PRACTICE EXAM 12: LIVING ENVIRONMENT REGENTS SIMULATION

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

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

Answer all questions in this part.

1. All living organisms must carry out which of the following life processes?

A. Metabolism, growth, response to stimuli, and reproduction

B. Photosynthesis, decomposition, and fermentation simultaneously

C. Locomotion, predation, and symbiosis at every life stage

D. Vocalization, social cooperation, and tool use within groups

2. The principle that all cells come from pre-existing cells was a major addition to

A. Mendel's laws of inheritance

B. Darwin's theory of evolution

C. the cell theory in biology

D. the laws of thermodynamics in physics

3. Proteins are made up of long chains of subunits called

A. simple sugars

B. amino acids

C. fatty acids

D. nucleotides

4. Substances that are too large to pass through the cell membrane by diffusion may enter the cell by

A. evaporation through small surface pores in the membrane

B. condensation across the membrane during periods of low pressure

C. filtration through the membrane driven by gravity from above

D. endocytosis, in which the membrane forms a vesicle around the substance

5. An enzyme that has been exposed to very high temperatures will lose its function because

A. the enzyme is converted into a different type of molecule entirely

B. the enzyme reacts chemically with the substrate molecules permanently

C. heat alters the enzyme's three-dimensional shape (denaturation)

D. the enzyme dissolves into the surrounding water completely

6. The green color of most plant leaves is due to a pigment called

A. chlorophyll

B. hemoglobin

C. melanin

D. carotene

7. The molecule that cells use directly as their main source of usable chemical energy is

A. glucose stored within the cytoplasm

B. starch in the form of small granules

C. fat stored within adipose tissue cells

D. ATP produced primarily in mitochondria

8. A DNA molecule consists of two strands twisted together to form a

A. flat circular ring

B. double helix

C. branched tree structure

D. single straight line

9. A diploid human body cell contains 46 chromosomes. After meiosis, each gamete will contain

A. 23 chromosomes

B. 46 chromosomes

C. 92 chromosomes

D. 12 chromosomes

10. In a cross between a homozygous tall pea plant (TT) and a homozygous short pea plant (tt), all of the offspring will be

A. homozygous tall (TT)

B. homozygous short (tt)

C. half tall and half short

D. heterozygous and tall (Tt)

11. A man with blood type B (genotype I^B i) and a woman with blood type A (genotype I^A i) could have a child with which blood type?

A. Only type AB

B. Only type O

C. Any of the four blood types A, B, AB, or O

D. Only type A or B, but not type O or AB

12. Skin cancer is most often associated with exposure to

A. ultraviolet radiation from sunlight

B. radio waves from electronic devices

C. infrared radiation from heat sources

D. visible light from indoor lamps

13. Cystic fibrosis is an autosomal recessive disorder. Two healthy parents have a child with cystic fibrosis. The most likely genotype of each parent is

A. homozygous dominant for the cystic fibrosis allele

B. heterozygous, each carrying one recessive allele

C. homozygous recessive but showing no symptoms

D. lacking the gene that causes cystic fibrosis entirely

14. Hemophilia is an X-linked recessive disorder. A man with hemophilia (X^h Y) marries a woman who is a carrier (X^H X^h). What is the probability that their son will have hemophilia?

A. 0%

B. 25%

C. 50%

D. 100%

15. The fossil record shows that whales evolved from four-legged land mammals. The best evidence for this conclusion is

A. the fact that modern whales spend their entire lives in the ocean

B. the chemical similarities between whale blubber and mammal body fat

C. the absence of any other large aquatic mammals in the modern world

D. transitional fossils showing intermediate forms with reduced hind limbs

16. Bacteria that survive antibiotic treatment and reproduce represent an example of

A. natural selection favoring resistant individuals already in the population

B. spontaneous generation of new bacteria during treatment

C. bacteria adapting their genes intentionally to survive

D. the antibiotic creating beneficial mutations in the bacteria

17. The thick waxy coating on the leaves of desert plants is an adaptation that helps the plant

A. attract pollinators visiting from neighboring oases

B. absorb additional sunlight for photosynthesis

C. reduce water loss through evaporation from the leaf surface

D. increase the rate of carbon dioxide uptake during drought

18. Two populations of birds are separated by a mountain range for thousands of years. When the populations are reunited, the birds no longer recognize each other's courtship songs and do not interbreed. This is an example of

A. directional selection eliminating intermediate phenotypes

B. competitive exclusion of one species by the other

C. parallel evolution producing identical traits independently

D. reproductive isolation leading to two distinct species

19. Which of the following includes both biotic and abiotic factors in a given area?

A. a population of one species of bird

B. an ecosystem such as a freshwater pond

C. a single organism such as a deer

D. a community of plants and animals in a forest

20. Producers at the base of a food chain obtain their energy from

A. sunlight, which they convert into chemical energy through photosynthesis

B. dead organisms that they consume to obtain nutrients directly

C. inorganic minerals dissolved in water and soil deposits

D. other producers that they compete with for resources

21. In an energy pyramid, the percentage of energy transferred from one trophic level to the next is approximately

A. 100%, since all energy is passed on completely

B. 50%, since half the energy is retained at each level

C. 25%, since one-fourth of the energy is transferred

D. 10%, since most energy is lost as heat

22. Carbon is returned to the atmosphere as carbon dioxide through which of the following processes?

A. photosynthesis carried out by green plants and algae

B. the formation of fossil fuels deep underground over time

C. cellular respiration and the burning of fossil fuels

D. the absorption of nitrogen by leguminous plants

23. In the water cycle, the process by which plants release water vapor into the atmosphere through their leaves is called

A. precipitation

B. transpiration

C. condensation

D. evaporation

24. A person's body temperature is regulated mainly by which structure in the brain?

A. the hypothalamus

B. the cerebellum

C. the medulla oblongata

D. the corpus callosum

25. The function of red blood cells in the human body is to

A. fight off invading pathogens in the bloodstream daily

B. produce antibodies during an active immune response

C. transport oxygen from the lungs to body tissues

D. form blood clots at the site of an injury

26. The exchange of gases between the blood and the air during breathing takes place in the

A. trachea

B. bronchi

C. larynx

D. alveoli

27. Bile, which helps to break down fats in the digestive system, is produced by the

A. pancreas

B. liver

C. stomach

D. small intestine

28. The hormone insulin is produced by the

A. pancreas, in response to high blood glucose levels

B. liver, in response to a sudden drop in blood pressure

C. kidneys, in response to dehydration of body tissues

D. thyroid gland, in response to cold temperatures

29. Antibiotics are effective treatments for

A. viral infections such as the common cold

B. fungal infections of the skin in most cases

C. genetic disorders inherited from one's parents

D. bacterial infections such as strep throat

30. A child receives a vaccine against measles. The vaccine works by

A. supplying ready-made antibodies that immediately neutralize the measles virus

B. providing antibiotics that destroy the measles virus directly upon contact

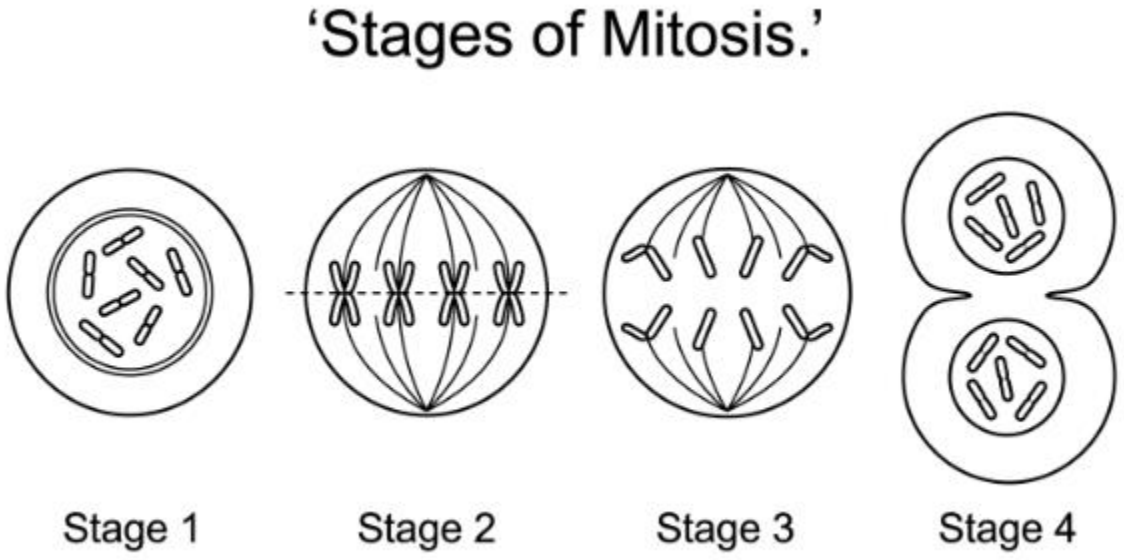
C. exposing the immune system to weakened virus so it produces memory cells

D. permanently altering the child's DNA to prevent the virus from replicating

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

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

31. A student examines a labeled diagram showing four stages of cell division in an animal cell.



Based on the diagram, which stage shows chromosomes aligned at the center of the cell?

A. Stage 2

B. Stage 1

C. Stage 4

D. Stage 3

32. Referring to the same diagram, which stage shows the separation of sister chromatids being pulled toward opposite poles?

A. Stage 1

B. Stage 3

C. Stage 2

D. Stage 4

33. Referring to the same diagram, the production of two daughter cells with identical genetic material occurs at

A. Stage 1

B. Stage 2

C. Stage 3

D. Stage 4

34. Referring to the same diagram, this process of cell division is best described as

A. meiosis producing four haploid gametes for sexual reproduction

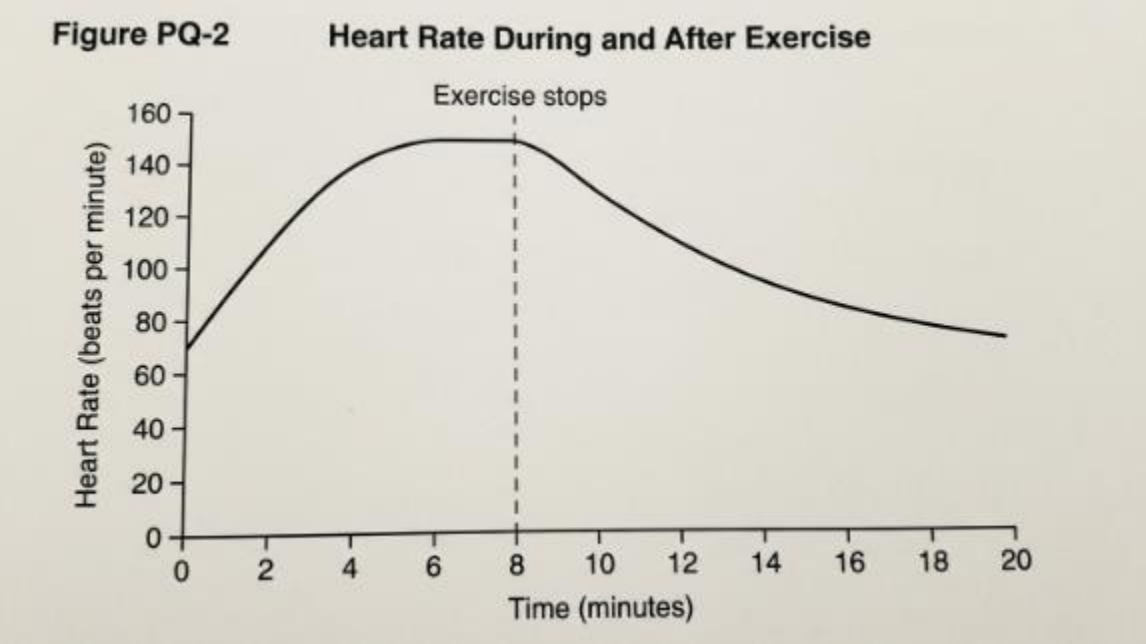
B. binary fission carried out by a prokaryotic bacterial cell

C. mitosis producing two genetically identical diploid cells

D. cytokinesis occurring without any preceding nuclear division

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

35. A student measures the heart rate of a healthy individual during and after exercise.



Based on the graph, the resting heart rate of this individual is approximately

A. 150 beats per minute

B. 70 beats per minute

C. 95 beats per minute

D. 110 beats per minute

36. Based on the same graph, the heart rate increased during exercise primarily because

A. the body's tissues required more oxygen and nutrients during exertion

B. the heart muscle became weaker and could not pump efficiently

C. body temperature dropped rapidly and required compensation

D. the lungs produced less carbon dioxide during physical activity

37. Based on the same graph, the gradual return of heart rate toward the resting value after exercise stopped illustrates

A. positive feedback amplifying the changes caused by exercise

B. random fluctuation in heart rate unrelated to physical activity

C. the heart's inability to recover quickly from physical stress

D. negative feedback restoring homeostasis after physical activity

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

38. A scientist studies a population of insects and tracks the frequency of two color phenotypes over five years in an area where new predators have been introduced.

Year	Green Insects (%)	Brown Insects (%)
1	75	25
2	68	32
3	55	45
4	40	60
5	25	75

Based on the data, the brown insect phenotype is becoming more common most likely because

A. the brown coloration mutates faster than the green coloration

B. brown insects are better camouflaged from the new predators

C. green insects reproduce more slowly than brown insects do

D. brown insects deliberately seek out other brown insects to mate

39. Based on the same data, the relationship between the green and brown insect populations is best described as

A. independent, with no influence between the two phenotypes

B. mutualistic, with each phenotype benefiting from the other

C. inversely related, as one increases the other decreases

D. directly proportional, both increasing together over time

40. Based on the same data, this five-year change in phenotype frequency is best described as an example of

A. natural selection acting on heritable color variation

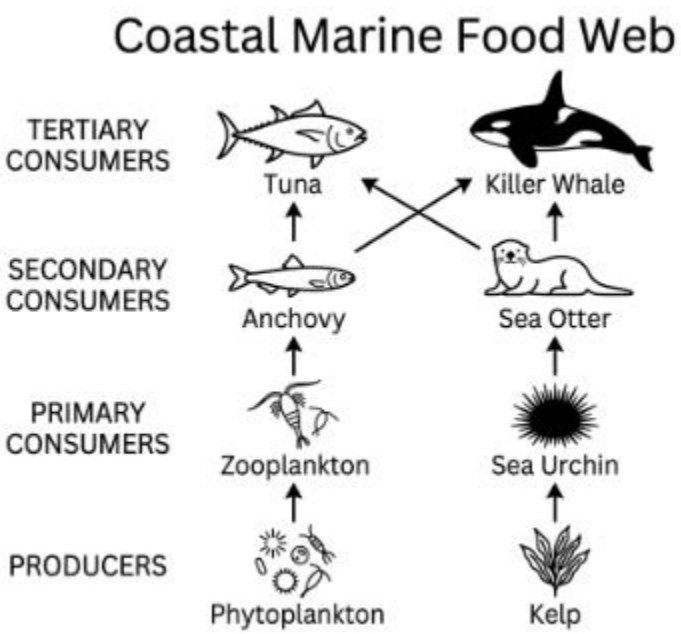
B. genetic engineering performed by the scientist directly

C. sexual selection driven by mate preferences alone

D. random genetic drift unrelated to the environment

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

41. A student examines a food web for a coastal marine ecosystem.



Based on the food web, the Killer Whale is best classified as

A. a producer at the base of the marine food web

B. a primary consumer that feeds on producers only

C. a secondary consumer in the middle of the web

D. a top predator that feeds on multiple trophic levels

42. Based on the same food web, if the Sea Otter population were drastically reduced by disease, the most likely short-term effect would be

A. a sudden decline in the Phytoplankton population due to lack of grazers

B. an increase in the Sea Urchin population, leading to overgrazing of Kelp

C. a complete disappearance of the Anchovy population from the area

D. an immediate die-off of Tuna due to lack of available food

43. Based on the same food web, the Killer Whale feeds at how many different trophic levels?

A. one trophic level only

B. four different trophic levels

C. two different trophic levels

D. three different trophic levels

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

Answer all questions in this part.

44. A student designs an experiment to test the effect of music on plant growth. To make the experiment scientifically valid, the student should

A. use multiple plants in both the experimental and control groups

B. test only one plant exposed to music for a single hour total

C. compare plants grown in different rooms with different conditions

D. judge plant growth subjectively without taking measurements

45. In the same experiment, which factor would be the dependent variable?

A. the type of music played to the plants in the experiment

B. the species of plant used for the experimental trial

C. the amount of water given to each plant per day

D. the change in height of the plants over the testing period

46. A scientific theory is best defined as

A. an educated guess that has not yet been tested experimentally

B. a well-supported explanation of natural phenomena based on extensive evidence

C. an opinion held by a single scientist working in a particular field

D. a guess about what might happen if an experiment were conducted

47. In gel electrophoresis, DNA fragments separate based on

A. their size, with smaller fragments moving farther through the gel

B. their color, since each fragment is a different color in the gel

C. the temperature at which they were created in the laboratory

D. the time of day at which the electric current was applied

48. Cloning a sheep involves

A. randomly combining genes from two different sheep parents

B. injecting bacterial DNA into a sheep embryo during gestation

C. transferring the nucleus of a body cell into an egg that has had its nucleus removed

D. crossing a sheep with a goat to create a hybrid animal species

49. A group of similar cells working together to perform a specific function forms

A. an organ system

B. a tissue

C. an organism

D. an organ

50. The fact that nerve cells, muscle cells, and blood cells all have the same DNA but look very different is best explained by

A. random mutations that occurred during embryonic development

B. the loss of certain genes from each specialized cell type

C. environmental factors directly altering each cell's appearance

D. differential gene expression in different cell types

51. Cells that require large amounts of energy, such as muscle cells, tend to contain

A. fewer ribosomes than less active cells in the body

B. larger central vacuoles than other body cells in tissues

C. more mitochondria than less active cells in the body

D. thicker cell walls than other body cells found in tissues

52. Water absorbed from the soil moves up through a tree primarily through specialized tissue called

A. xylem, found throughout the trunk and stems

B. phloem, which carries water downward to the roots

C. cambium, which produces new cells in the trunk

D. epidermis, the outermost protective layer of the plant

53. In which type of cell would you expect to find a large number of chloroplasts?

A. a human muscle cell during contraction

B. a green leaf cell in a sunlit plant

C. a bacterial cell in the human intestine

D. a fungal cell decomposing dead wood

54. In flowering plants, fertilization occurs after pollen is transferred to the

A. roots, where it travels upward through the stem to the flower

B. leaves, where photosynthesis is actively taking place

C. petals, which protect the developing seeds within the flower

D. stigma, from which sperm travels down to the ovule

55. Bees and flowering plants have a mutualistic relationship because

A. bees harm the plants while obtaining nectar from them

B. plants prevent bees from reproducing in their habitat

C. bees pollinate the flowers while collecting nectar for food

D. bees and plants compete with each other for nutrients

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

Answer all questions in this part.

56. During heavy exercise, muscle cells may temporarily switch from aerobic respiration to lactic acid fermentation because

A. oxygen is being used faster than it can be delivered to the muscle

B. lactic acid produces more energy than aerobic respiration overall

C. the muscle cells have completely run out of glucose for energy

D. carbon dioxide levels in the blood have decreased significantly

57. A red blood cell placed in a solution of distilled water (a hypotonic solution) will

A. shrink as water leaves the cell through the membrane

B. remain the same size as in normal blood plasma

C. develop a thick outer cell wall to protect itself from damage

D. swell and may burst due to the inflow of water by osmosis

58. Lichens consist of fungi and algae living together, with the fungus providing structure and the algae providing food through photosynthesis. This relationship is best described as

A. parasitism, with the fungus benefiting at the algae's expense

B. mutualism, since both partners benefit from the relationship

C. commensalism, since only the fungus benefits from the algae

D. competition, since both organisms need the same resources

59. After a forest fire destroys all the vegetation in an area, grasses and weedy plants are the first to grow back. Over many years they are replaced by shrubs and eventually by mature trees. This process is called

A. primary succession on bare rock

B. extinction of an entire community

C. secondary succession in a disturbed ecosystem

D. invasion by a non-native species

60. The introduction of an invasive species to a new ecosystem can disrupt the ecosystem because

A. the invasive species often lacks natural predators or competitors in its new habitat

B. all invasive species evolve more rapidly than native species in any environment

C. invasive species are physically larger than all the native species combined

D. invasive species require completely different environmental conditions than natives

61. A species is considered endangered when

A. it has been observed in the wild within the past year by scientists

B. its population has declined to dangerously low levels and faces possible extinction

C. it is too abundant in its natural environment to be managed by humans

D. its members are found primarily in zoos rather than in the wild only

62. Which of the following human activities contributes most to the increase of greenhouse gases in the atmosphere?

A. recycling of plastic bottles and aluminum cans

B. planting trees in deforested regions of the world

C. using public transportation instead of private cars

D. burning fossil fuels for electricity and transportation

63. Wetlands are valuable ecosystems because they

A. filter pollutants from water, prevent flooding, and provide wildlife habitat

B. produce most of the world's oxygen through photosynthesis daily

C. supply the majority of fossil fuels that humans use each year

D. block hurricanes from reaching inland populated areas of coasts

64. A trait that is expressed only when an individual has two copies of the responsible allele is called

A. a dominant trait

B. a codominant trait

C. a recessive trait

D. a sex-linked trait

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

A. a mating between the two individuals

B. that the two individuals are identical twins

C. that one individual has died before the other

D. a parent-to-child relationship between the two

66. A gene can best be defined as

A. a complete chromosome containing all the cell's DNA

B. a single nucleotide base found within a DNA strand

C. the entire genome of an organism in its body cells

D. a segment of DNA that codes for a specific protein or trait

67. The function of a protein depends most directly on its

A. number of amino acids in the chain

B. three-dimensional shape (conformation)

C. location within the cell when it was produced

D. age in days since the protein was first made

68. Cells that no longer divide, such as most mature nerve cells, are in a phase of the cell cycle known as

A. mitosis, the active division phase of the cell cycle

B. cytokinesis, the cytoplasmic division stage of mitosis

C. G_0, a resting phase outside the active cell cycle

D. S phase, when DNA is being replicated for division

69. A doctor recommends that patients complete a full course of antibiotics even if they feel better after a few days. This recommendation helps to prevent

A. permanent damage to the patient's liver and kidneys

B. the development and spread of antibiotic-resistant bacteria

C. allergic reactions to future doses of the same medication

D. the patient from contracting viral infections in the future

70. Embryonic stem cells are of particular interest to medical researchers because they

A. are easier to obtain than other types of human cells

B. divide more slowly than other cells, allowing precise control

C. cannot be rejected by the patient's immune system under any conditions

D. have the potential to develop into any cell type in the body

71. In a diffusion experiment, a student observes that a drop of food coloring placed in still water gradually spreads until the entire container is uniformly colored. This observation illustrates that

A. molecules in liquids stop moving once they reach the bottom of the container

B. food coloring is heavier than water and sinks downward only over time

C. molecules move from areas of higher concentration to lower concentration

D. food coloring chemically reacts with water to dissolve completely

72. To estimate the size of a cell viewed under a microscope, a student measures the diameter of the field of view and

A. compares the cell's color to a standard color reference chart

B. estimates how many cells of that size would fit across the field of view

C. weighs the cell using a precise laboratory scale

D. counts the number of organelles visible inside the cell

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

Answer all questions in this part.

73. A dichotomous key used to identify an organism is structured as

A. a long list of all species arranged in alphabetical order

B. a circular flowchart with no clear endpoint for identification

C. a numbered table showing genetic relationships only

D. a series of paired contrasting statements that lead to identification

74. To test for the presence of glucose in a solution, a student would most appropriately use

A. Lugol's iodine solution, which turns blue-black

B. Benedict's solution, which turns orange-red when heated

C. bromothymol blue, which turns yellow in the presence of glucose

D. litmus paper, which changes from blue to red rapidly

75. When viewing an object under a compound light microscope, the student should center the object in the field of view at

A. low power before switching to high power for a closer view

B. high power before switching to low power for a wider view

C. the highest available magnification regardless of object size

D. the lowest available magnification only, without switching to higher power

76. In the Making Connections laboratory, students design and conduct an investigation to test a question about exercise. A good investigative question for this lab would be

A. Is it possible for a student to exercise for one hour without resting?

B. Why does my heart beat faster sometimes than at other times of day?

C. How does the duration of exercise affect the time required for pulse rate to return to resting?

D. Should everyone be required to exercise as part of their daily routine?

77. In the Beaks of Finches simulation, a tool that picks up very few seeds in each round represents a

A. dominant gene that will rapidly spread through the population

B. beak variation that confers low fitness in the current environment

C. random mutation that will be repaired by enzymes shortly afterward

D. learned behavior that improves with practice during the simulation

78. In the Relationships and Biodiversity laboratory, students compare physical structures, biochemical similarities, and DNA sequences of different species. The most reliable single line of evidence for determining relatedness is generally

A. similarities in habitat between two species today

B. structural similarities in physical body features

C. biochemical similarity of enzymes considered alone

D. similarity in DNA base sequences between species

79. In the Diffusion Through a Membrane laboratory, a student notices that the contents of the dialysis tubing turn blue-black after adding Lugol's iodine to the surrounding water. This change indicates that

A. iodine molecules diffused through the tubing and reacted with starch inside

B. starch molecules diffused out of the tubing and into the surrounding water

C. glucose molecules reacted with iodine to produce the blue-black color

D. the dialysis tubing dissolved completely in the iodine solution

80. When a student needs to dispose of broken glass during a laboratory activity, the correct procedure is to

A. throw the broken glass directly into the regular classroom trash bin

B. wash the broken pieces in the sink and reuse them later if possible

C. place the broken glass in a specially marked broken-glass container

D. leave the broken glass on the laboratory counter for the teacher to remove

81. A student uses a metric ruler to measure the length of a leaf. The most accurate way to record this measurement is to

A. estimate the length to the nearest centimeter without using the markings

B. measure the leaf without aligning it with the start of the ruler scale

C. average measurements taken from different angles by different students

D. align the leaf with the zero mark and read the length to the nearest millimeter

82. In an experiment investigating the effect of a fertilizer on plant growth, the control group should consist of plants that

A. are given a different type of fertilizer than the experimental group

B. are grown under the same conditions but receive no fertilizer

C. are watered only once during the entire course of the experiment

D. are grown in a different greenhouse than the experimental group

83. When constructing a graph of experimental data, the title of the graph should

A. clearly describe the relationship being shown between the variables

B. include only the name of the student conducting the experiment

C. list every data point recorded in tabular form below the title

D. be a single word that names one of the variables being tested

84. A student conducts an experiment three times and obtains slightly different results each time. Repeating the experiment multiple times helps to

A. increase the size of the largest data value recorded in the table

B. eliminate any need for statistical analysis of the experimental results

C. account for random variation and improve the reliability of the results

D. ensure that the hypothesis will always be supported by the data collected

85. After completing an experiment, a student finds that the experimental results support the hypothesis. The most appropriate next step is to

A. publish the conclusion as a proven fact in a scientific journal immediately

B. consider further testing to confirm the result before drawing firm conclusions

C. modify the original hypothesis to match the results obtained

D. discard the data and start over with a different hypothesis to test

EXPLAINED ANSWER KEY — PRACTICE EXAM 12

1. A — All living organisms share a core set of life processes: metabolism (acquiring and using energy), growth, response to stimuli, and reproduction. Other features such as photosynthesis, locomotion, or vocalization apply only to specific groups of organisms and are not universal to all life.

2. C — The principle "all cells come from pre-existing cells," formulated by Rudolf Virchow, was added to the original work of Schleiden and Schwann to complete the modern cell theory. It rejected the older idea of spontaneous generation and established that cellular reproduction is the only source of new cells.

3. B — Proteins are polymers made of long chains of amino acids linked by peptide bonds. The sequence of amino acids — encoded by the gene — determines how the protein folds and therefore what function it can perform in the cell.

4. D — Endocytosis is a process in which the cell membrane folds inward around a large particle and pinches off a vesicle, bringing the substance into the cell. This is how cells take in molecules and even other cells too large to cross the membrane by ordinary diffusion or transport channels.

5. C — High temperatures disrupt the hydrogen bonds and other weak interactions that maintain an enzyme's specific three-dimensional shape, a process called denaturation. Because the active site loses its precise structure, the enzyme can no longer bind its substrate and catalyze the reaction.

6. A — Chlorophyll is the green pigment found in the thylakoid membranes of chloroplasts, where it absorbs red and blue light for photosynthesis and reflects green light, giving leaves their characteristic color. Hemoglobin, melanin, and carotene are unrelated to leaf coloration.

7. D — ATP (adenosine triphosphate) is the immediate, usable energy currency of all cells, produced primarily in mitochondria during aerobic respiration. Glucose, starch, and fats are longer-term energy stores that must first be broken down to generate ATP.

8. B — A DNA molecule consists of two complementary nucleotide strands wound around each other in the form of a right-handed double helix, with the sugar-phosphate backbones on the outside and the base pairs on the inside. This structure was first described by Watson and Crick in 1953.

9. A — Meiosis is a reduction division that halves the chromosome number, so a human gamete (sperm or egg) contains 23 chromosomes — one from each homologous pair. Fertilization then combines two gametes (23 + 23) to restore the diploid number of 46 in the zygote.

10. D — A TT × tt cross produces 100% Tt offspring: each gamete from the TT parent carries T, each gamete from the tt parent carries t, so every zygote receives one of each allele. Since T is dominant, all offspring will be heterozygous and display the tall phenotype.

11. C — A cross of I^B i × I^A i produces four equally likely genotypes — I^A I^B (AB), I^A i (A), I^B i (B), and ii (O) — so all four ABO blood types are possible. This illustrates how multiple alleles (I^A, I^B, i) interact, with I^A and I^B codominant and i recessive.

12. A — Ultraviolet (UV) radiation from sunlight damages DNA in skin cells by forming pyrimidine dimers, and accumulated mutations in growth-control genes can lead to skin cancers such as melanoma. Visible light, radio waves, and infrared radiation lack the energy needed to cause this level of DNA damage.

13. B — Because cystic fibrosis is autosomal recessive, the affected child must be homozygous recessive, which requires inheriting one recessive allele from each parent. Both healthy parents must therefore be heterozygous carriers — they each have one normal and one cystic fibrosis allele but do not show symptoms themselves.

14. C — In the cross X^h Y × X^H X^h, the father always passes Y to his sons, so sons inherit their single X from the mother. The mother passes X^H or X^h with equal probability, giving each son a 50% chance of receiving X^h and expressing hemophilia.

15. D — Transitional fossils of whale ancestors such as *Pakicetus*, *Ambulocetus*, and *Dorudon* show a clear sequence of intermediate forms with progressively reduced hind limbs and increasingly aquatic adaptations. This fossil series provides direct, dated evidence that modern whales descended from four-legged terrestrial mammals.

16. A — In a bacterial population, a few individuals already carry random mutations that confer antibiotic resistance. When the antibiotic is applied, susceptible bacteria die while resistant ones survive and reproduce, so the resistance allele increases in frequency — a textbook case of natural selection.

17. C — The thick waxy cuticle on desert plant leaves acts as a water-impermeable barrier that reduces transpiration from the leaf surface. Conserving water this way is critical for survival in arid environments where water loss can quickly exceed water uptake.

18. D — When the reunited populations no longer interbreed because of altered courtship behavior, they are reproductively isolated — they cannot exchange genes even when in contact. By the biological species concept, this means two distinct species have formed (allopatric speciation followed by behavioral isolation).

19. B — An ecosystem is defined as a community of living organisms (biotic factors) together with the physical and chemical environment (abiotic factors such as water, soil, light, and temperature). Populations, organisms, and communities all describe biotic groupings without explicitly including the abiotic surroundings.

20. A — Photosynthetic producers (plants, algae, cyanobacteria) capture energy from sunlight and convert it into chemical energy stored in glucose. This process introduces the energy that subsequently flows through every other trophic level in the food chain.

21. D — In a typical energy pyramid, only about 10% of the energy at one trophic level is incorporated into the biomass of the next; the other ~90% is lost as heat through metabolism and as undigested material. This 10% rule is the reason food chains rarely extend beyond four or five levels.

22. C — Cellular respiration carried out by living organisms continuously releases CO_2, and the human combustion of fossil fuels adds large additional quantities of CO_2 to the atmosphere. Photosynthesis is the opposite process (CO_2 uptake), and nitrogen fixation affects the nitrogen cycle, not carbon.

23. B — Transpiration is the process by which plants lose water vapor to the atmosphere through tiny openings called stomata on their leaves. This water loss helps draw water (and dissolved minerals) upward from the roots through the xylem.

24. A — The hypothalamus is the brain's primary control center for body temperature, acting like a thermostat that detects temperature changes and triggers compensatory responses such as sweating, shivering, vasodilation, or vasoconstriction. The other listed brain regions handle coordination, vital reflexes, or interhemispheric communication.

25. C — Red blood cells contain hemoglobin, an iron-rich protein that reversibly binds oxygen, allowing them to transport O_2 from the lungs to the body's tissues and CO_2 back to the lungs. White blood cells handle immune defense, and platelets handle clotting.

26. D — The alveoli are tiny thin-walled air sacs surrounded by capillaries deep in the lungs, where oxygen diffuses into the blood and carbon dioxide diffuses out. The trachea, bronchi, and larynx merely conduct air to and from these gas-exchange surfaces.

27. B — Bile is produced by the liver and stored in the gallbladder before being released into the small intestine, where it emulsifies dietary fats into small droplets that lipase can act on. The pancreas releases digestive enzymes but does not produce bile.

28. A — Insulin is produced by the beta cells of the islets of Langerhans in the pancreas in response to elevated blood glucose, particularly after meals. It signals body cells (especially muscle, fat, and liver) to take up glucose, lowering blood sugar back toward homeostasis.

29. D — Antibiotics target cellular structures and processes unique to bacteria, such as cell walls or bacterial ribosomes, making them effective against bacterial infections like strep throat. They have no effect on viruses, fungi, or genetic disorders, which lack these bacterial-specific targets.

30. C — A measles vaccine introduces a weakened (attenuated) form of the virus that cannot cause disease but does carry the same antigens as the wild virus. The immune system responds by producing antibodies and long-lived memory cells, so any future exposure to measles is met with a rapid, protective response.

31. A — Stage 2 shows chromosomes aligned along the equator of the cell (the metaphase plate), which is the defining feature of metaphase. This alignment ensures that each daughter cell will receive exactly one copy of every chromosome during the next stage.

32. B — Stage 3 depicts sister chromatids being pulled apart toward opposite poles by spindle fibers, which is characteristic of anaphase. The equal separation of sister chromatids is what guarantees genetic equivalence between the two daughter cells.

33. D — Stage 4 shows two daughter cells separated by a cleavage furrow, each with its own nucleus — the result of telophase and cytokinesis. At this point the original cell has fully divided into two genetically identical cells.

34. C — The diagram shows a single division that produces two daughter cells with the same chromosome number as the parent, which is the defining feature of mitosis. Meiosis would require two divisions and produce four haploid cells, ruling out the other options.

35. B — At time 0 on the graph, before any exercise begins, the heart rate is approximately 70 beats per minute. This baseline value represents the individual's resting heart rate, which falls within the normal adult range of about 60–100 bpm.

36. A — Exercise increases the metabolic demand of skeletal muscle for oxygen and glucose and the need to remove carbon dioxide and heat. The heart responds by beating faster to deliver more oxygenated blood to working tissues, producing the steep rise seen on the graph.

37. D — After exercise stops, sensors detect that physiological parameters have shifted from set point, and the body activates responses that slow the heart back down — a classic negative feedback loop restoring homeostasis. The gradual decline from the peak back toward 70 bpm reflects this regulated return to baseline.

38. B — Predation acts as a selective pressure, and brown insects against a new background (perhaps darker bark or soil) blend in better than green ones. Better-camouflaged individuals survive at higher rates and leave more offspring, so the brown phenotype increases in frequency over the five years.

39. C — The data show that as the percentage of brown insects rises (25 → 75%), the percentage of green insects falls (75 → 25%). Since the two percentages must add to 100, they are inversely related — an increase in one is necessarily matched by a decrease in the other.

40. A — A heritable variation (color) is associated with differential survival and reproduction in the presence of a new selective agent (predators), producing a shift in allele frequencies across generations. This is the textbook definition of natural selection in action.

41. D — In the food web shown, the Killer Whale has no predators and feeds on both Tuna (a tertiary consumer in the fish chain) and Sea Otter (a secondary consumer in the kelp chain). Feeding at the highest level on multiple chains makes it a top (apex) predator.

42. B — Sea Otters are a keystone species that keep Sea Urchin populations in check; without them, urchins multiply rapidly and graze down kelp forests. This trophic cascade illustrates how the loss of a single predator can drastically reshape an entire ecosystem.

43. C — The Killer Whale's two prey items in this web are the Tuna (a tertiary consumer) and the Sea Otter (a secondary consumer). Eating from these two different trophic levels gives a count of two — not one, three, or four.

44. A — A valid experiment requires multiple individuals (replicates) in both the experimental and control groups so that random variation can be averaged out and results compared meaningfully. Using a single plant or making subjective judgments leaves the conclusions vulnerable to chance and bias.

45. D — The dependent variable is the outcome that is measured to detect any effect of the independent variable. Here the experimenter manipulates the music (independent variable) and measures the resulting change in plant height (dependent variable).

46. B — In science, a "theory" is a comprehensive, well-substantiated explanation of natural phenomena that is supported by a large body of evidence from multiple lines of investigation. Examples include the theory of evolution and the cell theory — far stronger than an everyday "guess" or "hunch."

47. A — Gel electrophoresis applies an electric field across an agarose gel, drawing negatively charged DNA fragments toward the positive electrode. Smaller fragments move through the gel matrix more easily and travel farther, separating the fragments by size and producing distinct bands.

48. C — Cloning by somatic cell nuclear transfer (SCNT), the technique used to clone Dolly the sheep, removes the nucleus from an egg cell and replaces it with the nucleus of a body cell from the donor animal. The egg then develops using the donor's genome, producing a genetic copy of the donor.

49. B — A tissue is a group of similar cells working together to carry out a specific function — for example, muscle tissue or epithelial tissue. Tissues combine to form organs, organs combine to form organ systems, and systems combine to form whole organisms.

50. D — Although every body cell contains the same DNA, only a subset of genes is actively transcribed in each cell type. This differential gene expression is what allows nerve cells, muscle cells, and blood cells to develop their distinctive structures and functions from an identical genome.

51. C — Mitochondria are the primary site of ATP production through aerobic respiration, so cells with high energy demands — such as muscle cells, sperm cells, and liver cells — contain large numbers of mitochondria. The greater the energy requirement, the more mitochondria are typically present.

52. A — Xylem is the vascular tissue in plants that transports water and dissolved minerals upward from the roots through the stems and into the leaves. Phloem moves sugars produced in photosynthesis, and the cambium and epidermis perform other roles unrelated to upward water transport.

53. B — Chloroplasts are the site of photosynthesis and are abundant in the green photosynthetic cells of plant leaves, where light absorption is maximized. Animal, bacterial, and fungal cells lack chloroplasts because they do not perform photosynthesis.

54. D — Pollen lands on the sticky stigma at the top of the carpel, then sends out a pollen tube that grows down through the style to deliver sperm cells to the ovule inside the ovary, where fertilization occurs. The stigma is therefore the receptive surface for pollination.

55. C — Bees obtain nectar (a food source) from flowers, and in the process pollen sticks to their bodies and is transferred to other flowers, accomplishing pollination. Both the bees (food) and the plants (reproduction) benefit, defining a mutualistic relationship.

56. A — During heavy exercise, the demand for oxygen in working muscle cells can exceed the rate at which the cardiovascular and respiratory systems can deliver it. Without enough O_2 to complete aerobic respiration, muscles supplement ATP production by lactic acid fermentation, which does not require oxygen.

57. D — In a hypotonic solution such as distilled water, water moves into the red blood cell by osmosis because the cytoplasm is more solute-concentrated than the surrounding water. Lacking a cell wall, the cell swells and may eventually burst (a process called hemolysis).

58. B — In a mutualistic relationship, both partners benefit: in lichens, the fungus provides structure, water retention, and mineral nutrients, while the photosynthetic alga (or cyanobacterium) supplies organic food via photosynthesis. Each partner survives more successfully together than apart.

59. C — Secondary succession is the predictable sequence of community change that occurs in an area where vegetation has been destroyed but the soil remains intact, as after a fire. The progression from grasses to shrubs to trees is faster than primary succession because soil and seed banks are already present.

60. A — Invasive species in a new ecosystem often lack the natural predators, parasites, and competitors that controlled them in their native range. Freed from these constraints, their populations can explode and outcompete or consume native species, disrupting the ecosystem's balance.

61. B — An endangered species is one whose population has dropped to dangerously low levels and is at serious risk of becoming extinct in the near future. Conservation laws and recovery plans are designed to protect such species and reverse population declines.

62. D — Burning fossil fuels (coal, oil, natural gas) for electricity generation, transportation, and industry releases enormous quantities of CO_2 into the atmosphere and is the largest single human contribution to greenhouse gas emissions. Recycling, tree planting, and public transportation reduce emissions rather than add to them.

63. A — Wetlands provide critical ecosystem services: they trap and filter pollutants from runoff, store and slowly release floodwater (reducing downstream flooding), and offer habitat for a high diversity of plants, fish, birds, and amphibians. These functions make them among the most ecologically valuable habitats on Earth.

64. C — A recessive trait is expressed only when both alleles for the trait are recessive (homozygous recessive). A single dominant allele in a heterozygote will mask the recessive allele and prevent the recessive trait from appearing.

65. A — In a pedigree, a horizontal line connecting two individuals (typically a circle and a square) represents a mating between them, and a vertical line extending down from that horizontal line connects them to their offspring. Identical twins and death are shown with different conventions.

66. D — A gene is a specific segment of DNA on a chromosome that contains the coding instructions for a particular protein (or, in some cases, a functional RNA) and thereby influences a trait. A chromosome contains many genes, and a single nucleotide is only a building block of a gene.

67. B — A protein's function depends on its three-dimensional shape, because the shape determines which other molecules it can bind to and how it interacts with them. Even small changes in the amino acid sequence can disrupt folding and abolish protein function, as in sickle cell hemoglobin.

68. C — G_0 is a non-dividing resting phase outside the active cell cycle. Cells such as mature neurons enter G_0 once they have differentiated and generally remain there for the life of the organism, performing their specialized function without dividing further.

69. B — Stopping antibiotics early can leave behind partially resistant bacteria that survive the incomplete treatment and reproduce, increasing the prevalence of resistant strains. Completing the full course eliminates more of the bacterial population and reduces the chance that resistance will develop and spread.

70. D — Embryonic stem cells are pluripotent — they can differentiate into virtually any cell type in the body, from neurons to muscle to blood. This developmental versatility makes them especially promising for research and potential therapies aimed at repairing or replacing damaged tissues.

71. C — Diffusion is the net movement of molecules from regions of higher concentration to regions of lower concentration, driven by random molecular motion. The food coloring spreads until its molecules are evenly distributed throughout the water, when the system reaches equilibrium.

72. B — Once the diameter of the field of view is known (often measured at low power), the size of a specimen can be estimated by judging what fraction of the field it occupies — for example, "about 5 cells span the field, so each cell is about one-fifth of the diameter." This is the standard low-tech method for sizing structures under a microscope.

73. D — A dichotomous key consists of a sequence of paired contrasting statements; at each step the user picks the statement that fits the unknown organism and is directed to the next pair, eventually arriving at an identification. The branching, paired structure is what makes it "dichotomous."

74. B — Benedict's reagent is used to detect reducing sugars such as glucose: when heated with a glucose-containing solution, it changes from clear blue to green, yellow, or orange-red depending on concentration. Lugol's iodine detects starch, and bromothymol blue detects CO_2/pH changes.

75. A — Microscopists always begin at low power because the wide field of view makes it easy to find and center the specimen, and the working distance is large enough to prevent damage. Once the object is centered and roughly focused, switching to higher power keeps the specimen in view and brings finer detail into focus.

76. C — A good investigative question is specific, testable, and identifies the variables to be measured. "How does the duration of exercise affect the time required for pulse rate to return to resting?" clearly identifies the independent variable (duration), the dependent variable (recovery time), and can be answered with data.

77. B — In the simulation, tools represent variations in beak structure, and a tool that captures few seeds models a beak that is poorly suited to the available food. Such a finch would be less likely to obtain enough energy to survive and reproduce, illustrating low fitness in the current environment.

78. D — DNA base sequences provide the most direct and quantitative record of evolutionary relatedness: the fewer the differences between two species' homologous DNA sequences, the more recently they shared a common ancestor. Structural and biochemical similarities can support this evidence, but DNA data are generally the strongest single line.

79. A — Iodine molecules are small enough to pass through the pores of the dialysis tubing, while starch molecules are too large to leave. When iodine enters the tubing and contacts the starch inside, the characteristic blue-black color reaction occurs *within* the bag, confirming the starch's location.

80. C — Broken glass must be placed in a clearly labeled, puncture-resistant broken-glass container so that custodians and other students are not cut. It should never go into the regular trash, be left on the bench, or be reused for laboratory work.

81. D — Accurate measurement with a metric ruler requires aligning the object precisely with the zero mark on the scale and reading the length to the smallest division indicated — for a typical ruler, the nearest millimeter. Estimation or misalignment introduces avoidable measurement error.

82. B — A proper control group differs from the experimental group only in the variable being tested. Plants in the control group should therefore receive no fertilizer but be grown under all the same other conditions, so that any difference in growth can be attributed specifically to the fertilizer.

83. A — A graph's title should clearly convey what relationship the graph is illustrating — typically the dependent variable in terms of the independent variable (e.g., "Effect of Temperature on Enzyme Activity"). This allows the reader to understand the data at a glance, before examining the axes in detail.

84. C — Repeating an experiment provides multiple data points that can be averaged, allowing random variation (caused by uncontrolled factors and measurement error) to be smoothed out. The more replicates, the more reliable and reproducible the resulting conclusions become.

85. B — Even when results appear to support the hypothesis, sound scientific practice calls for further testing — often by independent researchers and under varied conditions — before treating the hypothesis as well-confirmed. Premature claims of proof undermine scientific credibility and can lead to retractions later.