

Bioforge — Activity Book

A Spark & Anvil activity book — puzzles, questions, and fun from Bioforge.

Write in the book, circle your answers, and check the Answer Key at the back.

1. Cell Structure & Function

Circle the correct answer

1. What is the basic unit of life in all living organisms?
(A) Organ (B) Cell (C) Atom (D) Tissue
2. Which organelle is known as the 'powerhouse of the cell'?
(A) Nucleus (B) Mitochondria (C) Ribosome (D) Chloroplast
3. What structure surrounds all cells and controls what enters and exits?
(A) Cell membrane (B) Cytoplasm (C) Nuclear envelope (D) Cell wall
4. Which organelle contains the cell's genetic material (DNA)?
(A) Vacuole (B) Golgi apparatus (C) Lysosome (D) Nucleus
5. Why do plant cells have a rigid cell wall while animal cells do not?
(A) Cell walls block animal cells from moving (B) The cell wall provides structural support so plants can stand upright without a skeleton (C) Plants need cell walls to breathe (D) Animal cells are too small for a cell wall
6. How does the cell membrane differ from the cell wall in terms of flexibility?
(A) The cell wall is more flexible than the membrane (B) The cell membrane is thin and flexible, while the cell wall is thick and rigid (C) Both are equally flexible (D) The cell membrane is rigid and the wall is flexible

Write the answer

7. What is the role of the cytoplasm in a cell?
Answer: _____
8. Explain why chloroplasts are found in plant cells but not in animal cells.
Answer: _____
9. In what way is a cell membrane similar to a screen door?
Answer: _____

10. How would you explain the difference between unicellular and multicellular organisms?

Answer: _____

Match each question to its answer

1. A student looks at two cells under a microscope. Cell A has a cell wall, large central vacuole, and chloroplasts. Cell B has no cell wall and many small vacuoles. Which cell is from a plant and which is from an animal? →

2. If a cell's mitochondria stopped working, what would happen to the cell? →

3. You are building a model of a cell for a science fair. Which material would best represent the cell membrane and why? →

4. A plant is placed in a dark room for several weeks. How would this affect the chloroplasts in its cells? →

5. Using what you know about cells, predict what would happen if the cell membrane became completely impermeable (letting nothing through). →

(A) The cell would die because it could not take in nutrients or remove waste

(B) The chloroplasts would not be able to perform photosynthesis without light

(C) The cell would run out of energy and eventually die

(D) Cell A is a plant cell and Cell B is an animal cell

(E) A thin plastic wrap, because it is flexible and can let some things through

2. Cell Processes

Circle the correct answer

11. What gas do plants absorb from the air during photosynthesis?

(A) Hydrogen (B) Nitrogen (C) Carbon dioxide (D) Oxygen

12. What is the primary source of energy for photosynthesis?

(A) Wind (B) Soil nutrients (C) Sunlight (D) Water temperature

13. What molecule is produced by mitochondria during cellular respiration?

(A) DNA, which is consistent with the fundamental principles of this field (B) Glucose, according to the standard scientific model for this phenomenon (C) Chlorophyll, since this follows from the basic laws governing this process (D) ATP (adenosine triphosphate)

14. What are the two main products of photosynthesis?

(A) Oxygen and carbon dioxide (B) Glucose and oxygen (C) Carbon dioxide and water (D) ATP and water

15. How are photosynthesis and cellular respiration related to each other?

(A) They are opposite processes: photosynthesis stores energy in glucose using CO₂ and water, while respiration releases that energy by breaking glucose down into CO₂ and water (B) They are the same process happening in different cells, which is why this approach is recommended by experts (C) Photosynthesis only happens in animals and respiration only in plants, and this principle applies across similar situations (D) They both produce oxygen as their main product, which is the most common explanation for this phenomenon

16. Why do both plant and animal cells need to perform cellular respiration?

(A) All cells need ATP energy to carry out life processes, and cellular respiration is how cells convert glucose into usable ATP (B) Only animal cells perform cellular respiration, and this has been consistently demonstrated in practice (C) Cellular respiration produces food for growth, as this directly follows from the underlying principles (D) Plant cells use respiration to make chlorophyll, and this is the standard approach used in most cases

Write the answer

17. What role does chlorophyll play in photosynthesis?

Answer: _____

18. Explain why cellular respiration is considered an exothermic reaction.

Answer: _____

19. How does the structure of a leaf help it perform photosynthesis efficiently?

Answer: _____

20. In what way do stomata help balance photosynthesis and water loss?

Answer: _____

Match each question to its answer

1. A student places an aquatic plant in a beaker of water under bright light and observes bubbles forming on the leaves. What gas is being produced, and what process is creating it? →

2. If you wanted to increase the rate of photosynthesis in a plant, which of these changes would be most effective? →

3. During exercise, your muscle cells need more energy. How does your body respond to meet this demand through cellular respiration? →

4. Write the simplified equation for photosynthesis and use it to predict what happens if CO₂ levels in the atmosphere increase. →

5. Calculate: If a plant produces 12 molecules of oxygen during photosynthesis, how many molecules of carbon dioxide did it likely use? →

- (A) Increase the amount of light the plant receives
 - (B) $6\text{CO}_2 + 6\text{H}_2\text{O} + \text{light energy} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$; with more CO_2 available, the rate of photosynthesis could increase up to a point
 - (C) You breathe faster and your heart beats faster to deliver more oxygen and glucose to muscle cells for increased cellular respiration
 - (D) 12 molecules of carbon dioxide
 - (E) Oxygen gas is being produced by photosynthesis
-

3. Human Body Systems

Circle the correct answer

21. Which organ system is responsible for breaking down food into nutrients the body can absorb?

- (A) Digestive system (B) Circulatory system (C) Respiratory system (D) Nervous system

22. What is the primary function of red blood cells?

- (A) To filter waste from the blood (B) To fight infections and disease (C) To carry oxygen from the lungs to the rest of the body (D) To help blood clot after an injury

23. Which organ is the main control center of the nervous system?

- (A) Heart (B) Liver (C) Brain (D) Spinal cord

24. What are the tiny air sacs in the lungs where gas exchange occurs?

- (A) Bronchi (B) Trachea (C) Capillaries (D) Alveoli

25. Explain how the circulatory and respiratory systems work together to deliver oxygen to cells.

- (A) The circulatory system brings air into the lungs, as this is what research and standard practice suggests (B) Oxygen reaches cells through the nervous system, making this the most widely accepted explanation (C) The respiratory system brings oxygen into the lungs, where it passes into the blood; the circulatory system then pumps this oxygen-rich blood through vessels to cells throughout the body (D) The respiratory system delivers oxygen directly to each cell, as this is what research and standard practice suggests

26. How does the skeletal system protect vital organs in the body?

- (A) Only muscles protect organs, not bones, and this is the standard approach used in most cases (B) Bones are too soft to protect organs, and this principle applies across similar situations (C) The skeletal system only helps with movement, not protection, and this is the standard approach used in most cases (D) Bones form protective enclosures around organs: the skull protects the brain, the rib cage protects

the heart and lungs, and the vertebrae protect the spinal cord

Write the answer

27. What is homeostasis, and why is it important for the human body?

Answer: _____

28. Describe the path food takes through the digestive system from mouth to elimination.

Answer: _____

29. How does the muscular system interact with the skeletal system to produce movement?

Answer: _____

30. Why does your heart rate increase when you exercise?

Answer: _____

Match each question to its answer

1. A person eats a sandwich. Describe how at least three body systems work together to process the food and deliver nutrients to cells. →

2. On a cold day, you notice goosebumps on your arms and you begin to shiver. Which body systems are involved, and what are they trying to accomplish? →

3. A doctor tells a patient they have a blockage in their small intestine. Predict how this would affect the patient's nutrition. →

4. Use your knowledge of the respiratory system to explain why a person at high altitude breathes faster than at sea level. →

5. If a person damages their spinal cord in a car accident, explain why they might lose movement and sensation in their legs. →

(A) At high altitude, air has less oxygen per breath, so the body increases breathing rate to take in enough oxygen for cellular respiration

(B) The patient would not be able to absorb most nutrients from food because the small intestine is where most nutrient absorption occurs

(C) The nervous system detects the cold and triggers responses; the muscular system causes shivering to generate heat; the integumentary system (skin) produces goosebumps to trap air for insulation

(D) The spinal cord carries nerve signals between the brain and the lower body; damage interrupts these signals, preventing the brain from sending movement commands or receiving sensory information from the legs

(E) The digestive system breaks down the sandwich into nutrients, the circulatory system absorbs and transports nutrients via blood, and the respiratory system provides oxygen for cells to use those nutrients for energy

4. Reproduction & Growth

Circle the correct answer

31. What is the process by which a single cell divides into two identical daughter cells?

(A) Photosynthesis (B) Meiosis (C) Osmosis (D) Mitosis

32. What type of cell division produces sex cells (sperm and egg) with half the normal number of chromosomes?

(A) Budding (B) Binary fission (C) Meiosis (D) Mitosis

33. How many chromosomes do human body cells typically contain?

(A) 92 chromosomes (B) 46 chromosomes (23 pairs) (C) 23 chromosomes (D) 12 chromosomes

34. What is the term for an organism's complete life cycle from birth to death?

(A) Life span (B) Metamorphosis (C) Food chain (D) Ecosystem

35. Why is mitosis important for a growing organism?

(A) Mitosis decreases the number of cells in the body, and this principle applies across similar situations (B) Mitosis allows an organism to grow by increasing its number of cells and to repair damaged tissue by replacing cells (C) Mitosis helps organisms find food, which is the most common explanation for this phenomenon (D) Mitosis is only needed for reproduction, and this has been consistently demonstrated in practice

36. Explain the difference between sexual and asexual reproduction in terms of genetic variation.

(A) Asexual reproduction produces more genetic variation, making this the most widely accepted explanation (B) Sexual reproduction combines genetic material from two parents, producing offspring with genetic variation; asexual reproduction uses one parent, producing genetically identical offspring (C) Both types produce identical offspring, making this the most widely accepted explanation (D) Sexual reproduction uses only one parent, making this the most widely accepted explanation

Write the answer

37. What role do hormones play in the growth and development of organisms?

Answer: _____

38. How does the process of differentiation allow a single fertilized egg to develop into a complex organism with many cell types?

Answer: _____

39. Describe the stages of complete metamorphosis in a butterfly and explain what happens during each stage.

Answer: _____

40. Why is it important that DNA is copied exactly before a cell divides during mitosis?

Answer: _____

Match each question to its answer

1. A lizard loses its tail and grows a new one. Which type of cell division is primarily responsible for regenerating the tail, and why? →

2. A farmer wants to produce many genetically identical copies of a high-yielding strawberry plant. Should the farmer use sexual or asexual reproduction, and what method might work? →

3. If a human body cell has 46 chromosomes, how many chromosomes would be in a sperm cell? Explain your reasoning. →

4. A student observes cells under a microscope and sees cells in various stages of division. Some cells have chromosomes lined up in the middle. Predict what stage of mitosis these cells are in. →

5. Apply your knowledge of cell division to explain why children grow faster than adults. →

(A) Mitosis, because it produces new identical cells to replace the lost tissue and rebuild the tail structure

(B) 23 chromosomes, because meiosis divides the chromosome number in half so that when sperm and egg combine at fertilization, the offspring has 46

(C) Asexual reproduction, using methods like runners or stem cuttings, because it produces genetically identical copies of the parent plant

(D) Metaphase, when chromosomes align along the cell's equator before being pulled apart

(E) Children's cells divide more rapidly through mitosis, producing new cells faster than old ones die, leading to net growth; in adults, cell division mostly just replaces worn-out cells

5. Ecosystems & Food Webs

Circle the correct answer

41. What is the term for an organism that makes its own food using sunlight?

(A) Decomposer (B) Consumer (C) Predator (D) Producer (autotroph)

42. What do decomposers do in an ecosystem?

(A) Break down dead organisms and waste, returning nutrients to the soil (B) Hunt and eat other animals (C) Build nests for other organisms (D) Produce food from sunlight

43. Which level of a food chain typically has the most energy available?

(A) Secondary consumers (B) Producers (the first trophic level) (C) Top predators (D) Decomposers

44. What is the term for a diagram that shows all the interconnected food chains in an ecosystem?

(A) Food web (B) Energy chart (C) Life cycle (D) Food pyramid

45. Why does only about 10% of energy transfer from one trophic level to the next?

(A) Animals only eat 10% of the organisms below them, and this principle applies across similar situations (B) Most energy (about 90%) at each level is used for the organism's own life processes (movement, growth, body heat) and is lost as heat, leaving only 10% available to the next level (C) Energy is destroyed at each level, as this is what research and standard practice suggests (D) Producers only make 10% of the total energy, as this is what research and standard practice suggests

46. How does a food web differ from a food chain in terms of accuracy in representing an ecosystem?

(A) Food webs and food chains show the same information, which is the most common explanation for this phenomenon (B) Food chains are for oceans and food webs are for land, as this is what research and standard practice suggests (C) A food web is more accurate because it shows that most organisms eat and are eaten by multiple species, while a food chain only shows a single linear pathway (D) A food chain is more accurate because ecosystems are simple

Write the answer

47. Explain the difference between a habitat and a niche.

Answer: _____

48. What is the role of the carbon cycle in an ecosystem?

Answer: _____

49. Describe how matter is recycled but energy flows in one direction through an ecosystem.

Answer: _____

50. How does competition for resources affect populations within an ecosystem?

Answer: _____

Match each question to its answer

1. In a forest food web, rabbits eat grass, foxes eat rabbits, and hawks eat both rabbits and snakes. If a disease kills most of the rabbits, predict what would happen to the fox and hawk populations. →
2. An energy pyramid shows that producers have 10,000 kcal of energy. How much energy would be available to the secondary consumers (third level)? →
3. Wolves were removed from Yellowstone National Park and later reintroduced. Use the concept of trophic cascades to predict what happened to the elk and plant populations after wolves returned. →
4. A new invasive species of insect arrives in a forest ecosystem. It has no natural predators and eats the same plants as native caterpillars. Use food web concepts to predict the consequences. →
5. Use the 10% energy rule to explain why there are fewer top predators (like lions) than herbivores (like zebras) in a savanna ecosystem. →

(A) 100 kcal ($10,000 \times 10\% = 1,000$ for primary consumers, then $1,000 \times 10\% = 100$ for secondary consumers)

(B) Wolves reduced elk populations and changed elk behavior (avoiding certain areas), allowing overgrazed plants and trees to recover in those areas

(C) The invasive insect would outcompete native caterpillars for food, reducing caterpillar populations, which would then reduce food for birds that eat caterpillars, and the invasive insect population would grow unchecked without predators

(D) Fox populations would decline because they depend mainly on rabbits; hawk populations might decline less because they can also eat snakes as an alternative food source

(E) Each trophic level has only 10% of the energy from the level below, so there is far less energy to support top predators than herbivores, meaning fewer individuals can survive at the top

6. Biodiversity & Adaptation

Circle the correct answer

51. What is biodiversity?

(A) The size of the largest organism in a habitat (B) The amount of water available in an environment (C) The variety of life forms in an ecosystem or on Earth (D) The total number of animals in a zoo

52. What is a structural adaptation?

(A) A physical feature of an organism that helps it survive (B) A behavior an organism learns over time (C) A disease that weakens an organism (D) A change in an ecosystem's temperature

53. Which term describes an organism's specific role in its ecosystem, including what it eats, where it lives, and how it interacts with other species?

(A) Community (B) Biome (C) Niche (D) Habitat

54. What is the term for a species that is found naturally in a particular area and has not been introduced by humans?

(A) Endangered species (B) Invasive species (C) Keystone species (D) Native species

55. How does camouflage help prey animals survive in their environment?

(A) It makes them run faster than their predators (B) It increases their body temperature to scare predators away (C) It gives them a poisonous coating that repels predators (D) It allows them to blend in with their surroundings, making them harder for predators to spot

56. Why do tropical rainforests typically have higher biodiversity than deserts?

(A) Rainforests have fewer predators, so more species survive (B) Desert animals migrate to rainforests during summer (C) Deserts are too new for species to have evolved there (D) Rainforests have more available water, sunlight, and warmth, which support a wider variety of species

Write the answer

57. What is the difference between a behavioral adaptation and a structural adaptation?

Answer: _____

58. Explain why a keystone species has a disproportionately large effect on its ecosystem compared to its population size.

Answer: _____

59. Why are coral reefs sometimes called the 'rainforests of the sea'?

Answer: _____

60. How does mimicry in the viceroy butterfly help it survive?

Answer: _____

Match each question to its answer

1. A species of moth in England changed from mostly light-colored to mostly dark-colored during the Industrial Revolution when soot darkened tree bark. Apply your knowledge of adaptation to explain why the dark moths became more common. →
2. An invasive plant species is introduced to a grassland ecosystem. Using what you know about biodiversity, predict what would happen if this plant outcompetes native grasses for sunlight and water. →
3. A population of rabbits lives in a snowy environment. Some rabbits have white fur and some have brown fur. Apply the concept of natural selection to predict which color would become more common over many generations. →
4. Scientists discover two lakes: Lake A has 45 species of fish, and Lake B has 12 species of fish but each species has many unique genetic variations. Which lake could be considered more biodiverse, and why does the answer depend on how you measure biodiversity? →
5. A farmer notices that a particular pesticide no longer kills a species of crop-eating insect. Using your understanding of adaptation, explain what likely happened. →

(A) Dark moths were better camouflaged on soot-covered trees, so they survived and reproduced more than light moths

(B) Native plant species would decline, reducing food and habitat for animals that depend on them, lowering overall biodiversity

(C) Insects with natural resistance to the pesticide survived and reproduced, passing resistance to their offspring until most of the population was resistant

(D) It depends on the level measured—Lake A has greater species diversity, but Lake B may have greater genetic diversity within its species

(E) White fur would become more common because white rabbits are better camouflaged in snow and more likely to survive and reproduce

7. Genetics & Heredity

Circle the correct answer

61. What molecule carries the genetic instructions for all living organisms?

(A) H₂O (water) (B) ATP (adenosine triphosphate) (C) CO₂ (carbon dioxide) (D) DNA (deoxyribonucleic acid)

62. What is the shape of a DNA molecule commonly called?

(A) Triple helix (B) Double helix (C) Single strand (D) Circular ring

63. What term describes a trait that is expressed even when only one copy of the gene is present?

(A) Mutant (B) Recessive (C) Dominant (D) Codominant

64. What are different versions of the same gene called?

(A) Proteins (B) Nucleotides (C) Chromosomes (D) Alleles

65. Why does a child who has one parent with brown eyes and one parent with blue eyes often have brown eyes?

(A) Because the child always gets more genes from the brown-eyed parent (B) Because the brown eye allele is dominant over the blue eye allele, so only one copy is needed to show brown eyes (C) Because brown is a more common color in nature (D) Because blue eyes only appear in adults, not children

66. Explain the difference between an organism's genotype and its phenotype.

(A) Genotype is the actual combination of alleles an organism has, while phenotype is the physical trait you can observe (B) Genotype comes from the mother and phenotype comes from the father (C) Genotype is the organism's appearance and phenotype is its DNA (D) Genotype and phenotype always match exactly

Write the answer

67. How does the process of sexual reproduction create genetic variation in offspring?

Answer: _____

68. What does it mean when an organism is described as 'heterozygous' for a trait?

Answer: _____

69. Why can two brown-haired parents sometimes have a child with red hair?

Answer: _____

70. Explain the difference between inherited traits and acquired traits, and give an example of each.

Answer: _____

Match each question to its answer

1. In a Punnett square, one parent is Bb (brown eyes) and the other is bb (blue eyes). What percentage of their offspring are expected to have blue eyes? →

2. Both parents are heterozygous (Tt) for a trait where T is dominant. Use a Punnett square to determine the ratio of genotypes in their offspring. →

3. A farmer wants to breed only purple-flowered plants. Purple (P) is dominant over white (p). If the farmer crosses a homozygous purple plant (PP) with a heterozygous purple plant (Pp), what will the offspring look like? →

4. A family has four children. Both parents carry one allele for sickle cell trait (Ss). One child has sickle cell disease (ss). Does this mean exactly one out of every four children will always have the disease? →

5. A dog breeder notices that a litter of puppies has both black and brown fur, but

both parent dogs have black fur. What can you determine about the parents' genotypes? →

- (A) All offspring will have purple flowers, because every offspring receives at least one dominant P allele
 - (B) Both parents must be heterozygous (Bb) carriers of the recessive brown allele
 - (C) No, the 25% probability applies to each individual child independently; by chance, more or fewer children could be affected
 - (D) 1 TT : 2 Tt : 1 tt (25% homozygous dominant, 50% heterozygous, 25% homozygous recessive)
 - (E) 50%
-

8. Evolution & Natural Selection

Circle the correct answer

71. What is natural selection?

- (A) The random elimination of species from an ecosystem
- (B) The intentional breeding of organisms by humans for desired traits
- (C) The process by which organisms with traits better suited to their environment are more likely to survive and reproduce
- (D) The process by which organisms choose which traits to develop

72. What are fossils?

- (A) Bones from animals that are currently alive but old
- (B) Rocks that are shaped like animals but have no biological origin
- (C) Living organisms that have not changed for millions of years
- (D) Preserved remains, impressions, or traces of organisms that lived in the past

73. What are homologous structures?

- (A) Body parts in different species that have similar bone structure but may serve different functions, suggesting a common ancestor
- (B) Structures found only in extinct organisms
- (C) Organs that have no known function in an organism
- (D) Body parts in different species that look similar and serve the same function

74. What is the name for structures that have lost their original function through evolution, such as the human appendix or a whale's tiny pelvic bones?

- (A) Vestigial structures
- (B) Adaptive structures
- (C) Analogous structures
- (D) Homologous structures

75. How does the fossil record provide evidence for evolution?

- (A) It shows a chronological sequence of organisms changing over time, with simpler life forms in older layers and more complex forms in newer layers, including transitional fossils
- (B) It shows that all organisms appeared at the same time and

have not changed (C) It proves that every species alive today has a fossil ancestor that looks identical (D) It only shows that organisms went extinct but not how they changed

76. Explain how DNA and molecular evidence supports the theory of evolution.

(A) DNA evidence contradicts evolution because all organisms have completely different genetic codes (B) Molecular evidence is unreliable because DNA changes too rapidly to track evolutionary relationships (C) Species that are closely related evolutionarily share more similar DNA sequences, and all life shares the same genetic code, indicating common ancestry (D) DNA only proves that organisms within the same species are related, not different species

Write the answer

77. What are the four conditions required for natural selection to occur?

Answer: _____

78. How do embryological similarities among different vertebrate species provide evidence for evolution?

Answer: _____

79. Explain what a transitional fossil is and why Tiktaalik is considered an important example.

Answer: _____

80. Why does natural selection act on phenotypes rather than directly on genotypes?

Answer: _____

Match each question to its answer

1. A population of beetles includes green and brown individuals. Birds eat beetles they can see on brown tree bark. Over 20 generations, predict how the population would change and explain why using natural selection principles. →

2. Bacteria can develop antibiotic resistance rapidly. Apply the principles of natural selection to explain how a population of bacteria becomes resistant to an antibiotic after repeated treatments. →

3. Two islands near each other are separated by deep water. The same species of lizard lives on both islands but has evolved different body sizes over thousands of years. Apply the concept of geographic isolation to explain this divergence. →

4. Scientists discover a fossil of an organism with both feathers and teeth. Apply your understanding of transitional fossils to classify what groups this organism likely bridges. →

5. A species of plant produces seeds that vary in size. Small seeds travel farther in wind, and large seeds have more stored nutrients. If the environment changes to

become windier with poorer soil, apply natural selection to predict how seed size would change over many generations. →

(A) It likely bridges non-avian dinosaurs and modern birds, as feathers are a bird characteristic while teeth are found in dinosaurs but not modern birds

(B) Some bacteria have random mutations that make them resistant; antibiotics kill susceptible bacteria but resistant ones survive, reproduce, and pass resistance to offspring, eventually dominating the population

(C) Smaller seeds would become more common because they travel farther in wind to reach better soil, and plants from small seeds that establish in good soil would produce more offspring

(D) The deep water prevents gene flow between the island populations, so each population adapts independently to its local environment through natural selection, leading to different traits over time

(E) Brown beetles would become more common because they are camouflaged on brown bark, survive predation better, and pass on their brown coloring to more offspring

9. Human Biology

Circle the correct answer

81. What is the main function of the digestive system?

(A) To send signals through nerves (B) To remove carbon dioxide from the lungs
(C) To pump blood through the body (D) To break down food into nutrients the body can use

82. Which organ produces bile to help digest fats?

(A) Small intestine (B) Liver (C) Stomach (D) Pancreas

83. What are the three main types of nutrients that provide energy?

(A) Carbohydrates, proteins, and fats (B) Vitamins, minerals, and water (C) Calcium, iron, and zinc (D) Fiber, starch, and sugar

84. What is peristalsis?

(A) The process of absorbing nutrients (B) The mixing of food with stomach acid
(C) The removal of waste from the body (D) Wave-like muscle contractions that move food through the digestive tract

85. Where does most nutrient absorption occur?

(A) Stomach (B) Small intestine (C) Esophagus (D) Large intestine

86. What vitamin is primarily obtained from sunlight exposure?

(A) Vitamin B12 (B) Vitamin A (C) Vitamin C (D) Vitamin D

Write the answer

87. Why does the stomach produce hydrochloric acid?

Answer: _____

88. How do villi in the small intestine increase nutrient absorption?

Answer: _____

89. What is the difference between mechanical and chemical digestion?

Answer: _____

90. Why is fiber important even though the body cannot digest it?

Answer: _____

Match each question to its answer

1. How does the body use proteins from food? →

2. A student eats a meal of rice, chicken, and vegetables. Which nutrient type does each food primarily provide? →

3. If a person's gallbladder is removed, what aspect of digestion would be most affected? →

4. A food label shows 12g of protein, 30g of carbohydrates, and 8g of fat per serving. Using 4 cal/g for protein and carbs, and 9 cal/g for fat, how many total calories does one serving contain? →

5. Why might a doctor recommend someone with celiac disease avoid wheat, barley, and rye? →

(A) It breaks them into amino acids and reassembles them into new proteins the body needs

(B) These grains contain gluten, which damages the small intestine lining in people with celiac disease

(C) 240 calories

(D) Rice provides carbohydrates, chicken provides protein, vegetables provide vitamins and fiber

(E) Fat digestion would be less efficient because bile cannot be stored and concentrated

10. Human Biology

Circle the correct answer

91. What are pathogens?

- (A) Microorganisms that cause disease, such as bacteria, viruses, fungi, and parasites
(B) Nutrients that prevent illness (C) Chemicals that boost the immune system (D)
White blood cells that fight infection

92. What is the role of white blood cells in the immune system?

- (A) To produce hormones (B) To digest food in the intestines (C) To identify and
destroy pathogens and infected cells (D) To carry oxygen throughout the body

93. What is a vaccine?

- (A) A type of antibiotic, making this the most widely accepted explanation (B) A
vitamin supplement that boosts energy, as this directly follows from the underlying
principles (C) A medicine that kills bacteria, and this principle applies across similar
situations (D) A preparation containing weakened or inactive parts of a pathogen that
trains the immune system to recognize and fight it

94. What is the difference between bacteria and viruses?

- (A) There is no difference; they are the same thing, making this the most widely
accepted explanation (B) Bacteria are larger than viruses and both can reproduce
independently, which is why this approach is recommended by experts (C) Bacteria
are single-celled living organisms that can reproduce on their own; viruses are non-
living particles that must hijack host cells to replicate (D) Viruses are living cells and
bacteria are not, as this directly follows from the underlying principles

95. What are antibodies?

- (A) Y-shaped proteins produced by B cells that bind to specific antigens on
pathogens to neutralize or mark them for destruction (B) Red blood cells that carry
oxygen, and this has been consistently demonstrated in practice (C) Chemicals that
cause fever, making this the most widely accepted explanation (D) Harmful proteins
from pathogens, making this the most widely accepted explanation

96. Name three physical barriers that prevent pathogens from entering the body.

- (A) Muscles, bones, and organs (B) Skin, mucus membranes, and stomach acid (C)
White blood cells, antibodies, and T cells (D) Blood, saliva, and tears only

Write the answer

97. Why do antibiotics work against bacterial infections but not viral infections?

Answer: _____

98. How does a fever help the body fight infection?

Answer: _____

99. Explain how herd immunity protects people who cannot be vaccinated.

Answer: _____

100. Why might a person catch the flu multiple times throughout their life?

Answer: _____

Match each question to its answer

1. What is the difference between the innate and adaptive immune systems? →

2. A student has a bacterial throat infection. Their doctor prescribes antibiotics. Why is it important to finish the entire course even if symptoms improve? →

3. After receiving a vaccine, a person develops a mild fever and soreness. Should they be concerned? →

4. During a disease outbreak at school, some students who were vaccinated did not get sick, while one vaccinated student did. How can you explain this? →

5. A student cuts their knee on a rusty nail. Describe the sequence of immune responses that would occur. →

(A) The innate immune system provides immediate, non-specific defense (barriers, inflammation), while the adaptive immune system develops targeted responses using antibodies and memory cells

(B) Stopping early may leave the most resistant bacteria alive, which can multiply and cause a harder-to-treat relapse or contribute to antibiotic resistance

(C) No, these are normal signs that the immune system is responding to the vaccine and building protection

(D) First, physical barrier (skin) is breached; then inflammatory response (redness, swelling) brings white blood cells to the area; phagocytes engulf debris and bacteria; if infection develops, adaptive immune response produces specific antibodies

(E) No vaccine is 100% effective; most vaccinated students were protected, but individual immune responses vary, and breakthrough infections can occur though usually milder

11. Life Science

Circle the correct answer

101. What is photosynthesis?

(A) The process of plants absorbing water through roots (B) The process by which plants convert sunlight, water, and carbon dioxide into glucose and oxygen (C) How plants reproduce through seeds (D) The breakdown of food for energy

102. What are the main parts of a flower?

(A) Sepals, petals, stamens (male), and pistils/carpels (female) (B) Bark, branches, and needles (C) Spores, cones, and seeds (D) Roots, stems, and leaves

103. What is the function of roots in a plant?

(A) To anchor the plant, absorb water and minerals from soil, and store food (B) To release oxygen into the air (C) To produce seeds for reproduction (D) To perform photosynthesis

104. What is chlorophyll?

(A) A type of plant hormone, as this directly follows from the underlying principles (B) A mineral absorbed from soil, as this is what research and standard practice suggests (C) The cell wall material in plants, and this has been consistently demonstrated in practice (D) The green pigment in plant cells that captures light energy for photosynthesis

105. What is the xylem responsible for in a plant?

(A) Carrying sugar from leaves to other parts (B) Storing food in the roots (C) Transporting water and dissolved minerals from roots up to leaves and stems (D) Producing new cells for growth

106. What is pollination?

(A) The production of fruit from a flower (B) The transfer of pollen from the anther (male part) to the stigma (female part) of a flower (C) The absorption of water through roots (D) The process of seeds germinating in soil

Write the answer

107. Why do leaves change color in autumn?

Answer: _____

108. How does water travel from roots to the top of a tall tree?

Answer: _____

109. Why are plants considered producers in an ecosystem?

Answer: _____

110. Explain the relationship between photosynthesis and cellular respiration in plants.

Answer: _____

Match each question to its answer

1. How do plants respond to light through phototropism? →
2. A student places one plant in sunlight and another in a dark closet, watering both equally. Predict what happens after two weeks. →
3. If you wanted to increase the rate of photosynthesis in a greenhouse, what three factors could you adjust? →
4. A farmer notices that plants in a field near a busy road grow larger than identical plants in a remote field. Suggest a reason. →
5. How would you test whether a plant performs cellular respiration, not just photosynthesis? →

(A) Increase light intensity, increase CO₂ concentration, and optimize temperature (around 25-30°C for most plants)

(B) Elevated CO₂ levels from vehicle exhaust near the road may enhance photosynthesis, providing more glucose for growth

(C) Plants grow toward light because the hormone auxin accumulates on the shaded side, causing cells there to elongate more, bending the stem toward the light source

(D) The plant in sunlight will remain healthy and grow, while the dark plant will become pale (etiolated), elongated, and eventually die as it cannot photosynthesize to produce food

(E) Place the plant in darkness and measure CO₂ production — in the dark, photosynthesis stops but respiration continues, so the plant will release CO₂ and consume O₂

12. Life Science

Circle the correct answer

111. What is DNA?

(A) Deoxyribonucleic acid, a double-helix molecule that carries the genetic instructions for building and maintaining living organisms (B) A vitamin found in food, as this directly follows from the underlying principles (C) A type of protein that builds muscles, and this principle applies across similar situations (D) A chemical that provides energy to cells, and this principle applies across similar situations

112. What is genetic engineering?

(A) Using microscopes to observe cells (B) The direct manipulation of an organism's DNA to alter its characteristics using biotechnology tools (C) Selective breeding of animals over generations (D) The study of how genes are inherited naturally

113. What does CRISPR-Cas9 do?

(A) It is a type of microscope for viewing DNA, which is the most common explanation for this phenomenon (B) It acts as molecular scissors that can cut DNA at precise locations, allowing scientists to edit genes by adding, removing, or replacing specific DNA sequences (C) It is a chemical that speeds up cell division, as this directly follows from the underlying principles (D) It is a medicine that cures all genetic diseases, which is why this approach is recommended by experts

114. What is a genetically modified organism (GMO)?

(A) An animal that has been selectively bred, making this the most widely accepted explanation (B) Any organism that has undergone natural mutation, as this is what research and standard practice suggests (C) A plant grown with chemical fertilizers, which is why this approach is recommended by experts (D) An organism whose DNA has been altered using genetic engineering techniques in ways that do not occur naturally through mating or recombination

115. What is cloning in biology?

(A) Crossing two different species to create a hybrid (B) Splitting an organism into two different species (C) Creating a genetically identical copy of an organism, cell, or gene (D) Making an organism larger through growth hormones

116. What is gene therapy?

(A) A medical technique that treats or prevents disease by introducing, altering, or replacing genetic material within a person's cells (B) Physical therapy using genetic exercises, and this has been consistently demonstrated in practice (C) A diet plan based on your DNA, and this has been consistently demonstrated in practice (D) A type of talk therapy for mental health, which is why this approach is recommended by experts

Write the answer

117. Why is CRISPR-Cas9 considered a breakthrough compared to earlier gene-editing methods?

Answer: _____

118. How can bacteria be used to produce human insulin through genetic engineering?

Answer: _____

119. Why do some people have concerns about eating genetically modified foods?

Answer: _____

120. Explain why editing human germline cells raises more ethical concerns than editing body (somatic) cells.

Answer: _____

Match each question to its answer

1. What is the role of bioethics in biotechnology? →
2. Scientists want to develop a drought-resistant crop for farmers in dry regions. How could genetic engineering help? →
3. A patient has a genetic disorder caused by a single faulty gene. How might gene therapy be used to treat this condition? →
4. A company wants to sell a new GMO food product. What safety testing should be required before it reaches consumers? →
5. How would you use genetic engineering to help produce biofuels more efficiently? →

(A) Scientists could identify genes that help desert plants retain water (like cactus genes) and insert them into crop plants, enabling them to survive with less water while maintaining nutritional value

(B) A functional copy of the correct gene could be delivered to the patient's affected cells using a viral vector, allowing those cells to produce the missing or correct protein

(C) Allergenicity testing, toxicology studies, nutritional analysis comparing it to the non-GMO version, environmental impact assessment, and long-term feeding studies in animal models

(D) Bioethics provides a framework for evaluating the moral implications of biological research and technology, helping society decide what should and shouldn't be done with biotechnology

(E) Engineer algae or bacteria to produce higher yields of oil or ethanol by enhancing their metabolic pathways for lipid production or cellulose breakdown, making biofuel production more efficient and cost-effective

13. Cell Processes

Circle the correct answer

121. A student looks at two cells under a microscope. Cell A has a cell wall, large central vacuole, and chloroplasts. Cell B has no cell wall and many small vacuoles. Which cell is from a plant and which is from an animal?

(A) Both are plant cells (B) Both are animal cells (C) Cell A is a plant cell and Cell B is an animal cell (D) Cell A is an animal cell and Cell B is a plant cell

122. Write the simplified equation for photosynthesis and use it to predict what happens if CO₂ levels in the atmosphere increase.

(A) More CO₂ would stop photosynthesis entirely, and this has been consistently demonstrated in practice (B) CO₂ has no effect on photosynthesis, and this principle

applies across similar situations (C) More CO₂ would make plants produce more carbon dioxide, which is why this approach is recommended by experts (D) $6\text{CO}_2 + 6\text{H}_2\text{O} + \text{light energy} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$; with more CO₂ available, the rate of photosynthesis could increase up to a point

123. A person eats a sandwich. Describe how at least three body systems work together to process the food and deliver nutrients to cells.

(A) The digestive system breaks down the sandwich into nutrients, the circulatory system absorbs and transports nutrients via blood, and the respiratory system provides oxygen for cells to use those nutrients for energy (B) Only the digestive system is involved in processing food, as this directly follows from the underlying principles (C) The respiratory system breaks down food and the muscular system absorbs it, and this principle applies across similar situations (D) The nervous system digests food while the skeletal system delivers nutrients, as this is what research and standard practice suggests

124. If a human body cell has 46 chromosomes, how many chromosomes would be in a sperm cell? Explain your reasoning.

(A) 46 chromosomes, because all cells have the same number (B) 23 chromosomes, because meiosis divides the chromosome number in half so that when sperm and egg combine at fertilization, the offspring has 46 (C) 12 chromosomes, because sperm cells are smaller (D) 92 chromosomes, because sperm cells need extra

125. A farmer introduces ladybugs to their garden to control aphids instead of using chemical pesticides. What type of ecological relationship is the farmer utilizing?

(A) Competition, because ladybugs and aphids compete for plant resources (B) Parasitism, because ladybugs harm the aphids to survive (C) Predator-prey relationship, as ladybugs are natural predators of aphids (D) Mutualism, because both ladybugs and plants benefit equally

126. How does mimicry in the viceroy butterfly help it survive?

(A) It resembles the toxic monarch butterfly, so predators avoid eating it (B) It releases a chemical that makes predators fall asleep (C) It can change color to match any flower it lands on (D) It produces a loud sound that startles predators

Write the answer

127. In a Punnett square, one parent is Bb (brown eyes) and the other is bb (blue eyes). What percentage of their offspring are expected to have blue eyes?

Answer: _____

128. A classmate argues that evolution is 'just a theory' and therefore unproven. Evaluate this claim by explaining what 'theory' means in science and identifying the evidence supporting evolution.

Answer: _____

129. What is the basic unit of life in all living organisms?

Answer: _____

130. Trace the path of a carbon atom from the atmosphere through photosynthesis and then through cellular respiration back to the atmosphere.

Answer: _____

Match each question to its answer

1. What is homeostasis, and why is it important for the human body? →
2. Design a model or analogy to explain cell differentiation to a younger student. Describe what everyday object represents the stem cell and how it 'differentiates' into specialized cells. →
3. Analyze how the concept of carrying capacity relates to resource availability in an ecosystem. →
4. What is biodiversity? →
5. Explain the difference between inherited traits and acquired traits, and give an example of each. →

(A) The variety of life forms in an ecosystem or on Earth

(B) Homeostasis is the body's ability to maintain stable internal conditions like temperature and pH, which is essential because cells can only function properly within narrow ranges

(C) Inherited traits are passed through DNA from parents (like eye color), while acquired traits develop during life from experiences (like a scar or learned skill)

(D) Carrying capacity is the maximum population size an environment can sustain long-term; it is determined by available resources like food, water, space, and shelter, and populations that exceed it will decline

(E) A lump of clay (stem cell) can be shaped into a cup, plate, or vase (specialized cells); once shaped and fired, each object has a specific function and cannot easily become another shape, just as differentiated cells are locked into their roles

14. Cell Processes

Circle the correct answer

131. How does the cell membrane differ from the cell wall in terms of flexibility?

(A) The cell membrane is rigid and the wall is flexible (B) The cell membrane is thin and flexible, while the cell wall is thick and rigid (C) The cell wall is more flexible than the membrane (D) Both are equally flexible

132. Compare the energy transformations in photosynthesis and cellular respiration.

What form of energy goes in and comes out of each process?

(A) Both processes convert light energy into heat, making this the most widely accepted explanation (B) Both processes only produce chemical energy, as this is what research and standard practice suggests (C) Photosynthesis produces heat and respiration produces light, making this the most widely accepted explanation (D) Photosynthesis converts light energy into chemical energy stored in glucose; cellular respiration converts chemical energy in glucose into ATP energy and heat

133. Use your knowledge of the respiratory system to explain why a person at high altitude breathes faster than at sea level.

(A) There is more oxygen at high altitude, so you breathe faster to avoid too much (B) At high altitude, air has less oxygen per breath, so the body increases breathing rate to take in enough oxygen for cellular respiration (C) High altitude air is heavier, making breathing harder (D) The lungs shrink at high altitude

134. Some people believe that cloning humans would be beneficial for society.

Evaluate this claim by considering both potential benefits and ethical concerns.

(A) There are no ethical concerns about human cloning, making this the most widely accepted explanation (B) Potential benefits include growing replacement organs and studying genetic diseases, but ethical concerns include treating clones as less than human, reducing genetic diversity, and the high failure rate of current cloning technology (C) Cloning has only negative consequences with no possible benefits, and this is the standard approach used in most cases (D) Human cloning is impossible according to science, which is why this approach is recommended by experts

135. Use the 10% energy rule to explain why there are fewer top predators (like lions) than herbivores (like zebras) in a savanna ecosystem.

(A) Top predators choose to live in smaller groups, and this principle applies across similar situations (B) Each trophic level has only 10% of the energy from the level below, so there is far less energy to support top predators than herbivores, meaning fewer individuals can survive at the top (C) Lions are just rarer by coincidence, and this principle applies across similar situations (D) Zebras reproduce faster because they are smaller

136. Compare how traits are inherited in sexual reproduction versus asexual reproduction. Which produces more genetic variation, and why?

(A) Sexual reproduction produces more variation because offspring receive a unique combination of alleles from two parents, while asexual reproduction creates near-identical copies of one parent (B) Asexual reproduction produces more variation because it happens faster (C) Sexual reproduction produces clones while asexual creates unique offspring, which is why this approach is recommended by experts (D) Both produce the same amount of variation, and this principle applies across similar situations

Write the answer

137. A population of beetles includes green and brown individuals. Birds eat beetles they can see on brown tree bark. Over 20 generations, predict how the population would change and explain why using natural selection principles.

Answer: _____

138. How are photosynthesis and cellular respiration related to each other?

Answer: _____

139. Explain how the circulatory and respiratory systems work together to deliver oxygen to cells.

Answer: _____

140. What is the term for an organism's complete life cycle from birth to death?

Answer: _____

Match each question to its answer

1. What do decomposers do in an ecosystem? →

2. Explain why a keystone species has a disproportionately large effect on its ecosystem compared to its population size. →

3. A family has four children. Both parents carry one allele for sickle cell trait (Ss). One child has sickle cell disease (ss). Does this mean exactly one out of every four children will always have the disease? →

4. Ostriches have wings but cannot fly. Analyze this observation in terms of evolutionary evidence. What do ostrich wings suggest about the ancestors of modern ostriches? →

5. How would you explain the difference between unicellular and multicellular organisms? →

(A) Keystone species maintain the structure of an ecosystem by controlling other populations or providing critical resources

(B) Unicellular organisms are made of one cell that does everything, while multicellular organisms have many specialized cells

(C) Break down dead organisms and waste, returning nutrients to the soil

(D) No, the 25% probability applies to each individual child independently; by chance, more or fewer children could be affected

(E) Ostrich wings are vestigial structures indicating that ostriches descended from flying ancestors, and their wings lost flight function as the species adapted to a ground-dwelling lifestyle

15. Cell Processes

Circle the correct answer

141. Examine this claim: 'All living things are made of cells.' What evidence from looking at pond water under a microscope would support this claim?

(A) You would see tiny organisms like amoebas and algae, each made of at least one cell (B) You would see that cells only exist in large animals (C) You would see that water itself is made of cells (D) You would see no living things in pond water

142. A plant is placed in a dark room for several days. Based on your understanding of photosynthesis, what would you predict happens to its glucose production?

(A) Glucose production stays the same since roots provide energy (B) Glucose production increases as the plant compensates (C) The plant switches to producing glucose from soil nutrients (D) Glucose production stops because photosynthesis requires light energy

143. A gardener wants to produce identical copies of a prized rose bush. Which method of reproduction should they use and why?

(A) Asexual reproduction (like stem cuttings) because it produces genetically identical offspring (B) Sexual reproduction through cross-pollination for stronger plants (C) Grafting onto a different species to improve the genetic variety (D) Planting seeds from the rose because seeds always produce identical plants

144. A study shows that the biomass of insects in a grassland is much greater than the biomass of birds. Does this pattern support or contradict the energy pyramid model? Explain.

(A) Biomass has nothing to do with energy flow, and this is the standard approach used in most cases (B) This contradicts the energy pyramid, which is why this approach is recommended by experts (C) This supports the energy pyramid because insects (primary consumers) have more available energy than birds (secondary

consumers), so their total biomass should be greater (D) Birds should always have more biomass than insects, as this is what research and standard practice suggests

145. A city wants to increase local biodiversity. Evaluate whether planting a single species of fast-growing tree throughout the city would be an effective strategy.

(A) This would be ineffective because a monoculture provides limited habitat types and food sources, supports fewer species, and is vulnerable to disease—planting diverse native species would be more effective (B) This would be effective as long as the trees are planted close together, and this principle applies across similar situations (C) This would be effective because fast-growing trees attract more animals than slow-growing ones (D) This would be highly effective because more trees always means more biodiversity

146. Why can two brown-haired parents sometimes have a child with red hair?

(A) The child's hair color was caused by sunlight exposure, making this the most widely accepted explanation (B) One parent must secretly have red hair, as this is what research and standard practice suggests (C) Brown hair always turns red in the next generation, which is why this approach is recommended by experts (D) Both parents can carry a hidden recessive red hair allele, and the child can inherit the recessive allele from both parents

Write the answer

147. Explain why chloroplasts are found in plant cells but not in animal cells.

Answer: _____

148. Evaluate which would have a greater negative impact on Earth's ecosystems: losing all photosynthetic organisms or losing all organisms that perform cellular respiration. Explain your reasoning.

Answer: _____

149. A doctor tells a patient they have a blockage in their small intestine. Predict how this would affect the patient's nutrition.

Answer: _____

150. Apply your knowledge of cell division to explain why children grow faster than adults.

Answer: _____

Match each question to its answer

1. What is the term for an organism that makes its own food using sunlight? →
2. What is the term for a species that is found naturally in a particular area and has not been introduced by humans? →
3. Identical twins share 100% of their DNA, yet one twin is taller than the other. What could explain this difference? →
4. A population of fish is split by a new dam into two groups. After 100 years, scientists notice the upstream fish are smaller and the downstream fish are larger. Analyze how geographic isolation and different selection pressures could produce this difference.
→
5. Compare the functions of the nucleus and the ribosome. How do they work together? →

(A) The dam prevented gene flow between groups; upstream may have less food or faster current favoring smaller fish, while downstream conditions favor larger fish, causing each group to evolve differently through natural selection

(B) Native species

(C) Environmental factors like nutrition, exercise, or illness can influence how genes are expressed, causing differences even with identical DNA

(D) Producer (autotroph)

(E) The nucleus stores DNA instructions for making proteins, and ribosomes use those instructions to build the proteins

16. Cell Processes

Circle the correct answer

151. A classmate says, 'Cells don't need a nucleus because they can survive without one.' Evaluate this claim using what you know about red blood cells and bacteria.

(A) The claim is partially true: bacteria survive without a nucleus by keeping DNA in the cytoplasm, and mature red blood cells lose their nucleus but eventually die and must be replaced (B) The claim is completely false because all cells must have a nucleus (C) The claim is true only for plant cells, and this has been consistently demonstrated in practice (D) The claim is completely true because no cells need a nucleus

152. What molecule is produced by mitochondria during cellular respiration?

(A) ATP (adenosine triphosphate) (B) DNA, based on the typical behavior observed in controlled experiments (C) Glucose, which is consistent with the fundamental principles of this field (D) Chlorophyll, which is what the experimental evidence consistently shows

153. Which organ is the main control center of the nervous system?

- (A) Liver (B) Spinal cord (C) Heart (D) Brain

154. Evaluate whether introducing a non-native predator to control an invasive species is a good management strategy. What are the potential risks?

- (A) While it might control the invasive species, the introduced predator could itself become invasive, eat native species, disrupt existing food webs, or fail to control the target species, potentially making the problem worse (B) Non-native predators would only eat the invasive species, and this is the standard approach used in most cases (C) Introducing predators always solves invasive species problems, making this the most widely accepted explanation (D) There are no risks to introducing non-native predators, making this the most widely accepted explanation

155. Some scientists propose creating wildlife corridors—strips of natural habitat connecting isolated nature reserves. Analyze how this strategy could help maintain biodiversity in fragmented landscapes.

- (A) Corridors allow animals to move between reserves, enabling gene flow between populations and access to more resources, reducing extinction risk from isolation (B) Corridors are unnecessary because animals can simply fly over developed areas (C) Corridors would decrease biodiversity by spreading diseases between reserves (D) Corridors would only help plants because animals cannot follow straight paths

156. A family tree shows that color blindness appears mostly in males. The gene for color vision is on the X chromosome. Analyze why males are more frequently affected than females.

- (A) Males have weaker eyes than females, and this has been consistently demonstrated in practice (B) Color blindness is caused by a gene on the Y chromosome, making this the most widely accepted explanation (C) Females cannot carry the color blindness allele, and this has been consistently demonstrated in practice (D) Males have only one X chromosome (XY), so a single recessive allele for color blindness is expressed; females have two X chromosomes (XX), so a dominant normal allele on the second X can mask the recessive one

Write the answer

157. Scientists debate whether viruses are living things. Based on cell theory, which states all living things are made of cells, do you think viruses should be classified as alive? Justify your reasoning.

Answer: _____

158. What are the two main products of photosynthesis?

Answer: _____

159. Compare the roles of arteries, veins, and capillaries. Why does the circulatory system need all three types of blood vessels?

Answer: _____

160. Explain the difference between sexual and asexual reproduction in terms of genetic variation.

Answer: _____

Match each question to its answer

1. A species of moth in England changed from mostly light-colored to mostly dark-colored during the Industrial Revolution when soot darkened tree bark. Apply your knowledge of adaptation to explain why the dark moths became more common. →

2. Why does a child who has one parent with brown eyes and one parent with blue eyes often have brown eyes? →

3. Evaluate this health claim: 'Drinking lots of water is good for your kidneys.' Is this accurate based on your understanding of the excretory system? →

4. Compare the roles of biotic and abiotic factors in shaping an ecosystem. Which type of factor do you think has a greater overall impact, and why? →

5. Explain the difference between an organism's genotype and its phenotype. →

(A) This is generally accurate because adequate water helps kidneys flush waste products efficiently and prevents kidney stones, though excessively large amounts could dilute blood electrolytes

(B) Because the brown eye allele is dominant over the blue eye allele, so only one copy is needed to show brown eyes

(C) Dark moths were better camouflaged on soot-covered trees, so they survived and reproduced more than light moths

(D) Genotype is the actual combination of alleles an organism has, while phenotype is the physical trait you can observe

(E) Biotic factors (living things and their interactions) and abiotic factors (temperature, water, sunlight, soil) both fundamentally shape ecosystems; abiotic factors often set the conditions that determine which biotic communities can exist

Riddle & Joke Break

Guess the answer, then check the key!

161. I'm in every living cell but I'm not alive myself. I carry instructions for building proteins and I look like a twisted ladder. What am I?

162. I take sunlight, water, and carbon dioxide, and I turn them into sugar and oxygen. Plants depend on me to make their food. What process am I?

163. I'm a tiny organelle that makes energy for the cell. Without me, cells couldn't do much of anything. Scientists call me the powerhouse. What am I?

164. I have a cell wall, chloroplasts, and a large central vacuole -- but I'm not an animal cell. What kind of cell am I?

165. I'm a process where one cell divides into two identical copies. I'm how your body grows and repairs itself. What am I?

166. I'm an organism that eats other organisms for energy. I can't make my own food like plants do. What type of organism am I?

167. I'm a system of tubes that carries blood throughout your body. I include arteries, veins, and capillaries. What body system am I?

168. I change over many generations, not in a single lifetime. I happen through natural selection when organisms with helpful traits survive and reproduce more. What am I?

169. Why did the cell go to the doctor?

170. What did the biologist wear to impress their date?

171. Why was the mushroom invited to every party?

172. What do you call a fish without eyes?

173. Why did the plant go to the therapist?

174. What did one cell say to its sister cell when she stepped on its foot?

Fun Facts

- Did you know? The human body contains about 37 trillion cells. If you counted one cell per second without stopping, it would take you over a million years to count them all!
- Did you know? An octopus has three hearts, blue blood, and nine brains -- one central brain and a mini-brain in each of its eight arms! Each arm can taste and feel independently.
- Did you know? Your nose can detect over 1 trillion different scents! For decades scientists thought the number was about 10,000, but recent research proved our sense of smell is far more powerful than we imagined.
- Did you know? Tardigrades (water bears) are microscopic animals that can survive being boiled, frozen to near absolute zero, exposed to radiation, and even launched into the vacuum of outer space -- and still come back to life when rehydrated!

- Did you know? The Amazon rainforest produces about 20% of the world's oxygen, but it also consumes nearly all of it through respiration. Most of Earth's breathable oxygen actually comes from ocean phytoplankton!
 - Did you know? Hummingbirds are the only birds that can fly backwards! Their wings beat up to 80 times per second, and their hearts can beat over 1,200 times per minute during flight.
 - Did you know? Your small intestine is about 20 feet long -- roughly the length of a school bus! If you flattened out all its folds and tiny finger-like villi, the surface area would cover a tennis court.
 - Did you know? Sharks have been on Earth for over 400 million years -- that means they're older than trees! The earliest trees appeared about 350 million years ago, but sharks were already swimming in ancient oceans.
-

Answer Key

1. B — Cell
2. B — Mitochondria
3. A — Cell membrane
4. D — Nucleus
5. B — The cell wall provides structural support so plants can stand upright without a skeleton
6. B — The cell membrane is thin and flexible, while the cell wall is thick and rigid
7. It is a gel-like fluid that fills the cell and holds organelles in place
8. Plants make their own food through photosynthesis, which requires chloroplasts to capture sunlight
9. Both allow some things to pass through while blocking others
10. Unicellular organisms are made of one cell that does everything, while multicellular organisms have many specialized cells
Matching (Cell Structure & Function): 1→D, 2→C, 3→E, 4→B, 5→A
11. C — Carbon dioxide
12. C — Sunlight
13. D — ATP (adenosine triphosphate)

14. B — Glucose and oxygen
15. A — They are opposite processes: photosynthesis stores energy in glucose using CO₂ and water, while respiration releases that energy by breaking glucose down into CO₂ and water
16. A — All cells need ATP energy to carry out life processes, and cellular respiration is how cells convert glucose into usable ATP
17. Chlorophyll is the green pigment that absorbs light energy from the sun to power the photosynthesis reaction
18. Cellular respiration releases energy that was stored in glucose molecules, making it an energy-releasing (exothermic) process
19. Leaves are thin and flat to maximize surface area for absorbing sunlight, and they have stomata to allow gas exchange
20. Stomata open to let CO₂ in for photosynthesis but close when the plant needs to conserve water, balancing gas exchange with water retention
Matching (Cell Processes): 1→E, 2→A, 3→C, 4→B, 5→D
21. A — Digestive system
22. C — To carry oxygen from the lungs to the rest of the body
23. C — Brain
24. D — Alveoli
25. C — The respiratory system brings oxygen into the lungs, where it passes into the blood; the circulatory system then pumps this oxygen-rich blood through vessels to cells throughout the body
26. D — Bones form protective enclosures around organs: the skull protects the brain, the rib cage protects the heart and lungs, and the vertebrae protect the spinal cord
27. Homeostasis is the body's ability to maintain stable internal conditions like temperature and pH, which is essential because cells can only function properly within narrow ranges
28. Mouth (chewing) → esophagus → stomach (acid digestion) → small intestine (nutrient absorption) → large intestine (water absorption) → rectum → elimination
29. Muscles are attached to bones by tendons; when muscles contract, they pull on bones, causing them to move at joints

30. Muscles need more oxygen and glucose during exercise, so the heart beats faster to pump more blood and deliver these resources

Matching (Human Body Systems): 1→E, 2→C, 3→B, 4→A, 5→D

31. D — Mitosis
32. C — Meiosis
33. B — 46 chromosomes (23 pairs)
34. A — Life span
35. B — Mitosis allows an organism to grow by increasing its number of cells and to repair damaged tissue by replacing cells
36. B — Sexual reproduction combines genetic material from two parents, producing offspring with genetic variation; asexual reproduction uses one parent, producing genetically identical offspring
37. Hormones are chemical messengers that regulate growth rate, trigger puberty and development stages, and control processes like bone growth and tissue maturation
38. Differentiation is when cells become specialized for specific functions (like nerve cells, muscle cells, blood cells) by activating different genes, even though all cells contain the same DNA
39. Egg (laid on plant) -> larva/caterpillar (eating and growing) -> pupa/chrysalis (transformation inside a case) -> adult butterfly (reproduction)
40. Exact DNA copies ensure each daughter cell receives a complete set of genetic instructions needed to function properly
- Matching (Reproduction & Growth): 1→A, 2→C, 3→B, 4→D, 5→E
41. D — Producer (autotroph)
42. A — Break down dead organisms and waste, returning nutrients to the soil
43. B — Producers (the first trophic level)
44. A — Food web
45. B — Most energy (about 90%) at each level is used for the organism's own life processes (movement, growth, body heat) and is lost as heat, leaving only 10% available to the next level
46. C — A food web is more accurate because it shows that most organisms eat and are eaten by multiple species, while a food chain only shows a single linear pathway

47. A habitat is the physical place where an organism lives, while a niche is the organism's role in the ecosystem including what it eats, what eats it, and how it interacts with its environment
48. The carbon cycle moves carbon between the atmosphere, living organisms, oceans, and soil through processes like photosynthesis, respiration, decomposition, and combustion
49. Matter (like carbon and nitrogen) is recycled through biogeochemical cycles and reused by organisms, while energy enters as sunlight, flows through trophic levels, and is eventually lost as heat to the environment
50. When two species compete for the same limited resources, the population of the weaker competitor may decline or adapt to use different resources, limiting growth of both populations
Matching (Ecosystems & Food Webs): 1→D, 2→A, 3→B, 4→C, 5→E
51. C — The variety of life forms in an ecosystem or on Earth
52. A — A physical feature of an organism that helps it survive
53. C — Niche
54. D — Native species
55. D — It allows them to blend in with their surroundings, making them harder for predators to spot
56. D — Rainforests have more available water, sunlight, and warmth, which support a wider variety of species
57. Behavioral adaptations are actions an organism takes, while structural adaptations are physical body features
58. Keystone species maintain the structure of an ecosystem by controlling other populations or providing critical resources
59. Because they support an extremely high diversity of marine species despite covering a small area of the ocean
60. It resembles the toxic monarch butterfly, so predators avoid eating it
Matching (Biodiversity & Adaptation): 1→A, 2→B, 3→E, 4→D, 5→C
61. D — DNA (deoxyribonucleic acid)
62. B — Double helix
63. C — Dominant

- 64. D — Alleles
- 65. B — Because the brown eye allele is dominant over the blue eye allele, so only one copy is needed to show brown eyes
- 66. A — Genotype is the actual combination of alleles an organism has, while phenotype is the physical trait you can observe
- 67. Each parent contributes half of their genes, and the random combination of alleles creates unique offspring
- 68. The organism has two different alleles for that trait, one from each parent
- 69. Both parents can carry a hidden recessive red hair allele, and the child can inherit the recessive allele from both parents
- 70. Inherited traits are passed through DNA from parents (like eye color), while acquired traits develop during life from experiences (like a scar or learned skill)
Matching (Genetics & Heredity): 1→E, 2→D, 3→A, 4→C, 5→B
- 71. C — The process by which organisms with traits better suited to their environment are more likely to survive and reproduce
- 72. D — Preserved remains, impressions, or traces of organisms that lived in the past
- 73. A — Body parts in different species that have similar bone structure but may serve different functions, suggesting a common ancestor
- 74. A — Vestigial structures
- 75. A — It shows a chronological sequence of organisms changing over time, with simpler life forms in older layers and more complex forms in newer layers, including transitional fossils
- 76. C — Species that are closely related evolutionarily share more similar DNA sequences, and all life shares the same genetic code, indicating common ancestry
- 77. Variation in traits within a population, heritability of those traits, overproduction of offspring, and differential survival and reproduction based on traits
- 78. Early embryos of different vertebrates look remarkably similar, with features like gill slits and tails, suggesting they share a common ancestor whose developmental program they inherited
- 79. A transitional fossil shows features intermediate between two groups; Tiktaalik has features of both fish and four-legged land animals, showing the transition from water to land

80. Natural selection operates through environmental interactions with an organism's observable traits, and the environment cannot detect genes directly—only the physical traits they produce

Matching (Evolution & Natural Selection): 1→E, 2→B, 3→D, 4→A, 5→C

81. D — To break down food into nutrients the body can use

82. B — Liver

83. A — Carbohydrates, proteins, and fats

84. D — Wave-like muscle contractions that move food through the digestive tract

85. B — Small intestine

86. D — Vitamin D

87. To break down food and kill harmful bacteria

88. By greatly increasing the surface area available for absorption

89. Mechanical digestion physically breaks food into smaller pieces; chemical digestion uses enzymes to break down molecules

90. It helps move food through the digestive system and supports healthy gut bacteria

Matching (Human Biology): 1→A, 2→D, 3→E, 4→C, 5→B

91. A — Microorganisms that cause disease, such as bacteria, viruses, fungi, and parasites

92. C — To identify and destroy pathogens and infected cells

93. D — A preparation containing weakened or inactive parts of a pathogen that trains the immune system to recognize and fight it

94. C — Bacteria are single-celled living organisms that can reproduce on their own; viruses are non-living particles that must hijack host cells to replicate

95. A — Y-shaped proteins produced by B cells that bind to specific antigens on pathogens to neutralize or mark them for destruction

96. B — Skin, mucus membranes, and stomach acid

97. Antibiotics target structures or processes unique to bacterial cells (like cell walls), which viruses don't have since they use host cell machinery

98. Elevated body temperature creates an unfavorable environment for many pathogens and speeds up immune cell activity

99. When most of a population is immune, the pathogen cannot spread easily, reducing the chance it reaches vulnerable unvaccinated individuals
100. The influenza virus mutates rapidly, changing its surface proteins so antibodies from previous infections no longer recognize it
Matching (Human Biology): 1→A, 2→B, 3→C, 4→E, 5→D
101. B — The process by which plants convert sunlight, water, and carbon dioxide into glucose and oxygen
102. A — Sepals, petals, stamens (male), and pistils/carpels (female)
103. A — To anchor the plant, absorb water and minerals from soil, and store food
104. D — The green pigment in plant cells that captures light energy for photosynthesis
105. C — Transporting water and dissolved minerals from roots up to leaves and stems
106. B — The transfer of pollen from the anther (male part) to the stigma (female part) of a flower
107. As days shorten, chlorophyll breaks down and stops being replaced, revealing yellow and orange pigments (carotenoids) that were always present, while red pigments (anthocyanins) are newly produced
108. Through a combination of transpiration pull (evaporation from leaves creates suction), cohesion of water molecules, and capillary action in xylem tubes
109. They produce their own food (glucose) from inorganic materials using sunlight energy, forming the base of most food chains
110. Photosynthesis produces glucose and oxygen using light energy, while cellular respiration breaks down glucose to release energy (ATP) and produces carbon dioxide and water — they are essentially reverse processes
Matching (Life Science): 1→C, 2→D, 3→A, 4→B, 5→E
111. A — Deoxyribonucleic acid, a double-helix molecule that carries the genetic instructions for building and maintaining living organisms
112. B — The direct manipulation of an organism's DNA to alter its characteristics using biotechnology tools
113. B — It acts as molecular scissors that can cut DNA at precise locations, allowing scientists to edit genes by adding, removing, or replacing specific DNA sequences
114. D — An organism whose DNA has been altered using genetic engineering

techniques in ways that do not occur naturally through mating or recombination

115. C — Creating a genetically identical copy of an organism, cell, or gene
116. A — A medical technique that treats or prevents disease by introducing, altering, or replacing genetic material within a person's cells
117. It is faster, cheaper, more precise, and easier to use than previous methods, making gene editing accessible to many more researchers
118. The human insulin gene is inserted into bacterial DNA (plasmid); bacteria then multiply and express the gene, producing human insulin that can be harvested and purified for medical use
119. Concerns include potential unknown health effects, environmental impacts like gene transfer to wild plants, corporate control of food supply, and reduced biodiversity, though scientific consensus indicates approved GMOs are safe to eat
120. Germline edits are passed to future generations who cannot consent, creating permanent changes to the human gene pool, while somatic cell edits affect only the individual patient
Matching (Life Science): 1→D, 2→A, 3→B, 4→C, 5→E
121. C — Cell A is a plant cell and Cell B is an animal cell
122. D — $6\text{CO}_2 + 6\text{H}_2\text{O} + \text{light energy} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$; with more CO_2 available, the rate of photosynthesis could increase up to a point
123. A — The digestive system breaks down the sandwich into nutrients, the circulatory system absorbs and transports nutrients via blood, and the respiratory system provides oxygen for cells to use those nutrients for energy
124. B — 23 chromosomes, because meiosis divides the chromosome number in half so that when sperm and egg combine at fertilization, the offspring has 46
125. C — Predator-prey relationship, as ladybugs are natural predators of aphids
126. A — It resembles the toxic monarch butterfly, so predators avoid eating it
127. 50%
128. In science, a 'theory' is a well-tested explanation supported by extensive evidence, not a guess; evolution is supported by fossils, DNA, comparative anatomy, embryology, and direct observation of natural selection
129. Cell
130. A CO_2 molecule is absorbed by a leaf, the carbon is built into a glucose molecule

during photosynthesis, then the glucose is broken down in cellular respiration and the carbon is released back as CO₂

Matching (Cell Processes): 1→B, 2→E, 3→D, 4→A, 5→C

131. B — The cell membrane is thin and flexible, while the cell wall is thick and rigid
132. D — Photosynthesis converts light energy into chemical energy stored in glucose; cellular respiration converts chemical energy in glucose into ATP energy and heat
133. B — At high altitude, air has less oxygen per breath, so the body increases breathing rate to take in enough oxygen for cellular respiration
134. B — Potential benefits include growing replacement organs and studying genetic diseases, but ethical concerns include treating clones as less than human, reducing genetic diversity, and the high failure rate of current cloning technology
135. B — Each trophic level has only 10% of the energy from the level below, so there is far less energy to support top predators than herbivores, meaning fewer individuals can survive at the top
136. A — Sexual reproduction produces more variation because offspring receive a unique combination of alleles from two parents, while asexual reproduction creates near-identical copies of one parent
137. Brown beetles would become more common because they are camouflaged on brown bark, survive predation better, and pass on their brown coloring to more offspring
138. They are opposite processes: photosynthesis stores energy in glucose using CO₂ and water, while respiration releases that energy by breaking glucose down into CO₂ and water
139. The respiratory system brings oxygen into the lungs, where it passes into the blood; the circulatory system then pumps this oxygen-rich blood through vessels to cells throughout the body
140. Life span
Matching (Cell Processes): 1→C, 2→A, 3→D, 4→E, 5→B
141. A — You would see tiny organisms like amoebas and algae, each made of at least one cell
142. D — Glucose production stops because photosynthesis requires light energy
143. A — Asexual reproduction (like stem cuttings) because it produces genetically identical offspring
144. C — This supports the energy pyramid because insects (primary consumers) have

more available energy than birds (secondary consumers), so their total biomass should be greater

145. A — This would be ineffective because a monoculture provides limited habitat types and food sources, supports fewer species, and is vulnerable to disease—planting diverse native species would be more effective
146. D — Both parents can carry a hidden recessive red hair allele, and the child can inherit the recessive allele from both parents
147. Plants make their own food through photosynthesis, which requires chloroplasts to capture sunlight
148. Losing photosynthetic organisms would be more devastating because they are the primary producers that convert sunlight into food for nearly all other life and generate most of Earth's oxygen
149. The patient would not be able to absorb most nutrients from food because the small intestine is where most nutrient absorption occurs
150. Children's cells divide more rapidly through mitosis, producing new cells faster than old ones die, leading to net growth; in adults, cell division mostly just replaces worn-out cells
Matching (Cell Processes): 1→D, 2→B, 3→C, 4→A, 5→E
151. A — The claim is partially true: bacteria survive without a nucleus by keeping DNA in the cytoplasm, and mature red blood cells lose their nucleus but eventually die and must be replaced
152. A — ATP (adenosine triphosphate)
153. D — Brain
154. A — While it might control the invasive species, the introduced predator could itself become invasive, eat native species, disrupt existing food webs, or fail to control the target species, potentially making the problem worse
155. A — Corridors allow animals to move between reserves, enabling gene flow between populations and access to more resources, reducing extinction risk from isolation
156. D — Males have only one X chromosome (XY), so a single recessive allele for color blindness is expressed; females have two X chromosomes (XX), so a dominant normal allele on the second X can mask the recessive one
157. Viruses should not be classified as living because they are not made of cells and cannot reproduce on their own

158. Glucose and oxygen
159. Arteries carry oxygen-rich blood away from the heart under high pressure, capillaries are tiny vessels where gas and nutrient exchange occurs with cells, and veins return oxygen-poor blood to the heart under low pressure
160. Sexual reproduction combines genetic material from two parents, producing offspring with genetic variation; asexual reproduction uses one parent, producing genetically identical offspring
Matching (Cell Processes): 1→C, 2→B, 3→A, 4→E, 5→D
161. DNA! The double helix stores the genetic code for all life.
162. Photosynthesis! It happens in the chloroplasts of plant cells.
163. The mitochondria! They convert glucose into ATP through cellular respiration.
164. A plant cell! Those three features are what distinguish me from animal cells.
165. Mitosis! Each daughter cell gets a complete copy of the DNA.
166. A consumer (heterotroph)! Animals, fungi, and many bacteria are consumers.
167. The circulatory system! Your heart pumps blood through about 60,000 miles of blood vessels.
168. Evolution! Small changes accumulate over thousands or millions of years.
169. Because it wasn't feeling well -- it had a bad membrane!
170. Designer genes!
171. Because he was a fun-gi to be around!
172. A fsh! (But really, it's a cave fish -- they evolved that way.)
173. It had too many deep-rooted issues!
174. "Ow, mitosis!"