PRACTICE EXAM 41: LIFE SCIENCE: BIOLOGY SIMULATION (50 QUESTIONS)

Instructions: This simulation exam mirrors the format of the New York State Regents Examination in Life Science: Biology. Questions are organized into stimulus-based clusters. Read each cluster's stimulus completely before answering any questions in that set. Select the one best answer for each question.

Base your answers to questions 1 through 5 on the information below and on your knowledge of biology.

Eukaryotic cells contain many specialized organelles that work together to produce and process the molecules the cell needs. Ribosomes are tiny structures that synthesize proteins by translating mRNA. The endoplasmic reticulum (ER) is a network of membranes connected to the nuclear envelope; rough ER has ribosomes attached to its outer surface and helps process the proteins they produce, while smooth ER (without ribosomes) makes lipids and detoxifies certain substances. The Golgi apparatus receives proteins and lipids from the ER, modifies them, and packages them in vesicles for delivery to other parts of the cell. Lysosomes contain digestive enzymes that break down worn-out cell parts, large molecules, and engulfed particles such as bacteria.

1. Proteins are synthesized in the cell by:

A. The Golgi apparatus, which is responsible for the manufacture of all cellular proteins
B. The smooth endoplasmic reticulum, which makes lipids and proteins together at the same time
C. The lysosomes, which contain the enzymes needed to assemble polypeptide chains in the cell
D. The ribosomes, which translate mRNA into chains of amino acids

2. Rough endoplasmic reticulum is given its name because:

A. It has ribosomes attached to its outer surface, giving it a "rough" appearance under a microscope
B. It contains rough particles of digestive enzymes that break down proteins in the cell
C. It has a wrinkled membrane that is unlike any other organelle of the cell
D. It functions only during the rough early stages of a cell's life cycle

3. The Golgi apparatus is best compared to a:

A. Power plant, because it produces the energy that the cell uses throughout the day
B. Library, because it stores all of the genetic information used by the cell every day
C. Shipping and packaging center, because it modifies and packages molecules for delivery
D. Wall, because it surrounds the cell and protects it from harmful external substances

4. Lysosomes are sometimes called the cell's "recycling centers" because they:

A. Generate ATP molecules from the breakdown of nutrients in the cell's cytoplasm
B. Contain digestive enzymes that break down worn-out cell parts and engulfed particles
C. Produce new ribosomes that synthesize proteins as the cell grows during its lifetime
D. Convert sunlight into the chemical energy that the cell uses to perform work

5. A cell that secretes large amounts of protein would be expected to have:

A. A particularly extensive rough endoplasmic reticulum and many ribosomes
B. Very few ribosomes since cells that secrete proteins do not normally synthesize many proteins
C. Many chloroplasts that help with the synthesis of all of the secreted proteins
D. No Golgi apparatus, since cells that secrete proteins do not need to package them

Base your answers to questions 6 through 10 on the information below and on your knowledge of biology.

A class investigated how substrate concentration affects the rate of an enzyme-catalyzed reaction. They used a fixed amount of the enzyme amylase (which breaks down starch) and added increasing concentrations of starch (the substrate). The rate of reaction was measured by how quickly the starch was broken down at each concentration. Temperature and pH were held constant. Results:

Trial	Starch concentration (%)	Reaction rate (units/min)
1	0.0	0
2	0.5	5
3	1.0	10
4	2.0	18
5	4.0	24
6	8.0	26
7	16.0	26

6. The independent variable in this investigation is the:

A. Reaction rate, measured in units per minute at each level of starch in the test tube
B. Temperature and pH, which were both held constant throughout the experiment

C. Starch concentration (percentage), which was varied between each trial
D. Amount of amylase enzyme, which was kept the same in every trial

7. As substrate concentration increases from 0.5% to 4.0%, the reaction rate:

A. Decreases steadily as more starch is added to the reaction mixture in each trial
B. Increases as more substrate becomes available for the enzyme to act on
C. Stays the same regardless of the substrate concentration in the reaction mixture
D. Rises and falls in a random pattern as substrate concentration changes between trials

8. Between Trials 6 and 7, the reaction rate stops increasing. This plateau is best explained by the fact that:

A. The enzyme has been completely destroyed by exposure to high substrate levels
B. The temperature of the reaction mixture has been raised between the two trials
C. The pH of the reaction mixture has changed sharply between the two trials
D. All available enzyme active sites are occupied (the enzyme is "saturated")

9. If the experiment were repeated with twice as much enzyme, the plateau reaction rate would most likely:

A. Roughly double, because more enzymes mean more active sites available to act on substrate
B. Stay exactly the same, since enzyme amount has no effect on the plateau rate at all
C. Decrease by half, because more enzymes compete with each other for available substrate
D. Drop to zero, because excess enzyme always blocks any further reaction from happening

10. In Trial 1, the reaction rate is zero. This occurs because:

A. The enzyme has been denatured by extreme conditions in the experimental setup
B. The product of the reaction has built up and stopped the reaction completely
C. No substrate is present, so the enzyme has nothing to act on in the test tube
D. The reaction has reached its substrate-saturated plateau at zero concentration

Base your answers to questions 11 through 15 on the information below and on your knowledge of biology.

Flowering plants reproduce sexually through structures called flowers. A typical flower contains both male and female reproductive parts. The male parts, called stamens, consist of anthers (where pollen grains are produced) on the ends of long filaments. The female parts, called the pistil (or carpel), consist of an ovary at the base, a style above it, and a stigma at the top. Pollination is the transfer of pollen from the anther to the stigma. Many flowers rely on animals (insects, birds, bats) for pollination, while others use wind. After pollination, sperm cells from the pollen grain travel down through the style to the ovary, where fertilization occurs. The fertilized ovules develop into seeds, and the ovary develops into the fruit that contains them.

11. The male reproductive structure of a flower is the:

A. Pistil, which produces the ovules that develop into the seeds of the plant
B. Ovary, which contains the eggs that are fertilized by the sperm of the plant
C. Stigma, which receives pollen grains from another flower during pollination
D. Stamen, which consists of an anther on a long filament that produces pollen

12. Pollen grains are produced in the:

A. Stigma, the sticky structure at the top of the pistil where pollen lands
B. Anther, the structure at the top of the stamen of a typical flowering plant
C. Ovary, the structure at the base of the pistil that contains the ovules
D. Filament, the long stalk that supports the pollen-producing structure of a flower

13. Pollination is the transfer of:

A. Pollen from the anther of one flower to the stigma of another (or the same) flower
B. Sperm cells directly from one flower's ovary to another flower's ovary during reproduction
C. Nectar from one flower to another by pollinating insects searching for food in the area
D. Fertilized ovules from the ovary of one plant to the soil where they will grow

14. After pollination and fertilization, the ovary of a flower develops into:

A. A new pollen grain that is released to start the next generation of plants
B. A new stamen of a flower that will produce the next generation of pollen
C. A fruit, which contains the seeds that develop from the fertilized ovules
D. A new leaf that contributes to the plant's photosynthesis for the next year

15. A flower that produces brightly colored petals and a sweet fragrance is most likely pollinated by:

A. Wind, which carries the pollen passively from flower to flower across long distances
B. Water, which moves the pollen between flowers in aquatic plants near streams
C. Gravity, which pulls the pollen straight down from the flower to the soil below
D. Animals such as insects or birds, which are attracted to the petals' color and scent

Base your answers to questions 16 through 20 on the information below and on your knowledge of biology.

ATP (adenosine triphosphate) is the main energy-carrying molecule of cells. An ATP molecule contains three phosphate groups linked together. When the last phosphate is removed, energy is released and ATP becomes ADP (adenosine diphosphate). When a cell has plenty of energy available (for example, from cellular respiration), ADP can be combined with another phosphate group to make ATP again. This continuous cycling between ATP and ADP allows cells to capture energy from food and release it where and when it is needed. ATP is sometimes called the "energy currency" of cells because it carries energy in a usable form to nearly every energy-requiring process.

16. When a cell breaks down ATP to release energy, ATP is converted to:

A. Glucose, which the cell breaks down further in cellular respiration to release more energy
B. ADP and an inorganic phosphate, releasing the energy that was stored in the chemical bond
C. RNA, which the cell uses to make new proteins from amino acids in the cytoplasm
D. Carbon dioxide and water, the same products produced during cellular respiration

17. ADP can be converted back to ATP by:

A. Releasing one phosphate group and giving off energy at the same time
B. Combining with glucose to produce more energy for the cell's daily needs at once
C. Adding another phosphate group, which requires an input of energy
D. Splitting into two smaller molecules that each store half of the cell's energy

18. ATP is sometimes called the "energy currency" of the cell because:

A. It carries energy in a usable form to nearly every energy-requiring process in the cell
B. It is the only molecule in the cell that contains any kind of chemical energy at all
C. It is exchanged between cells the way currency is exchanged between people in society
D. It can be converted directly into money in financial transactions made by the cell

19. The energy needed to convert ADP back into ATP comes primarily from:

A. Sunlight absorbed directly by ATP molecules in animal cells throughout the day
B. The breakdown of waste materials produced by the cell during its normal functions
C. The active transport of ions across the cell membrane through specialized proteins
D. Cellular respiration, which releases energy from glucose to drive the formation of ATP

20. Why does a cell need to make ATP continuously rather than storing it in large amounts?

A. ATP is the only energy source the cell needs, so storage is unnecessary at all times
B. ATP is used very rapidly, so cells must produce it continuously to meet ongoing energy needs
C. ATP is permanently stored in the nucleus of the cell for use during emergencies only
D. ATP cannot be stored anywhere because it would damage the cell if it were collected

Base your answers to questions 21 through 25 on the information below and on your knowledge of biology.

A mutation is a change in the DNA sequence of an organism. Mutations can occur naturally during DNA replication or be caused by environmental factors such as ultraviolet radiation, certain chemicals (mutagens), or viruses. A point mutation involves the substitution, addition, or deletion of a single nucleotide base. A frameshift mutation occurs when one or more nucleotides are added or deleted, shifting the reading frame of the mRNA and changing the codons that follow. Mutations can be harmful, helpful, or neutral. Harmful mutations may cause disease (such as sickle cell anemia, which results from a single base change). Helpful mutations may give an organism an advantage and can spread through a population by natural selection. Many mutations are neutral and have no effect on the organism.

21. A change in a single nucleotide of DNA is called a:

A. Frameshift mutation, which always shifts the reading frame of the entire mRNA molecule
B. Chromosomal mutation, which changes the structure of an entire chromosome in the cell
C. Point mutation, which involves a change in a single nucleotide of the DNA
D. Nondisjunction event, which is a failure of chromosomes to separate in meiosis

22. Sickle cell anemia is caused by:

A. A single base substitution in the gene that codes for hemoglobin, the protein in red blood cells
B. The deletion of an entire chromosome from each cell of an affected individual
C. A duplication of the chromosome that carries the hemoglobin gene in red blood cells
D. The complete failure of the body to produce any hemoglobin in red blood cells

23. Mutations are important to evolution because they:

A. Always benefit the organism by improving its ability to survive in any environment
B. Are guaranteed to be passed on to every offspring of the affected individual at birth
C. Quickly produce entirely new species within a single generation of the affected organism
D. Provide the source of genetic variation upon which natural selection acts

24. Ultraviolet radiation can act as a mutagen because it:

A. Increases the rate of cellular respiration in cells exposed to UV light directly
B. Damages DNA and can cause changes in the nucleotide sequence of the molecule
C. Provides extra energy that the cell uses to repair existing damage to DNA molecules
D. Heats the cell's DNA, causing it to melt completely into single strands at low temperatures

25. A frameshift mutation typically has more drastic effects than a single base substitution because it:

A. Always occurs on the X chromosome, where it affects both males and females equally
B. Changes the gene's location on the chromosome and disrupts other genes nearby in the cell
C. Shifts the reading frame so that all codons downstream of the mutation are altered
D. Causes the cell to stop transcribing all of its DNA permanently after the mutation occurs

Base your answers to questions 26 through 30 on the information below and on your knowledge of biology.

Genetic engineering is the deliberate modification of an organism's DNA. One common technique uses restriction enzymes, which are special "molecular scissors" that cut DNA at specific recognition sequences. When the same restriction enzyme cuts DNA from two different sources (for example, a human gene and a bacterial plasmid), the cut ends have matching sequences and can be joined together using another enzyme called DNA ligase. The new DNA molecule, containing genetic material from two different sources, is called recombinant DNA. This technique has many applications, including the production of human insulin by bacteria that have been given the human insulin gene. Genetically modified bacteria, plants, and animals are now used to produce medicines, improve crops, and study diseases.

26. Restriction enzymes are useful in genetic engineering because they:

A. Cut DNA at specific recognition sequences, allowing scientists to isolate particular pieces of DNA
B. Make exact copies of large DNA molecules with great speed and accuracy in a test tube
C. Add new nucleotides to DNA strands during the process of replication in the lab
D. Translate mRNA into proteins inside the cells of genetically engineered bacteria

27. DNA ligase is used in genetic engineering to:

A. Cut large DNA molecules into smaller fragments at specific recognition sequences
B. Join two pieces of DNA together to form a single continuous strand of DNA
C. Copy mRNA into DNA so that the gene can be inserted into a new organism's genome
D. Translate the genetic code of DNA into a chain of amino acids in the laboratory

28. Bacteria are commonly used to produce human insulin because:

A. Bacteria naturally produce human insulin without any modification at all
B. Human insulin is far less expensive to extract from bacteria than to make in the lab by hand
C. The bacteria absorb insulin directly from their growth medium for human use
D. Bacteria can be modified to contain and express the human insulin gene, and they reproduce quickly

29. The fact that a human gene can function inside a bacterium is strong evidence for:

A. The independent evolution of bacteria and humans on different continents over time
B. The recent introduction of bacterial DNA into human cells in nature by some unknown process
C. The universality of the genetic code in nearly all organisms
D. The complete genetic similarity between humans and bacteria today

30. A piece of DNA containing genetic material from two different sources is called:

A. Recombinant DNA, since it has been recombined from multiple sources by the experimenter
B. Mitochondrial DNA, which is the only DNA found in human cells that has multiple sources
C. Junk DNA, which carries no information and is therefore considered to be wasted
D. Vestigial DNA, which is left over from organisms' evolutionary ancestors and has no use

Base your answers to questions 31 through 35 on the information below and on your knowledge of biology.

Populations grow in different patterns depending on environmental conditions. Exponential growth (sometimes shown as a "J-shaped curve") occurs when resources are unlimited: the population's size doubles, then doubles again, growing faster and faster over time. Exponential growth is uncommon in nature because resources are always limited eventually. Logistic growth (an "S-shaped curve") is more typical: a population grows rapidly at first, then slows as it approaches the carrying capacity (K) of its environment, and eventually levels off. Real populations often follow logistic patterns because limiting factors such as food, space, and disease constrain their numbers. When a population briefly grows beyond carrying capacity, it usually experiences a "die-off" before returning to a sustainable level.

31. Exponential growth is sometimes called "J-shaped" because:

A. The graph of population size over time is shaped like a wide capital letter U
B. The graph of population size over time has a curve that resembles the letter J
C. The growth of the population follows a perfectly straight upward line over time
D. The growth pattern of the population produces a wavy line that resembles a J shape

32. Logistic growth differs from exponential growth in that logistic growth:

A. Continues forever at the same rate without any change at all over time
B. Decreases the population to zero by the end of a single growing season
C. Only occurs in laboratory cultures of microbes, not in any populations in the wild
D. Slows as the population approaches the carrying capacity of the environment

33. Exponential growth is uncommon in nature because:

A. Most populations can be perfectly controlled by predators and disease at all times
B. Most populations have no available food, water, or space to begin growing in the wild
C. Resources are always limited, so factors eventually slow population growth
D. The environment always cools too rapidly for any population to grow exponentially

34. The leveling-off portion of the S-shaped logistic curve occurs because:

A. The population has reached the carrying capacity of its environment
B. The population is in the early phase of growth, before reproduction has begun in earnest

C. The population is shrinking because of a die-off from disease and starvation in the area
D. The population is undergoing exponential growth without any environmental limits

35. A bacterial culture growing in fresh nutrient broth shows exponential growth for several hours. Eventually, growth slows and stops. The most likely reason is that:

A. The bacteria have suddenly evolved a new way of growing that bypasses all old rules
B. Nutrients have been used up and waste products have accumulated in the broth
C. The bacteria have been transferred to a different container without their notice
D. The bacterial cells have decided to stop reproducing in order to save energy for later

Base your answers to questions 36 through 40 on the information below and on your knowledge of biology.

Bioremediation is the use of living organisms — usually microbes or plants — to clean up environmental pollution. Certain bacteria and fungi can metabolize harmful substances such as petroleum, pesticides, or solvents, breaking them down into less toxic compounds. For example, after oil spills, microbes that consume hydrocarbons can be added to the spill area, where they help degrade the oil. Some plants can also absorb and store heavy metals from contaminated soil (a process sometimes called "phytoremediation"). Bioremediation is often less expensive and less environmentally disruptive than physical removal of pollutants, but it can be slow and may not work for all contaminants.

36. Bioremediation is best defined as:

A. The use of physical removal techniques such as dredging to clean up pollution from soil
B. The complete elimination of all microorganisms from a polluted environment by humans
C. The application of fertilizers to polluted water to promote algal blooms in the area
D. The use of living organisms (such as microbes or plants) to clean up environmental pollution

37. Certain bacteria can be used to clean up oil spills because they:

A. Filter the oil through their cell membranes and release it back into the environment unchanged
B. Cool the oil by absorbing heat from the surrounding water, causing the oil to solidify in place
C. Metabolize the hydrocarbons in the oil and break them down into less harmful compounds
D. Carry the oil in their bodies away from the spill site to a different ocean location

38. One advantage of bioremediation compared with physical cleanup methods is that it:

A. Is often less expensive and less environmentally disruptive than removing pollutants by hand
B. Always produces results within a few hours regardless of the size of the contamination
C. Removes 100% of all pollutants from every contaminated site under any condition
D. Eliminates the need to monitor the cleanup site at all after the bioremediation begins

39. Phytoremediation is a specific form of bioremediation that uses:

A. Bacteria to break down petroleum products and other oils in contaminated soils
B. Plants to absorb and store heavy metals or other pollutants from contaminated soil
C. Fungi to digest large quantities of pesticides on the surface of farm fields
D. Fish to filter pollutants from contaminated streams and rivers in farm areas

40. A limitation of bioremediation is that it:

A. Always produces large amounts of harmful waste that cannot be safely disposed of
B. Creates new pollutants that are far more harmful than the original contamination
C. Permanently destroys all the microbes in the ecosystem where it is applied
D. Can be slow and may not work effectively for every type of pollutant

Base your answers to questions 41 through 45 on the information below and on your knowledge of biology.

The fossil record is the collection of fossils preserved in sedimentary rock layers around the world. Fossils provide a partial history of life on Earth, including evidence of organisms that no longer exist. By dating fossils — either by their position in rock layers (relative dating) or by radioactive dating techniques (absolute dating) — scientists can construct a timeline of life. The fossil record shows that life has changed dramatically over Earth's 4.6-billion-year history. Several "mass extinction" events have occurred, in which a large fraction of species disappeared in a relatively short time. The most famous example is the extinction of the (non-avian) dinosaurs about 66 million years ago, likely caused by a large asteroid impact combined with other factors. After each mass extinction, the surviving species diversified into new forms in a phenomenon called "adaptive radiation."

41. The fossil record is best described as:

A. The DNA found inside the cells of ancient organisms that have been preserved underground
B. The bones of recently deceased animals found at the surface of Earth in tropical regions
C. The collection of fossils preserved in sedimentary rock layers around the world over time
D. A digital catalog of all the fossils ever discovered, stored in museums around the globe

42. Determining the age of a fossil by measuring the radioactive isotopes it contains is called:

A. Absolute (or radiometric) dating, which gives a specific age in years for a fossil
B. Relative dating, which only ranks fossils as older or younger but gives no specific ages
C. Carbon dating only, the single method used for all fossils regardless of their age
D. Strata dating, which gives the geographic location of the fossil but not its age

43. A mass extinction event is best described as:

A. The slow disappearance of a single species over millions of years of geological time
B. A relatively rapid loss of a large fraction of Earth's species in a short period of time
C. The appearance of many new species during a single generation of organisms on Earth
D. The slow rise in biodiversity over the course of Earth's 4.6-billion-year history

44. The extinction of the (non-avian) dinosaurs about 66 million years ago is thought to have been caused largely by:

A. The slow cooling of Earth over the course of several million years of climate change
B. The evolution of mammals, which directly outcompeted the dinosaurs for food and habitat
C. The arrival of early human hunters, who hunted all of the dinosaurs to extinction
D. A large asteroid impact (along with other factors) that drastically altered global climate

45. After a mass extinction, surviving species often undergo:

A. Complete genetic stasis, with no further evolutionary change for millions of years afterward
B. A return to their pre-extinction populations within just a single generation of organisms
C. Adaptive radiation, in which surviving lineages diversify rapidly into new ecological niches
D. The same kind of mass extinction event repeating within a few decades after the first one

Base your answers to questions 46 through 50 on the information below and on your knowledge of biology.

The human excretory system removes waste products from the body and helps maintain homeostasis. The major organs of the urinary excretory system are the kidneys, which filter the blood; the ureters, which carry urine from the kidneys; the urinary bladder, which stores urine; and the urethra, which releases urine from the body. Inside each kidney are about a million tiny filtering units called nephrons. As blood flows through a nephron, water, salts, urea, and other small molecules are filtered out. Useful substances such as glucose and most of the water are reabsorbed back into the blood; wastes such as urea (a nitrogen-containing waste from the breakdown of proteins) remain in the urine. The kidneys also help regulate the blood's water content, ion concentration, and pH.

46. The basic filtering unit of the kidney is called the:

A. Nephron, of which there are about one million in each kidney of the body
B. Alveolus, the structure where gas exchange takes place in the human lungs
C. Villus, the tiny projection that helps absorb nutrients in the small intestine
D. Neuron, the basic cell of the nervous system that transmits the body's signals

47. The kidneys help maintain homeostasis by:

A. Producing the body's blood cells, which carry oxygen from the lungs to body tissues
B. Producing the digestive enzymes that the body uses to break down ingested foods
C. Storing the body's main supply of carbohydrates and proteins for daily use
D. Filtering wastes from the blood and regulating water, ions, and pH of the body fluids

48. Urea, the major nitrogen-containing waste filtered by the kidneys, comes from the breakdown of:

A. Carbohydrates such as starches and sugars in the diet of an organism
B. Proteins (which contain nitrogen in their amino acid building blocks)
C. Fats and oils in the bloodstream after a high-fat meal has been consumed by the body
D. Water in the bloodstream, which the body breaks down to release nitrogen for use

49. The correct sequence of urine flow through the excretory system is:

A. Kidneys → urethra → urinary bladder → ureters → out of the body
B. Urinary bladder → kidneys → ureters → urethra → out of the body
C. Kidneys → ureters → urinary bladder → urethra → out of the body
D. Ureters → kidneys → urethra → urinary bladder → out of the body

50. During the formation of urine in a nephron, glucose is normally:

A. Reabsorbed back into the blood because the body needs it as an energy source
B. Excreted entirely in the urine because the body cannot make use of any glucose
C. Broken down into amino acids before it leaves the kidney to be used elsewhere
D. Converted into urea by the nephron before being excreted from the body

PRACTICE EXAM 41 — EXPLAINED ANSWER KEY (Q1–Q50)

1. D — Ribosomes are the molecular machines that read mRNA and assemble proteins by linking amino acids together. They can be free in the cytoplasm or attached to the rough endoplasmic reticulum. Neither the Golgi, the smooth ER, nor lysosomes synthesize proteins.

2. A — Rough ER gets its name from the studded appearance produced by ribosomes bound to its outer (cytoplasmic) surface. Those bound ribosomes feed newly made proteins directly into the ER for processing. Smooth ER lacks ribosomes and therefore looks smooth.

3. C — The Golgi receives proteins and lipids from the ER, chemically modifies them, sorts them, and ships them out in transport vesicles to their final destinations. This sorting-and-shipping role is what the "packaging center" analogy captures. Nothing about the Golgi resembles a power plant, library, or wall.

4. B — Lysosomes are sacs of hydrolytic enzymes that digest old organelles, worn-out macromolecules, and ingested particles such as bacteria. Their products are then reused by the cell, which is why they are called recycling centers. Defects in lysosomes cause storage diseases like Tay-Sachs.

5. A — Cells that secrete large amounts of protein need extensive protein-synthesis and processing capacity, so they contain abundant ribosomes and rough ER. Plasma cells, pancreatic acinar cells, and other secretory cells are textbook examples. Structure-function matching is a recurring theme in cell biology.

6. C — The independent variable is the one the experimenter deliberately changes between trials, and here only the starch concentration varies from trial to trial. Enzyme amount, temperature, and pH are controlled variables. Reaction rate is the dependent variable.

7. B — At low substrate concentrations, more substrate means more frequent collisions with enzyme active sites and therefore faster reaction. The data show the rate climbing from 5 to 24 units/min as starch rises from 0.5% to 4.0%. This is the classic initial portion of the substrate-saturation curve.

8. D — At very high substrate concentrations, every active site is essentially always occupied; adding more substrate cannot speed the reaction further. The enzyme is said to be saturated. This produces the characteristic plateau seen between Trials 6 and 7.

9. A — The plateau rate is limited by the number of available active sites. Doubling the enzyme doubles the number of active sites, allowing the reaction to run roughly twice as fast at saturation. This is why enzyme concentration scales the maximum rate (V_max) directly.

10. C — Enzymes require substrate to act on; with starch concentration at 0%, there is nothing for amylase to break down. The enzyme itself is fine, but it has no work to do. This baseline confirms the experiment is measuring substrate-driven activity.

11. D — The stamen, made up of the anther and its supporting filament, is the male reproductive part of a flower. The pistil (with its ovary, style, and stigma) is the female structure. Knowing this division of parts is fundamental to plant reproduction.

12. B — Pollen grains develop inside the anthers, which sit at the tops of the stamens. The filament merely supports the anther, while the stigma and ovary are female structures. When mature, the anther splits open to release pollen.

13. A — Pollination, by definition, is the movement of pollen from a flower's anther to a stigma — either on the same flower (self-pollination) or on another flower (cross-pollination). It is a prerequisite for fertilization but is not fertilization itself. Many agents perform this transfer, including wind, water, and animals.

14. C — After fertilization, the ovary wall develops into the fruit, which encloses and protects the seeds (the matured ovules). This is why fruits like apples, tomatoes, and peaches contain seeds at their core. Fruits also help disperse seeds by attracting animals.

15. D — Bright colors and sweet fragrance are classic floral advertisements for animal pollinators such as bees, butterflies, hummingbirds, and bats. Wind-pollinated flowers, by contrast, tend to be small, dull, and unscented. The flower's appearance reflects its pollination strategy.

16. B — Breaking the bond between the second and third phosphate releases the energy stored there and leaves behind ADP (adenosine diphosphate) plus a free inorganic phosphate. The released energy is used to power cellular work. ATP and ADP cycle back and forth as the cell does its job.

17. C — Recombining a free phosphate group with ADP rebuilds the high-energy bond and produces ATP. Doing so requires an input of energy, which the cell normally obtains from cellular respiration. This is essentially the reverse of ATP breakdown.

18. A — Like money in an economy, ATP can be spent on almost any energy-requiring cellular process — muscle contraction, active transport, biosynthesis, and so on. Its universal usability across reactions is what makes it the cell's "currency." Other molecules can store energy, but few can spend it as flexibly.

19. D — Cellular respiration releases energy from glucose in a series of controlled steps, and much of that energy is captured by attaching phosphate to ADP, regenerating ATP. This is why cells continuously need food and oxygen. The ATP–ADP cycle is tightly coupled to respiration.

20. B — Cells use ATP almost as fast as they make it; a typical cell turns over its entire ATP pool many times per minute. Continuous regeneration is therefore necessary to keep up with demand. Storing ATP in large amounts is not how cells handle energy.

21. C — A point mutation is a change at a single nucleotide position — most often a substitution of one base for another, but also small insertions or deletions of single bases. Chromosomal mutations and nondisjunction involve much larger-scale changes. Frameshift mutations involve insertions or deletions that shift the reading frame.

22. A — Sickle cell anemia results from a single base substitution in the β-globin gene, which changes one amino acid (glutamic acid to valine) in hemoglobin. This small change dramatically alters how hemoglobin behaves under low oxygen. It is the classic example of how a point mutation can cause disease.

23. D — Mutations create the genetic variation that natural selection acts on; without mutation, populations could not evolve. Not all mutations are beneficial — many are neutral or harmful — but the rare beneficial ones can spread under selection. This is why mutation is sometimes called evolution's raw material.

24. B — Ultraviolet light directly damages DNA, especially by creating pyrimidine dimers that distort the helix and cause errors during replication. Resulting changes in the nucleotide sequence are mutations. UV-induced DNA damage is why excessive sun exposure raises the risk of skin cancer.

25. C — Because the ribosome reads mRNA in triplets without "punctuation," inserting or deleting one nucleotide shifts every codon downstream, changing nearly the entire protein from that point onward. A single base substitution, by contrast, alters at most one amino acid. Frameshift mutations therefore tend to be far more damaging.

26. A — Restriction enzymes are bacterial proteins that recognize specific short DNA sequences (typically 4–8 base pairs) and cut the DNA at or near those sites. This precision allows scientists to isolate particular fragments for cloning or analysis. They are the foundational tool of recombinant DNA technology.

27. B — DNA ligase forms covalent phosphodiester bonds, joining DNA fragments end-to-end. In genetic engineering, it seals together pieces of DNA that have been cut by restriction enzymes — for example, joining a human gene to a bacterial plasmid. The same enzyme is also used by cells during DNA replication and repair.

28. D — Bacteria divide rapidly, are easy to culture, and can be engineered to express foreign genes like human insulin. Inserting the human insulin gene into a plasmid and introducing that plasmid into bacteria produces large quantities of insulin cheaply. Before recombinant insulin, the hormone had to be extracted from animal pancreases.

29. C — A bacterial cell can transcribe and translate a human gene because both organisms read the same genetic code — the same codons specify the same amino acids. This universality is why genetic engineering across species is possible. It is also one of the strongest molecular arguments for common ancestry.

30. A — DNA that has been assembled from sequences originating in two or more sources is called recombinant DNA. Cutting with restriction enzymes and joining with DNA ligase is the standard way to create it. Recombinant DNA is the basis of the biotechnology industry.

31. B — When plotted, exponential growth produces a curve that climbs ever more steeply, resembling the right-hand stroke of the letter J. The shape reflects the fact that growth rate is proportional to current population size. The "J-curve" is the standard textbook description.

32. D — Logistic growth tracks exponential growth at first but slows as resources become limited, eventually leveling off at the carrying capacity. This produces the characteristic S-shaped curve. The slowdown distinguishes logistic from exponential growth.

33. C — In real environments, food, space, predators, disease, and other density-dependent factors always come into play, preventing populations from growing without bound. Exponential growth therefore tends to be a short-term phenomenon. Logistic growth, with its plateau at K, is far more representative of nature.

34. A — The flat upper portion of the S-curve corresponds to a population that has reached the environment's carrying capacity. At that point, births and deaths roughly balance, and population size stabilizes. The carrying capacity (K) is the very feature distinguishing logistic from exponential models.

35. B — In a closed nutrient broth, bacteria initially have abundant food and grow exponentially. Over time, nutrients are exhausted and toxic metabolic byproducts (such as acids and alcohols) accumulate, halting growth. This is why closed bacterial cultures show a stationary phase and eventually a death phase.

36. D — Bioremediation specifically uses living organisms — bacteria, fungi, or plants — to break down or remove environmental pollutants. Dredging, sterilization, or fertilizer addition are not bioremediation. The term is widely used in environmental engineering and ecological restoration.

37. C — Some bacteria possess enzymes that can degrade hydrocarbons such as those found in petroleum, converting them into CO_2 and water (and other less toxic compounds). After oil spills, such bacteria can be encouraged to grow on the spill. This biological breakdown is far slower than mechanical removal but reaches places mechanical methods cannot.

38. A — Bioremediation often costs less than excavation, incineration, or other physical cleanup methods and is less disruptive to ecosystems. The trade-off is that biological processes can be slower. Cost-effectiveness is one of the main reasons bioremediation has been embraced at many contaminated sites.

39. B — Phytoremediation uses plants — including certain grasses, sunflowers, and other species — to absorb heavy metals (like lead, arsenic, and cadmium) or organic pollutants from soil. The plants can then be harvested and disposed of as concentrated contaminated material. This technique has been used at metal-polluted brownfield sites.

40. D — Biological processes are usually slower than physical or chemical cleanup, and some contaminants (especially many heavy metals and synthetic chemicals) cannot be broken down by any known organism. Bioremediation also requires specific conditions (temperature, oxygen, nutrients) to work well. These limitations restrict where the approach can be applied.

41. C — The fossil record refers specifically to the body of fossils preserved in sedimentary rocks around the world, used to reconstruct the history of life. Recently deceased animals at the surface are not fossils, and the record is far broader than any single museum catalog. The record is incomplete — but it is our main physical archive of prehistoric life.

42. A — Radiometric (absolute) dating uses the known decay rates of radioactive isotopes such as ^{40}K or ^{238}U to assign a specific age in years to a fossil or the rock containing it. Relative dating, by contrast, only orders fossils in time without yielding actual ages. Carbon-14 dating is one specific radiometric method, useful only for relatively young (under ~50,000-year-old) material.

43. B — A mass extinction is a relatively brief geological interval in which a large fraction (often more than half) of species go extinct worldwide. There have been at least five major mass extinctions in Earth's history. They are distinguishable in the fossil record by abrupt drops in species diversity across rock layers.

44. D — The leading explanation for the end-Cretaceous extinction is a massive asteroid impact at what is now Chicxulub (Mexico), which triggered global wildfires, debris-darkened skies, and rapid climate change. Volcanic activity (the Deccan Traps) likely added stress. Mammals did not outcompete the dinosaurs, and humans evolved tens of millions of years later.

45. C — Mass extinctions empty many ecological niches, and the surviving lineages often diversify rapidly to fill them — a pattern called adaptive radiation. The radiation of mammals after the dinosaurs disappeared is the classic example. Such radiations have repeatedly reshaped Earth's biota.

46. A — Each kidney contains roughly one million nephrons, the microscopic units that filter blood and produce urine. Alveoli, villi, and neurons belong to other organ systems. Understanding the nephron is central to understanding kidney function.

47. D — The kidneys filter the blood, removing nitrogenous wastes (mainly urea), and adjust water content, salt balance, and acid–base balance to keep the internal environment stable. They do not make blood cells, digestive enzymes, or store macronutrients. Their role in homeostasis is critical, which is why kidney failure is life-threatening.

48. B — Amino acids contain nitrogen, and when proteins (or excess amino acids) are broken down, that nitrogen is converted in the liver to urea for excretion. Carbohydrates and fats contain no nitrogen and so do not produce urea. This is why dietary protein has a noticeable effect on urea levels.

49. C — Urine is formed in the kidneys, travels down the ureters to the urinary bladder, where it is stored, and then leaves the body through the urethra. The other listed sequences scramble the anatomy. Knowing this pathway is fundamental to clinical anatomy.

50. A — In a healthy nephron, glucose is filtered into the tubule but then almost entirely reabsorbed into the bloodstream because it is a valuable energy source. Glucose normally does not appear in urine; its presence (glucosuria) often signals diabetes mellitus. This selective reabsorption is one of the kidney's key economical strategies.