

MARKING KEY: CONFIDENTIAL

4. A laboratory investigation was conducted using three distinct food samples. The samples were treated as follows: Test Tube 1: Biuret reagent was added. Test Tube 2: Benedict's solution was added (and heated). Test Tube 3: Iodine solution was added. All three test tubes showed a positive result. Which of the following correctly matches the test tube, the organic compound it contains, and the observable positive result? (1)
- A. Test tube 1, protein, Orangey or red precipitate appears
 - B. Test tube 2, reducing sugar, A purple (mauve) color appears
 - C. ✓ **Test tube 3, starch, A blue-black color appears**
 - D. Test tube 2, protein, Orangey or red precipitate appears

Answer: C

Iodine solution is the test for starch and it turns blue-black, so test tube 3 with a positive result holds starch. The other two are matched wrongly in the options: Biuret reagent tests for protein and turns purple, and Benedict's solution heated with a reducing sugar gives an orange to brick-red precipitate. Option A is tempting because test tube 1 really does contain protein, but the colour given there belongs to Benedict's test, not to Biuret.

5. How does bile assist the enzymes found in the small intestine to work most effectively? (1)
- A. It increases the acidity of the food coming from the stomach.
 - B. ✓ **It neutralizes stomach acid to create an alkaline environment.**
 - C. It breaks down lipids into fatty acids and glycerol.
 - D. It cools the temperature of the semi-digested food.

Answer: B

Food leaving the stomach is soaked in hydrochloric acid, with a pH near 2. Bile from the liver is alkaline because it carries hydrogen carbonate, and it neutralises that acid so the small intestine sits at about pH 7 to 8. Pancreatic and intestinal enzymes such as amylase, trypsin and lipase work fastest at that pH, so they can now act. Option C is tempting because bile really does act on fat, but bile is not an enzyme: it breaks large fat drops into tiny ones, and lipase does the chemical splitting into fatty acids and glycerol.

6. In the human respiratory system, the actual site of gas exchange is the: (1)
- A. Trachea
 - B. Bronchi
 - C. ✓ **Alveoli**
 - D. Larynx

Answer: C

The alveoli are millions of tiny air sacs at the end of the airways. Their walls are one cell thick, they are moist, they are wrapped in capillaries and together they give a huge surface area, so oxygen and carbon dioxide diffuse across quickly. The bronchi are the tempting answer because air passes through them on the way in, but their walls are thick and held open by cartilage and they have no capillary network, so they only conduct air.

7. During the process of inhalation (breathing in), what specific changes occur in the thorax to allow air to enter the lungs? (1)
- A. The diaphragm relaxes and becomes dome-shaped
 - B. The internal intercostal muscles contract to pull the ribs downward.
 - C. The volume of the chest decreases, forcing air into the lungs
 - D. ✓ **The external intercostal muscles contract, pulling the ribs up**

Answer: D

Breathing in is an active movement. The external intercostal muscles contract and swing the ribs up and out, and at the same time the diaphragm contracts and flattens. The chest cavity therefore gets bigger, the pressure inside drops below the pressure outside, and air flows in down that pressure difference. Option A is tempting because the diaphragm does become dome-shaped, but that happens when it relaxes during breathing out.

8. How does a high-altitude environment initially affect a person's breathing compared to being at sea level? (1)
- A. The higher concentration of oxygen causes the breathing rate to slow down
 - B. ✓ **The lower concentration of oxygen in the air causes a person to breathe faster**
 - C. The increased atmospheric pressure makes it easier for oxygen to diffuse into the blood
 - D. Altitude has no measurable impact on the depth or rate of ventilation

Answer: B

The air at high altitude still holds about 21 percent oxygen, but the atmospheric pressure is lower, so the partial pressure of oxygen is lower and less oxygen crosses into the blood with each breath. Chemoreceptors sense the falling oxygen and the brain answers by making breathing faster and deeper. Option C is tempting because pressure is mentioned, but atmospheric pressure at altitude is lower than at sea level, not higher, so diffusion into the blood gets harder rather than easier.

9. A person undergoing a blood test finds that their red blood cells lack both A and B antigens. Based on this finding, which of the following statements is true? (1)
- A. The person belongs to Blood Group AB
 - B. The person can safely receive a transfusion from a Group A donor
 - C. ✓ **The person's blood plasma contains both anti-A and anti-B antibodies.**
 - D. The person is considered a universal recipient

Answer: C

Red cells with neither the A nor the B antigen belong to blood group O. In the ABO system a person carries antibodies in the plasma against the antigens they do not have, so group O plasma contains both anti-A and anti-B. Option D is the trap: group O is the universal donor because its cells display nothing to attack, while the universal recipient is group AB, whose plasma carries no ABO antibodies at all.

10. The right ventricle has a thinner muscular wall compared to the left ventricle. What is the primary functional reason for this structural difference? (1)
- A. The right ventricle stores blood rather than pumping it
 - B. ✓ **The right ventricle only pumps blood to the nearby lungs, requiring less pressure**
 - C. The right ventricle carries deoxygenated blood, which is less dense
 - D. The right ventricle lacks the electrical stimulation needed for high pressure

Answer: B

The right ventricle pushes blood only as far as the lungs, which are close by and offer little resistance, so a moderate pressure is enough and a thinner wall can produce it. The left ventricle has to drive blood through the whole body, so it needs far more force and a much thicker muscular wall. Option C is tempting, but deoxygenated blood is not meaningfully lighter, and both ventricles pump the same volume with each beat. The difference is the distance and resistance ahead of each one.

11. Which of the following scenarios best illustrates the concept of artificial active immunity? (1)
- A. Person recovering from a cold and becoming immune to that specific strain naturally
 - B. Using an antiseptic on a cut to prevent bacteria from entering the bloodstream
 - C. ✓ **A child receiving a weakened strain of polio through injection to prevent future infection**
 - D. Individual receiving emergency rabies shot containing antibodies after a dog bite

Answer: C

Active immunity means your own body makes the antibodies and keeps memory cells. Artificial means the exposure was arranged on purpose rather than by catching the disease. A weakened polio strain given by injection is a vaccine: it cannot cause the illness, but the immune system still responds and remembers, so both conditions are met. Option D is the trap because a rabies shot containing ready-made antibodies is artificial passive immunity, borrowed protection that fades because the body built no memory of its own.

12. Which of the following is the primary method of transmission for a human to develop an adult tapeworm infection (Taeniasis)? (1)
- A. Walking barefoot on soil contaminated with larvae
 - B. Drinking water contaminated with tapeworm eggs
 - C. Being bitten by an infected mosquito vector
 - D. ✓ **Eating undercooked meat containing larval cysts**

Answer: D

An adult tapeworm develops when a person swallows the larval cysts, called cysticerci, that sit in the muscle of infected beef or pork. Cooking kills them, so undercooked meat is the route. Inside the small intestine the larva turns itself out, hooks onto the wall and grows into the adult worm. Option B is tempting because contaminated water does spread the parasite, but swallowing the eggs gives the larval stage in the body tissues, a condition called cysticercosis, and not an adult worm in the gut.

13. What is a major social impact of HIV/AIDS that complicates prevention and control efforts in Ethiopia? (1)
- A. The rapid expansion of digital communication.
 - B. The elimination of traditional religious practices
 - C. ✓ **Social stigma and discrimination against People living with HIV**
 - D. An increase in the literacy rate across rural provinces.

Answer: C

Stigma and discrimination are what keep the epidemic hidden. People who fear being talked about avoid testing, do not tell their partners, and stop collecting their medicine, so infections that could have been found and treated keep spreading. Prevention programmes depend on people coming forward, and stigma is what stops them. Option A is tempting because it names a modern change, but wider digital communication helps a campaign reach people, so it supports prevention rather than complicating it.

14. Consider the following statements regarding the rules for writing scientific names: I. The genus name is written first and begins with a capital letter. II. The species name begins with a capital letter. III. When printed, the entire scientific name should be in italics. IV. The genus name can be abbreviated to a single capital letter after its first use. Which of the following represents the correct set of rules? (1)
- A. I, II, and III
 - B. ✓ **I, III, and IV**
 - C. II, III, and IV
 - D. I, II, and IV

Answer: B

The binomial system has fixed rules. The genus is written first with a capital letter, the species name is written second with a small letter, the whole name is printed in italics, and after the first mention the genus may be shortened to its initial, as in *E. coli*. So statements I, III and IV are the correct set. Option A is tempting because it keeps statement II, but a capital letter on the species name breaks the rule.

15. An animal with a soft body, a muscular foot, and a visceral mass protected by a shell belongs to which phylum? (1)
- A. Arthropoda
 - B. Echinodermata
 - C. ✓ **Mollusca**
 - D. Chordata

Answer: C

A soft body, a single muscular foot for creeping and a visceral mass covered by a mantle that secretes a shell are the defining features of phylum Mollusca. Snails, clams and mussels all fit that description. Arthropoda is the tempting answer because arthropods also have a hard outer covering, but theirs is a jointed exoskeleton of chitin around the whole body, and they move on jointed legs rather than a muscular foot.

16. A biologist observes an organism that is microscopic and single-celled. To decide whether to classify it in Kingdom Monera or Kingdom Protista, which of the following must be determined? (1)
- A. ✓ **Whether the genetic material is enclosed within a separate nucleus**
 - B. Whether the organism can move using a muscular foot.
 - C. Whether the organism is capable of causing diseases in humans
 - D. Whether the organism lives in a marine or terrestrial environment

Answer: A

The line between Monera and Protista is the nucleus. Monera are prokaryotes, so their genetic material lies loose in the cytoplasm with no nuclear membrane around it. Protista are eukaryotes, so their DNA is enclosed in a true nucleus. Being microscopic and single-celled fits both, so the nucleus is what must be checked. Option C is tempting because disease is easy to test for, but both kingdoms contain organisms that make people ill, so it separates nothing.

17. In a coral reef ecosystem, energy flows through various organisms based on their feeding relationships. Consider a specific marine food chain observed by researchers: Algae → Parrotfish → Grouper → Barracuda. Which one of the following statements regarding this food chain is incorrect? (1)
- A. Algae occupy the first trophic level as it converts solar energy into chemical energy
 - B. Algae population holds the highest amount of stored energy compared to all other levels
 - C. ✓ **The Parrotfish functions as a carnivore that regulates the Grouper population**
 - D. The Barracuda has the least amount of available energy due to loss at each level

Answer: C

The question asks for the statement that is wrong. The parrotfish eats algae, which makes it a herbivore and the primary consumer of this chain, and it is eaten by the grouper rather than controlling it, so statement C is the incorrect one. Statement B is the tempting choice because it sounds like an odd thing to say, but it is true: the producer level always holds the most stored energy, since only about a tenth passes on at each step.

18. Which one of the following is an adaptation used to reduce water loss in plants? (1)
- A. Having a single layered epidermis in leaves
 - B. Thin broad leaves
 - C. Large and wide stomata
 - D. ✓ **Leaves covered with waxy cuticle**

Answer: D

The waxy cuticle is a layer of cutin laid down on top of the epidermis, and wax does not let water through. It seals the leaf surface so that water can leave mainly through the stomata, where the plant can control it. Option C is the tempting one because stomata are involved in water loss, but large wide stomata would let far more water vapour escape, so that is the opposite of an adaptation for saving water.

19. Temperature, rock types, soil drainage and pH levels are critical components that influence an ecosystem. These are examples of: (1)
- A. Biotic factors
 - B. ✓ **Abiotic factors**
 - C. Biological factors
 - D. Adaptive factors

Answer: B

Temperature, rock type, soil drainage and pH are all non-living parts of the surroundings, and non-living factors in an ecosystem are called abiotic factors. They set the physical limits that decide which species can live in a place. Option A is tempting because these factors act on living things, but biotic factors are the living members themselves, such as plants, predators, parasites and decomposers.

20. A biologist is organizing a museum exhibit and wants to categorize four research scientists based on the specific groups of organisms they study. Scientist A: Studies the structure, function of animals. Scientist B: Focuses on the scientific study of plants, their physiology and genetics. Scientist C: Investigates the complex world of insects. Based on these descriptions, Scientists A, B, C can be classified under which biology sub-fields, respectively? (1)

- A. ✓ **Zoology, Botany, Entomology** B. Botany, Zoology, Entomology
C. Zoology, Entomology, Ornithology D. Entomology, Zoology, Botany

Answer: A

The sub-fields are named after what they study. Zoology is the study of animals, botany is the study of plants, and entomology is the study of insects. Scientist A studies animals, B studies plants and C studies insects, so the order is zoology, botany, entomology. Option B is tempting because it holds the same three words, but it puts botany with the animal researcher and zoology with the plant researcher.

21. Which scientist is credited with providing the experimental support for the concept of infectious disease and pinpointing the causal agents for tuberculosis and cholera? (1)

- A. ✓ **Robert Koch** B. Antoine van Leeuwenhoek
C. Galen D. Wilmot

Answer: A

Robert Koch supplied the experimental proof that a particular microbe causes a particular disease. He grew bacteria in pure culture, gave the disease to healthy animals and recovered the same organism, a method now known as Koch's postulates. Working that way he identified the tuberculosis bacterium in 1882 and the cholera bacterium in 1883. Antoine van Leeuwenhoek is the tempting answer because he was the first person to see microorganisms through his own lenses, but he only described them and never linked one of them to a named disease.

22. Which statement best describes the positioning and role of the endodermis in a plant stem? (1)

- A. It is the outermost layer of the cortex that protects the epidermis
B. ✓ **It is the innermost layer of the cortex that separates the cortex from the vascular bundles**
C. It is a loosely arranged layer of cells located within the vascular bundles
D. It is the central core of the stem used primarily for water transport

Answer: B

The stem is built in rings from outside in: epidermis, then cortex, then the vascular bundles in the middle. The endodermis is the innermost ring of the cortex, so it forms the boundary between the cortex and the vascular tissue. Its cells carry a waterproof band that forces water and dissolved minerals to pass through the cells rather than between them, which lets the plant control what reaches the xylem. Option A is tempting because it also names a boundary, but the endodermis is the inner edge of the cortex, not the outer one, and nothing inside the cortex can protect the epidermis.

23. A gardener notices that after planting maize, the seed remains at its original depth even after the first leaves appear. In contrast, nearby bean seeds have carried their cotyledons above ground. Which of the following is true about these types of germination? (1)

- A. Maize germination is epigeal
B. In maize, the hypocotyl elongates rapidly
C. ✓ **Bean germination is epigeal**
D. In bean seed radicle transforms into the primary leaf

Answer: C

In epigeal germination the hypocotyl, the part of the stem below the cotyledons, elongates and lifts the cotyledons above the soil. That is what the bean does, so statement C is true. In hypogeal germination the cotyledons stay at their planting depth and the epicotyl pushes the shoot up, which is the maize pattern described in the question. Option B is tempting because rapid hypocotyl elongation is a real process, but it belongs to the bean, and if maize did it the seed would have moved.

24. A farmer applies a metabolic poison to a plant that stops all ATP production (cellular energy) in the roots and leaves. Based on the mechanisms of transport, what is the most likely result? (1)
- A. Both water and food transport will stop immediately because both are passive processes
 - B. Water transport will stop, but the translocation of food will continue normally.
 - C. ✓ **Water transport through the xylem will continue, but food transport in the phloem will stop**
 - D. The plant will switch to using diffusion to move food through the dead cells of the xylem

Answer: C

Water rises in the xylem by transpiration pull. Evaporation from the leaves creates tension, and the water column holds together by cohesion, so no ATP is needed and dead xylem vessels are enough. Food transport in the phloem is different: sucrose has to be actively loaded into the sieve tubes at the source, and that pumping runs on ATP. With ATP production stopped, water keeps moving while translocation stops. Option B is tempting because it names the same two systems, but it has them the wrong way round.

25. A germinating seedling is placed in a clinostat that rotates slowly and continuously in a horizontal position. After several days, what is the expected growth pattern of the root and the shoot? (1)
- A. Both the root and shoot grow downward toward the force of gravity
 - B. Both the root and shoot grow upward away from the force of gravity
 - C. The root grows downward and the shoot grows upward
 - D. ✓ **Both the root and shoot continue to grow horizontally in a straight line**

Answer: D

Gravitropism needs gravity to pull from one steady direction so that auxin can settle on the lower side and bend the organ. A clinostat turns the seedling slowly and continuously, so every side becomes the lower side in turn and no side receives a lasting signal. With the stimulus cancelled the root and shoot keep growing straight out along the horizontal. Option C is tempting because it describes the normal result, but that only happens when the seedling is held still and gravity acts on one side.

26. A phospholipid molecule contains a hydrophilic (water-loving) region. Which specific part of the molecule makes up this polar region? (1)
- A. The fatty acid chain
 - B. The glycerol molecule
 - C. ✓ **The phosphate group**
 - D. The hydrocarbon tail

Answer: C

A phospholipid has a glycerol backbone carrying two fatty acid tails and one phosphate group. The phosphate group holds a negative charge, so it attracts water molecules and forms the hydrophilic head, while the two hydrocarbon tails are uncharged and water repelling. That split is what makes the molecules line up into a bilayer. Option B is tempting because glycerol sits in the head end of the molecule, but the charge that pulls water in comes from the phosphate group.

27. Which property of water allows it to act as a temperature buffer in living organisms, preventing rapid internal temperature changes? (1)
- A. Low density as ice
 - B. ✓ **High specific heat capacity**
 - C. Surface tension
 - D. Low latent heat of vaporization

Answer: B

Water has a high specific heat capacity, which means a large amount of heat energy is needed to raise its temperature by one degree, because much of that energy goes into breaking hydrogen bonds rather than speeding the molecules up. Cells and body fluids are mostly water, so they warm and cool slowly and internal reactions keep running at a steady temperature. Option D is tempting because heat and water are both mentioned, but the statement is false: water has a high latent heat of vaporisation, which is why sweating cools the body so well.

28. A patient presents with an enlarged thyroid gland (goiter). This condition is most directly linked to a deficiency in: (1)
- A. Iron
 - B. Calcium
 - C. ✓ **Iodine**
 - D. Chloride

Answer: C

The thyroid gland needs iodine to build the hormone thyroxine. When the diet is short of iodine the gland cannot make enough hormone, the pituitary keeps sending thyroid stimulating hormone, and the gland grows larger and larger trying to answer that call. The swelling that results is a goitre, which is why iodised salt is used to prevent it. Iron is the tempting answer because it is the best known dietary deficiency, but a shortage of iron causes anaemia, not a swollen thyroid.

29. Which one of the following takes place during Anaphase that ensures each daughter cell receives an identical set of genes (chromosomes)? (1)
- A. Homologous chromosomes pair up
 - B. ✓ **Sister chromatids are pulled apart to opposite poles**
 - C. The nuclear envelope reforms around the chromatin
 - D. Genetic recombination occurs through crossing over

Answer: B

During the S phase each chromosome is copied into two identical sister chromatids joined at the centromere. In anaphase the centromeres separate and the spindle fibres pull one chromatid of every pair to each pole. Because the two chromatids are exact copies, each daughter cell ends up with the same complete set of genes. Option A is tempting because pairing sounds like an orderly step, but homologous chromosomes pair in prophase I of meiosis and never do so in mitosis.

30. Which of the following stages of the cell cycle is incorrectly matched with its primary function? (1)
- A. G1 Phase: Accumulation of energy reserves and DNA building blocks
 - B. S Phase: Replicating DNA to form sister chromatids
 - C. G2 Phase: Synthesis of proteins required for chromosome manipulation
 - D. ✓ **M Phase: Physical separation of the cytoplasmic components**

Answer: D

The question asks for the pair that does not match. M phase is mitosis, and what it separates is the duplicated chromosomes into two nuclei. Dividing the cytoplasm into two cells is cytokinesis, a separate event that follows mitosis, so option D describes the wrong process. Option B is tempting to pick because it is short, but replicating DNA into sister chromatids is exactly what the S phase does, so it is matched correctly.

31. A student observes two distinct types of cell division under a microscope. Process 1: A single division results in two diploid daughter cells. Process 2: Two successive divisions result in four haploid daughter cells. Which statement correctly describes these two processes? (1)
- A. ✓ **Process 1 represents mitosis, while Process 2 represents meiosis**
 - B. Process 1 produces genetic variation through crossing over
 - C. Process 2 is used by the body to repair worn-out or damaged cells
 - D. Both Process 1 and Process 2 are variations of mitosis

Answer: A

Mitosis is one division that gives two daughter cells with the same chromosome number as the parent, so process 1 is mitosis. Meiosis is two divisions in a row that give four cells with half the chromosome number, so process 2 is meiosis. Option C is tempting because repair really is a job of cell division, but the body repairs damaged tissue by mitosis, that is process 1, while meiosis is used only to make gametes.

32. A patient experiences a sharp ache because tooth decay has penetrated the innermost chamber containing blood vessels and nerves. Which specific part of the tooth is undergoing inflammation and causing this sensation? (1)

- A. ✓ **Pulp cavity**
- B. Enamel
- C. Crown
- D. Dentine

Answer: A

The pulp cavity is the innermost chamber of the tooth and it holds the blood vessels and the nerve endings. Enamel and dentine have no nerves of their own, so decay causes no sharp pain until it eats through them and reaches the pulp, where the nerve becomes inflamed. Dentine is the tempting answer because it lies directly outside the pulp and it does pass sensations inward through tiny tubules, but the chamber that actually contains the blood vessels and nerves is the pulp.

33. What is the primary function of the thymus gland within the lymphatic and immune systems? (1)

- A. It filters pathogens and debris from the lymph
- B. ✓ **It serves as the site where T-lymphocytes mature**
- C. It engulfs damaged cells and cellular wastes
- D. It stores and concentrates excess bile

Answer: B

T lymphocytes are made in the bone marrow but they travel to the thymus to finish developing. There they are trained to recognise foreign antigens and any cell that would attack the body itself is destroyed, which is why they are called T cells after the thymus. Option A is tempting because it describes real lymphatic work, but filtering pathogens and debris out of lymph is done by the lymph nodes, not by the thymus.

34. In which part of nephron does K^+ and H^+ ions are selectively secreted into the filtrate, while Na^+ , Cl^- , and HCO_3^- ions are reabsorbed to maintain blood pH and electrolyte balance? (1)

- A. Bowmans capsule
- B. ✓ **Distal convoluted tubule**
- C. Proximal convoluted tubule
- D. Loop of Henle

Answer: B

The distal convoluted tubule is where the final adjustment of the blood is made. It secretes potassium and hydrogen ions into the filtrate and reabsorbs sodium, chloride and hydrogen carbonate back into the blood, so it sets both the pH and the electrolyte balance, under the control of aldosterone. The proximal convoluted tubule is the tempting answer because a great deal of reabsorption happens there, but that segment does bulk recovery of glucose, amino acids, salts and water, while the fine selective tuning happens further along.

35. Which of the following statements is incorrect regarding the characteristics of lymphocytes? (1)

- A. They circulate continuously between the bloodstream and the lymphatic system
- B. T cells, B cells, and natural killer cells are the primary types of lymphocytes
- C. ✓ **Lymphocytes use phagocytosis to engulf and digest pathogens and cellular debris**
- D. Some Lymphocytes are produced and complete their full maturation in the bone marrow

Answer: C

The question asks for the incorrect statement. Lymphocytes fight infection by recognising antigens: B cells make antibodies, T cells kill infected cells or help other cells, and natural killer cells destroy abnormal cells. Swallowing and digesting pathogens by phagocytosis is the work of neutrophils and macrophages, so statement C is wrong. Option D is tempting because maturation sites are easy to mix up, but B lymphocytes really do mature in the bone marrow, so that statement is true.

36. Why is nutrient recycling essential for the long term survival of an ecosystem? Because: (1)
- A. It allows energy to be captured from the sun and reused multiple times by consumers
 - B. It prevents the accumulation of toxic organic waste in the atmosphere
 - C. ✓ **The total amount of matter and essential elements on Earth is finite and limited**
 - D. Decomposers require a constant supply of inorganic minerals to perform cellular

Answer: C

Energy flows through an ecosystem once and leaves as heat, but matter does not. The Earth holds a fixed stock of carbon, nitrogen, phosphorus and the other elements life is built from, and no new supply arrives. Decomposers therefore have to break dead bodies and waste down and return those elements to the soil and air so producers can use them again. Option A is the trap because it sounds similar, but energy cannot be recycled: it is used once at each level and lost.

37. Which of the following organisms are producers in the aquatic ecosystem? (1)
- A. Fungi
 - B. Zooplankton
 - C. Grasshopper
 - D. ✓ **Phytoplankton**

Answer: D

Phytoplankton are the microscopic photosynthetic organisms that drift in the sunlit surface water. They capture light energy and make their own food, which makes them producers, and almost every aquatic food chain starts with them. Zooplankton is the tempting answer because the names look alike, but zooplankton are tiny animals that feed on phytoplankton, which makes them consumers.

38. Which stage of the nitrogen cycle involves the conversion of ammonium into nitrate? (1)
- A. ✓ **Nitrification**
 - B. Depolymerization
 - C. Ammonification
 - D. Denitrification

Answer: A

Nitrification is the two-step oxidation carried out by soil bacteria: Nitrosomonas turns ammonium into nitrite, and Nitrobacter turns the nitrite into nitrate. Nitrate is the form most plants take up through their roots. Ammonification is the tempting answer because it also deals with ammonium, but it is the earlier step, where decomposers break the nitrogen in dead matter and urea down into ammonium.

39. Which two of the following natural structures serve as models for biomimicry in house construction? (1)
- A. Swallow nests and spider webs
 - B. Termite mounds and mosquito proboscis
 - C. ✓ **Swallow nests and termite mounds**
 - D. Shellfish exoskeletons and elephant trunks

Answer: C

Biomimicry means copying a natural design to solve a human problem. Swallows build strong domed nests from mud mixed with plant fibre, which is the idea behind reinforced mud and cement walls, and termite mounds keep a steady temperature inside through a system of vents and chimneys, which architects have copied for buildings that need little air conditioning. Both are models for building houses, so C is the pair. Option B is tempting because the mosquito proboscis really is a biomimicry model, but it inspired painless injection needles, which is medicine and not construction.

40. Which of the three Rs principles focuses on minimizing animal suffering by using less invasive techniques, providing better medical care, and improving living conditions during experiments? (1)

- A. ✓ **Refinement**
- B. Production
- C. Replacement
- D. Reduction

Answer: A

The three Rs are Replacement, Reduction and Refinement. Refinement is the one about how the animals are treated: use less invasive methods, give pain relief and proper veterinary care, and improve the housing so the animals suffer as little as possible. Reduction is the tempting answer because it also improves animal welfare, but it works by cutting the number of animals used, not by improving the conditions of the ones in the study.

41. During embryonic development, the process in which the three germ layers undergo differentiation into specific tissue types is called: (1)

- A. Zygote
- B. Gastrulation
- C. ✓ **Organogenesis**
- D. Blastulation

Answer: C

Gastrulation forms the three germ layers, and organogenesis is the stage that follows, where the cells of those layers specialise into particular tissues and build the organs. Ectoderm becomes skin and nervous tissue, mesoderm becomes muscle, bone and blood, and endoderm becomes the gut lining and its glands. Gastrulation is the tempting answer because it is the step right before, but it produces the layers rather than turning them into tissue types.

42. Which of the following reproductive characteristics distinguishes rats from both birds and crocodiles? (1)

- A. The production of amniotic fluid to protect the developing embryo from attack
- B. The presence of a leathery or hard-shelled egg that can withstand terrestrial environments
- C. The provision of parental care to increase the offspring's chances of survival
- D. ✓ **The presence of mammary glands used by the mother to provide milk to the young**

Answer: D

A rat is a mammal, and mammary glands that produce milk for the young are found in mammals alone. Birds and crocodiles feed their young in other ways or not at all. Option A is the trap: rats, birds and crocodiles are all amniotes, so all three surround the embryo in amniotic fluid, and a feature shared by all three cannot tell them apart. Parental care also fails for the same reason, since crocodiles and birds both guard their young.

43. How does the substance Cantharidin, secreted by blister beetles, assist in medical treatment? (1)

- A. ✓ **It acts as a protein blocker that can prevent viral cell reproduction and treat tumors**
- B. It is a powerful pain reliever for migraines
- C. It improves blood circulation and decreases joint inflammation
- D. It is used as a permanent pigment for food and cosmetics

Answer: A

Cantharidin is the irritant chemical that blister beetles release when they are disturbed. Inside cells it blocks a protein enzyme that controls cell signalling, and that blocking action is what is being used medically: it can stop virus-infected cells from multiplying and it is under study against tumour cells. The same property is used to remove warts from the skin. Option B is tempting because many animal toxins are studied as painkillers, but cantharidin is a blistering agent that causes pain rather than relieving it.

44. A type of learning which is based on past experience and reasoning to solve problems. Humans have used this learning to solve problems ranging from starting a fire to traveling to the moon. This type of learning is: (1)
- A. Classical conditioning
B. ✓ **Insight learning**
C. Instinctive behaviours
D. Sensitization

Answer: B

Insight learning is working out the answer by putting past experience together in the mind, so the solution appears without a run of trial and error. Making fire and planning a journey to the moon both come from reasoning over knowledge already gathered, which is why humans are the example given. Classical conditioning is the tempting answer because it is also learning, but it is learning by association, where an animal links two stimuli that keep appearing together, and no reasoning is involved.

45. When the body temperature rises above the normal range, the control center activates an effector to reverse the situation. Which of the following is a correct physiological response? (1)
- A. Vasoconstriction and shivering to produce heat
B. ✓ **Vasodilation and activation of sweat glands to allow heat evaporation**
C. Deactivation of sweat glands and skeletal muscle contraction
D. A positive feedback loop that further increases the temperature

Answer: B

When the body gets too hot the hypothalamus acts as the control centre and switches on two effectors. The arterioles in the skin dilate so more warm blood reaches the surface and heat escapes, and the sweat glands release sweat which carries heat away as it evaporates. Both responses reverse the rise, which is what negative feedback means. Option A is tempting because it names real thermoregulation responses, but vasoconstriction and shivering are the answer to being too cold, and they would make the fever worse.

46. Which property of enzymes refers to their inability to pass through a semipermeable membrane (dialysis) due to their high molecular weight? (1)
- A. Precipitation
B. Molecular weight
C. ✓ **Colloidal nature**
D. Precipitation

Answer: C

Enzymes are large protein molecules, and in water they spread out as a colloid rather than a true solution. Colloidal particles are far too big to slip through the pores of a semipermeable membrane, so an enzyme stays behind during dialysis while small ions and sugars pass out. That is the property named colloidal nature. Option B is tempting because high molecular weight is the underlying reason, but the question asks for the property that describes the behaviour, and molecular weight is a measurement rather than a property of the solution. Note that options A and D are printed identically.

47. Which one of the following interactions is primarily responsible for stabilizing the secondary structure of a protein? (1)
- A. ✓ **Hydrogen bonding**
B. Ionic bonding
C. Disulfide Bridge
D. Hydrophobic interaction

Answer: A

The secondary structure is the alpha helix and the beta pleated sheet, the regular shapes the chain folds into. They are held by hydrogen bonds between the carbon-oxygen group of one peptide bond and the nitrogen-hydrogen group of another further along the chain. Each bond is weak, but there are many of them, so the shape holds. The disulfide bridge is the tempting answer because it is the strongest link in a protein, but it joins cysteine side chains and holds the tertiary structure.

48. Which of the following regulatory mechanisms involves the enzyme-catalyzed addition or removal of a functional group (such as a phosphate) to covalently alter a protein's activity between an active and an inactive state? (1)

- A. ✓ **Covalent modification** B. Allosteric regulation
C. Competitive inhibition D. Feedback inhibition

Answer: A

Covalent modification means a group is chemically attached to the protein or taken off it, and the commonest example is a phosphate group added by a kinase and removed by a phosphatase. Because the group is bonded on, the switch between the active and inactive form lasts until an enzyme reverses it. Allosteric regulation is the tempting answer because it also switches enzymes on and off, but there the regulator settles on a second site with weak forces and drifts away again, and nothing is bonded to the protein.

49. In the process of glycolysis, the enzyme that catalyzes rearrangement of Glucose 6-phosphate to Fructose 6-phosphate without the addition or removal of atoms is categorized in which class of enzyme? (1)

- A. Transferase B. ✓ **Isomerases**
C. Lyases D. Ligases

Answer: B

Glucose 6-phosphate and fructose 6-phosphate have exactly the same atoms and the same formula, and only their arrangement differs, so the reaction is a rearrangement within one molecule. Enzymes that do that are isomerases. Transferase is the tempting answer because a phosphate group is present in both names, but a transferase moves a group from one molecule to another, and here the phosphate never leaves the sugar.

50. A competitive inhibitor reduces the rate of an enzyme-catalyzed reaction by specifically binding to the: (1)

- A. Allosteric site B. Regulatory site
C. Both active and allosteric site D. ✓ **Active site**

Answer: D

A competitive inhibitor has a shape close to that of the substrate, so it fits into the active site and sits there. While it occupies the site the true substrate cannot bind and the reaction slows. Because the two compete for the same place, adding more substrate restores the rate. Option A is the trap: binding at an allosteric site, away from the active site, is what a non-competitive inhibitor does, and extra substrate cannot overcome that kind of inhibition.

51. During DNA duplication, if DNA fails to replicate because of DNA supercoiling at the region ahead of the replication fork, which enzyme is most likely failing to function correctly? (1)

- A. DNA Helicases B. ✓ **Topoisomerase**
C. DNA polymerase D. DNA ligase

Answer: B

Helicase unwinds the double helix at the replication fork, and unwinding one part of a long molecule makes the region ahead of it twist tighter and tighter into supercoils. Topoisomerase relieves that strain by cutting one or both strands, letting the tension unwind, then sealing the cut. If it fails, the DNA ahead locks up and replication stops. Helicase is the tempting answer because it is working at the same place, but helicase is the cause of the supercoiling rather than the cure for it.

52. A DNA strand has the sequence 3'-CGATTAGGG-5'. What is the complementary mRNA sequence that would bond to this strand? (1)
- A. 3'-GCTAATCCC-5' B. 5'-GCTAATCCC-3'
- C. ✓ 5'-GCUAAUCCC-3' D. 5'-GCUAAUCCG-3'

Answer: C

The messenger RNA is built to be complementary and antiparallel to the template, and RNA carries uracil where DNA carries thymine. Reading the template 3'-CGATTAGGG-5' base by base gives C to G, G to C, A to U, T to A, T to A, A to U, G to C, G to C and G to C, so the transcript is 5'-GCUAAUCCC-3'. Option B is tempting because the order of bases is right, but it is written with thymine, and RNA never contains thymine.

53. A plant with round seeds is test-crossed. Which one of the following is NEVER a possible result of this specific cross? (Assume: Round seed (R) is dominant over wrinkled seed (r)) (1)
- A. 100% Round seeds B. ✓ 100% Wrinkled seeds
- C. 50% Round and 50% Wrinkled seeds D. 1:1 Genotypic ratio

Answer: B

A test cross means crossing the unknown plant with the homozygous recessive, rr. The round parent is either RR or Rr. If it is RR every offspring gets an R and all the seeds are round. If it is Rr, half the offspring are Rr and round and half are rr and wrinkled, which gives the 50 to 50 split and the 1 to 1 ratio. Either way the round parent passes on at least some R alleles, so a result of all wrinkled offspring can never appear. Option C is tempting because a wrinkled result feels like the point of a test cross, but half wrinkled is the outcome, never all of them.

54. An Rh-negative woman marries a man who is heterozygous Rh-positive. What is the probability that they will have an Rh-negative child? (1)
- A. 0% B. 25%
- C. ✓ 50% D. 100%

Answer: C

Rh positive is dominant, so the Rh negative woman must be dd and the heterozygous man is Dd. He makes two kinds of gamete, D and d, in equal numbers, while she can only give d. The offspring are therefore half Dd, which is Rh positive, and half dd, which is Rh negative, so the chance of an Rh negative child is 50 percent. Option B is tempting because 25 percent is the familiar figure for a recessive child, but that comes from a cross where both parents are heterozygous, and here the mother is already recessive.

55. While studying a tissue sample, a biologist identifies branched cells and the presence of intercalated discs. Which type of muscle tissue is being observed? (1)
- A. ✓ Cardiac muscles B. Skeletal muscles
- C. Smooth muscles D. Mixed muscles

Answer: A

Cardiac muscle fibres are short and branched, and neighbouring fibres are joined end to end by intercalated discs. Those discs carry the electrical signal straight from one fibre to the next, so the whole heart wall contracts as a single sheet. Skeletal muscle is the tempting answer because it is also striped under the microscope, but its fibres are long, unbranched and hold many nuclei, and they have no intercalated discs.

56. Which one of the following ions binds with troponin to allow actin and myosin to interact during muscle contraction? (1)

- A. Sodium
- B. ✓ Calcium
- C. Potassium
- D. Chlorine

Answer: B

When a nerve impulse reaches the muscle fibre, calcium ions are released from the sarcoplasmic reticulum. Calcium binds to troponin on the actin filament, troponin changes shape and pulls tropomyosin aside, and the myosin binding sites on actin are uncovered so the heads can attach and pull. Sodium is the tempting answer because sodium ions do carry the action potential along the membrane, but inside the fibre it is calcium that acts on troponin.

57. Which one of the following type of bone cells are used to break down bones and help them to form into correct shapes? (1)

- A. Osteoblasts
- B. Osteocytes
- C. ✓ Osteoclasts
- D. Osteoprogenitor

Answer: C

Osteoclasts are large cells with several nuclei that dissolve the mineral and protein of bone and carry the pieces away. Bone is constantly remodelled, so osteoclasts remove material where it is not needed while osteoblasts lay new bone down, and between them the bone is shaped correctly and repaired. Osteoblasts are the tempting answer because the two names look almost the same, but they build bone rather than break it down.

58. Which one of the following types of joint allows for movement primarily in one plane, similar to the bending and straightening action of the elbow and knee? (1)

- A. ✓ Hinge joints
- B. Condylod joints
- C. Pivot joints
- D. Saddle joint

Answer: A

A hinge joint has a curved surface fitting into a hollow one, and the ligaments hold it so that movement is possible in one plane only. That gives bending and straightening, which is exactly what the elbow and the knee do. A pivot joint is the tempting answer because it is also a limited joint, but it allows rotation about a long axis, as when the head turns from side to side on the neck.

59. Which of the following pairs incorrectly matches a male reproductive structure with its function? (1)

- A. Semiferous tubules → produce immature sperm cells
- B. Epididymis → matures and stores sperm cells
- C. ✓ Seminal vesicle → secretes mucus-rich fluids
- D. Prostate gland → secretes an alkaline buffer

Answer: C

The question asks for the pair that is matched wrongly. Seminal vesicles secrete a thick alkaline fluid rich in fructose, and that sugar is the fuel the sperm use to swim, so calling their secretion mucus-rich is incorrect. The mucus in semen comes from the bulbourethral glands. Option D is tempting to pick because alkalinity sounds like the seminal vesicle's job, but the prostate does secrete an alkaline fluid, and that pairing is correct.

60. During the process of spermatogenesis, certain tall somatic cells located in the seminiferous tubules provide essential nourishment to developing sperm. What are these cells called? (1)
- A. Primary spermatocytes
B. Secondary spermatocytes
C. Primordial germ cells
D. ✓ Sertoli cells

Answer: D

Sertoli cells are the tall supporting cells that stretch from the wall of the seminiferous tubule toward its centre. Developing sperm cells lie in pockets against them, and the Sertoli cells feed them, remove the leftover cytoplasm and form the barrier that protects them from the blood. Primary spermatocytes are the tempting answer because they are found in the same tubule, but they are the germ cells that are dividing into sperm, not the cells that nourish them.

61. During days 12-14 of the cycle, estrogen provides positive feedback to the hypothalamus and pituitary. What is the immediate physiological result of this feedback? (1)
- A. The immediate onset of menstrual bleeding
B. ✓ A surge in LH leading to the release of an egg
C. The inhibition of FSH to prevent growth of follicle
D. The degeneration of the ovary to corpus luteum

Answer: B

For most of the cycle oestrogen holds the pituitary back, but around days 12 to 14 the mature follicle pours out so much oestrogen that the feedback flips to positive. The pituitary answers with a sharp surge of luteinising hormone, and about a day and a half later the follicle bursts and releases the egg. Option C is tempting because FSH really is damped at this stage, but the immediate result of the positive feedback is the LH surge and ovulation.

62. Which one of the following is categorized as a barrier method of contraception? (1)
- A. Pills
B. ✓ Diaphragm
C. Contraceptive implant
D. Contraceptive injection

Answer: B

A barrier method works by physically stopping the sperm from reaching the egg. The diaphragm is a soft dome placed over the cervix, so it blocks the entrance to the uterus. Pills are the tempting answer because they are the best known method, but they work by hormones that prevent ovulation, so no barrier is involved.

63. While conducting a mark-recapture study on birds, a biologist catches and marks 150 birds. One week later, 120 birds are caught, and 30 of them are found to be marked. Based on this data, what is the estimated total population of birds? (1)
- A. 300
B. 1,200
C. ✓ 600
D. 450

Answer: C

This is the mark and recapture, or Lincoln index, calculation. The share of marked birds in the second catch stands for the share of marked birds in the whole population, so $N = \frac{M \times C}{R}$, where $M = 150$ marked at the start, $C = 120$ caught the second time and $R = 30$ of those found to be marked. That gives $N = \frac{150 \times 120}{30} = 600$. The same result comes from noticing that $30/120$ is a quarter, so the 150 marked birds are a quarter of the population. Option A is tempting if you add the three figures together, but the estimate comes from the proportion, not from a sum.

64. Which of the following conditions is a fundamental requirement for a population to exhibit an exponential growth model? (1)
- A. ✓ **An ideal environment with unlimited resources**
 - B. A negative per capita rate of increase ($r < 0$)
 - C. A population size that has reached its carrying capacity
 - D. The presence of limited resources and high competition

Answer: A

Exponential growth is the J-shaped curve, where the population keeps multiplying at the same per capita rate and gets faster and faster. That only happens where nothing holds the population back: unlimited food, space and water, and no serious predation or disease. Option D is the trap because it describes the real world, but limited resources and competition give logistic growth, the S-shaped curve that flattens out at the carrying capacity.

65. A demographer observes a population where the percentage of individuals in the 0-14 age group is significantly higher than those in the above 60 group, resulting in a broad-based, narrow-topped pyramid. What does this shape primarily indicate about the country's development? (1)
- A. It is a developed nation with a stationary population and high life expectancy
 - B. It is an elderly population that is shrinking due to low crude birth rates
 - C. It is a stable population where mortality and fertility rates are nearly equal
 - D. ✓ **It is a developing nation with high fertility rates and lower life expectancy**

Answer: D

A broad base means a large share of the people are children, which comes from a high birth rate. A narrow top means few people live into old age, which means a low life expectancy and a high death rate. Together those describe a developing country with fast population growth. Option A is tempting because it names a real pyramid shape, but a developed country with a stationary population has straight sides and a wide top, since births are low and most people reach old age.

66. Which of the following is classified as a mechanical measure of soil and water conservation? (1)
- A. Planting tree seedlings on farmlands
 - B. ✓ **Constructing check dams and terraces**
 - C. The Green Legacy initiative
 - D. Enclosing degraded land from animals

Answer: B

Mechanical, or physical, conservation measures are structures that are built on the land to slow water down and hold soil in place. Check dams across gullies and terraces across a slope both do that, so they are mechanical measures. Planting tree seedlings is the tempting answer because it also protects soil, but living cover is a biological measure, and the Green Legacy initiative and area enclosure fall in the same biological group.

67. In a food chain consisting of: Algae → Small Fish → Large Fish → Fish Eagle, which organism would you expect to have the highest concentration of DDT, and why? (1)
- A. Small Fish, because toxins (DDT) are lost as they move up the trophic levels
 - B. ✓ **Fish Eagle, because toxins (DDT) accumulate as they move up the trophic levels**
 - C. Algae, because they are the first to absorb the toxin (DDT) from the water
 - D. Large Fish, because they have more fatty tissue to store the toxins (DDT) than birds

Answer: B

DDT dissolves in fat and the body cannot break it down or excrete it, so it stays stored in the tissues. Every animal eats many organisms from the level below it, and it keeps all the DDT from each of them, so the concentration multiplies at every step. This is biomagnification, and the fish eagle at the top of the chain carries the highest concentration. Option C is tempting because the algae do absorb the DDT first, but they hold the smallest amount in each gram of tissue.

68. How does a conscious citizen contribute to sustainable development according to biology? (1)
- A. By consuming more non-renewable resources to increase the economy
 - B. By ignoring environmental conditions to focus on industrial growth
 - C. ✓ **By developing bio-based technologies that reduce waste products**
 - D. By preventing the use of all biotechnology in agriculture

Answer: C

Sustainable development means meeting today's needs without using up what the next generation will need. Bio-based technologies do that: biofertiliser, biogas from waste, biodegradable packaging and biological pest control all cut pollution and reduce the drain on limited resources. Option A is tempting because it points to economic growth, but consuming more non-renewable resources empties a stock that cannot be refilled, so any growth it gives is short lived.

69. Which of the following pairs of bacteria functions as a bioinsecticide by producing protein against insects? (1)
- A. *Thiobacillus ferrooxidans* and *Thiobacillus thiooxidans*
 - B. ✓ ***Bacillus thuringiensis* and *Bacillus popilliae***
 - C. *Beauveria bassiana* and *Metarhizium anisopliae*
 - D. *Leptosporidium ferrooxidans* and *Thiobacillus organoparus*

Answer: B

Bacillus thuringiensis produces a crystal protein that becomes a toxin in the gut of insect larvae and kills them, and *Bacillus popilliae* infects beetle grubs and causes milky disease. Both are bacteria used as bioinsecticides, so B is the pair. Option C is the trap: *Beauveria bassiana* and *Metarhizium anisopliae* also kill insects and are also used in biological control, but they are fungi, and the question asks for bacteria.

70. Glyphosate-resistant crops are genetically engineered to allow farmers to: (1)
- A. cultivate crops that produce their own pesticide chemical
 - B. increase the diversity of different crop species grown in a single field
 - C. ✓ **apply herbicide to a field without damaging the primary crop**
 - D. eliminate the need for any herbicide application on the plants

Answer: C

Glyphosate kills a plant by blocking an enzyme the plant needs to make certain amino acids. A glyphosate-resistant crop carries a form of that enzyme the herbicide cannot block, so the farmer can spray the whole field and the weeds die while the crop keeps growing. Option A is tempting because it describes another common genetic modification, but a crop that makes its own insect poison is a Bt crop, and that has nothing to do with herbicide.

71. Grade 12 students performing a Gram stain procedure identified that a specimen they are studying is Gram-negative. Which of the following characteristics is wrong about the structure of this bacterium? (1)
- A. A cell wall composed of two distinct major layers
 - B. High concentrations of Lipopolysaccharides (LPS)
 - C. ✓ **A significantly reduced or absent periplasmic space**
 - D. The presence of porin proteins to facilitate transport

Answer: C

The question asks which statement is wrong about a Gram-negative bacterium. Gram-negative cells have a thin peptidoglycan layer with an outer membrane over it, and the gap between the two membranes, the periplasmic space, is wide and well developed, which is where many of their enzymes sit. Saying it is reduced or absent is therefore incorrect. Option B is tempting to pick because lipopolysaccharide sounds unusual, but LPS in the outer membrane is a real Gram-negative feature and that statement is true.

72. In the classification of fungi, the family known as Zygomycota is characterized by the production of: (1)

- A. ✓ **sporoniospore on the surface of a club-shaped sporangia**
- B. ascospores within a sac-like structure called an ascus
- C. basidiospores on the surface of a club-shaped basidium
- D. flagellated zoospores that swim through aquatic habitats

Answer: A

Zygomycota make their asexual spores inside a sporangium carried on an upright stalk, which is the structure seen in bread mould, and they make zygospores when two hyphae fuse. Option A is the only choice naming a sporangium, so it is the one that fits. Option C is the tempting answer because it repeats the club-shaped wording, but basidiospores formed on a basidium belong to the Basidiomycota, the mushrooms.

73. Which of the following groups of protozoa utilizes conjugation as a method of genetic exchange? (1)

- A. ✓ **Ciliates**
- B. Sporozoans
- C. Amebae
- D. Flagellates

Answer: A

Conjugation in ciliates such as Paramecium is a temporary joining of two cells. They line up side by side, exchange micronuclei so that each ends with a new combination of genes, then separate and go on dividing. No new individual is produced, so it is genetic exchange rather than reproduction. Flagellates are the tempting answer because they are also single-celled protozoa, but they reproduce by binary fission and do not conjugate.

74. In the viral replication process, some bacteriophages integrate their DNA into the host cell chromosome and remain dormant for many generations. This cycle is known as the: (1)

- A. lytic cycle
- B. productive cycle
- C. ✓ **lysogenic cycle**
- D. Chronic release

Answer: C

In the lysogenic cycle the phage DNA is inserted into the bacterial chromosome and becomes a prophage. From then on it is copied every time the bacterium divides, so it is passed to all the descendants while causing no harm, until a trigger such as ultraviolet light switches it into the lytic cycle. The lytic cycle is the tempting answer because it is the better known one, but there the phage takes over the cell at once, makes new phages and bursts the cell, so nothing stays dormant.

75. Which one of the following techniques is not correctly matched with temperature used and its time of exposure? (1)

- A. ✓ **Hot air oven, 150°C, 2.5 seconds**
- B. Autoclaves, 121°C, 15 minutes
- C. Tyndallisation, 100°C for 20 minutes
- D. Boiling, 100°C for 10 minutes

Answer: A

The question asks which pairing of temperature and time is wrong. A hot air oven uses dry heat, and dry heat kills far more slowly than steam, so the standard setting is about 160 to 170 degrees for one to two hours. A 2.5 second exposure would sterilise nothing, so option A is the mismatch. Option B is tempting because the numbers feel small, but 121 degrees for 15 minutes is exactly the standard autoclave cycle, and moist heat under pressure works that fast.

76. Which of the following statement is wrong about anabolism? Anabolism:

(1)

- A. is the constructive phase of metabolism
- B. is an endergonic reaction
- C. is the process whereby simpler substances are joined together to form complex macromolecules
- D. ✓ **releases energy as a result of the build-up of molecules**

Answer: D

Anabolism is the building side of metabolism: small molecules are joined into large ones, such as amino acids into proteins or glucose into glycogen. Building bonds needs energy put in, which makes anabolism endergonic and is why ATP is spent on it. Statement D says energy is released, which describes catabolism instead, so D is the wrong statement. Option A is tempting to pick, but calling anabolism the constructive phase of metabolism is correct.

77. During the non-cyclic photophosphorylation stage of photosynthesis, what is the specific role of the water molecule?

(1)

- A. To combine with CO₂ to form the unstable 6-carbon intermediate
- B. To act as the final electron acceptor in the electron transport chain
- C. To catalyze the reduction of NADP⁺ into NADPH in the stroma
- D. ✓ **To provide electrons to replace those lost by Photosystem II**

Answer: D

In non-cyclic photophosphorylation, light energy knocks electrons out of photosystem II and they travel down the electron transport chain, so photosystem II is left short of electrons. Water is split by light in a reaction called photolysis, $2H_2O \rightarrow 4H^+ + 4e^- + O_2$, and those electrons refill photosystem II, while the protons help build the gradient and the oxygen is released as a waste gas. Option B is the trap: water is the electron donor at the beginning of the chain, and the final electron acceptor is NADP⁺.

78. All of the following can happen in both photophosphorylation and oxidative phosphorylation except:

(1)

- A. Generation of ATP using chemiosmosis
- B. Use of ATP synthase enzyme to generate ATP
- C. Phosphorylation of ADP to produce ATP
- D. ✓ **Conversion of light energy to chemical energy (ATP)**

Answer: D

Photophosphorylation and oxidative phosphorylation share the same machinery. Both build a proton gradient across a membrane, both let the protons flow back through ATP synthase, and both end by adding phosphate to ADP. What differs is the energy source at the start: photophosphorylation begins with light captured by chlorophyll, while oxidative phosphorylation begins with electrons taken from food molecules. Option A is tempting because chemiosmosis sounds specific, but both processes use it, so it is not the exception.

79. In the Calvin cycle, when three molecules of carbon dioxide (CO₂) are fixed through three turns of the cycle, which of the following statements accurately describes the resulting products? (1)
- A. A total of five molecules of 3-phosphoglycerate (3-PGA) are produced during the fixation stage
 - B. Three molecules of ATP are consumed to reduce 3-phosphoglycerate (3-PGA) into glyceraldehyde-3-phosphate (G3P)
 - C. **Six molecules of NADPH are required to reduce the 1,3-bisphosphoglycerate into glyceraldehyde-3-phosphate (G3P)**
 - D. The process results in the immediate net synthesis of one six-carbon glucose molecule

Answer: C

Three turns fix three molecules of carbon dioxide and produce six molecules of 3-phosphoglycerate, one for each of the three-carbon halves. Every one of those six is first phosphorylated by ATP and then reduced by NADPH to glyceraldehyde-3-phosphate, so six NADPH are needed, which is what option C states. Option B is tempting because the number three keeps appearing in the question, but the reduction step uses six ATP, one per 3-phosphoglycerate, not three.

80. What is the primary function of the Electron Transport Chain (ETC) in the inner mitochondrial membrane? (1)
- A. To oxidize ATP into ADP to release energy for the cell
 - B. To synthesize glucose from carbon dioxide and water
 - C. **✓ To create a proton gradient using energy from electron transfers**
 - D. To produce 4 molecules of CO₂ for every turn of the cycle

Answer: C

The electron transport chain takes the electrons carried by NADH and FADH₂ and passes them from carrier to carrier down to oxygen. Energy is released at each transfer, and the carriers use it to pump protons out of the matrix into the intermembrane space, building a concentration and charge gradient. The protons then flow back through ATP synthase and ATP is made. Option A is tempting because ATP is mentioned, but ATP is the product of this arrangement, and the chain does not break ATP down.

81. Which one of the following best represents the products of one turn of the Krebs cycle for one Acetyl CoA? (1)
- A. 2 ATP, 2 NADH, and 2 Pyruvate
 - B. **✓ 3 NADH, 1 FADH, 1 ATP, and 2 CO₂**
 - C. 6 NADH, 2 FADH, 2 ATP, and 4 CO₂
 - D. 1 Glucose, 6 Oxygen molecules and 6 CO₂

Answer: B

Each turn of the Krebs cycle handles one acetyl CoA. The two carbons entering are released as two molecules of carbon dioxide, three NAD⁺ are reduced to NADH, one FAD is reduced to FADH₂, and one ATP is made through GTP at the substrate level. That is option B. Option C is tempting because those figures also come from the Krebs cycle, but they are the totals for one glucose, which is broken into two acetyl CoA and so drives the cycle twice.

82. In the absence of oxygen, why is fermentation necessary for a cell? (1)
- A. **✓ To regenerate NAD⁺ so that glycolysis can continue**
 - B. To produce large amounts of ATP for the cell
 - C. To convert ethanol back into NADH
 - D. To allow the electron transport chain to function without oxygen

Answer: A

Glycolysis needs a supply of NAD⁺ at the step where glyceraldehyde-3-phosphate is oxidised. Without oxygen the electron transport chain stops, so NADH is not reoxidised there and the cell would run out of NAD⁺ within seconds and glycolysis would halt. Fermentation hands the hydrogen from NADH to pyruvate, forming lactic acid or ethanol, and that frees NAD⁺ so glycolysis can keep running. Option B is tempting, but fermentation itself makes no ATP: the two ATP a cell gains come from glycolysis, which fermentation only keeps going.

83. The Eternity of Life theory was supported by some scientists because they believed:

(1)

- A. The Universe is constantly expanding
- B. ✓ **Life is an inherent property of an unchanging Universe**
- C. Life was created by a supernatural force at a specific point in time
- D. Life originated from resistant spores arriving from another planet

Answer: B

The eternity of life idea belongs with the steady state view of the universe: if the universe had no beginning and does not change in its overall character, then life too had no beginning and has always been present somewhere. That is why it was said that life is an inherent property of the universe and needed no moment of origin. Option A is tempting because it is a true statement about the universe, but an expanding universe points to a beginning in time, which argues against the eternal unchanging picture that this theory rests on.

84. Which of the following is a key postulate of Neo-Darwinism that was not part of Darwin's original theory?

(1)

- A. New need
- B. Natural selection
- C. Struggle for existence
- D. ✓ **Genetic variability**

Answer: D

Darwin could see that individuals in a population vary, but he had no way to explain where the variation came from or how it was passed on. Neo-Darwinism added the answer after Mendel's work was rediscovered: genetic variability produced by mutation and by recombination during meiosis, described in terms of allele frequencies in a population. Natural selection is the tempting answer, but that was the centre of Darwin's own theory, so it is not the new part.

85. In a forest with light-colored trees, light moths are camouflaged and survive better than dark moths, which are easily seen and eaten by birds. Over time, the moth population shifts to favor the light-colored trait because it offers a survival advantage in this specific environment. This shift toward one extreme characteristic is an example of:

(1)

- A. Stabilizing selection
- B. ✓ **Directional selection**
- C. Disruptive selection
- D. Artificial selection

Answer: B

In directional selection one extreme of a range of variation is favoured, so the average of the population shifts steadily toward that extreme over generations. Here the light colour survives better on light trees, so the population moves toward light moths. Stabilising selection is the tempting answer because it is also natural selection acting steadily, but it favours the middle of the range and removes both extremes, so the average stays where it was.

86. A single nucleotide polymorphism changes one nucleotide in a gene sequence. As a result, the gene gains a stop codon 500 base pairs too soon and when the protein is translated, it is cut short. Which of the following types of mutations did the point mutation cause?

(1)

- A. Silent
- B. Missense
- C. ✓ **Nonsense**
- D. Insertion

Answer: C

A nonsense mutation is a base change that turns a codon which stood for an amino acid into a stop codon. The ribosome reads the new stop and lets go, so the chain ends 500 bases early and the shortened protein almost never works. Missense is the tempting answer because it is also a point mutation, but a missense change swaps one amino acid for a different one and the protein is still made to full length.

87. Which one of the following is not among assumptions of Hardy-Weinberg equilibrium? (1)

- A. No mutation
- B. No natural selection
- C. ✓ **No random mating**
- D. No migration

Answer: C

Hardy-Weinberg equilibrium describes a population where nothing is changing the allele frequencies, and its assumptions are: random mating, no mutation, no natural selection, no migration and a very large population. Option C states the opposite of one of them, so it is the one that is not an assumption. Option A is tempting to pick because a question about mutation feels like the odd one out, but no mutation is genuinely one of the conditions.

88. Which part of the neuron is responsible for receiving signals from sensory receptors or other neurons? (1)

- A. ✓ **Dendrites**
- B. Axon
- C. Cell body (Soma)
- D. Myelin sheath

Answer: A

Dendrites are the short branched fibres spreading out from the cell body, and their job is to receive signals, whether from a sensory receptor or from the axon of another neuron, and carry them toward the cell body. The many branches let one neuron collect input from a large number of others. The axon is the tempting answer because it also carries impulses, but it carries them away from the cell body to the next cell.

89. During depolarization, which of the following events occurs? (1)

- A. Potassium channels open and K^+ rushes out
- B. ✓ **Sodium channels open and Na^+ rushes into the cell**
- C. Calcium channels open and Ca^{2+} rushes into the cell
- D. The inside of the cell becomes more negative than the resting state

Answer: B

At rest the inside of a neuron is negative. When the membrane reaches threshold the voltage-gated sodium channels open and sodium ions rush in down both the concentration and the charge gradient, so the inside becomes less negative and then briefly positive. That reversal is depolarisation. Option A is tempting because potassium movement is also part of an action potential, but potassium leaving the cell is repolarisation, the recovery step that follows.

90. Which one of the following is not among the functions of brainstem? (1)

- A. Regulating heartbeat, breathing and blood pressure
- B. Coordinating head movements in response to visual and auditory stimuli
- C. Coordinating reflex actions of vomiting, coughing, sneezing, and swallowing
- D. ✓ **Maintaining balance and posture of the body**

Answer: D

The brainstem, made of the medulla, pons and midbrain, controls heartbeat, breathing and blood pressure, runs reflexes such as coughing, sneezing, vomiting and swallowing, and turns the head toward what is seen or heard. Balance and posture are not on that list: they are the work of the cerebellum, which is why option D is the exception. Option A is tempting because the heart and lungs feel like separate systems, but the medulla is part of the brainstem, so their control belongs there.

91. Imagine you are outside on a sunny day and having trouble reading your textbook. In bright light, what happens to your pupil? (1)
- A. The pupil is pulled open wide (it dilates).
 - B. ✓ **The circular muscles of the iris contract**
 - C. The radial muscles contract
 - D. The pupil cannot regulate the size of pupil

Answer: B

The iris carries two sets of muscle. In bright light the circular muscles contract while the radial muscles relax, so the pupil becomes small and less light reaches the retina, which protects it. Option C is the trap: the radial muscles contract in dim light, and that pulls the pupil wide open so more light can enter.

92. Glucagon is secreted by which cells of the pancreas? (1)
- A. ✓ **Alpha (α) cells**
 - B. Beta (β) cells
 - C. Delta (δ) cells
 - D. Acini cells

Answer: A

The islets of Langerhans hold different cell types. The alpha cells secrete glucagon, which raises blood glucose by making the liver break glycogen down and release the sugar into the blood. Beta cells are the tempting answer because they are the better known ones, but beta cells secrete insulin, which does the opposite and lowers blood glucose.

93. The functional unit of the kidney responsible for filtering blood and forming urine is the: (1)
- A. Neuron
 - B. Alveoli
 - C. ✓ **Nephron**
 - D. Renal

Answer: C

The nephron is the functional unit of the kidney, and each kidney holds about a million of them. Every nephron filters blood at the glomerulus and Bowman's capsule, then reabsorbs the water, glucose and salts the body needs along its tubule and secretes the ions it does not, and what is left is urine. The neuron is the tempting answer because the two words sound almost the same, but a neuron is a nerve cell and has nothing to do with the kidney.

94. Insulin is a hormone known to regulate blood sugar levels. However, one of the following is not an action of insulin. Which is it? (1)
- A. Increase conversion of glucose into glycogen and deposition of it in the body
 - B. Increase the rate of oxidation of glucose in the tissues
 - C. Stimulates the rate of conversion of glucose into fat
 - D. ✓ **Activates hepatic gluconeogenesis**

Answer: D

Insulin is released when blood glucose is high, and everything it does lowers that level: it drives glucose into cells, speeds up its oxidation, stores it as glycogen and turns the surplus into fat. Gluconeogenesis is the making of new glucose in the liver from amino acids and glycerol, which raises blood sugar, so insulin holds it back rather than activating it. That makes option D the exception. Option A is tempting to pick, but converting glucose into glycogen for storage is one of insulin's main actions.

95. Which one of the following greenhouse gases is emitted from the use of fertilizer and animal waste? (1)

- A. CH₄
- B. ✓ N₂O
- C. SF₆
- D. HFCs

Answer: B

Nitrogen fertiliser and animal manure add far more nitrogen to the soil than crops can take up. Soil bacteria work on the surplus through nitrification and denitrification, and nitrous oxide escapes as a by-product of those reactions. Each nitrous oxide molecule traps far more heat than a carbon dioxide molecule, and it stays in the atmosphere for over a century. Methane is the tempting answer because it is also a farming gas, but it comes from cattle digestion, flooded rice fields and rotting waste rather than from fertiliser.

96. Which of the following is NOT a direct consequence of man-made climate change, but rather a secondary or indirect effect? (1)

- A. Rising sea level
- B. Rising maximum temperatures
- C. Thawing of permafrost
- D. ✓ Increasing spread of pests

Answer: D

Warming raises maximum temperatures, and that heat thaws permafrost and melts ice and expands sea water, so those three follow from the warming itself. Pests spread further for a different reason: the climate changes first, and then milder winters and longer warm seasons let insects survive where they could not before and move into new areas. It sits one step further down the chain, which makes it an indirect effect. Rising sea level is the tempting answer because it takes decades to show, but slow is not the same as indirect, and it comes straight from thermal expansion and melting ice.

END OF THE MARKING KEY

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