PRACTICE EXAM 12 — QUESTIONS 1–50

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.

Students filled lengths of dialysis tubing with a solution containing both starch and glucose, sealed each tube, and placed each bag into a beaker of distilled water. After 30 minutes, students tested both the water inside the bag and the water in the surrounding beaker with two indicators: Lugol's iodine (turns blue-black in the presence of starch) and Benedict's reagent (turns red-orange when heated in the presence of glucose). Dialysis tubing has microscopic pores that allow small molecules to pass through but not large ones. The results are shown below.

Sample	Iodine Test	Benedict's Test
Inside bag (start)	Blue-black (starch present)	Red (glucose present)
Inside bag (30 min)	Blue-black (starch present)	Red (glucose present)
Beaker water (start)	Amber (no starch)	Blue (no glucose)
Beaker water (30 min)	Amber (no starch)	Red (glucose present)

1. What is the main scientific question this experiment is designed to investigate?

A. Whether iodine and Benedict's reagent chemically react with each other in distilled water
B. Whether starch and glucose molecules can pass through a selectively permeable membrane
C. Whether dialysis tubing can dissolve when placed in distilled water for thirty minutes
D. Whether glucose can be chemically converted into starch inside the dialysis tubing

2. Based on the data in the table, which conclusion is best supported?

A. Both starch and glucose passed through the membrane into the surrounding beaker water
B. Neither starch nor glucose passed through the membrane in either direction during the test
C. Starch passed through the membrane but glucose remained entirely inside the dialysis bag
D. Glucose passed through the membrane while starch remained inside the dialysis bag

3. Glucose passed through the dialysis tubing but starch did not. The most likely explanation is that:

A. Glucose molecules carry a positive charge that attracts them toward the water side
B. Starch molecules dissolve in water and become permanently trapped inside the bag
C. Starch molecules are too large to fit through the pores in the dialysis tubing
D. Glucose is actively pumped through the membrane using ATP supplied by the cell

4. The movement of glucose from inside the bag to the surrounding water is best described as:

A. Diffusion, in which molecules move from a higher to a lower concentration along a gradient
B. Active transport, in which ATP energy pumps molecules across a selective membrane
C. Endocytosis, in which the membrane folds inward to engulf large particles of solute
D. Osmosis, which describes the movement of water across a selectively permeable membrane

5. The dialysis tubing in this experiment serves as a model for which cellular structure?

A. The nuclear envelope, which surrounds the genetic material in eukaryotic cells
B. The endoplasmic reticulum, which folds proteins synthesized at the cellular ribosomes
C. The cell membrane, which selectively allows certain molecules to pass into the cell
D. The Golgi apparatus, which packages proteins for transport to the cell surface

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

Researchers investigated how substrate concentration affects the rate of an enzyme-catalyzed reaction. The enzyme lactase breaks down the disaccharide lactose into the simple sugars glucose and galactose. Equal volumes of lactase solution were added to test tubes containing different concentrations of lactose. The rate of glucose production in each tube was measured in micromoles per minute. The data are summarized below.

Lactose Concentration (mM)	Rate of Glucose Production (µmol/min)
1	5
2	9
5	18
10	25
20	28
50	30
100	30

6. Based on the description, the role of lactase in this reaction is best described as:

A. Providing additional substrate that combines with lactose during the reaction process
B. Catalyzing the breakdown of lactose into glucose and galactose without being consumed

C. Being consumed alongside lactose and incorporated into the products of the reaction
D. Increasing the activation energy required for lactose to break apart into smaller sugars

7. The data show that beyond approximately 20 mM lactose, the rate of reaction levels off. The best explanation for this observation is:

A. The enzyme molecules are completely destroyed at high substrate concentrations
B. The lactose molecules form clumps that prevent each other from binding to the enzyme
C. The galactose product begins inhibiting the enzyme at high substrate concentrations
D. All enzyme active sites become occupied, so adding more substrate cannot speed the reaction

8. If researchers doubled the amount of lactase enzyme while keeping the lactose concentration at 100 mM, the most likely result would be:

A. The maximum rate of reaction would approximately double from the original value
B. The maximum rate of reaction would remain unchanged because lactose is the limit
C. The reaction would stop entirely because there is too much enzyme in the solution
D. The reaction would slow down because the enzymes would compete with each other

9. People with lactose intolerance lack sufficient lactase in their digestive systems. This deficiency primarily affects their ability to:

A. Break down starches in the mouth into simpler sugars during the chewing process
B. Absorb amino acids from milk proteins into the bloodstream of the small intestine
C. Digest the sugar found in milk and dairy products in the small intestine
D. Produce the stomach acid required to begin the digestion of all dairy products

10. Lactose is best classified as which type of biological molecule?

A. A lipid, which stores energy in long fatty acid chains within living cells
B. A carbohydrate, specifically a disaccharide composed of two simple sugars
C. A protein, made up of long chains of amino acids folded into a shape
D. A nucleic acid, which carries genetic information from one generation to another

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

A class investigated how different wavelengths (colors) of light affect the rate of photosynthesis in *Elodea*, a freshwater aquatic plant. Identical sprigs of *Elodea* were placed in four test tubes of water containing sodium bicarbonate as a source of dissolved CO2. Each tube was then exposed to a different colored light filter (red, blue, yellow, or green) of equal intensity for 15 minutes. Students counted the number of oxygen bubbles released by each sprig per minute. The data are shown below.

Light Color	Bubbles per Minute
Red	28
Blue	26
Yellow	8
Green	3

11. The data suggest that *Elodea* photosynthesis is most efficient under which colors of light?

A. Red and blue light, both of which produce many more bubbles than yellow or green
B. Green and yellow light, which are absorbed strongly by chlorophyll in the cell
C. Yellow light alone, which provides the wavelengths chlorophyll uses for energy
D. Green light alone, which is the wavelength most strongly absorbed by all plant pigments

12. The very low rate of photosynthesis under green light is best explained by the fact that:

A. Green light has too much energy and destroys the chloroplasts in *Elodea* leaves
B. Green wavelengths cannot reach the chloroplasts inside *Elodea* cells under water
C. Green light contains no usable energy at all and cannot drive any photosynthesis
D. Chlorophyll reflects green light rather than absorbing it for use in photosynthesis

13. The oxygen bubbles released by the *Elodea* in this experiment come from which source?

A. The carbon dioxide molecules dissolved in the surrounding sodium bicarbonate solution
B. The glucose molecules synthesized during the light-independent reactions in chloroplasts
C. The water molecules split during the light-dependent reactions of photosynthesis
D. The ATP molecules produced inside the mitochondria of each *Elodea* leaf cell

14. Inside the *Elodea* cells, the organelle directly responsible for capturing light energy is the:

A. Chloroplast, which contains chlorophyll molecules that absorb light energy directly
B. Mitochondrion, which produces most of the cell's ATP using oxygen as a reactant
C. Ribosome, which synthesizes proteins by joining amino acids into long chains
D. Nucleus, which stores the cell's genetic information and controls cell activities

15. If the experiment were repeated using a filter that blocked all light from reaching the *Elodea*, the most likely result would be:

A. The rate of oxygen production would increase because no light energy would be wasted
B. No oxygen bubbles would be produced because photosynthesis requires light energy
C. The rate of oxygen production would equal the rate observed under green light alone
D. The *Elodea* would die immediately because chlorophyll requires constant light exposure

Base your answers to questions 16 through 19 on the information below and on your knowledge of biology.

A class investigated cellular respiration in germinating pea seeds. Three identical thermos flasks were each filled with the same number of pea seeds, prepared as described below. A thermometer was placed inside each flask and a stopper was sealed in place. The flasks were stored at room temperature (22°C) and temperatures were recorded every 4 hours for 24 hours.

Flask	Contents	Temperature After 24 Hours
1	Living germinating peas (soaked 24 h)	31°C
2	Dry, non-germinating peas (untreated)	22°C
3	Germinating peas boiled for 5 minutes to kill them	21°C

16. The temperature rise observed inside Flask 1 is best explained by the fact that:

A. Germinating seeds absorb heat from the environment more efficiently than dry seeds
B. The water surrounding germinating seeds traps solar radiation inside the sealed flask
C. Living seeds emit light energy that is then converted into heat by the flask interior
D. Living seeds release heat as a byproduct of cellular respiration during germination

17. Flask 3 (boiled germinating peas) was included in the experiment in order to:

A. Serve as a control showing that dead seeds do not carry out cellular respiration
B. Demonstrate that boiled seeds produce more heat because their cell walls are broken
C. Demonstrate that water alone is sufficient to raise the temperature inside a flask
D. Compare two different living seed types under different environmental temperatures

18. The chemical equation that best summarizes the aerobic respiration occurring in Flask 1 is:

A. carbon dioxide + water → glucose + oxygen + ATP
B. water + oxygen → glucose + carbon dioxide + ATP
C. glucose + oxygen → carbon dioxide + water + ATP
D. glucose + carbon dioxide → water + oxygen + ATP

19. If the experiment were repeated using germinating seeds in a flask filled with pure nitrogen gas instead of air, the most likely result would be:

A. The temperature rise would be greater because nitrogen traps heat more effectively
B. The temperature rise would be the same as in the original Flask 1 conditions
C. The temperature would rise faster because nitrogen accelerates the rate of respiration
D. Little or no temperature rise would occur because oxygen is needed for aerobic respiration

Base your answers to questions 20 through 24 on the information below and on your knowledge of biology.

Huntington's disease (HD) is an inherited disorder of the nervous system caused by an expansion of a repeated three-nucleotide sequence (CAG) in the HTT gene on chromosome 4. In healthy individuals, the CAG sequence repeats between 10 and 35 times within the gene. In people who develop HD, the sequence repeats more than 39 times. The expanded sequence produces a longer-than-normal huntingtin protein that misfolds and damages neurons over time. HD is inherited as an autosomal dominant trait, meaning that a single copy of the affected allele is sufficient to cause the disease.

20. The CAG triplets in the HTT gene code for the amino acid glutamine. An expanded CAG sequence therefore inserts:

A. Many additional copies of a different amino acid that is not glutamine in the protein
B. Many additional copies of the amino acid glutamine into the huntingtin protein chain
C. A stop codon that prevents the huntingtin protein from being completed by the ribosome
D. A frameshift that completely changes the amino acid sequence of the entire protein

21. Each CAG triplet codes for one amino acid because:

A. The genetic code is read in pairs of two nucleotides at a time during translation
B. Ribosomes only recognize the first base of each codon when matching amino acids
C. The genetic code reads nucleotides in groups of three, each triplet specifying one amino acid
D. CAG is the only DNA triplet that is capable of coding for glutamine in human cells

22. A person heterozygous for the Huntington's allele (one normal allele and one expanded allele) will:

A. Develop the disease, because Huntington's disease is inherited as an autosomal dominant trait
B. Not develop the disease, because two copies of the expanded allele are required
C. Develop the disease only if both copies of the gene are inherited from one parent
D. Develop the disease only after passing the allele on to one of their own children

23. A person with Huntington's disease (genotype Hh) has children with a person who does not carry the allele (genotype hh). The probability that any single child will inherit the disease is:

A. 0%, because the unaffected parent cannot pass on the disease allele to any child
B. 100%, because the affected parent must pass on the disease allele to every child
C. 25%, because only one of four genotype combinations produces an affected child
D. 50%, because the affected parent passes the expanded allele to half of their children

24. The expanded CAG repeat in the HTT gene is best classified as which type of mutation?

A. A point mutation involving a single base substitution within the gene sequence
B. An expansion mutation in which a short DNA sequence is repeated many extra times

C. A chromosomal translocation moving a segment to an entirely different chromosome
D. A silent mutation that has no effect on the amino acid sequence of the protein

Base your answers to questions 25 through 29 on the information below and on your knowledge of biology.

Red-green color blindness in humans is inherited as an X-linked recessive trait. The allele for normal color vision (X^N) is dominant to the allele for color blindness (X^n). The Y chromosome does not carry an allele for this gene. A woman with normal color vision who is a carrier of the color-blindness allele (genotype X^N X^n) has children with a man who has normal color vision (genotype X^N Y).

25. What is the probability that any single son of this couple will be color blind?

A. 0%, because color blindness cannot be inherited from a parent with normal color vision
B. 25%, because only one of four offspring genotype combinations produces color blindness
C. 50%, because half of the sons will inherit the recessive allele from their carrier mother
D. 100%, because every son will inherit the affected X chromosome from his carrier mother

26. What is the probability that any single daughter of this couple will be color blind?

A. 0%, because every daughter inherits at least one normal X^N allele from her father
B. 25%, because one of four offspring genotype combinations in the cross produces the trait
C. 50%, because half of the daughters will be homozygous for the color-blindness allele
D. 100%, because every daughter will inherit the affected X chromosome from her mother

27. Color blindness occurs more often in males than in females. The best explanation for this pattern is:

A. The gene for color vision is located on the Y chromosome, which only male children carry
B. Females naturally produce a chemical that protects them from inheriting color blindness
C. The color-blindness allele mutates more frequently during the production of male sperm
D. Males have only one X chromosome, so a single recessive allele is enough to produce the trait

28. A color-blind father and a homozygous normal-vision mother have children together. The expected outcome is:

A. All of their sons will be color blind regardless of the alleles inherited from the mother
B. None of their children will be color blind, but all of their daughters will be carriers
C. Half of their daughters will be color blind, and half of their sons will be color blind
D. All of their daughters will be color blind, and none of their sons will be color blind

29. In the Punnett square for the original cross (X^N X^n × X^N Y), the genotype X^n Y represents:

A. A female carrier who has one normal allele and one color-blindness allele on her X chromosomes
B. A male who has two copies of the color-blindness allele and is therefore color blind
C. A male who carries the color-blindness allele on his single X chromosome and is color blind
D. A female who has inherited the color-blindness allele from both of her two parents

Base your answers to questions 30 through 36 on the information below and on your knowledge of biology.

Before the Industrial Revolution in England, the peppered moth (*Biston betularia*) existed in two color forms: a light, mottled form (common) and a rare dark form. The light moths blended in with the lichen-covered tree bark on which they rested during the day, while the dark moths were highly visible against this background. By the mid-1800s, soot from coal-burning factories had darkened tree bark and killed the lichens in industrial regions of the country. Within several decades, the dark form of the moth became dramatically more common in those polluted regions. Birds are major daytime predators of these moths.

30. Before the Industrial Revolution, the light-colored moths were more common because:

A. Light moths were camouflaged on lichen-covered bark and were less likely to be eaten by birds
B. Light moths reproduced more rapidly than dark moths in every kind of environmental condition
C. Light moths actively avoided predators by hiding under leaves during the daylight hours
D. Dark moths suffered from a genetic defect that prevented them from being able to reproduce

31. After the Industrial Revolution began, the dark form of the moth became more common in polluted regions because:

A. Light moths spontaneously turned dark in response to soot from coal-burning factories
B. Dark moths were camouflaged on dark, sooty bark and were less visible to bird predators
C. Birds preferentially fed on the dark moths because they were easier to spot in the trees
D. Pollution caused random mutations that increased the reproductive rate of dark moths

32. The change in the peppered moth population is best classified as an example of:

A. Genetic engineering, in which scientists deliberately modify the genome of a species
B. Acquired characteristics, in which moths learn to change their color during their lifetime
C. Convergent evolution, in which two unrelated species develop similar physical traits
D. Natural selection, in which a heritable trait becomes more common under environmental pressure

33. The dark color form of the peppered moth existed in small numbers even before the Industrial Revolution. This pre-existing variation is best explained by:

A. The dark coloration appearing for the first time as a direct response to industrial pollution
B. The dark moths arriving in England from a different country during the early 1800s
C. Random mutations occurring in the moth population over many generations prior to the change
D. Light moths slowly converting their bodies to dark coloration during cold English winters

34. After environmental laws reduced industrial pollution in the late 1900s, lichens returned and tree bark became lighter once again. The most likely long-term outcome is:

A. The light form of the moth gradually became more common again in those formerly polluted regions
B. The dark form remained permanently dominant because evolution cannot reverse its direction
C. Both color forms went extinct because moths could not survive a sudden environmental change
D. A new third color form of the moth appeared to replace both the light and dark color types

35. Bird predation in this scenario is best described as the:

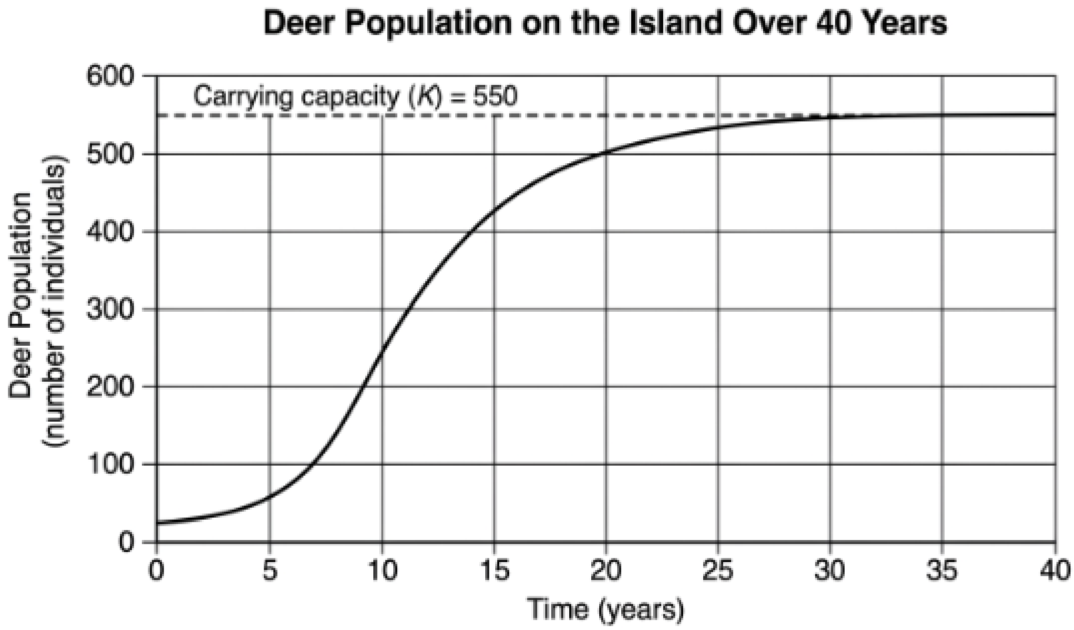
A. Mechanism that introduced the dark allele into the moth population for the very first time
B. Random factor that determined which moths reproduced regardless of their coloration
C. Process that produced new mutations in moths by damaging their genetic material
D. Selective pressure that determined which color form was more likely to survive and reproduce

36. For natural selection to act on moth coloration, the trait must be:

A. Acquired by individual moths through learning during their adult lifetimes after hatching
B. Heritable, meaning it can be passed from parent moths to their offspring through genes
C. Reversible within a single generation whenever the environment changes color again
D. Identical in every member of the moth population at the start of the selection event

Base your answers to questions 37 through 41 on the information below and on your knowledge of biology.

Ecologists studied a population of deer that was introduced to a previously deer-free island in 1980. Initially, the deer population grew rapidly. However, as the population continued to grow, the rate of increase slowed, and eventually the population leveled off at a stable size. The graph below shows the deer population on the island over a 40-year period.



37. The early portion of the deer population growth, when numbers increased rapidly, is best classified as:

A. Logistic growth, which describes a population leveling off near a maximum size
B. Linear growth, which describes a constant numerical increase per unit of time
C. Exponential growth, which describes accelerating increase under abundant resources
D. Negative growth, which describes a population that is decreasing in size over time

38. The leveling off of the deer population at a stable size is best explained by:

A. The population reaching the carrying capacity of the island's environment for deer
B. The complete loss of mating pairs after the population grew above 100 deer in total
C. A disease that infected and killed every adult deer over the age of 10 years on the island
D. Hunters deliberately introducing predators to the island specifically to control the deer

39. The factors that limit the deer population's growth on the island most likely include:

A. The amount of sunlight reaching the surface of the island throughout the year
B. The availability of food, water, and space, as well as disease and predation pressure
C. The number of trees the deer can climb to escape land-based predator pressure
D. The depth of the soil beneath the trees where the deer construct their nesting dens

40. If a new predator that hunts deer were introduced to the island, the most likely effect on the deer population would be:

A. The deer population would immediately become extinct within a few days of the predator's arrival
B. The deer population would continue growing at the same rate as before the new predator arrived

C. The deer population would suddenly double in size as the deer respond to the new threat
D. The deer population would decrease and stabilize at a lower carrying capacity than before

41. The deer population's growth pattern over the 40-year period is best described as which type of curve?

A. An S-shaped or logistic growth curve, where growth slows as carrying capacity is approached
B. A J-shaped or exponential curve, where growth continues to accelerate without any limit
C. A bell-shaped or normal distribution curve, where the population peaks and then declines
D. A flat or constant population curve, which shows no change in numbers over any time period

Base your answers to questions 42 through 46 on the information below and on your knowledge of biology.

The carbon cycle describes the movement of carbon among the atmosphere, living organisms, the oceans, and Earth's crust. Major pathways include the following: photosynthesis pulls carbon dioxide from the atmosphere into plants and other producers; cellular respiration releases carbon dioxide back into the atmosphere from living organisms; decomposition releases carbon from dead organisms into soils and the atmosphere; combustion of fossil fuels releases carbon that was stored underground for millions of years; and dissolution moves carbon dioxide between the atmosphere and the surface waters of the ocean.

42. Which process in the carbon cycle removes carbon dioxide directly from the atmosphere?

A. Cellular respiration in plants, animals, fungi, and bacteria across nearly all environments
B. Combustion of fossil fuels in factories, vehicles, and electric power plants worldwide
C. Photosynthesis carried out by green plants, algae, and other photosynthetic organisms
D. Decomposition of dead organic material by bacteria and fungi in the forest soils

43. Which human activity has contributed most directly to the recent increase in atmospheric carbon dioxide?

A. Selective breeding of domesticated farm animals over many human generations
B. Drinking large quantities of carbonated beverages containing dissolved carbon dioxide
C. Growing additional crop plants such as corn and wheat for use as human food
D. Burning fossil fuels such as coal, oil, and natural gas in vehicles and power plants

44. The carbon stored in fossil fuels originally came from:

A. Volcanic eruptions that released carbon dioxide gas from deep within Earth's mantle
B. Ancient living organisms that were buried and converted to coal, oil, and gas over time
C. Meteorites that struck Earth's surface many millions of years ago carrying organic matter
D. Carbon dioxide that was directly compressed into solid form by the weight of ocean water

45. Forests act as important carbon "sinks" because:

A. Trees absorb CO_2 during photosynthesis and store the carbon in wood and leaves for many years
B. Trees release large quantities of CO_2 into the atmosphere during their active growing seasons
C. Forests cool the surrounding atmosphere by reflecting incoming sunlight back into space
D. Forest soils are too acidic to allow the decomposition of dead organic material to occur

46. A large-scale deforestation event would most likely affect the carbon cycle by:

A. Permanently removing carbon dioxide from the atmosphere over many decades of recovery
B. Causing no measurable change because trees represent only a tiny fraction of the cycle
C. Increasing atmospheric CO_2 because fewer trees remain to absorb it through photosynthesis
D. Cooling the global climate because forests no longer release heat into the atmosphere

Base your answers to questions 47 through 50 on the information below and on your knowledge of biology.

Climate change driven by rising atmospheric carbon dioxide levels is altering ecosystems worldwide. As average global temperatures rise, many plant and animal species are shifting their ranges toward the poles or to higher elevations to remain within their preferred temperature range. Species that cannot move or adapt quickly enough face an increased risk of extinction. Coral reefs face an additional stressor: ocean warming can cause coral bleaching, in which the symbiotic algae that normally live inside coral tissues are expelled, leaving the coral colorless and starved of nutrients.

47. A species that cannot move and cannot adapt fast enough to keep up with climate change is most likely to:

A. Develop the ability to photosynthesize in order to obtain energy directly from sunlight
B. Experience population declines and face an increased risk of local or global extinction
C. Transform within one generation into a completely new species adapted to warming conditions
D. Migrate to underground caves where temperatures remain stable throughout the entire year

48. Coral bleaching occurs when:

A. Sunlight breaks down the green pigments inside the coral tissues, leaving the coral colorless
B. Predatory fish remove all of the soft tissue from the coral skeletons during their feeding
C. Acid rain falls directly onto exposed coral colonies during low-tide periods of the day
D. Heat stress causes corals to expel the symbiotic algae that normally provide them with food

49. The relationship between corals and their symbiotic algae before bleaching occurs is best described as:

A. Predation, in which corals consume the algae as their primary food source within the reef
B. Parasitism, in which the algae feed on the coral tissue without harming the algae themselves
C. Mutualism, in which both the coral and the algae benefit from living together closely
D. Competition, in which the algae and the corals fight for the same limited reef resources

50. Engineers and scientists are designing strategies to help reefs survive climate change. When evaluating different proposed strategies, the most important trade-off to consider is:

A. The balance among effectiveness, cost, side effects on the ecosystem, and feasibility of large-scale use
B. The aesthetic appeal of the engineering equipment when it is viewed from the surface of the water
C. The number of patents the engineering team has filed during the previous calendar year
D. The amount of public attention the project receives from major news media outlets globally

PRACTICE EXAM 12 — EXPLAINED ANSWER KEY (Q1–Q50)

1. B — The experiment tests whether starch (large) and glucose (small) molecules can move through a membrane with selective pores. Comparing the indicator results inside the bag and in the surrounding water reveals which molecules crossed. This is the foundational principle of selective permeability that governs all biological membranes.

2. D — Iodine in the beaker water remained amber (no starch crossed), but Benedict's reagent in the beaker water turned red after 30 minutes (glucose did cross). Only glucose moved across the membrane; the starch stayed inside because of its size. The data clearly distinguish which molecule was small enough to pass.

3. C — Dialysis tubing has small pores that allow water and small solutes to pass while blocking larger molecules. Starch is a large polysaccharide made of long chains of glucose units, while glucose is a small monosaccharide. Size selectivity — not charge, dissolution, or active transport — explains why glucose crossed and starch did not.

4. A — Glucose moved from a region of high concentration (inside the bag) to a region of low concentration (the surrounding water) without any energy input. This passive movement down a concentration gradient is the definition of diffusion. No ATP, membrane folding, or selective transport protein is required.

5. C — Like the cell membrane, dialysis tubing is selectively permeable — it allows some substances through while blocking others based on size. The other organelles listed perform different functions (genetic storage, protein folding, packaging) that are not modeled by simple pore-based selectivity. This is why the dialysis-tubing model is widely used in biology labs.

6. B — An enzyme is a biological catalyst that speeds up a specific reaction by lowering activation energy and is not consumed in the process. Lactase specifically catalyzes the hydrolysis of lactose into glucose and galactose. The same enzyme molecule can perform this reaction many times in succession.

7. D — At low substrate concentrations, many active sites are free, so adding substrate increases the reaction rate. Once all enzyme active sites are saturated, the reaction proceeds at its maximum rate (Vmax) regardless of additional substrate. This saturation behavior is a defining feature of enzyme kinetics.

8. A — When the reaction is limited by enzyme active sites being fully occupied, adding more enzyme supplies more active sites and proportionally raises the maximum rate. Doubling enzyme concentration roughly doubles Vmax as long as substrate remains in excess. This relationship is exploited widely in industrial enzyme applications.

9. C — Lactase is produced in the small intestine and breaks lactose into absorbable simple sugars. People with insufficient lactase cannot digest milk sugar efficiently, so undigested lactose passes into the large intestine where bacteria ferment it, producing the characteristic symptoms of lactose intolerance. The deficiency specifically affects milk-sugar digestion.

10. B — Lactose is a disaccharide composed of one glucose and one galactose joined by a glycosidic bond, placing it in the carbohydrate family. Carbohydrates include monosaccharides, disaccharides, and polysaccharides. Recognizing the major macromolecule classes is foundational to cell biology.

11. A — Red light produced 28 bubbles/min and blue produced 26 bubbles/min, while yellow and green produced only 8 and 3 bubbles/min. Chlorophyll absorbs strongly in the red and blue regions of the visible spectrum and uses that absorbed light to drive photosynthesis. The differential bubble counts directly reflect this absorption pattern.

12. D — Chlorophyll appears green because it reflects (and transmits) green wavelengths rather than absorbing them. Without absorption, that light energy cannot be captured to power the light-dependent reactions, so very little oxygen is produced. This is also why most plant leaves appear green to our eyes.

13. C — During the light-dependent reactions of photosynthesis, water molecules are split (photolysis), releasing electrons, hydrogen ions, and oxygen gas. The oxygen released to the atmosphere — and the bubbles seen rising from *Elodea* — originates from water, not from carbon dioxide. This was a key discovery in the history of photosynthesis research.

14. A — Chloroplasts contain stacks of thylakoid membranes embedded with chlorophyll and accessory pigments that absorb light energy. The other organelles listed serve unrelated roles (energy release, protein synthesis, genetic storage) and do not capture light. The chloroplast is the defining organelle of photosynthetic eukaryotes.

15. B — Photosynthesis depends on light energy to power the splitting of water and the production of ATP and NADPH. Without any light, the light-dependent reactions cannot occur and no oxygen is produced. This is why plants kept in complete darkness eventually die.

16. D — Cellular respiration is exothermic: as glucose is broken down to release ATP, a substantial fraction of the chemical energy is given off as heat. Germinating peas have very high metabolic activity and produce measurable warmth in an insulated flask. Dry seeds are dormant and boiled seeds are dead, so neither releases heat.

17. A — A proper control isolates the variable being tested. Flask 3 contains the same seed material as Flask 1 but with the cells killed by boiling, so any temperature change in Flask 3 cannot be due to respiration. Because Flask 3 did not warm up, the warming in Flask 1 can be attributed specifically to living metabolism.

18. C — Aerobic respiration combines glucose with oxygen to produce carbon dioxide, water, and ATP. This equation is essentially the reverse of photosynthesis and is the foundation of energy production in nearly all animals, plants, and aerobic microbes. Memorizing the reactants and products is essential for Regents biology.

19. D — Aerobic respiration requires oxygen as the final electron acceptor in the electron transport chain, where most ATP is generated. Without oxygen, only the small amount of ATP from glycolysis would be produced via fermentation, and heat output would drop sharply. Replacing air with nitrogen would essentially halt aerobic metabolism.

20. B — Because each CAG codon codes for the amino acid glutamine, an expansion of CAG triplets adds extra glutamine residues to the huntingtin protein. The resulting "polyglutamine tract" causes the protein to misfold and aggregate, damaging neurons over time. This polyQ expansion mechanism underlies several neurodegenerative diseases.

21. C — The genetic code is a triplet code: each three-nucleotide codon specifies one amino acid (or a start/stop signal). This relationship holds for nearly all organisms, which is why it is sometimes called the "universal" genetic code. A codon-by-codon reading frame is what links DNA sequence to protein sequence.

22. A — Huntington's disease is inherited as an autosomal dominant trait, so a single copy of the expanded allele is sufficient to cause the disease. A heterozygote (Hh) will therefore develop HD just as an affected homozygote would. This pattern is why HD typically appears in multiple generations of an affected family.

23. D — In an Hh × hh cross, half of the offspring receive H (affected) and half receive h (unaffected). Each child therefore has a 50% chance of inheriting the disease allele. This 50% recurrence risk is what makes genetic counseling so important for HD families.

24. B — The HD mutation expands a normally short CAG repeat into a much longer tandem repeat, lengthening the gene by adding many extra copies of the same triplet. This category — trinucleotide repeat expansion — is distinct from point mutations, frameshifts, and chromosomal rearrangements. Several inherited neurological disorders share this mechanism.

25. C — Sons inherit Y from the father and X from the mother. The carrier mother (X^N X^n) passes X^N or X^n with equal probability, so half her sons receive X^n Y and are color blind. This is why X-linked recessive disorders show characteristic mother-to-son transmission patterns.

26. A — Daughters receive an X from each parent. The father can only contribute his X^N allele, so every daughter has at least one normal allele and expresses normal color vision. Daughters of this couple may be carriers (X^N X^n) but cannot themselves be color blind.

27. D — Males are hemizygous for X-linked genes — they have only one X chromosome, so any recessive allele on that X is automatically expressed. Females need two recessive alleles to express the trait, which is far less common. This explains why most X-linked recessive disorders affect males much more often than females.

28. B — A color-blind father (X^n Y) and a homozygous normal mother (X^N X^N) will produce daughters who are all X^N X^n (carriers, with normal vision) and sons who are all X^N Y (normal vision, not carriers). No child inherits two copies of the recessive allele. This is why daughters of affected fathers are obligate carriers.

29. C — The X^n Y genotype indicates a male (XY) whose single X chromosome carries the recessive color-blindness allele. Because males have no second X to mask the recessive allele, this individual expresses color blindness. This hemizygous expression is the defining feature of X-linked recessive inheritance in males.

30. A — Before industrial pollution, lichen-covered bark provided a light, mottled background that camouflaged the light form of the moth from visually hunting birds. Dark moths stood out against this background and were eaten more frequently. Differential survival based on visibility drove the population color frequencies.

31. B — Sooty bark darkened by industrial pollution provided camouflage for the dark form and exposed the light form to predators. Birds removed disproportionately more light moths, allowing dark moths to survive and reproduce in greater numbers. The population shifted toward darker coloration over only a few decades.

32. D — The peppered moth case is the textbook example of natural selection in real time: a heritable trait (color) under environmental pressure (visual predation in a changed habitat) shifts in frequency over generations. Coloration is genetic, not learned or acquired, and the change occurred without any deliberate human breeding. It demonstrates that selection can produce rapid evolutionary change.

33. C — Genetic variation arises continuously in populations through random mutations and the reshuffling of alleles during sexual reproduction. The dark allele existed at low frequency before the Industrial Revolution because mutations had already produced it in earlier generations. The new environment then selected for that pre-existing variation.

34. A — When pollution was reduced, lichens returned and tree bark became lighter again. Light moths now had the survival advantage, so their frequency in the population rose over subsequent generations. Field studies confirmed exactly this reversal, demonstrating that the direction of selection follows the direction of environmental change.

35. D — A selective pressure is any environmental factor that causes differential survival or reproduction among phenotypes. Bird predation removed visible moths from the population, leaving camouflaged moths to reproduce. This is the textbook definition of how natural selection operates.

36. B — Natural selection can only change a population's traits over generations if those traits are heritable — encoded in genes and passed from parent to offspring. Acquired or learned changes do not enter the gene pool. Heritability is therefore a prerequisite for evolution by natural selection.

37. C — The early years of the graph show the deer population doubling and redoubling, accelerating as new individuals add still more reproducers. This accelerating pattern under abundant resources is exponential growth. It is characteristic of populations entering a new habitat with few limiting factors.

38. A — Carrying capacity (K) is the maximum population size that the environment can sustainably support, given available food, water, space, and other resources. Once the deer reach K (≈550 here), births and deaths roughly balance and population size stabilizes. This plateau is the hallmark of logistic growth.

39. B — Carrying capacity is set by limiting factors such as food, water, space, disease, and predation. As the population grows, these resources are spread thinner among more individuals, reducing survival or reproduction. Recognizing density-dependent limiting factors is central to ecology.

40. D — Adding a predator imposes an additional source of mortality on the deer population, lowering the number of deer the environment can sustain. The population would decline and stabilize at a new, lower carrying capacity. Predator-prey dynamics like this are common in real ecosystems.

41. A — The deer population shows the classic S-shaped logistic curve: slow early growth, rapid exponential growth in the middle, and a plateau as the population approaches carrying capacity. This shape is one of the most important patterns in population ecology. It contrasts with the J-shaped curve of unlimited exponential growth.

42. C — Photosynthesis pulls atmospheric CO2 into producers, where carbon is incorporated into organic molecules such as glucose. Respiration, combustion, and decomposition all release CO2 into the atmosphere — they do not remove it. Photosynthesis is therefore the primary mechanism by which the biosphere draws down CO2.

43. D — Burning fossil fuels — coal, oil, and natural gas — releases carbon that has been buried for hundreds of millions of years back into the atmosphere as CO2. This rate of release vastly exceeds the rate at which the carbon cycle can absorb it through photosynthesis and ocean uptake. It is the principal driver of recent atmospheric CO2 increases.

44. B — Coal, oil, and natural gas formed from the remains of ancient organisms (mainly plants and marine microorganisms) buried in sediments under heat and pressure over many millions of years. The carbon in those organisms was originally pulled from the atmosphere by photosynthesis. Burning fossil fuels effectively returns this ancient carbon to the modern atmosphere.

45. A — Trees take up large amounts of CO2 during photosynthesis and store the carbon as cellulose and other organic molecules in their wood, leaves, and roots. As long as the forest is growing and the wood is not burned or decomposed, that carbon stays out of the atmosphere. This makes mature, intact forests one of the most important terrestrial carbon sinks on Earth.

46. C — Cutting down forests removes a major sink for atmospheric CO_2; even more carbon is released if the wood is burned or left to decompose. The result is a net increase in atmospheric CO_2 levels. Deforestation is one of the largest contributors to global carbon emissions after fossil fuel combustion.

47. B — Climate change is shifting habitats faster than many species' ranges or evolutionary changes can keep up. Without the ability to move, adapt, or survive in altered conditions, populations decline and species risk extinction. This is a primary driver of the current global biodiversity crisis.

48. D — Reef-building corals depend on symbiotic algae (zooxanthellae) living in their tissues for most of their nutrition. When sea temperatures rise above the corals' tolerance, the coral expels these algae, losing its color and most of its food supply. Prolonged or repeated bleaching events can kill large stretches of reef.

49. C — Mutualism is a symbiotic relationship in which both species benefit. The coral provides shelter and CO_2 to the algae, and the algae provide sugars from photosynthesis to the coral. Disrupting this partnership through bleaching threatens the entire reef ecosystem.

50. A — Sound engineering decisions consider not just whether a design works, but how much it costs, what unintended impacts it may have, and whether it can be implemented at the scale needed to make a real difference. Single-criterion evaluations miss critical drawbacks. This trade-off framework is central to how engineers and scientists approach complex environmental problems.