosome from the father will develop as

A. a female with XX sex chromosomes

B. an individual with no sex chromosomes

C. a male with XY sex chromosomes

D. an individual with three sex chromosomes

13. Hemophilia is a sex-linked recessive disorder in which blood does not clot normally. A female with one normal allele and one hemophilia allele on her X chromosomes

A. will always develop hemophilia herself

B. cannot pass hemophilia to any of her children

C. is unable to have children of her own

D. is a carrier but does not show the disorder

14. For thousands of years, dog breeders have produced different dog breeds by selecting which dogs are allowed to reproduce. This is an example of

A. artificial selection by humans choosing the parents

B. natural selection by the environment of the dogs

C. genetic engineering by inserting foreign genes

D. cloning of identical genetic copies of dogs

15. Charles Darwin's theory of evolution by natural selection differs from earlier ideas because Darwin proposed that

A. organisms develop new traits during their lifetimes and pass them on

B. inherited variation and differential survival drive evolutionary change in populations

C. species are unchanging and remain the same across all generations

D. all life on Earth was created in its present form very recently

16. A severe storm reduces a population of beetles from 5,000 individuals to only 20 surviving individuals. The surviving 20 happen to have very different allele frequencies from the original population. This is an example of

A. natural selection favoring the fittest beetles

B. coevolution between beetles and their predators

C. directional selection toward one extreme trait

D. the bottleneck effect changing allele frequencies

17. The forelimbs of cats, whales, and bats all contain the same set of bones in similar arrangements, despite having very different functions. These structures are best described as

A. analogous structures developed independently

B. vestigial structures no longer functional

C. homologous structures inherited from a common ancestor

D. acquired structures formed during the animal's lifetime

18. When two species compete for the exact same resources in the same habitat, one species typically eliminates or displaces the other. This principle is known as

A. competitive exclusion of one of the species

B. resource partitioning between the two species

C. mutualism benefiting both species at once

D. coevolution between the competing species

19. All of the resources a species uses, the conditions it can tolerate, and its role in the ecosystem together describe its

A. habitat where the species lives

B. niche occupied by the species

C. community of interacting species

D. population of the same species

20. In an energy pyramid, the level containing the smallest total amount of available energy is occupied by

A. producers at the base of the pyramid

B. primary consumers eating producers

C. tertiary consumers at the top of the pyramid

D. decomposers recycling dead material

21. The release of carbon dioxide into the atmosphere during the burning of fossil fuels is called

A. nitrogen fixation by bacteria in roots

B. photosynthesis by green plants in sunlight

C. transpiration through stomata on leaves

D. combustion of buried organic carbon

22. A species that is found only in one specific geographic region and nowhere else in the world is described as

A. an extinct species with no living members

B. an endemic species native to that region only

C. an invasive species introduced from elsewhere

D. a cosmopolitan species found worldwide

23. An ecosystem with greater biodiversity tends to be more stable over time because

A. multiple species can take over when others are lost

B. all species in the ecosystem look exactly alike

C. each species occupies the same niche as the others

D. predator populations grow without any natural limits

24. When a single ancestral species rapidly evolves into many new species, each adapted to a different ecological niche, the process is called

A. mass extinction of many unrelated species

B. competitive exclusion of the original species

C. adaptive radiation into many diverse niches

D. genetic drift in a small isolated population

25. Gas exchange between the blood and body tissues occurs in

A. arteries with thick muscular walls

B. veins carrying blood toward the heart

C. atria of the heart's upper chambers

D. capillaries with thin permeable walls

26. In a typical neuron, the long extension that carries electrical signals away from the cell body toward other neurons or muscles is called

A. an axon transmitting the signal outward

B. a dendrite receiving incoming signals

C. a synapse connecting two adjacent neurons

D. a myelin sheath insulating the neuron

27. Light entering the eye is converted into nerve signals by specialized cells located in the

A. cornea at the front of the eye

B. retina at the back of the eyeball

C. iris that controls the pupil size

D. lens that focuses the light entering

28. The pituitary gland is often called the "master gland" of the endocrine system because it

A. produces all of the body's red blood cells

B. controls heart rate and blood pressure directly

C. filters waste products out of the bloodstream

D. secretes hormones that regulate other endocrine glands

29. The pancreas helps regulate blood glucose levels by releasing two hormones — insulin and glucagon — that are produced in clusters of cells called the

A. nephrons inside the kidneys

B. alveoli inside the lungs

C. islets of Langerhans in the pancreas

D. villi inside the small intestine

30. When tissue is damaged by injury or infection, the area often becomes red, swollen, warm, and painful. This response is called

A. inflammation, a non-specific immune response

B. anaphylaxis, a severe allergic reaction

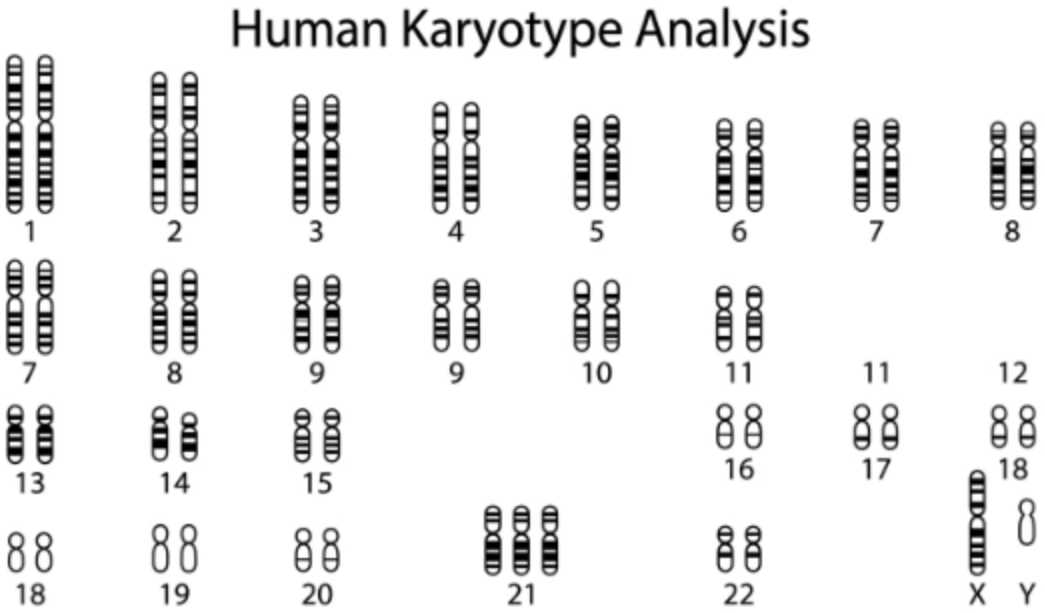
C. autoimmunity, an attack on self tissue

D. immunosuppression, a weakened immune state

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 the karyotype of a human cell.



Based on the karyotype shown, the cell came from a person with

A. Turner syndrome with only one X chromosome

B. Down syndrome with three copies of chromosome 21

C. Klinefelter syndrome with three sex chromosomes

D. a normal chromosome count of 46 total chromosomes

32. Referring to the same karyotype, the total number of chromosomes in this cell is

A. 44 chromosomes

B. 45 chromosomes

C. 47 chromosomes

D. 48 chromosomes

33. Referring to the same karyotype, the condition shown is most commonly caused by

A. a point mutation in a single gene

B. exposure to high levels of radiation

C. an infection by a virus during pregnancy

D. nondisjunction during the formation of a gamete

34. Referring to the same karyotype, the person has the sex chromosome arrangement

A. XY, indicating a biological male

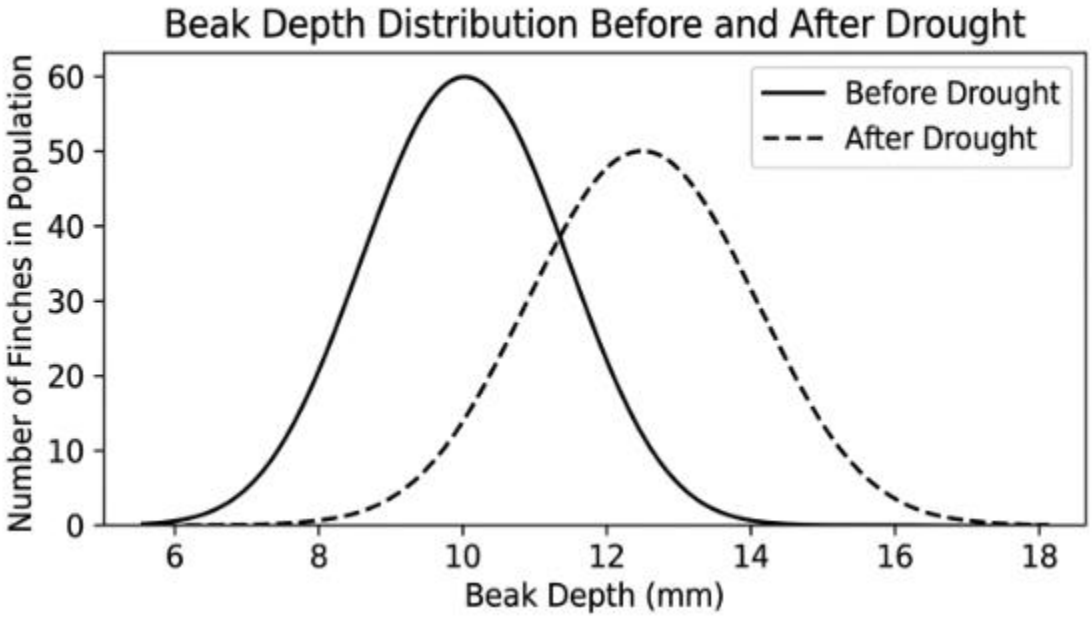
B. XX, indicating a biological female

C. XO, with only one X chromosome

D. YY, with two Y chromosomes

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

35. A student examines a graph showing the distribution of beak depths in a finch population before and after a long drought.



Based on the graph, the type of natural selection acting on this finch population is best described as

A. stabilizing selection favoring the average beak depth

B. directional selection favoring one extreme of beak depth

C. disruptive selection favoring both extremes simultaneously

D. random genetic drift independent of beak depth

36. Based on the same graph, the most likely reason for the change in beak depth distribution is that

A. larger beaks make finches less visible to their predators

B. smaller beaks help finches escape from predator attacks

C. larger beaks crack open the tough seeds remaining after drought

D. beak depth has no effect on the survival of these finches

37. Based on the same graph, if the drought conditions continue for many more generations, the most likely long-term consequence is that

A. the average beak depth of the population will continue to increase

B. the average beak depth will return to its original pre-drought value

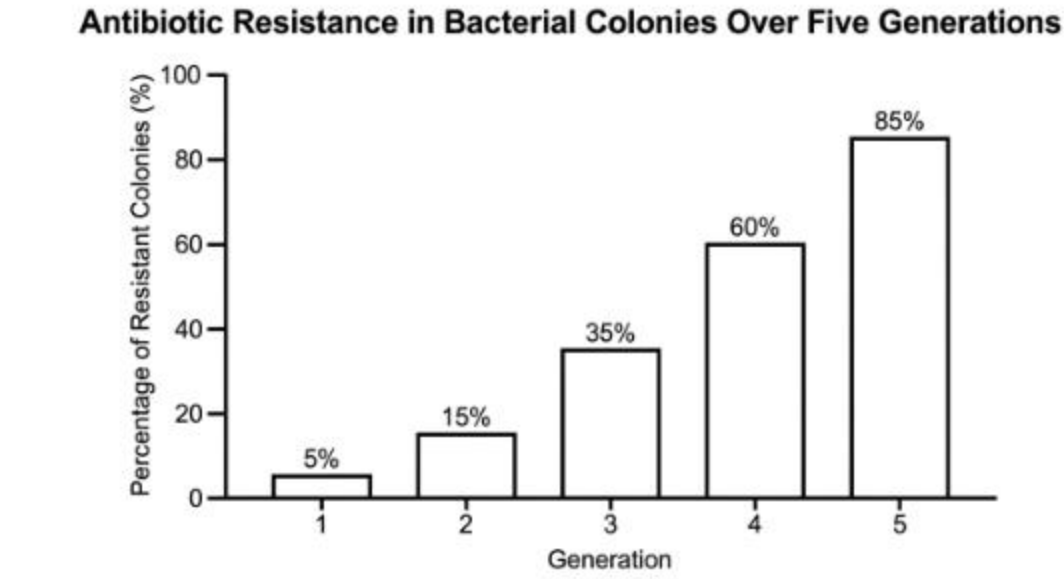
C. the finch population will become entirely identical in beak depth

D. the finch population will rapidly evolve into a completely different species

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

38. A student examines a bar graph showing the percentage of bacterial colonies resistant to a particular antibiotic over five generations of exposure.

[Figure PQ-3]



Based on the bar graph, the trend over time shows that

A. the percentage of resistant bacteria steadily decreases

B. the percentage of resistant bacteria steadily increases

C. the percentage of resistant bacteria remains the same

D. the bacteria stop reproducing after a few generations

39. Based on the same graph, the trend is best explained by

A. bacteria intentionally choosing to become resistant

B. antibiotics causing every bacterium to mutate at once

C. resistance being introduced from a different species

D. natural selection favoring bacteria with resistance alleles

40. Based on the same graph, a real-world consequence of this trend is that

A. antibiotics will become permanently effective against all infections

B. bacteria will completely disappear from human bodies

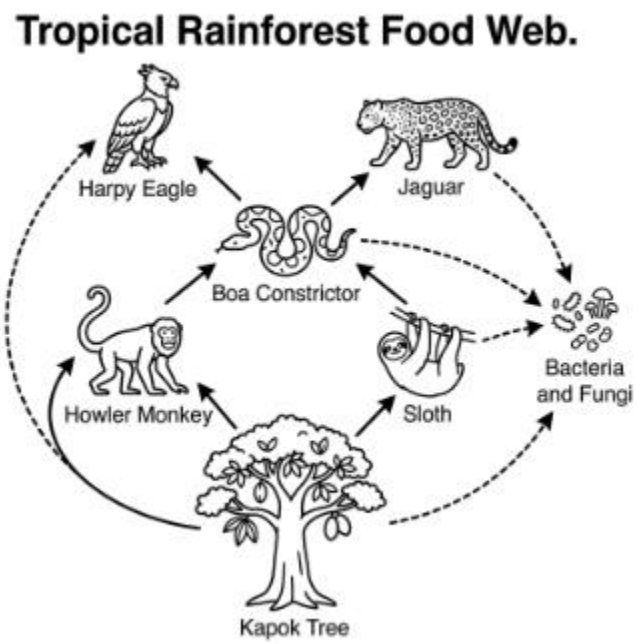
C. some antibiotics will become less effective at treating infections

D. all viral infections will become much more difficult to treat

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

41. A student examines a food web for a tropical rainforest ecosystem.

Figure PQ-4



Based on the rainforest food web shown, the only producer at the base of the web is

A. the kapok tree that produces food by photosynthesis

B. the howler monkey that eats fruits and leaves

C. the harpy eagle that hunts other animals

D. the jaguar that preys on other rainforest animals

42. Based on the same food web, if 10,000 units of energy are stored in the kapok tree, approximately how much energy reaches the harpy eagle (a tertiary consumer)?

A. 10,000 units of energy reach the eagle

B. 1,000 units of energy reach the eagle

C. 10 units of energy reach the eagle

D. 0 units of energy reach the eagle

43. Based on the same food web, if a disease eliminated all the jaguars from the ecosystem, the most likely short-term effect would be

A. an immediate decrease in the kapok tree population

B. a sudden increase in the harpy eagle population

C. a complete collapse of all trophic levels at once

D. an increase in the populations of the jaguar's prey

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

Answer all questions in this part.

44. A student tests whether music affects plant growth by playing music for some plants and not for others. To make this a valid controlled experiment, the student must

A. use plants of many different species in each group

B. keep all other conditions the same except for music

C. play different types of music to each plant

D. measure plant growth only at the end of the experiment

45. To measure the mass of a small leaf accurately, a student should use

A. an electronic balance that reads to the nearest tenth of a gram

B. a graduated cylinder marked in milliliters of liquid

C. a meter stick marked in centimeters of length

D. a thermometer measuring degrees Celsius

46. A student wants to compare the average mass of fish in five different lakes. The most appropriate type of graph for this data is

A. a circle (pie) graph showing parts of a whole

B. a line graph showing change over time

C. a scatter plot showing two related variables

D. a bar graph comparing values across categories

47. After fertilization, the single fertilized egg cell divides many times to form a hollow ball of cells called a

A. zygote at the very beginning of development

B. fetus in the later stages of pregnancy

C. blastocyst that implants in the uterine wall

D. gamete produced by meiosis in the gonads

48. Cells that have the potential to develop into many different types of specialized cells in the body are called

A. stem cells found in embryos and some adult tissues

B. red blood cells that carry oxygen throughout the body

C. nerve cells that transmit electrical signals only

D. skin cells that form a protective outer barrier

49. A person with blood type AB has red blood cells that display

A. only the A antigen on the cell surface

B. both the A and B antigens on the cell surface

C. only the B antigen on the cell surface

D. neither the A nor the B antigen on the cell surface

50. A woman who is Rh-negative is pregnant with a child who is Rh-positive. During pregnancy, complications can arise because

A. the woman's blood and the fetus's blood always mix completely

B. Rh-positive blood is always rejected by the developing fetus

C. the fetus produces antibodies that attack the mother's blood

D. the woman's immune system may produce antibodies against fetal blood

51. DNA fingerprinting can be used to identify individuals because

A. every person has the same DNA sequence in their cells

B. every person has a unique combination of DNA sequences

C. DNA changes randomly throughout a person's lifetime

D. DNA can be analyzed only from blood and saliva samples

52. In genetic engineering, restriction enzymes are used to

A. cut DNA at specific base sequences

B. join cut DNA fragments together permanently

C. translate DNA directly into proteins

D. amplify DNA samples for analysis

53. In a population, mutations provide the raw material for natural selection by

A. directly improving an organism during its lifetime

B. always producing beneficial changes in the DNA

C. introducing genetic variation that selection can act upon

D. preventing any changes from occurring in the species

54. The theory of punctuated equilibrium proposes that evolution occurs

A. at a steady, constant rate over millions of years

B. only in response to direct human intervention

C. through the inheritance of acquired characteristics

D. in rapid bursts followed by long stable periods

55. The biome with the greatest biodiversity on Earth is the

A. tropical rainforest near the equator

B. arctic tundra at the polar regions

C. desert with very low precipitation

D. open ocean at deep water levels

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

Answer all questions in this part.

56. When a person stands up suddenly, blood pressure tends to drop briefly. The body responds by increasing the heart rate and constricting blood vessels. This response is best described as

A. positive feedback amplifying the pressure drop

B. negative feedback restoring normal blood pressure

C. an acquired behavior learned through experience

D. a permanent adaptation to standing positions

57. In each kidney, the microscopic functional units that actually filter the blood are called

A. alveoli in the lungs

B. villi in the small intestine

C. capillaries surrounding all tissues

D. nephrons within each kidney

58. Within a nephron, the cluster of capillaries where blood is initially filtered under high pressure is called the

A. ureter carrying urine to the bladder

B. loop of Henle reabsorbing water

C. glomerulus where filtration begins

D. collecting duct carrying urine away

59. The alveoli of the lungs are specialized for efficient gas exchange because they have

A. thin walls and a large total surface area

B. thick muscular walls that pump air actively

C. a small total surface area for slow exchange

D. a covering of cilia that move particles outward

60. When a doctor taps the tendon just below a person's kneecap, the lower leg jerks forward without conscious thought. This is an example of

A. a voluntary movement controlled by the brain

B. a reflex action controlled by the spinal cord

C. a learned response from childhood training

D. a hormonal response from the endocrine system

61. The outermost layer of the skin, which serves as the body's main physical barrier against pathogens, is the

A. dermis containing blood vessels and nerves

B. hypodermis containing fat for insulation

C. muscle layer below the skin tissues

D. epidermis at the skin's outer surface

62. The hormone that triggers ovulation — the release of an egg from the ovary — is

A. luteinizing hormone (LH) from the pituitary gland

B. insulin from the pancreas after eating

C. adrenaline from the adrenal glands in stress

D. thyroxine from the thyroid gland in the neck

63. In humans, the egg cell can typically be fertilized by sperm for approximately

A. one minute after the egg is released from the ovary

B. one full month after release from the ovary

C. 24 hours after the egg is released from the ovary

D. one full year after release from the ovary

64. In humans, normal body cells contain 46 chromosomes. After meiosis, each gamete (sperm or egg) contains

A. 46 chromosomes from the parent cell

B. 23 chromosomes, half the parent number

C. 92 chromosomes, twice the parent number

D. 12 chromosomes, one-quarter the parent number

65. At fertilization, when a sperm cell joins with an egg cell, the resulting zygote contains

A. 46 chromosomes, restoring the diploid number

B. 23 chromosomes, remaining a haploid cell

C. 92 chromosomes, doubling the diploid number

D. 12 chromosomes, far below the diploid number

66. The correct order of human development from fertilization is

A. fetus, embryo, zygote, blastocyst

B. embryo, fetus, zygote, blastocyst

C. blastocyst, embryo, zygote, fetus

D. zygote, blastocyst, embryo, fetus

67. Two genes located very close together on the same chromosome tend to

A. be inherited independently of each other

B. be inherited together as linked genes

C. separate from each other during meiosis

D. always produce identical phenotypes in offspring

68. In four-o'clock flowers, crossing a red-flowered plant (RR) with a white-flowered plant (WW) produces all pink-flowered offspring (RW). This pattern best illustrates

A. complete dominance of red over white

B. codominance with both colors visible separately

C. incomplete dominance with a blended phenotype

D. sex-linked inheritance limited to one parent

69. Huntington's disease is caused by an autosomal dominant allele. A person with one copy of the Huntington's allele and one normal allele

A. will eventually develop Huntington's disease in life

B. will not develop the disease but be a carrier

C. cannot pass the allele on to any children

D. only develops the disease if both parents had it

70. A logistic growth curve shows a population that initially grows rapidly but then levels off as it approaches

A. its biotic potential under perfect conditions

B. zero individuals as the population dies out

C. an exponential increase without any limit

D. the carrying capacity of its environment

71. When an invasive species is introduced to a new ecosystem, native biodiversity often decreases because the invasive species

A. helps the native species reproduce more successfully

B. only competes with other invasive species nearby

C. competes with or preys on natives without natural controls

D. immediately goes extinct in its new environment

72. The mass extinction at the end of the Cretaceous period, approximately 66 million years ago, is widely believed to have been triggered by

A. a slow change in Earth's orbit around the Sun

B. an asteroid impact and resulting environmental changes

C. the rise of mammals competing with dinosaurs

D. a global ice age that lasted for millions of years

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

Answer all questions in this part.

73. In the Beaks of Finches laboratory, students record the number of seeds collected by each "beak" tool in 15 seconds. The most appropriate variable to use as the dependent variable is

A. the number of seeds collected by each beak tool

B. the type of beak tool given to each student

C. the type of seed used in the feeding round

D. the length of time given for each feeding round

74. In the Making Connections laboratory, students typically use a clothespin to squeeze repeatedly while measuring

A. the temperature of the muscle being used

B. the volume of air breathed in and out

C. the amount of light absorbed by the muscle

D. the number of squeezes and the pulse rate

75. In the Diffusion Through a Membrane laboratory, students test for the presence of glucose using Benedict's solution. A positive test for glucose is indicated by a color change from

A. clear to dark blue when no heat is needed

B. red to clear when heated for several minutes

C. blue to orange or red when heated for several minutes

D. yellow to green when no heat is required

76. In the Relationships and Biodiversity laboratory, students compare a hypothetical valuable species (Botana curus) to three related species. The species most likely to produce the same valuable chemical as Botana curus is the one that

A. shows the most similar DNA, protein, and pigment results

B. has the largest leaves and longest stems of all

C. lives in a completely different climate region

D. has been most recently discovered by scientists

77. When preparing a wet-mount slide of an Elodea leaf, the student should first

A. apply Benedict's solution to the leaf surface

B. place the leaf in a drop of water on the slide

C. heat the leaf gently with a Bunsen burner

D. cover the leaf with iodine solution to stain it

78. Many cells appear nearly transparent under a microscope. To make the cell structures more visible, students often apply

A. distilled water to the slide before observation

B. Bunsen burner heat to expose the cells

C. mineral oil to lubricate the slide surface

D. methylene blue or iodine stain to color the cells

79. On a line graph, a single data point at the position (25, 80) means that

A. 25 is the only value that matters in the data

B. 80 is divided by 25 to give the result

C. when the x-value is 25, the y-value is 80

D. the slope of the line equals 80 over 25

80. A student measures the length of an earthworm and reports it as "8.5 cm." This measurement was most likely taken with

A. a meter stick marked only in whole meters

B. a ruler marked in millimeters and centimeters

C. an electronic balance measuring in grams

D. a thermometer measuring in degrees Celsius

81. In a laboratory activity, a student burns a small food sample beneath a tube of water and measures the temperature change. This procedure is designed to estimate the

A. energy content of the food sample

B. mass of the food sample being burned

C. number of calories absorbed by the student

D. pH of the water being heated up

82. In an experiment investigating how exercise affects pulse rate, the room temperature, time of day, and the age of the subjects are all kept constant. These factors are best described as

A. independent variables being manipulated

B. dependent variables being measured

C. controlled variables held constant in all trials

D. control groups used for comparison purposes

83. After completing an experiment, a student should draw conclusions that are

A. always supportive of the original hypothesis stated

B. based on what the student personally hoped to find

C. designed to make the lab partner's data look better

D. based directly on the data actually collected

84. To test whether an unknown solution is an acid or a base, a student dips a strip of pH indicator paper into the solution. This test will reveal the solution's

A. exact molecular composition by element

B. acidity or basicity on the pH scale

C. concentration in moles per liter only

D. temperature in degrees Celsius

85. When measuring small, precise volumes of liquid in the laboratory, the most appropriate piece of equipment is

A. a beaker with general volume markings only

B. a flask with no precise volume markings

C. a graduated pipette with precise markings

D. an Erlenmeyer flask for mixing solutions

Practice Exam 8 — Answer Key and Explanations

1. B — The cytoskeleton is a network of protein filaments (microtubules, microfilaments, intermediate filaments) that gives cells shape, anchors organelles, and enables movement. It functions like a cellular skeleton, distinct from the rigid external cell wall or the boundary plasma membrane.

2. D — Lysosomes contain hydrolytic enzymes that digest worn-out organelles, damaged proteins, and material brought in by endocytosis. They function as the cell's recycling and waste-disposal system, breaking complex molecules into reusable building blocks.

3. C — Active transport moves substances against their concentration gradient (low to high), which requires energy supplied by ATP and specialized membrane proteins called pumps. The sodium-potassium pump is the most familiar example, keeping nerve and muscle cells electrically excitable.

4. A — Lipids include fats and oils that store energy long-term, and phospholipids that form the bilayer of every cell membrane. This dual role makes lipids both the body's main energy reserve and the structural basis of all cellular boundaries.

5. D — The vast majority of enzymes are proteins whose specific three-dimensional shape creates an active site complementary to their substrate. This shape-based specificity is why denaturing conditions such as extreme heat or pH destroy enzyme function.

6. B — Cohesion among water molecules creates a continuous water column inside the xylem, allowing transpiration at the leaves to pull water upward from the roots. This explains how water reaches the tops of trees over 100 meters tall without any pumping mechanism.

7. A — Guanine pairs with cytosine through three hydrogen bonds in DNA, while adenine pairs with thymine through two hydrogen bonds. This complementary base pairing is the rule that makes DNA replication possible and explains why G–C-rich DNA regions are more stable.

8. C — Helicase unwinds the DNA double helix by breaking the hydrogen bonds holding complementary bases together, creating a replication fork where the two strands are exposed for copying. DNA polymerase then synthesizes new strands using each exposed strand as a template.

9. D — Translation — the assembly of amino acids into a polypeptide chain — takes place at the ribosome, where mRNA is read codon by codon and tRNAs deliver matching amino acids. Ribosomes may be free in the cytoplasm or attached to the rough endoplasmic reticulum.

10. B — Transfer RNA (tRNA) molecules each carry one specific amino acid at one end and an anticodon at the other end that pairs with the matching mRNA codon. This anticodon–codon pairing ensures the correct amino acid is added to the growing polypeptide chain.

11. A — A frameshift mutation occurs when an insertion or deletion of one or more bases (not a multiple of three) shifts the reading frame of every codon downstream. The result is typically a completely different and usually nonfunctional protein from that point onward.

12. C — Sex in humans is determined by the sex chromosomes inherited at fertilization: XX produces a female, XY produces a male. Receiving X from the mother and Y from the father gives the XY combination that drives male development through the SRY gene on the Y chromosome.

13. D — Carriers of X-linked recessive disorders have one normal X allele and one recessive disease allele. The dominant normal allele masks the recessive one, so the carrier is unaffected, but she can pass the recessive allele to half of her children — affecting any sons who inherit it.

14. A — Artificial selection occurs when humans choose which individuals reproduce based on desired traits, producing breeds with specific characteristics over many generations. Dog breeds, crop varieties, and livestock all originated through this human-directed form of selection.

15. B — Darwin's central insight was that natural variation among individuals, combined with differential survival and reproduction in a given environment, drives evolutionary change in populations over generations. This mechanism replaced earlier ideas of inherited acquired traits, fixed species, or special creation.

16. D — A bottleneck event occurs when a population is drastically reduced by a non-selective event (storm, flood, fire), leaving survivors whose allele frequencies may differ greatly from the original population. The resulting reduced genetic diversity often leaves bottlenecked populations vulnerable to future challenges.

17. C — Homologous structures share underlying anatomical organization because they were inherited from a common ancestor, even when their functions have diverged. The shared limb-bone arrangement in cats, whales, and bats is classic evidence of descent with modification.

18. A — Competitive exclusion (Gause's principle) states that two species occupying the exact same niche cannot coexist indefinitely — the more efficient competitor will eliminate the other. Real coexistence requires resource partitioning or other niche differences.

19. B — A niche is the complete role of a species in its ecosystem, including all resources used, all conditions tolerated, and all interactions with other species. Habitat refers only to where a species lives, while niche describes how it lives.

20. C — Only about 10% of energy passes from one trophic level to the next, so each level holds far less energy than the one below it. Tertiary consumers at the top of the pyramid therefore contain the smallest total amount of available energy.

21. D — Combustion is the rapid oxidation of carbon-containing fuels, releasing CO_2 that was sequestered in coal, oil, or natural gas. Burning fossil fuels returns this ancient carbon to the atmosphere, which is the primary driver of recent increases in atmospheric CO_2.

22. B — An endemic species is one whose entire global range is restricted to a single, often small, geographic area. Endemic species are especially vulnerable to extinction because habitat loss in that one region can wipe out the species entirely.

23. A — Greater biodiversity means more species are available to fill ecological roles, providing functional redundancy. If one species is lost, others can often take over its role, allowing the ecosystem to continue functioning and recover from disturbance.

24. C — Adaptive radiation is the rapid evolutionary diversification of one ancestral species into many descendant species, each adapted to a different niche. Darwin's Galapagos finches and the cichlid fishes of African lakes are classic examples of this evolutionary pattern.

25. D — Capillaries have walls only one cell thick, allowing gases, nutrients, and wastes to diffuse easily between blood and surrounding tissues. Their enormous combined surface area and short diffusion distance make them the actual site of exchange in the circulatory system.

26. A — The axon is the long fiber that carries action potentials away from the neuron's cell body toward synapses at its tip. Dendrites do the opposite — receiving incoming signals — and the myelin sheath wraps the axon to speed transmission.

27. B — The retina lines the back of the eye and contains photoreceptor cells (rods and cones) that convert light into nerve impulses. The cornea, iris, and lens focus and regulate light but do not perform the actual conversion to signals.

28. D — The pituitary gland secretes a range of hormones that control the thyroid, adrenals, gonads, and other endocrine glands. Because it directs so many other hormone systems, it earned the name "master gland," though it is itself directed by the hypothalamus.

29. C — The islets of Langerhans are clusters of endocrine cells scattered throughout the pancreas; their alpha cells produce glucagon and beta cells produce insulin. Together these two hormones work in opposition to keep blood glucose within homeostatic limits.

30. A — Inflammation is a non-specific (innate) immune response triggered by tissue damage or infection, producing redness, swelling, warmth, and pain through increased blood flow and immune cell activity. It is the body's general first-line response, separate from the specific antibody-based adaptive response.

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

31. B — The karyotype shows three copies of chromosome 21 instead of two, which is the defining feature of Down syndrome (trisomy 21). This is the most common viable chromosomal trisomy in humans, occurring in approximately 1 in 700 births.

32. C — A normal human karyotype contains 46 chromosomes; an extra copy of chromosome 21 brings the total to 47. The extra chromosome means a person with Down syndrome has 47 chromosomes in every cell.

33. D — Nondisjunction is the failure of chromosomes (or chromatids) to separate properly during meiosis, producing a gamete with an extra or missing chromosome. When such a gamete is fertilized, the resulting zygote has a trisomy or monosomy — the cause of most chromosomal disorders, including Down syndrome.

34. A — The karyotype shows one X chromosome and one Y chromosome, the XY arrangement that produces male development through the SRY gene on the Y chromosome. The trisomy at chromosome 21 does not affect sex determination, which is controlled by the sex chromosome pair.

35. B — The post-drought curve has shifted to the right (toward larger beak depths), with the population's average moving toward one extreme rather than staying near the mean or splitting toward both extremes. This rightward shift is the signature of directional selection.

36. C — During drought, soft seeds become scarce while tough, hard-shelled seeds remain available. Finches with larger, deeper beaks can crack these tough seeds and survive to reproduce, while small-beaked finches starve — selectively shifting the population toward larger beaks.

37. A — As long as drought conditions persist, the same selective pressure continues to favor larger beaks each generation. The population's mean beak depth will therefore continue to shift to the right until either conditions change or genetic variation runs out.

38. B — The bars rise steadily from 5% in Generation 1 to 85% in Generation 5, showing a clear and consistent increase in the percentage of resistant colonies. This pattern is the visual signature of selection acting strongly on resistance over successive generations.

39. D — Random mutations occasionally produce bacteria with resistance alleles. The antibiotic kills susceptible bacteria but spares the resistant ones, which then reproduce — increasing the resistance allele frequency in each generation through natural selection.

40. C — When resistant strains dominate bacterial populations, antibiotics that previously cleared infections become ineffective, leading to treatment failures. This is why antibiotic resistance is one of the most serious global public health threats today.

41. A — Producers are autotrophs that capture energy directly from sunlight through photosynthesis, forming the base of every food web. The kapok tree is the only photosynthesizing organism shown in this rainforest food web.

42. C — Only about 10% of energy passes between trophic levels. Tracing 10,000 → 1,000 → 100 → 10 units across producer → primary → secondary → tertiary consumer levels gives 10 units of energy reaching the harpy eagle.

43. D — Removing the jaguar (a top predator) eliminates a major source of mortality for its prey. The populations of monkeys, sloths, and boa constrictors that the jaguar normally hunts would therefore increase in the short term.

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

44. B — A valid controlled experiment isolates the variable being tested by keeping all other conditions identical between experimental and control groups. Only music (the independent variable) should differ; everything else — light, water, temperature, plant variety — must be the same.

45. A — An electronic balance is designed to measure mass precisely and is sensitive enough for small samples like a leaf. The other instruments measure volume, length, or temperature — none of which are mass.

46. D — Bar graphs are designed for comparing values across discrete categories, exactly matching the situation of comparing five separate lakes. Line graphs are for continuous trends, pie charts for parts of a whole, and scatter plots for relationships between two variables.

47. C — After about a week of cell division, the dividing zygote develops into the blastocyst — a hollow ball of cells with an inner cell mass — which then implants in the uterine lining. This implantation establishes the pregnancy and begins formation of the placenta.

48. A — Stem cells are unspecialized cells that retain the capacity to divide and differentiate into many specialized cell types. Embryonic stem cells are pluripotent (able to become any cell type), while adult stem cells are more limited but still serve in tissue repair and renewal.

49. B — Blood type AB results from codominant expression of both the A and B alleles, so red blood cells display both A and B antigens simultaneously on their surface. Because such individuals produce neither anti-A nor anti-B antibodies, AB is the universal recipient blood type.

50. D — An Rh-negative woman exposed to Rh-positive fetal blood (usually during delivery or trauma) produces anti-Rh antibodies. In a subsequent Rh-positive pregnancy, these maternal antibodies can cross the placenta and attack fetal red blood cells, causing hemolytic disease of the newborn.

51. B — Except for identical twins, every individual has a unique combination of DNA sequences at variable regions of the genome. DNA fingerprinting compares these regions to produce identification with extremely high accuracy, making it valuable for forensic investigation and paternity testing.

52. A — Restriction enzymes recognize specific short DNA sequences and cut the double helix at those exact sites. This precise cutting ability allows scientists to isolate genes and combine DNA from different sources, forming the foundation of recombinant DNA technology.

53. C — Natural selection requires existing variation to act on; mutations are the ultimate source of new genetic variation in populations. Without mutations, selection would have no novel material to favor or eliminate, and evolution would eventually grind to a halt.

54. D — Punctuated equilibrium, proposed by Eldredge and Gould, holds that most species remain stable for long periods and then undergo rapid evolutionary change during shorter intervals — often during speciation events. This contrasts with the gradualist view of slow, steady change.

55. A — Tropical rainforests near the equator combine warm temperatures, high rainfall, and year-round growing conditions that support more species than any other terrestrial biome. Although they cover only about 6% of Earth's land surface, they harbor more than half of all known terrestrial species.

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

56. B — Heart rate increase and vasoconstriction oppose the initial drop in blood pressure, restoring it to normal — the hallmark pattern of negative feedback. The baroreceptor reflex in the carotid arteries and aorta drives this rapid homeostatic correction.

57. D — Each kidney contains approximately one million nephrons — the microscopic units that filter blood, reabsorb useful substances, and form urine. The total filtering surface they provide is what allows the kidneys to process the entire blood supply many times per day.

58. C — The glomerulus is a tangled cluster of capillaries inside the Bowman's capsule of each nephron, where high blood pressure forces fluid out of the blood and into the nephron tubule. This first step — filtration — creates the filtrate that will eventually become urine.

59. A — The alveoli have extremely thin walls (one cell thick) for short diffusion distances and an enormous combined surface area (roughly the size of a tennis court). Together these features maximize the rate at which oxygen and carbon dioxide can exchange across the lung membrane.

60. B — The knee-jerk (patellar) reflex is a classic monosynaptic reflex arc that travels through the spinal cord without involving the brain. This rapid response — happening before conscious awareness — is the defining feature of a reflex.

61. D — The epidermis is the outermost layer of skin, composed of stratified epithelial cells that are continuously replaced. Its keratinized surface provides the physical barrier that blocks pathogens, prevents water loss, and protects against mechanical damage.

62. A — A surge of luteinizing hormone (LH) from the anterior pituitary triggers ovulation about midway through the menstrual cycle. Detection of this LH surge is how at-home ovulation predictor tests work.

63. C — After ovulation, the unfertilized egg remains viable for only about 12 to 24 hours before degenerating. This narrow window is the reason fertility tracking focuses on the day before and the day of ovulation.

64. B — Meiosis cuts the chromosome number in half, so each human gamete contains 23 chromosomes — one member of each homologous pair. This haploid state is essential so that fertilization restores the normal diploid count of 46.

65. A — Fertilization combines the 23 chromosomes from the sperm with the 23 chromosomes from the egg, restoring the diploid number of 46 chromosomes in the zygote. This restored diploid state is then maintained through every subsequent mitotic cell division.

66. D — The correct developmental sequence is: zygote (fertilized egg) → blastocyst (hollow ball that implants) → embryo (weeks 2–8, organs forming) → fetus (week 9 onward, organs maturing). Each stage represents a distinct phase of prenatal development.

67. B — Genes located close together on the same chromosome rarely separate during crossing over and are therefore inherited together as a linked group. This linkage explains why some traits appear to be co-inherited even though their genes are physically distinct.

68. C — Incomplete dominance produces a heterozygous phenotype that is a blend of the two homozygous phenotypes — red plus white giving pink in this case. Unlike codominance (which shows both phenotypes separately), incomplete dominance produces a single intermediate phenotype.

69. A — Huntington's disease is autosomal dominant, so a single copy of the disease allele is sufficient to produce the disorder later in life. Onset typically occurs in middle adulthood, after most affected individuals have already had children — which is why the allele persists despite being fatal.

70. D — A logistic growth curve is S-shaped: it begins with exponential growth but levels off as resource limitations slow reproduction. The asymptote it approaches is the carrying capacity (K) — the maximum population the environment can sustainably support.

71. C — Without their native predators, parasites, and pathogens, invasive species often grow unchecked and outcompete or directly consume native species. The resulting decline or extinction of native species is a leading cause of biodiversity loss worldwide.

72. B — The Cretaceous–Paleogene (K–Pg) extinction, 66 million years ago, ended the dinosaurs and is best explained by the impact of a large asteroid in what is now the Yucatán Peninsula. The resulting climate disruption — dust blocking sunlight, wildfires, acid rain — killed roughly three-quarters of all species.

PART D — LABORATORY PRACTICAL (Questions 73–85)

73. A — In Beaks of Finches, the independent variable is the beak tool (what is changed) and the dependent variable is the number of seeds collected in a set time (what is measured to detect the effect). The seed count is what varies in response to beak type.

74. D — In the Making Connections lab, students squeeze a clothespin repeatedly and record both the number of squeezes per interval and the pulse rate before and after the activity. The data link muscle activity (squeezes) to the cardiovascular response (pulse rate).

75. C — Benedict's solution starts blue and turns green, yellow, orange, or brick red when heated with reducing sugars such as glucose, with the final color indicating sugar concentration. Heating is required for the reaction to occur, distinguishing Benedict's from indicators like Lugol's iodine.

76. A — Closer DNA sequence and protein structure indicate more recent common ancestry and a higher likelihood of shared biochemical pathways. Since the valuable chemical is the product of such a pathway, the species most similar at the molecular level is the most likely to produce the same chemical.

77. B — A wet-mount slide is prepared by placing the specimen in a small drop of water on the slide, then gently lowering a cover slip onto it. The water keeps the specimen alive and flat for clear viewing under the microscope.

78. D — Stains such as methylene blue and iodine bind selectively to cell structures, making nuclei, cell walls, and other features visible against the otherwise transparent cytoplasm. Without staining, most internal cellular details are too clear to see under a light microscope.

79. C — The first coordinate (25) is the x-value and the second (80) is the y-value, by convention written as (x, y). The point therefore represents the data pair where the independent variable equals 25 and the corresponding dependent variable equals 80.

80. B — A measurement of 8.5 cm has a precision of one tenth of a centimeter, corresponding to a ruler marked in millimeters and centimeters. Whole-meter sticks, balances, and thermometers measure different quantities or lack this precision.

81. A — Burning a food sample and measuring how much it warms a known volume of water uses the energy released to estimate the food's energy content (calorimetry). This is the same principle used to determine Calorie content on nutrition labels.

82. C — Controlled variables are factors held constant across all groups so that any difference in outcome can be attributed to the independent variable. Room temperature, time of day, and subject age must all be controlled to isolate the effect of exercise on pulse rate.

83. D — Scientific conclusions must be drawn from the actual experimental data, not from prior hopes or expectations. This evidence-based reasoning is what distinguishes science from opinion and keeps conclusions trustworthy and reproducible.

84. B — pH indicator paper changes color depending on the hydrogen ion concentration of the solution, with a color chart matching the strip to a value on the pH scale (0–14). Acids fall below 7, bases above, and a neutral solution sits at 7.

85. C — A graduated pipette is calibrated for precise volume measurement and is the standard tool for delivering small, accurate liquid volumes in the lab. Beakers and flasks have broad markings intended for approximate volumes only.