

# PRACTICE EXAM 4: LIVING ENVIRONMENT REGENTS SIMULATION

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**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 a characteristic shared by ALL living things on Earth?

- A. The ability to move from one location to another
- B. The presence of complex multicellular organization
- C. The ability to perform photosynthesis using sunlight
- D. The ability to respond to changes in the environment

2. The smallest unit of life that can perform all life functions is

- A. an organ that carries out a specific function
- B. a cell with a membrane and genetic material
- C. a tissue made of many similar cells
- D. an organism made of cooperating cells

3. In a plant cell, the structure responsible for storing water and helping maintain the cell's shape is the

- A. nucleus containing the cell's DNA
- B. mitochondrion releasing energy from food
- C. central vacuole filled with cell sap

D. ribosome assembling protein chains

4. The cell membrane controls what enters and leaves the cell because it is

A. selectively permeable, allowing only certain substances to pass

B. composed entirely of solid protein that blocks all movement

C. freely permeable to every type of molecule and ion

D. continuously rebuilt by the nucleus once each hour

5. Each enzyme typically catalyzes only one specific reaction because its

A. shape constantly changes during the reaction

B. molecules are identical to those of the substrate

C. active site has a shape that fits only specific substrates

D. structure depends entirely on the surrounding pH level

6. When ATP is used to power a cellular activity, it is converted to

A. glucose and oxygen for further breakdown

B. ADP plus a free phosphate group

C. DNA that can be stored in the nucleus

D. carbon dioxide and water as waste

7. Which of the following correctly summarizes the overall process of photosynthesis?

A.  $\text{glucose} + \text{oxygen} \rightarrow \text{carbon dioxide} + \text{water} + \text{ATP}$

B.  $\text{carbon dioxide} + \text{ATP} \rightarrow \text{glucose} + \text{oxygen} + \text{water}$

C.  $\text{water} + \text{oxygen} + \text{sunlight} \rightarrow \text{glucose} + \text{carbon dioxide}$

D. carbon dioxide + water + sunlight → glucose + oxygen

8. Which of the following is true of RNA but NOT of DNA?

A. RNA contains the nitrogen base uracil instead of thymine

B. RNA is a long molecule containing genetic information

C. RNA contains nitrogen bases attached to sugar groups

D. RNA is found inside the cells of all living organisms

9. A pea plant heterozygous for tall (Tt) is crossed with a homozygous short pea plant (tt). What percentage of offspring are expected to be tall?

A. 25% tall offspring expected

B. 50% tall offspring expected

C. 75% tall offspring expected

D. 100% tall offspring expected

10. A trait that is determined by two or more genes acting together is best described as

A. a sex-linked trait found only on the X chromosome

B. an environmentally acquired characteristic not inherited

C. a polygenic trait influenced by multiple genes together

D. a recessive trait masked by a dominant counterpart

11. A mutation that occurs in a sperm or egg cell

A. cannot affect any cells of the parent organism

B. can be passed on to the offspring of the organism

C. is always corrected before fertilization can occur

D. has no effect on the resulting organism's genome

12. Which of the following is an advantage of asexual reproduction over sexual reproduction?

- A. Offspring show greater genetic diversity in each generation
- B. Offspring inherit traits from two genetically different parents
- C. Offspring can adapt more easily to changing environments
- D. Offspring can be produced rapidly without needing a mate

13. Evidence from fossils, comparative anatomy, and DNA all support the conclusion that

- A. modern species share common ancestors from the distant past
- B. all current species were created in their present forms recently
- C. species do not change over time and remain genetically stable
- D. evolution proceeds only through inherited acquired traits

14. The bones in a human arm, a whale flipper, and a bat wing have similar arrangements despite serving different functions. These bones are best described as

- A. analogous structures with no shared ancestor
- B. vestigial structures no longer used in any species
- C. homologous structures inherited from a common ancestor
- D. embryonic structures present only before birth

15. The process by which one species gradually divides into two or more separate species is called

- A. natural selection by environmental pressure
- B. adaptation by inherited useful changes
- C. genetic drift in a small population

D. speciation following long-term reproductive isolation

16. A bee gathers nectar from a flower while transferring pollen between flowers as it feeds. The relationship between the bee and the flower is best described as

- A. mutualism, in which both species benefit from the interaction
- B. parasitism, in which the bee harms the flower for its own benefit
- C. commensalism, in which only the bee benefits from the relationship
- D. predation, in which one species kills and consumes the other

17. Which of the following is an abiotic factor that affects organisms in a pond ecosystem?

- A. The number of frogs feeding on insects in the pond
- B. The temperature of the water in the pond
- C. The species of fish competing for food
- D. The decomposers breaking down dead leaves

18. The largest number of individuals of a species that an ecosystem can support over time is known as

- A. the biotic potential of the species
- B. the ecological niche of the species
- C. the carrying capacity of the environment
- D. the population doubling time for the species

19. Bacteria that live in the root nodules of certain plants convert atmospheric nitrogen gas into compounds plants can use. This process is called

- A. nitrogen fixation carried out by symbiotic bacteria
- B. denitrification carried out by soil bacteria

- C. photosynthesis carried out by leaf chloroplasts
- D. cellular respiration carried out by all organisms

20. Bare rock left by a retreating glacier is gradually colonized first by lichens, then by mosses, and eventually by larger plants. This is an example of

- A. secondary succession after a forest fire
- B. ecological collapse of a damaged community
- C. competitive exclusion of established species
- D. primary succession on previously bare ground

21. Compared to the nervous system, the endocrine system

- A. uses electrical signals to communicate rapidly
- B. has effects that last for only a few milliseconds
- C. uses chemical messengers carried in the bloodstream
- D. controls voluntary movements of skeletal muscles

22. When blood glucose levels rise after a meal, the pancreas releases the hormone insulin, which signals body cells to absorb glucose. This is an example of

- A. a negative feedback mechanism maintaining homeostasis
- B. a positive feedback mechanism amplifying a signal
- C. a permanent adaptation to changes in diet
- D. a learned response controlled by the conscious brain

23. The skeletal system supports the body and also

- A. circulates blood throughout the body tissues

- B. produces blood cells inside the bone marrow
- C. produces hormones for the immune response
- D. filters wastes from the bloodstream constantly

24. In the human digestive system, the mechanical breakdown of food begins in the

- A. small intestine, where enzymes finish digestion
- B. stomach, where acid denatures protein structure
- C. large intestine, where water is reabsorbed
- D. mouth, where teeth chew the food into smaller pieces

25. A disease-causing microorganism is generally called a

- A. nutrient absorbed from food during digestion
- B. pathogen capable of causing illness
- C. hormone released by an endocrine gland
- D. neurotransmitter released at a synapse

26. Antibiotic medications are effective against bacterial infections but generally NOT against viral infections because

- A. viruses are too large to be affected by antibiotics
- B. bacteria are not actually killed by any medications
- C. viruses are killed only by very high body temperatures
- D. viruses lack the cellular structures that antibiotics target

27. An allergic reaction occurs when the immune system

- A. responds to a harmless substance as if it were a threat

- B. completely fails to respond to any foreign substances
- C. produces too few antibodies to fight off pathogens
- D. attacks the body's own healthy red blood cells

28. Maintaining biodiversity in an ecosystem is important because

- A. it ensures that all species look identical and are well adapted
- B. it eliminates the need for natural selection to occur
- C. it provides genetic variation that helps species respond to change
- D. it prevents any changes from occurring in the environment

29. Which of the following farming practices is most likely to support long-term sustainability?

- A. Heavy use of synthetic pesticides each growing season
- B. Planting only a single crop variety year after year
- C. Clearing forest land to plant additional crop fields
- D. Rotating different crops to maintain soil nutrients

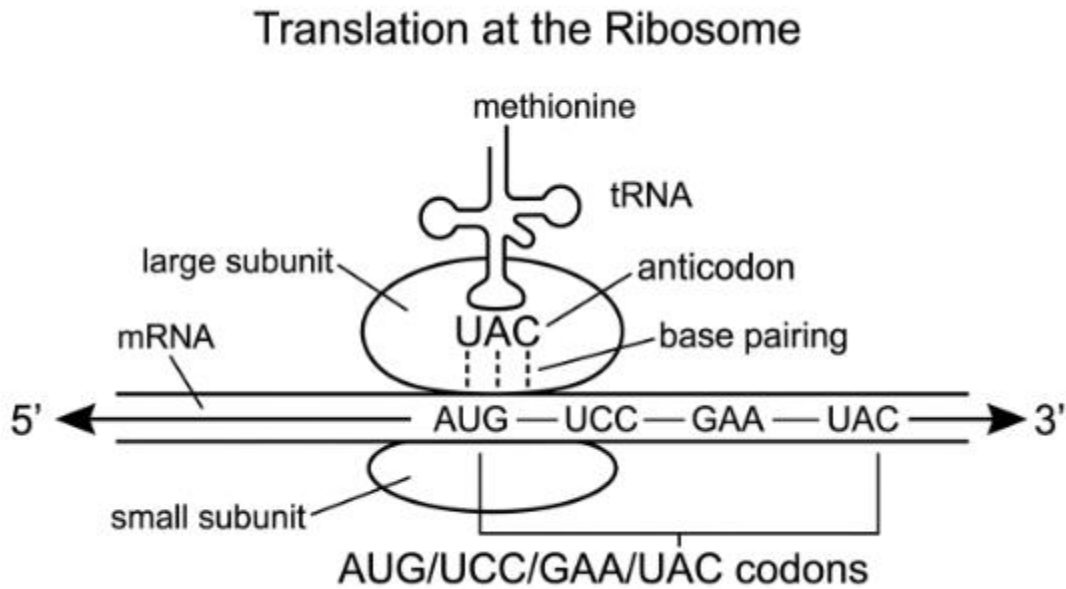
30. Sulfur and nitrogen compounds released by burning fossil fuels can dissolve in atmospheric water and fall to Earth as

- A. ozone, which protects against ultraviolet radiation
- B. acid rain, which damages forests and aquatic ecosystems
- C. greenhouse gases, which trap heat in the atmosphere
- D. solid waste, which can be safely buried in landfills

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

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

31. A student examines a diagram showing a stage of protein synthesis at a ribosome.



In the diagram, the tRNA molecule pairing with the codon AUG is carrying

- A. the amino acid methionine to begin the protein
- B. a nitrogen base that will replace the AUG codon
- C. a new mRNA strand to begin transcription
- D. a strand of DNA from the cell's nucleus

32. Referring to the same diagram, the structure that holds the mRNA and tRNA in position during translation is the

- A. nucleus of the cell where DNA is stored
- B. mitochondrion that generates ATP energy
- C. chloroplast that captures light energy

D. ribosome at the site of protein assembly

33. Referring to the same diagram, the sequence of bases on the mRNA was originally determined by

A. random assembly of bases in the cytoplasm

B. the sequence of amino acids in a finished protein

C. the sequence of bases on a DNA template

D. environmental signals from outside the cell

34. Referring to the same diagram, the next tRNA to enter the ribosome will pair with the codon UCC. Its anticodon will be

A. UCC, matching the codon directly

B. AGG, complementary to the codon

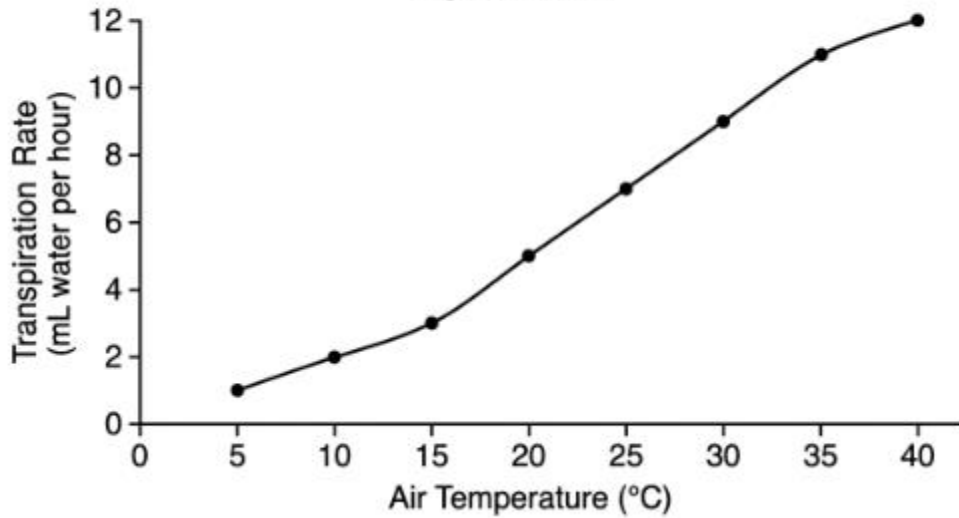
C. TCC, the DNA version of the codon

D. GGT, the reverse of the codon

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

35. A student measures the transpiration rate of a bean plant at different air temperatures.

Transpiration Rate vs. Air Temperature in a Bean Plant.  
Figure PQ-2



Based on the graph, the transpiration rate of the bean plant at 30°C is approximately

- A. 1 milliliter per hour
- B. 3 milliliters per hour
- C. 5 milliliters per hour
- D. 9 milliliters per hour

36. Based on the same graph, as air temperature increases, the transpiration rate of the bean plant

- A. increases steadily across the range shown
- B. decreases steadily across the range shown
- C. remains constant across the range shown
- D. increases and then decreases sharply

37. Based on the same graph, the change in transpiration rate occurs primarily because higher temperatures

- A. cause leaves to stop producing chlorophyll quickly

- B. increase the rate at which water evaporates from leaves
- C. cause the plant's roots to absorb less water at first
- D. damage the plant's vascular tissue irreversibly

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

38. A Punnett square shows a cross between a colorblind father and a carrier mother.

**Sex-Linked Colorblindness Cross.**

	$X^b$	$Y$
$X^B$	$X^B X^b$ (carrier daughter, normal vision)	$X^B Y$ (normal vision son)
$X^b$	$X^b X^b$ (colorblind daughter)	$X^b Y$ (colorblind son)

$X^B$  = normal vision allele (dominant);  $X^b$  = colorblind allele (recessive).

Based on the Punnett square, the genotype of the colorblind father is

- A.  $X^B Y$ , with the dominant normal allele
- B.  $X^B X^b$ , with one of each allele
- C.  $X^b Y$ , with only the recessive allele
- D.  $X^b X^b$ , with two recessive alleles

39. Based on the same Punnett square, the percentage of daughters from this cross expected to be colorblind is

- A. 0% of the daughters
- B. 25% of the daughters
- C. 75% of the daughters
- D. 50% of the daughters

40. Based on the same Punnett square, daughters who inherit the genotype  $XBXb$  will

- A. have normal vision but be carriers of colorblindness
- B. be colorblind because of the single recessive allele
- C. be unable to have any children of their own later
- D. develop colorblindness later in life regardless of genotype

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 freshwater wetland ecosystem.

## Freshwater Wetland Food Web

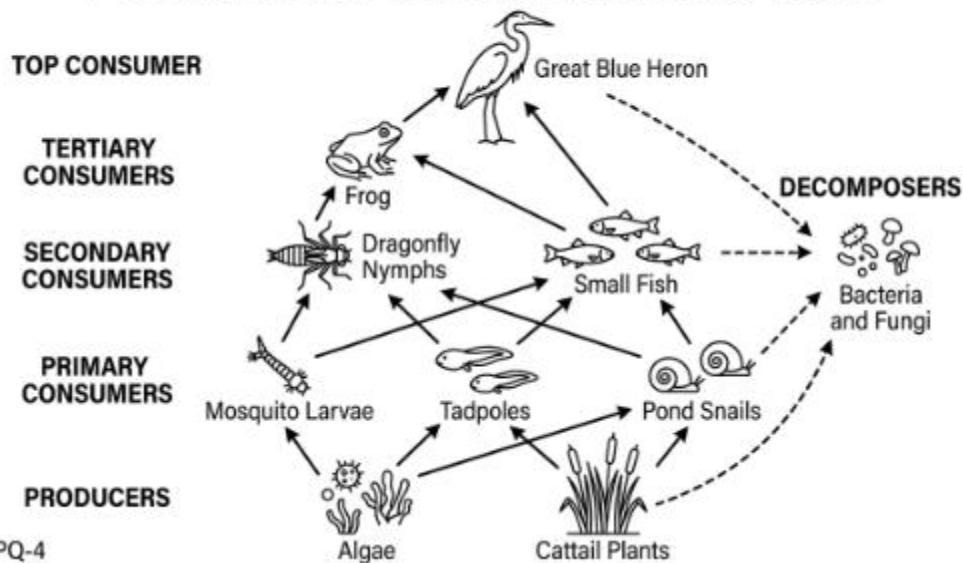


Figure PQ-4

Based on the food web shown, the dragonfly nymph is best classified as

- A. a producer at the base of the food web
- B. a secondary consumer that eats primary consumers
- C. a tertiary consumer that eats top predators
- D. a decomposer breaking down dead organisms

42. Based on the same food web, if 1,000 units of energy are available in the algae, the approximate amount of energy that reaches the great blue heron is

- A. 1,000 units of energy
- B. 500 units of energy
- C. 1 unit of energy
- D. 0 units of energy

43. Based on the same food web, if the cattail plants were removed from the wetland ecosystem, the most direct effect would be on

- A. the pond snails that feed on cattails as food
- B. the small fish that prey on mosquito larvae
- C. the great blue heron at the top of the food web
- D. the dragonfly nymphs that feed on tadpoles in the water

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

Answer all questions in this part.

44. A biologist designs an experiment to test the effect of light intensity on plant growth. To produce valid results, the biologist should

- A. use plants of many different species in the test
- B. change both light intensity and temperature at once
- C. measure only the tallest plant in each group
- D. test many plants and repeat the experiment multiple times

45. When presenting data showing how a population changed over five years, the most appropriate type of graph is

- A. a circle graph showing the parts of a whole
- B. a scatter plot of unrelated random measurements
- C. a line graph showing change over time
- D. a bar graph with no axis labels

46. During meiosis, the exchange of segments between homologous chromosomes is called

- A. crossing over, which increases genetic variation
- B. binary fission, which produces identical daughter cells
- C. nondisjunction, which produces extra chromosomes
- D. random fertilization, which combines two gametes

47. Compared to asexual reproduction, sexual reproduction is more likely to produce offspring that

- A. are genetically identical to one of the parents
- B. show genetic variation different from either parent
- C. inherit only the dominant allele of every gene
- D. survive every kind of environmental change unchanged

48. A scientist studying a sample of DNA finds that 30% of the bases are adenine. According to Chargaff's rules, the percentage of cytosine in this sample is

- A. 30% cytosine
- B. 70% cytosine
- C. 50% cytosine
- D. 20% cytosine

49. Gel electrophoresis separates fragments of DNA based on

- A. the size of each DNA fragment
- B. the color of each DNA fragment
- C. the temperature at which DNA melts
- D. the number of cells the DNA came from

50. The thyroid gland releases hormones that regulate the body's

- A. blood sugar levels through insulin release
- B. response to stress through adrenaline release
- C. overall metabolic rate throughout the body
- D. ability to fight infections from foreign pathogens

51. The cells of the nervous system that transmit electrical signals throughout the body are called

- A. muscle cells that contract for movement
- B. red blood cells that carry oxygen
- C. epithelial cells that form a body barrier
- D. neurons that send rapid electrical signals

52. Bees, butterflies, and other pollinators perform a service for the ecosystem by

- A. transferring pollen between flowers, allowing plants to reproduce
- B. consuming all the seeds produced by plants in the area
- C. competing with plants for the sunlight they need to grow
- D. preventing other animals from approaching nearby flowers

53. A biome characterized by low precipitation, sparse vegetation, and extreme temperature variation is best described as

- A. a tropical rainforest with dense vegetation
- B. a desert with low rainfall and limited plant cover
- C. a tundra covered in permanent ice and snow
- D. a deciduous forest with seasonal leaf loss

54. As global temperatures rise, the geographic range of many species is observed to shift

- A. southward toward the equator in both hemispheres
- B. only east or west along established lines of latitude
- C. toward higher latitudes or higher elevations in many cases
- D. exactly opposite to the direction predicted by climate models

55. Fertilizer runoff into a lake can cause excessive algae growth followed by oxygen depletion when the algae die and decompose. This process is called

- A. eutrophication of the lake water
- B. desertification of the lake basin
- C. reforestation of the lake area
- D. evaporation of the lake water completely

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

Answer all questions in this part.

56. During which phase of mitosis do duplicated chromosomes line up at the center of the cell?

- A. Prophase, when chromosomes first condense
- B. Telophase, when daughter nuclei form
- C. Anaphase, when chromatids separate
- D. Metaphase, when chromosomes align in the middle

57. At the end of meiosis I, the daughter cells produced are

- A. diploid and identical to the parent cell
- B. tetraploid with twice the parent's chromosomes
- C. haploid with half the parent's chromosome number
- D. unable to undergo any further cell divisions

58. In a pedigree, an individual shown as a half-filled symbol typically represents

- A. an affected individual showing the disorder
- B. a heterozygous carrier of a recessive allele
- C. an unaffected individual with two dominant alleles
- D. a person who has died from the genetic disorder

59. Over time, a population of moths in a forest with darkening tree bark shifts toward predominantly darker individuals. This is best described as

- A. stabilizing selection toward an intermediate trait
- B. disruptive selection toward two extremes at once
- C. artificial selection performed by humans intentionally

D. directional selection favoring one extreme of the trait

60. In evolutionary biology, the term "fitness" refers specifically to

- A. an organism's ability to survive and reproduce in its environment
- B. an organism's physical strength compared with other species
- C. an organism's level of intelligence and learning ability
- D. an organism's body size relative to that of competitors

61. A polar bear's thick white fur, which provides camouflage and insulation in the Arctic, is best classified as

- A. a behavioral adaptation learned during life
- B. a structural adaptation inherited from parents
- C. an acquired adaptation developed through use
- D. a physiological adaptation involving body chemistry

62. In a stable ecosystem, the relationship between a predator population and its prey population is best described as

- A. the prey population always outcompeting the predator
- B. the predator population growing without any limit
- C. the two populations rising and falling in linked cycles
- D. the two populations having no effect on each other

63. An increase in atmospheric carbon dioxide due to human activity is most directly linked to

- A. the formation of the seasonal ozone hole
- B. the extinction of all bacterial species on Earth

- C. the depletion of soil minerals in farmland
- D. the warming of Earth's average surface temperature

64. The kidneys help maintain homeostasis by

- A. regulating water balance and removing nitrogenous wastes
- B. producing the hormones that initiate the immune response
- C. circulating blood to all parts of the body's tissues
- D. generating most of the ATP used during exercise

65. Compared to arteries, veins typically have

- A. thicker muscular walls that handle higher pressure
- B. fewer connections to the body's smallest capillaries
- C. thinner walls and valves that prevent backflow
- D. no role in the circulation of blood at all

66. Oxygen moves from the alveoli into the blood by

- A. active transport that requires ATP
- B. diffusion from higher to lower concentration
- C. osmosis through aquaporin channels only
- D. endocytosis by red blood cells in capillaries

67. The enzyme amylase, found in saliva, begins the chemical digestion of

- A. starches into smaller sugars in the mouth
- B. proteins into amino acids in the stomach

- C. fats into fatty acids in the small intestine
- D. nucleic acids into nucleotides in the throat

68. In humans, fertilization — the fusion of egg and sperm — typically occurs in the

- A. uterus where the embryo will implant
- B. ovary where eggs are first produced
- C. cervix at the entrance to the uterus
- D. fallopian tube between the ovary and uterus

69. During pregnancy, the developing fetus receives nutrients and oxygen from the mother through the

- A. amniotic fluid surrounding the fetus
- B. fetal lungs absorbing oxygen from fluid
- C. placenta connecting fetal and maternal blood supplies
- D. uterine wall through direct cellular contact

70. In an autoimmune disease such as type 1 diabetes, the immune system

- A. fails to respond to foreign pathogens entirely
- B. attacks the body's own healthy tissues by mistake
- C. produces too many red blood cells in the bone marrow
- D. shuts down completely for an extended period of time

71. A disease that can be transmitted from one person to another through direct or indirect contact is called

- A. an infectious or communicable disease
- B. a chronic disease that develops slowly

- C. a genetic disorder inherited from parents
- D. a degenerative condition that worsens with age

72. The proteins produced by the immune system that bind specifically to antigens on foreign invaders are called

- A. enzymes catalyzing chemical reactions in cells
- B. hormones regulating distant organs in the body
- C. neurotransmitters released by nerve cells
- D. antibodies marking pathogens for destruction

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

Answer all questions in this part.

73. In the Relationships and Biodiversity laboratory, paper chromatography is used to compare

- A. the temperatures at which different proteins denature
- B. the rates at which different cells absorb water
- C. the molecular structure of plant pigments and proteins
- D. the speeds of different chemical digestion reactions

74. In gel electrophoresis, smaller DNA fragments move

- A. more slowly through the gel than larger fragments
- B. faster and farther through the gel than larger fragments
- C. in random directions throughout the entire gel
- D. only when an enzyme is added to the gel mixture

75. A student measures the length of an earthworm using a metric ruler. The most appropriate unit for this measurement is

- A. milliliters per second of length
- B. kilometers per hour of length
- C. degrees Celsius of length
- D. centimeters of length

76. When preparing a wet-mount slide of an onion cell, a cover slip is added to

- A. flatten the specimen and prevent air bubbles
- B. provide nutrients to keep the cell alive
- C. stain the cell membrane a darker color
- D. increase the total magnification of the microscope

77. In the Beaks of Finches simulation laboratory, the "beak" of each student is represented by

- A. a randomly selected piece of plastic
- B. a specific food item to be collected
- C. a different tool such as a pair of pliers or tweezers
- D. a written description of feeding behavior

78. In the Making Connections laboratory, students measure the pulse rate before and after a physical activity such as squeezing a clothespin. This experiment investigates

- A. the rate at which photosynthesis occurs in plants
- B. the relationship between muscle activity and heart rate
- C. the effect of light intensity on cellular respiration
- D. the way enzymes change shape at different temperatures

79. In the Diffusion Through a Membrane laboratory, a starch solution is placed inside the dialysis tubing and the tubing is suspended in iodine solution. After several minutes, the contents of the tubing turn blue-black, indicating that

- A. starch molecules moved out of the tubing into the iodine
- B. water molecules moved out of the tubing into the iodine
- C. iodine and starch reacted on the outside of the tubing
- D. iodine molecules moved into the tubing and reacted with starch

80. When constructing a line graph from experimental data, the independent variable should be plotted on the

- A. y-axis at the top of the graph
- B. y-axis at the right side of the graph
- C. x-axis along the horizontal direction
- D. diagonal line across the entire graph

81. In a controlled experiment, the variable that is intentionally changed by the experimenter is called

- A. the independent variable being manipulated
- B. the dependent variable being measured
- C. the controlled variable held constant
- D. the experimental hypothesis being tested

82. A student wishes to switch from low power to high power on a compound microscope. The student should first

- A. remove the slide and start over with a new one
- B. center the specimen in the field of view
- C. add more stain to the specimen on the slide

D. cover the eyepiece with a colored filter

83. In a biology laboratory, broken glass should be

- A. swept into the regular trash can immediately
- B. left on the floor until cleanup at the end of class
- C. picked up with bare hands and washed in the sink
- D. disposed of in a designated broken-glass container

84. In the Beaks of Finches laboratory, after several rounds of feeding, students who collected the fewest seeds are removed from the next round. This step models

- A. genetic engineering altering the bird population
- B. random mutation introducing new beak shapes
- C. natural selection eliminating less successful individuals
- D. cooperation among birds for shared resources

85. Which of the following is one of the four required New York State Living Environment laboratory investigations?

- A. The Bacterial Growth and Antibiotic Resistance laboratory
- B. The Beaks of Finches simulation laboratory
- C. The Frog Dissection and Anatomy laboratory
- D. The Daphnia Heart Rate and Stimulant laboratory

## Practice Exam 4 – Answer Key and Explanations

- 1. D** — All living things share certain characteristics including the ability to respond to stimuli, maintain homeostasis, reproduce, grow, and use energy. Movement, multicellularity, and photosynthesis are not universal — many living organisms lack each of these traits.
- 2. B** — The cell is defined as the smallest unit capable of carrying out all life processes, from metabolism to reproduction. Tissues, organs, and organisms are higher levels of organization built from cells, while subcellular parts cannot perform life functions on their own.
- 3. C** — Plant cells contain a large central vacuole filled with water and dissolved substances called cell sap. Pressure from this water (turgor pressure) pushes outward against the cell wall, helping the plant maintain its shape and remain upright.
- 4. A** — Selectively permeable means the membrane allows some substances to pass while blocking others, controlling what enters and leaves the cell. This selectivity is essential for maintaining the proper internal environment necessary for life processes.
- 5. C** — Each enzyme has an active site with a specific three-dimensional shape that fits only one or a few substrates, much like a key fitting a particular lock. This shape specificity is what gives enzymes their selective control over biochemical reactions.
- 6. B** — ATP releases energy by losing one of its three phosphate groups, becoming ADP (adenosine diphosphate) plus a free phosphate. The cell then reattaches a phosphate to ADP using energy from food, recycling it back into ATP.
- 7. D** — Photosynthesis uses light energy to combine carbon dioxide and water, producing glucose and releasing oxygen as a byproduct. This reaction is the foundation of nearly all food chains on Earth and the original source of atmospheric oxygen.
- 8. A** — RNA uses uracil (U) in place of thymine (T) found in DNA — this is the single most distinctive chemical difference between the two molecules. RNA is also typically single-stranded and contains ribose sugar instead of deoxyribose.
- 9. B** — A  $Tt \times tt$  cross produces 50%  $Tt$  (tall, heterozygous) and 50%  $tt$  (short, homozygous recessive). Since the dominant  $T$  allele is needed for the tall trait, only the  $Tt$  offspring will be tall — exactly half.
- 10. C** — Polygenic traits result from the combined action of multiple genes, often producing a range of phenotypes rather than discrete categories. Human height, skin color, and eye color are examples of traits controlled in this way.
- 11. B** — Mutations in gametes (sperm or egg cells) are heritable because they become part of every cell in the offspring formed from those gametes. Mutations in body (somatic) cells, by contrast, affect only the individual and are not passed on.
- 12. D** — Asexual reproduction does not require finding or attracting a mate, so a single individual can rapidly produce many offspring. This is a major advantage in stable environments or when colonizing new habitats quickly.

- 13. A** — Fossil sequences show change in body forms over millions of years, comparative anatomy reveals shared underlying structures, and DNA comparisons confirm degrees of relatedness between species. All three independent lines of evidence converge on common ancestry.
- 14. C** — Homologous structures share a common evolutionary origin and similar underlying bone arrangement, even when they perform different functions in different species. This is strong evidence of descent with modification from a shared ancestor.
- 15. D** — Speciation is the formation of new species from existing ones, typically following long-term reproductive isolation that prevents gene flow between populations. Over time, separated populations accumulate enough genetic differences to become distinct species.
- 16. A** — Mutualism is a symbiotic relationship in which both organisms benefit. The bee receives nectar (food), and the flower achieves cross-pollination (reproduction) — a textbook example of mutual benefit.
- 17. B** — Abiotic factors are non-living physical and chemical components of an environment, such as temperature, water, sunlight, and soil. The other choices all involve living organisms and are therefore biotic factors.
- 18. C** — Carrying capacity is the maximum population size that an environment can sustainably support given available resources such as food, water, and space. Populations tend to fluctuate around this limit as resources allow.
- 19. A** — Nitrogen fixation is the process by which bacteria — including those in legume root nodules — convert atmospheric nitrogen gas ( $N_2$ ) into ammonia and related compounds plants can absorb. This makes essential nitrogen available to support plant growth.
- 20. D** — Primary succession occurs on surfaces with no preexisting soil or organisms, such as bare rock left by glaciers or new lava flows. Pioneer species like lichens slowly break down rock to form soil, allowing later species to colonize.
- 21. C** — The endocrine system communicates through hormones released into the bloodstream, which travel to distant target cells. This produces slower but longer-lasting effects than the rapid electrical signals of the nervous system.
- 22. A** — Negative feedback opposes a change and restores conditions to a set point — insulin lowers blood glucose when it rises too high after a meal. This is the primary mechanism for maintaining homeostasis in nearly all body systems.
- 23. B** — Bone marrow inside many bones produces red blood cells, white blood cells, and platelets — a process called hematopoiesis. This makes the skeletal system essential to both support and blood production.
- 24. D** — Mechanical (physical) digestion begins in the mouth as teeth chew food into smaller pieces, increasing surface area for enzyme action. Chemical digestion of starch also begins there through the action of salivary amylase.

**25. B** — A pathogen is any microorganism — bacterium, virus, fungus, protist, or other agent — capable of causing disease in a host. Recognizing pathogens as the cause of infectious disease is the foundation of the germ theory of disease.

**26. D** — Antibiotics target structures unique to bacterial cells, such as the bacterial cell wall or bacterial ribosomes. Viruses lack these structures and instead rely on host cell machinery, so antibiotics have nothing to act on.

**27. A** — In an allergic reaction, the immune system mistakenly identifies a harmless substance (pollen, food, dust) as a threat and mounts a response. The resulting release of histamine causes the symptoms — sneezing, itching, swelling — characteristic of allergies.

**28. C** — Biodiversity preserves a wide range of genetic variation across species and ecosystems. This variation is the raw material that allows natural selection to act when environments change, enabling species and ecosystems to adapt and persist.

**29. D** — Crop rotation alternates different crops on the same land each season, allowing soil nutrients to replenish and breaking pest and disease cycles. The other practices deplete soil, reduce biodiversity, or destroy natural habitat.

**30. B** — When sulfur dioxide and nitrogen oxides dissolve in atmospheric water, they form sulfuric and nitric acids that fall as acid rain. Acid rain lowers the pH of soils and water bodies, damaging trees, killing aquatic organisms, and corroding structures.

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

**31. A** — AUG is the universal start codon for protein synthesis and codes for the amino acid methionine. The tRNA pairing with AUG always carries methionine, which becomes the first amino acid of every newly synthesized protein.

**32. D** — The ribosome is the cellular structure that brings together mRNA and tRNA molecules to assemble polypeptides during translation. Its two subunits clamp around the mRNA and hold tRNAs in position so amino acids can be joined.

**33. C** — The mRNA sequence is transcribed directly from a DNA template using complementary base pairing. The order of bases on DNA therefore determines the order of bases on mRNA, which in turn determines the order of amino acids in the protein.

**34. B** — RNA-to-RNA base pairing follows the rules U–A and C–G. The codon UCC therefore pairs with the anticodon AGG, bringing the appropriate tRNA-carried amino acid into position at the ribosome.

**35. D** — Reading the curve on the graph at 30°C gives a transpiration rate of approximately 9 mL of water per hour. This corresponds to the data point plotted at (30, 9) on the smooth ascending curve.

**36. A** — Across the full temperature range shown ( $5^{\circ}\text{C}$  to  $40^{\circ}\text{C}$ ), the curve rises smoothly from approximately 1 mL/hr to 12 mL/hr. The pattern is a steady, continuous increase rather than a leveling off, decrease, or sudden drop.

**37. B** — Transpiration is the loss of water vapor through tiny pores called stomata on leaf surfaces. Higher temperatures increase the kinetic energy of water molecules and accelerate evaporation, which is why transpiration rates rise as temperature climbs.

**38. C** — Colorblindness is a sex-linked recessive disorder, and males have only one X chromosome. A colorblind male must carry the recessive allele on his single X ( $X^bY$ ), so  $X^bY$  is the only genotype that produces colorblindness in males.

**39. D** — The Punnett square shows two daughter genotypes —  $X^BX^b$  (carrier, normal vision) and  $X^bX^b$  (colorblind). Half of all daughters (1 of 2) are therefore colorblind, giving 50%.

**40. A** —  $X^BX^b$  daughters have one dominant normal-vision allele ( $X^B$ ) and one recessive colorblind allele ( $X^b$ ). The dominant allele masks the recessive, so these daughters see normally but can pass the colorblind allele to their own children.

**41. B** — Dragonfly nymphs eat mosquito larvae and tadpoles, which are primary consumers feeding on algae. Eating primary consumers places dragonfly nymphs at the third trophic level, defining them as secondary consumers.

**42. C** — Only about 10% of energy passes from one trophic level to the next. Following the algae  $\rightarrow$  primary consumer  $\rightarrow$  small fish  $\rightarrow$  heron pathway,  $1,000 \rightarrow 100 \rightarrow 10 \rightarrow 1$  unit reaches the heron — illustrating why top predators support smaller populations.

**43. A** — Pond snails are the only consumer shown in the food web that feeds directly on cattail plants. Removing cattails would therefore most directly reduce the food supply available to the pond snail population.

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

**44. D** — A valid experiment requires a large sample size and repeated trials to reduce the effect of random variation and confirm that results are reproducible. Without repetition, a single trial might produce a misleading result that does not reflect the true relationship.

**45. C** — Line graphs are the standard choice for showing continuous data that change over time, such as population size measured year by year. The connecting line makes trends and rates of change easy to identify at a glance.

**46. A** — Crossing over occurs in prophase I of meiosis when homologous chromosomes exchange corresponding segments of DNA. This recombination produces gametes with new combinations of alleles, increasing the genetic variation passed to offspring.

**47. B** — Sexual reproduction combines genetic material from two parents through meiosis and fertilization, producing offspring with novel allele combinations. This variation is the basis for evolution by natural selection in changing environments.

**48. D** — Chargaff's rules state that in DNA, A pairs with T and G pairs with C, so the amounts of each pair are equal. If A = 30%, then T = 30%, leaving 40% for G and C combined — split evenly at 20% each.

**49. A** — In gel electrophoresis, an electric current pulls negatively charged DNA fragments through a gel matrix. Smaller fragments move through the gel's pores more easily and travel farther, separating fragments by size into distinct bands.

**50. C** — The thyroid produces hormones (primarily thyroxine, T<sub>4</sub>) that regulate metabolic rate — how fast cells convert food into energy. Disorders of the thyroid disrupt energy use, body temperature, and growth throughout the body.

**51. D** — Neurons are specialized cells that transmit electrical impulses called action potentials over long distances. They communicate with other neurons or with muscle and gland cells through chemical messengers called neurotransmitters at synapses.

**52. A** — Pollinators transfer pollen from the male anthers of one flower to the female stigmas of another, enabling fertilization and seed production. This service is essential for the reproduction of most flowering plants, including many human food crops.

**53. B** — Deserts are characterized by very low precipitation (typically less than 25 cm/year), sparse plant cover adapted to drought, and large daily temperature swings between hot days and cool nights. These features distinguish them from forests, tundra, and rainforests.

**54. C** — As temperatures rise, conditions previously found at lower latitudes or elevations shift to higher ones, and species track this shift to remain within their preferred temperature range. Many plant and animal ranges are documented moving poleward or upslope as a result.

**55. A** — Eutrophication occurs when nutrient enrichment (especially nitrogen and phosphorus) causes explosive algal growth. When the algae die, decomposing bacteria consume dissolved oxygen, creating low-oxygen "dead zones" that suffocate fish and other aquatic life.

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

**56. D** — During metaphase, the duplicated chromosomes align along the cell's equator (metaphase plate), attached to spindle fibers from opposite poles. This precise alignment ensures that each daughter cell will receive exactly one copy of each chromosome.

**57. C** — Meiosis I separates homologous chromosome pairs, reducing the chromosome number from diploid (2n) to haploid (n). The two daughter cells produced still contain duplicated chromosomes but only one of each homologous pair.

**58. B** — A half-filled symbol on a pedigree conventionally indicates a heterozygous carrier — an individual with one normal and one recessive allele who does not show the disorder but can pass the allele to offspring. Filled symbols indicate affected individuals; empty symbols indicate unaffected non-carriers.

**59. D** — Directional selection occurs when individuals at one extreme of a trait distribution are favored, shifting the population's average toward that extreme over generations. The classic example is the peppered moth, in which darker individuals were favored as tree bark darkened during industrialization.

**60. A** — In biology, fitness is defined strictly as reproductive success — the ability to survive long enough to reproduce and pass alleles to the next generation. Strength, intelligence, and size matter only insofar as they contribute to producing surviving offspring.

**61. B** — Structural adaptations are inherited physical features of an organism's body, such as fur color, body shape, or limb structure. Polar bear fur is an inherited body trait, not a learned behavior or a temporary physiological change.

**62. C** — Predator and prey populations are linked in a feedback loop: as prey increase, predators have more food and reproduce more; as predators rise, prey populations fall; reduced prey then causes predator populations to decline. The result is the classic oscillating cycle seen in lynx and hare data.

**63. D** — Carbon dioxide is a greenhouse gas that absorbs infrared radiation and re-emits it toward Earth's surface, warming the lower atmosphere. Rising atmospheric CO<sub>2</sub> from fossil fuel combustion is the primary driver of recent global warming.

**64. A** — The kidneys filter blood through nephrons, removing nitrogenous wastes (especially urea) and adjusting water, salt, and pH levels. By controlling fluid composition and volume, kidneys play a central role in maintaining homeostasis.

**65. C** — Veins carry blood back to the heart under low pressure, so their walls are thinner than those of arteries. One-way valves inside veins prevent backflow, keeping blood moving toward the heart against gravity in the limbs.

**66. B** — In the alveoli, oxygen concentration is high in the air and low in the surrounding blood, while carbon dioxide concentrations are the opposite. Gases move from high to low concentration by diffusion, requiring no cellular energy.

**67. A** — Salivary amylase breaks down starches (complex carbohydrates) into shorter sugar chains and maltose in the mouth. This is why chewing starchy foods like bread for a long time produces a slightly sweet taste as sugars are released.

**68. D** — After ovulation, the egg travels into the fallopian tube where sperm typically meet and fertilize it. The fertilized egg then continues toward the uterus, where it implants in the uterine wall to begin pregnancy.

**69. C** — The placenta is a temporary organ that forms during pregnancy and connects the developing fetus to the mother's blood supply through the umbilical cord. Nutrients, oxygen, and waste products are exchanged across the placenta without the two blood supplies mixing directly.

**70. B** — In autoimmune diseases, the immune system mistakenly identifies the body's own tissues as foreign and attacks them. In type 1 diabetes, immune cells destroy the insulin-producing beta cells of the pancreas, leading to lifelong insulin dependence.

**71. A** — Infectious or communicable diseases are caused by pathogens that can be transmitted between individuals through contact, droplets, water, food, or vectors. Chronic, genetic, and degenerative conditions are not contagious in this way.

**72. D** — Antibodies are Y-shaped proteins produced by B lymphocytes that bind to specific antigens on pathogens. Once bound, antibodies mark pathogens for destruction by other immune cells or neutralize them directly.

## **PART D – LABORATORY PRACTICAL (Questions 73–85)**

**73. C** — In the Relationships and Biodiversity laboratory, paper chromatography is used to compare plant pigment extracts, and additional tests compare proteins and enzymes. The molecular similarities revealed help determine which species is most closely related to a hypothetical valuable plant.

**74. B** — DNA fragments are negatively charged and pulled toward the positive electrode through the gel matrix. Smaller fragments encounter less resistance in the gel pores and travel farther in a given time, while larger fragments lag behind near the wells.

**75. D** — Centimeters are the appropriate metric unit for measuring a length of a few centimeters to about a meter, the range typical for an earthworm. The other choices mix length with time or temperature units, which makes them invalid measures of length.

**76. A** — A cover slip pressed gently over the specimen flattens it, spreads the water layer evenly, and squeezes out air bubbles that would otherwise distort the image. This produces a clearer, sharper view under the microscope.

**77. C** — In the Beaks of Finches simulation, each student uses a different tool — such as tweezers, pliers, clothespins, or chopsticks — to represent a different beak type. The tool's success at picking up "food" models how beak shape affects feeding efficiency in real finches.

**78. B** — The Making Connections laboratory has students record pulse rates before, during, and after squeezing a clothespin to study how the body responds to muscle activity. The data reveal the relationship between muscle work and cardiovascular response.

**79. D** — Iodine molecules are small enough to diffuse through the dialysis tubing pores, while starch molecules are too large to pass through. When iodine enters and meets starch inside the tubing, it produces the characteristic blue-black color, confirming the iodine moved in.

**80. C** — By convention, the independent variable (what the experimenter changes) is plotted on the horizontal x-axis, while the dependent variable (what is measured) is plotted on the vertical y-axis. This standard layout allows graphs to be read consistently across all scientific work.

**81. A** — The independent variable is the factor the experimenter intentionally changes to test its effect. The dependent variable is measured in response, and controlled variables are held constant — together these define the structure of a controlled experiment.

**82. B** — At higher magnification, the field of view is much smaller, so anything not centered under low power will fall outside the field once the higher objective is rotated into place. Centering the specimen first ensures it remains visible after switching.

**83. D** — Broken glass poses cut and contamination hazards and should never be placed in regular trash, left on the floor, or handled bare-handed. A clearly labeled broken-glass container safely contains the sharp material until proper disposal.

**84. C** — Removing the least successful "finches" from the next round models differential survival and reproduction — the core mechanism of natural selection. Over rounds, the population shifts toward beak types that gather food more efficiently, just as it would in nature.

**85. B** — The four required New York State Living Environment labs are Relationships and Biodiversity, Making Connections, Beaks of Finches, and Diffusion Through a Membrane. The other choices are not part of the required state-mandated lab investigations.