# Growforge — Activity Book

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

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

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# 1. Seeds of Science: Plant Basics and Life Cycles

## Circle the correct answer

**1.** What is the primary function of a plant's roots?
(A) To release seeds into the environment (B) To produce food through photosynthesis (C) To attract pollinators with bright colors (D) To absorb water and nutrients from the soil

**2.** Which part of a plant is responsible for making food through photosynthesis?
(A) Stems (B) Flowers (C) Leaves (D) Roots

**3.** What does a stem do for a plant?
(A) Produces seeds for reproduction (B) Stores pollen for pollination (C) Absorbs sunlight for energy (D) Transports water and nutrients between roots and leaves

**4.** A seed is placed in a cup of soil, watered, and kept in a dark closet. After a week, a pale shoot appears. What does this tell you about germination?
(A) The seed died because it had no light (B) Seeds need direct sunlight to germinate (C) The pale color means the plant is fully healthy (D) Seeds can begin to germinate without light

**5.** What three things does a seed need to begin germinating?
(A) Water, warmth, and oxygen (B) Sunlight, soil, and fertilizer (C) Darkness, sand, and carbon dioxide (D) Wind, rain, and cold temperatures

**6.** Put these stages of a flowering plant's life cycle in the correct order: Germination, Seed Dispersal, Pollination, Seed Formation.
(A) Seed Formation → Pollination → Germination → Seed Dispersal (B) Germination → Pollination → Seed Formation → Seed Dispersal (C) Pollination → Germination → Seed Dispersal → Seed Formation (D) Seed Dispersal → Seed Formation → Germination → Pollination

## Write the answer

**7.** Why do some seeds have hooks or barbs on their outer surface?
Answer: _____

**8.** A dandelion seed has a fluffy parachute structure. Which method of seed dispersal does this represent?
Answer: _____

**9.** A coconut falls from a palm tree into the ocean and floats to a distant island where it sprouts. What type of seed dispersal is this?
Answer: _____

**10.** What is the function of a flower in a plant's life cycle?
Answer: _____

## Match each question to its answer

**1.** Two identical bean seeds are planted. One is watered regularly; the other receives no water. After two weeks, only the watered seed has sprouted. What can you conclude? →
**2.** What is the tiny plant inside a seed called? →
**3.** A fruit forms around a seed after fertilization. Why is this important for the plant? →
**4.** You plant 10 radish seeds in each of three pots. Pot A gets 4 hours of light, Pot B gets 8 hours, and Pot C gets 12 hours. All get the same water and soil. What is the independent variable? →
**5.** What is pollination? →

(A) The amount of light each pot receives
(B) The transfer of pollen from the male part to the female part of a flower
(C) The embryo
(D) Water is necessary for seed germination
(E) The fruit protects the seed and helps with dispersal

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# 2. Photosynthesis and Plant Energy

## Circle the correct answer

**11.** What is photosynthesis?
(A) The process by which plants absorb nutrients from the soil (B) The method plants use to reproduce through seeds (C) The process by which plants use sunlight, water, and carbon dioxide to make food (glucose) and release oxygen (D) The way plants release water through their leaves

**12.** What gives plants their green color?
(A) Chlorophyll, a pigment found in chloroplasts (B) Green minerals absorbed from the soil (C) Water reflecting green light (D) Oxygen stored inside the leaves

**13.** What are the three inputs (raw materials) needed for photosynthesis?
(A) Nitrogen, minerals, and heat (B) Sunlight, water, and carbon dioxide (C) Chlorophyll, roots, and wind (D) Oxygen, glucose, and soil

**14.** What are the two outputs (products) of photosynthesis?
(A) Carbon dioxide and water (B) Minerals and nitrogen (C) Glucose (sugar) and oxygen (D) Chlorophyll and starch

**15.** Where inside a plant cell does photosynthesis take place?
(A) In the chloroplasts (B) In the cell wall (C) In the nucleus (D) In the mitochondria

**16.** How do leaves take in carbon dioxide from the air?
(A) Through the roots underground (B) Through the stem's outer bark (C) Through tiny pores called stomata on the leaf surface (D) Through the flower petals

## Write the answer

**17.** A plant is placed in a sealed jar with a carbon dioxide sensor. Over several hours in sunlight, the $CO_2$ level drops. Why?
Answer: _____

**18.** Why don't roots perform photosynthesis?
Answer: _____

**19.** In autumn, many leaves change from green to red, orange, and yellow. What causes this color change?
Answer: _____

**20.** A student places an aquatic plant (Elodea) in water under bright light and observes bubbles forming on the leaves. What gas is being released?
Answer: _____

## Match each question to its answer

**1.** How does the relationship between photosynthesis and cellular respiration benefit both plants and animals? →
**2.** What type of energy transformation occurs during photosynthesis? →
**3.** Why are plants considered 'producers' in a food chain? →
**4.** Two identical plants are grown for two weeks. Plant A is kept in a sunny window. Plant B is kept in a dark closet. Plant A is healthy and green; Plant B is pale and

wilting. What explains the difference? →
**5.** What happens to the glucose that a plant produces during photosynthesis? →

(A) Light energy is converted into chemical energy (stored in glucose)
(B) Plant B couldn't photosynthesize without light, so it couldn't make food to sustain itself
(C) Photosynthesis produces oxygen that animals breathe, while respiration produces $CO_2$ that plants use
(D) It's used for energy through cellular respiration, stored as starch, or used to build plant structures
(E) Because they produce their own food from sunlight through photosynthesis

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# 3. Soil Science and Plant Nutrition

## Circle the correct answer

**21.** What are the three main components of soil?
(A) Rocks, leaves, and sunlight, which is the most common explanation for this phenomenon (B) Carbon dioxide, oxygen, and nitrogen gas, and this principle applies across similar situations (C) Fertilizer, seeds, and worms, and this principle applies across similar situations (D) Minerals (sand, silt, clay), organic matter (decayed organisms), and air/water in pore spaces

**22.** What is the difference between sand, silt, and clay particles in soil?
(A) They differ in color: sand is yellow, silt is brown, clay is red (B) They differ in age: sand is newest, clay is oldest (C) They differ in particle size: sand is largest, silt is medium, and clay is smallest (D) They differ in weight: clay is heaviest, sand is lightest

**23.** What three numbers appear on a bag of fertilizer (like 10-10-10), and what do they represent?
(A) Carbon, Oxygen, and Hydrogen — the building blocks of water (B) Nitrogen (N), Phosphorus (P), and Potassium (K) — the three primary plant nutrients (C) Iron, Calcium, and Magnesium — trace minerals for roots (D) Temperature, moisture, and pH — growing conditions

**24.** A gardener notices that their tomato plant has yellowing leaves starting from the bottom. Which nutrient deficiency is most likely?
(A) Nitrogen deficiency — nitrogen is mobile in plants, so older leaves yellow first as the plant redirects nitrogen to new growth (B) Potassium deficiency — potassium only affects fruit production (C) Phosphorus deficiency — phosphorus makes leaves turn white (D) Iron deficiency — iron causes browning at the tips

**25.** What is soil pH, and why does it matter for plant growth?
(A) Soil pH measures acidity or alkalinity; it affects which nutrients are available for plant roots to absorb (B) Soil pH measures water content; it shows how much to water (C) Soil pH measures soil density; it tells you how deep to plant seeds (D) Soil pH measures temperature; it determines how fast seeds germinate

**26.** Why is loam considered the ideal soil type for most garden plants?
(A) Loam contains the most fertilizer of any natural soil type (B) Loam is the lightest soil, making it easiest for roots to grow through (C) Loam has a balanced mixture of sand, silt, and clay, providing good drainage, moisture retention, and nutrient availability (D) Loam is the darkest soil color, which absorbs more sunlight

## Write the answer

**27.** What is composting, and how does it improve soil?
Answer: _____

**28.** How do earthworms benefit soil health?
Answer: _____

**29.** A farmer plants corn in the same field year after year without rotating crops. Over time, yields decrease. Why?
Answer: _____

**30.** What role do nitrogen-fixing bacteria play in the nitrogen cycle?
Answer: _____

## Match each question to its answer

**1.** You have three soil samples: pure sand, pure clay, and loam. You pour equal amounts of water through each. Which drains fastest and which holds the most water? →
**2.** What is humus, and why is it important for soil? →
**3.** How does erosion threaten food production? →
**4.** A gardener adds lime (calcium carbonate) to their soil. What effect will this have? →
**5.** What are mycorrhizae, and how do they help plants? →

(A) It will raise the soil pH, making it less acidic
(B) Sand drains fastest; clay holds the most water
(C) Fungi that form symbiotic relationships with plant roots, extending the root network and increasing nutrient absorption
(D) Erosion removes the nutrient-rich topsoil layer that plants need for growth
(E) Humus is dark, decomposed organic matter that improves soil fertility, structure,

and water-holding capacity

# 4. Plant Reproduction and Pollination

## Circle the correct answer

**31.** What are the four main parts of a complete flower?
(A) Sepals, petals, stamens (male), and pistil (female) (B) Chloroplasts, stomata, xylem, and phloem (C) Roots, stems, leaves, and flowers (D) Pollen, nectar, ovules, and seeds

**32.** What is the difference between self-pollination and cross-pollination?
(A) Self-pollination happens in spring; cross-pollination happens in summer (B) Self-pollination uses wind; cross-pollination uses insects (C) Self-pollination transfers pollen within the same flower or plant; cross-pollination transfers pollen between different plants (D) Self-pollination produces seeds; cross-pollination produces fruit

**33.** Why do many flowers have bright colors, sweet nectar, and pleasant fragrances?
(A) To attract humans who will water and care for the plant (B) To absorb more sunlight for photosynthesis (C) To scare away herbivores that might eat the plant (D) To attract pollinators like bees, butterflies, and hummingbirds that transfer pollen between flowers

**34.** Corn plants have small, drab flowers with no scent or nectar, but produce large amounts of lightweight pollen. What pollination method does corn likely use?
(A) Self-pollination only — corn doesn't need external help (B) Wind pollination — the pollen is carried by air currents to reach other corn plants (C) Water pollination — rain carries pollen between plants (D) Insect pollination — bees are attracted to the corn silk

**35.** After a flower is pollinated, what happens to the ovule inside the ovary?
(A) The ovule turns into a leaf and the ovary becomes a root (B) The ovule develops into a seed, and the ovary develops into a fruit (C) The ovule becomes a new flower on the same plant (D) The ovule dissolves and the ovary produces more pollen

**36.** What is the difference between a fruit and a vegetable, scientifically?
(A) A fruit is the mature ovary of a flower containing seeds; a vegetable can be any other edible plant part (root, stem, leaf) (B) Fruits grow above ground and vegetables grow below ground (C) There is no scientific difference — it's just a culinary distinction (D) Fruits are sweet and vegetables are savory — that's the scientific definition

## Write the answer

**37.** A strawberry plant sends out long horizontal stems called 'runners' that take root and form new plants. What type of reproduction is this?
Answer: _____

**38.** What advantage does sexual reproduction (via seeds) provide over asexual reproduction in plants?
Answer: _____

**39.** What is the role of the pollen tube during fertilization?
Answer: _____

**40.** Bees can see ultraviolet light that humans cannot. Many flowers have UV patterns (called nectar guides) on their petals. Why is this an example of co-evolution?
Answer: _____

## Match each question to its answer

**1.** What are monocots and dicots? How can you tell them apart by looking at their seeds? →
**2.** A farmer wants all of their apple trees to produce the same high-quality fruit. Why might they use grafting (attaching a branch from one tree onto another) rather than planting seeds? →
**3.** What is the anther's role in a flower? →
**4.** Some plants, like holly, have separate male and female plants. A gardener plants only female holly bushes but gets no berries. Why? →
**5.** What is double fertilization in flowering plants? →

(A) Monocots have one seed leaf (cotyledon); dicots have two seed leaves — this determines many other structural differences
(B) One sperm fertilizes the egg to form the embryo; a second sperm fuses with polar nuclei to form the endosperm (food for the developing seed)
(C) Grafting preserves the exact genetics of the desired variety; seeds from sexual reproduction would produce variable offspring
(D) Without a nearby male holly plant to produce pollen, the female flowers can't be pollinated and fertilized to produce berries
(E) The anther produces and releases pollen grains containing male reproductive cells

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# 5. Plant Genetics and Heredity

## Circle the correct answer

**41.** Who is known as the 'Father of Genetics,' and what organism did he study?
(A) Gregor Mendel, who studied inheritance patterns in pea plants (B) Charles Darwin, who studied finches on the Galápagos Islands (C) Louis Pasteur, who studied bacteria in milk (D) James Watson, who studied fruit flies in laboratories

**42.** What is the difference between a dominant allele and a recessive allele?
(A) A dominant allele expresses its trait when one or two copies are present; a recessive allele only expresses its trait when two copies are present (B) Dominant alleles are larger molecules than recessive alleles (C) Dominant alleles are always better for survival than recessive alleles (D) Dominant alleles come from the mother; recessive alleles from the father

**43.** What is a genotype?
(A) The genetic makeup (allele combination) of an organism, represented by letters like TT, Tt, or tt (B) The number of chromosomes in a cell (C) The color of an organism's flowers or leaves (D) The physical appearance of an organism

**44.** What is a phenotype?
(A) The observable physical characteristics of an organism, like flower color or plant height (B) The number of genes on a chromosome (C) The process of passing traits to offspring (D) The allele combination written in the DNA

**45.** In pea plants, tall (T) is dominant over short (t). A tall plant is crossed with a short plant. All offspring are tall. What are the likely genotypes of the parents?
(A) Both parents are Tt (heterozygous) (B) The tall parent is TT (homozygous dominant) and the short parent is tt (homozygous recessive) (C) The tall parent is tt and the short parent is TT (D) The tall parent is Tt and the short parent is Tt

**46.** Two heterozygous tall pea plants (Tt) are crossed. What ratio of phenotypes would you expect in the offspring?
(A) 1 tall : 3 short (25% tall, 75% short) (B) 3 tall : 1 short (75% tall, 25% short) (C) 1 tall : 1 short (50% each) (D) All tall (100% tall)

## Write the answer

**47.** What does 'heterozygous' mean?
Answer: _____

**48.** Why did Mendel choose to study pea plants for his genetics experiments?
Answer: _____

**49.** In snapdragons, red (R) and white (W) flower colors show incomplete dominance. What color flowers does an RW plant produce?

Answer: _____

**50.** A purple-flowered pea plant is crossed with a white-flowered pea plant. All 120 offspring have purple flowers. The purple-flowered offspring are then crossed with each other. In the second generation, 90 plants have purple flowers and 30 have white flowers. Explain these results.

Answer: _____

## Match each question to its answer

**1.** What is the difference between a gene and an allele? →
**2.** A plant breeder wants to determine whether a tall pea plant is TT or Tt. What cross should they perform? →
**3.** What is selective breeding, and how has it been used to create modern crop varieties? →
**4.** Two plants are crossed. Both parents have round seeds (R is dominant over wrinkled r). The offspring include 75% round and 25% wrinkled seeds. What were the genotypes of both parents? →
**5.** What is a mutation, and can mutations in plants ever be beneficial? →

(A) Selecting and breeding plants with desirable traits over many generations to enhance those traits — like larger fruit, disease resistance, or faster growth

(B) A mutation is a change in DNA sequence; yes, some mutations can be beneficial — like drought resistance or pest resistance

(C) Cross the tall plant with a homozygous recessive (tt) short plant — this is called a test cross

(D) A gene is a segment of DNA that codes for a trait; alleles are different versions of that gene

(E) Both parents were Rr (heterozygous)

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# 6. Ecosystems and Plant Interactions

## Circle the correct answer

**51.** What is the difference between a food chain and a food web?

(A) A food chain is found in water; a food web is found on land (B) A food chain includes only plants; a food web includes only animals (C) A food chain shows energy gained; a food web shows energy lost (D) A food chain shows a single linear path of energy transfer; a food web shows multiple interconnected food chains in an ecosystem

**52.** What are the three types of symbiotic relationships?
(A) Predation, competition, and cooperation, which is the most common explanation for this phenomenon (B) Mutualism (both benefit), commensalism (one benefits, other unaffected), and parasitism (one benefits, other harmed) (C) Photosynthesis, respiration, and decomposition, and this is the standard approach used in most cases (D) Herbivory, carnivory, and omnivory, as this is what research and standard practice suggests

**53.** Mycorrhizal fungi colonize plant roots, providing water and minerals in exchange for sugars from the plant. What type of symbiosis is this?
(A) Mutualism — both the fungus and the plant benefit (B) Parasitism — the fungus is harming the plant (C) Commensalism — only the fungus benefits (D) Competition — they are competing for the same resources

**54.** Why do we say that energy flows through an ecosystem but matter cycles?
(A) Energy is recycled through decomposition while matter escapes as heat (B) Both energy and matter flow in one direction only (C) Energy enters as sunlight and is lost as heat at each level; matter (atoms) is recycled between organisms, soil, water, and atmosphere (D) Neither energy nor matter can be recycled in any ecosystem

**55.** What is the 10% rule in ecology?
(A) Plants use only 10% of available sunlight for photosynthesis (B) Only about 10% of energy is transferred from one trophic level to the next; the rest is lost as heat through metabolism (C) Ecosystems can only lose 10% of their species before collapsing (D) 10% of all species in an ecosystem are producers

**56.** Mistletoe grows on tree branches, sending special roots into the tree to steal water and nutrients. What type of relationship is this?
(A) Parasitism — mistletoe benefits at the tree's expense (B) Predation — the mistletoe kills and consumes the tree (C) Commensalism — the tree is unaffected by mistletoe (D) Mutualism — both the tree and mistletoe benefit

## Write the answer

**57.** What role do decomposers play in an ecosystem, and why are they essential for plant growth?
Answer: _____

**58.** Two plant species are growing close together. Species A grows taller and shades Species B, reducing B's access to sunlight. What ecological interaction is occurring?
Answer: _____

**59.** What is ecological succession, and how do pioneer species like lichens contribute to it?

Answer: _____

**60.** How do plants defend themselves against herbivores without being able to run away?

Answer: _____

## Match each question to its answer

**1.** An invasive plant species is introduced to a new ecosystem and rapidly outcompetes native plants. Why might the invasive species be so successful? →
**2.** What is nitrogen fixation, and why can't most plants directly use nitrogen gas from the atmosphere? →
**3.** In a forest food web, a disease kills most of the caterpillars. Predict TWO effects this might have on the rest of the ecosystem. →
**4.** What is the water cycle's connection to plants? →
**5.** Some acacia trees in Africa have a mutualistic relationship with ants. The tree provides hollow thorns for ant nests and nectar. How do the ants benefit the tree? →

(A) It likely has no natural predators, diseases, or competitors in the new environment that would normally keep its population in check

(B) Plants they eat would increase (less herbivory), and birds that eat caterpillars would decline (less food available)

(C) The ants aggressively attack herbivores and competing plants that threaten the acacia, acting as living bodyguards

(D) Nitrogen fixation converts $N_2$ gas into usable forms like ammonia; plants can't break the strong triple bond in $N_2$ molecules on their own

(E) Plants absorb water through roots and release it through transpiration, contributing significantly to atmospheric moisture and precipitation patterns

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# 7. Plant Adaptations and Evolution

## Circle the correct answer

**61.** What is a plant adaptation?

(A) Any change a plant makes during its lifetime in response to its environment (B) A behavior plants choose to improve their growth (C) A heritable trait that increases a plant's ability to survive and reproduce in its environment (D) A trait that makes a plant look attractive to humans

**62.** Cacti have evolved thick, fleshy stems that store water, and their leaves have been reduced to spines. Explain how BOTH of these traits help cacti survive in deserts.
(A) Thick stems resist wind damage; spines capture rainfall (B) Thick stems absorb sunlight faster; spines help the plant climb (C) Fleshy stems produce more seeds; spines attract pollinators (D) Fleshy stems store water for drought survival; spines reduce water loss by replacing broad leaves and also deter herbivores

**63.** What is the significance of the evolution of seeds in plant history?
(A) Seeds freed plants from needing water for reproduction and provided protection and nutrition for the embryo, enabling colonization of drier environments (B) Seeds made plants grow taller than any previous organisms, making this the most widely accepted explanation (C) Seeds enabled plants to perform photosynthesis more efficiently, and this is the standard approach used in most cases (D) Seeds allowed plants to move from place to place on their own, which is the most common explanation for this phenomenon

**64.** Mangrove trees grow in saltwater coastal areas. They have special root structures that rise above the water and filter salt. How do these adaptations allow mangroves to survive where most trees cannot?
(A) Aerial roots provide oxygen in waterlogged soil (which lacks air), and salt-filtering mechanisms prevent toxic salt accumulation in tissues (B) The roots absorb extra sunlight from the water's surface reflection (C) The aerial roots allow mangroves to walk to better locations (D) The roots catch fish that provide nutrients to the tree

**65.** Place these plant groups in the correct evolutionary order from oldest to most recent: Flowering plants, Mosses, Ferns, Conifers.
(A) Mosses → Ferns → Conifers → Flowering plants (B) Ferns → Mosses → Flowering plants → Conifers (C) Conifers → Flowering plants → Mosses → Ferns (D) Flowering plants → Conifers → Ferns → Mosses

**66.** Some plants in the rainforest canopy have 'drip tips' — elongated pointed leaf tips. What advantage does this shape provide?
(A) Drip tips channel water off leaves quickly, preventing algae, mold, and bacterial growth on constantly wet leaf surfaces (B) Drip tips help the plant lean toward sunlight (C) Drip tips collect extra rainwater for the plant to absorb (D) Drip tips deter insects from landing on the leaves

## Write the answer

**67.** What evidence supports the idea that all land plants evolved from aquatic green algae ancestors?
Answer: _____

**68.** Arctic tundra plants are typically very short, growing close to the ground in cushion or mat shapes. Explain the survival advantage of this growth form.
Answer: _____

**69.** What was the significance of the evolution of vascular tissue (xylem and phloem) in plants?
Answer: _____

**70.** Sundews and pitcher plants are carnivorous plants that trap and digest insects. Both evolved independently in different plant families. What does this example of convergent evolution tell us?
Answer: _____

## Match each question to its answer

**1.** Fire-adapted plants like the lodgepole pine have serotinous cones that only open after exposure to intense heat. How is this an adaptive advantage? →
**2.** C4 and CAM photosynthesis are alternative pathways some plants use instead of the standard C3 pathway. What environmental problem do C4 and CAM plants solve? →
**3.** How has natural selection shaped the relationship between flowering plants and their pollinators over millions of years? →
**4.** Deciduous trees drop their leaves in autumn. What is the adaptive advantage of this seemingly wasteful behavior? →
**5.** Why was the evolution of flowers and fruits considered a revolutionary event in plant evolution? →

(A) Flowers enabled more efficient pollination through animal partnerships, and fruits improved seed dispersal, allowing flowering plants to diversify into the most species-rich plant group
(B) Dropping leaves prevents water loss through transpiration during winter when water is frozen and unavailable, and avoids damage from snow/ice weight
(C) Co-evolution: plants with traits matching pollinator preferences reproduced more successfully, and pollinators efficient at accessing specific flowers gained more food — both lineages became increasingly specialized
(D) Seeds are released after fire clears competing vegetation and enriches soil with ash, giving seedlings ideal conditions with minimal competition
(E) They reduce water loss during photosynthesis in hot, dry, or arid conditions by concentrating $CO_2$ or fixing it at night

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# 8. Capstone: Sustainable Gardening and Agricultural Science

## Circle the correct answer

**71.** A farmer notices that crop yields have been declining each year despite using the same amount of fertilizer. Which soil science concept BEST explains this problem?
(A) The fertilizer has expired and lost its chemical potency over time (B) Soil degradation from monoculture depletes specific nutrients and beneficial microorganisms faster than fertilizer replaces them (C) Plants develop immunity to fertilizer and need increasingly stronger doses (D) The sun's energy output varies year to year affecting all crop growth equally

**72.** Design a school garden plan that maximizes biodiversity while producing food. Which combination of planting strategies would be MOST effective?
(A) Growing all crops hydroponically indoors to eliminate pest and weather problems (B) Planting only the highest-yielding vegetable variety in every bed for maximum food production (C) Companion planting with nitrogen-fixers, pollinator border strips, and crop rotation between raised beds (D) Using only native wildflowers since they require less maintenance than food crops

**73.** A plant breeder wants to develop a tomato variety that is both drought-resistant AND produces large fruit. Why is this goal challenging from a genetics perspective?
(A) All tomato varieties are genetically identical so there is no variation to select from (B) Drought resistance is caused by the environment, not by genes, so it cannot be bred (C) Drought resistance and large fruit size may be controlled by different genes that are difficult to combine, and plants often trade growth for stress tolerance (D) It is impossible to change any genetic traits in tomatoes through breeding

**74.** What is the primary goal of integrated pest management (IPM) in sustainable agriculture?
(A) To control pests using a combination of biological, cultural, and chemical methods while minimizing environmental harm (B) To genetically modify all crops to be pest-resistant (C) To completely eliminate all insects from agricultural fields (D) To use only organic pesticides instead of synthetic ones

**75.** A gardener observes that basil planted near tomatoes seems to have fewer aphids than basil planted alone. Design an experiment to test whether companion planting actually reduces aphid populations.
(A) Plant one basil plant next to tomatoes and one alone, then check for aphids after one day (B) Plant multiple replicates of basil with and without tomato companions, control for sunlight, water, and soil conditions, then count aphids on each group over several weeks (C) Spray the basil planted alone with pesticide to see if it matches the companion-planted basil (D) Ask other gardeners whether they have noticed the same thing happening in their gardens

**76.** How does crop rotation help maintain soil fertility compared to growing the same crop year after year?

(A) Different crops use different nutrients and some crops like legumes add nitrogen back to the soil, maintaining nutrient balance (B) Each crop produces a different type of soil that the next crop prefers (C) Crop rotation is mainly for appearance since farms look better with variety (D) Rotating crops confuses pests so they cannot find the plants to eat

## Write the answer

**77.** A community wants to create a rain garden to manage stormwater runoff. Which plant characteristics should they prioritize when selecting species?

Answer: _____

**78.** Explain how the loss of a single pollinator species could affect an entire agricultural ecosystem.

Answer: _____

**79.** What is the main advantage of using cover crops during the off-season in sustainable farming?

Answer: _____

**80.** A scientist discovers that a wild relative of wheat growing in a harsh mountain environment has genes for drought tolerance. How might these genes be useful for modern agriculture?

Answer: _____

## Match each question to its answer

**1.** Which of the following BEST describes how composting transforms organic waste into useful garden material? →
**2.** Evaluate the following claim: 'Organic farming is always better for the environment than conventional farming.' →
**3.** How do mycorrhizal fungi benefit plants in a sustainable garden, and why might tilling soil disrupt this relationship? →
**4.** What is food security, and why is maintaining genetic diversity in crop plants important for achieving it? →
**5.** A greenhouse grower wants to maximize tomato growth. They can control light duration, light intensity, temperature, $CO_2$ levels, and water. Which factor should they investigate FIRST, and why? →

(A) Microorganisms break down organic matter through decomposition, releasing nutrients and creating humus that improves soil structure and water retention

(B) Food security means reliable access to sufficient nutritious food; genetic diversity provides the raw material for breeding crops that can resist new diseases, pests, and changing climate conditions

(C) Mycorrhizal fungi extend plant root networks to access more water and nutrients; tilling physically breaks the fungal network, destroying these beneficial connections

(D) Light intensity, because it is often the primary limiting factor for photosynthesis, which drives all plant growth

(E) This claim is an oversimplification — organic farming avoids synthetic chemicals but may require more land, and both systems have environmental trade-offs depending on specific practices

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# 9. Plant Biology

## Circle the correct answer

**81.** What is the male reproductive organ of a flower called?
(A) Stamen (B) Sepal (C) Petal (D) Pistil

**82.** What is the female reproductive organ of a flower called?
(A) Pistil (B) Receptacle (C) Stamen (D) Anther

**83.** What is the transfer of pollen from an anther to a stigma called?
(A) Germination (B) Fertilization (C) Pollination (D) Dispersal

**84.** What structure protects a seed and helps with dispersal?
(A) Root (B) Fruit (C) Stem (D) Leaf

**85.** What is the part of a seed that contains a tiny, undeveloped plant?
(A) Cotyledon (B) Embryo (C) Seed coat (D) Endosperm

**86.** What do we call plants that complete their entire life cycle in one year?
(A) Biennials (B) Annuals (C) Evergreens (D) Perennials

## Write the answer

**87.** Why do many flowers have bright colors and sweet nectar?
Answer: _____

**88.** How does a seed differ from a spore in terms of structure?
Answer: _____

**89.** What is the difference between self-pollination and cross-pollination?
Answer: _____

**90.** Why do some seeds need to pass through an animal's digestive system before they can germinate?
Answer: _____

## Match each question to its answer

**1.** Explain why cotyledons are important during seed germination. →
**2.** A gardener notices that a squash plant produces flowers but never sets fruit. What is the most likely problem? →
**3.** You find a seed with a fluffy, parachute-like structure attached. How is this seed most likely dispersed? →
**4.** A student places bean seeds on a damp paper towel in a sealed plastic bag. After 5 days, tiny roots emerge. What conditions did the student provide that triggered germination? →
**5.** A farmer wants to grow seedless watermelons. How are seedless watermelons typically produced? →

(A) They provide stored food energy to the embryo before it can photosynthesize
(B) Moisture and warmth
(C) By wind
(D) The flowers are not being pollinated
(E) By crossing plants with different numbers of chromosomes to create sterile offspring

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# 10. Plant Biology

## Circle the correct answer

**91.** What molecule carries the genetic instructions in plant cells?
(A) RNA (B) ATP (C) DNA (D) Chlorophyll

**92.** What is a gene?
(A) A type of plant hormone (B) A segment of DNA that codes for a specific trait (C) A cell organelle (D) An entire chromosome

**93.** What term describes the physical appearance of an organism resulting from its genes?
(A) Phenotype (B) Karyotype (C) Allele (D) Genotype

**94.** What term describes the genetic makeup of an organism?
(A) Taxonomy (B) Genotype (C) Phenotype (D) Genome

**95.** Who is known as the 'father of genetics' for his experiments with pea plants?
(A) Gregor Mendel (B) Louis Pasteur (C) Charles Darwin (D) Robert Hooke

**96.** What are different versions of the same gene called?
(A) Chromosomes (B) Genomes (C) Alleles (D) Mutations

## Write the answer

**97.** Explain why a plant with genotype 'Rr' shows the dominant trait even though it carries a recessive allele.
Answer: _____

**98.** Why does cross-pollination between two different plant varieties often produce offspring that are more vigorous?
Answer: _____

**99.** Why can two parent plants with purple flowers produce some offspring with white flowers?
Answer: _____

**100.** How does selective breeding differ from natural selection?
Answer: _____

## Match each question to its answer

**1.** Explain why vegetatively propagated plants (clones) are genetically identical to the parent but seed-grown plants are not. →
**2.** A farmer has a tomato variety that tastes great but gets diseased easily, and another variety that is disease-resistant but tastes bland. How could the farmer use selective breeding to improve both traits? →
**3.** Using a Punnett square, predict the ratio of tall (T) to short (t) pea plants when crossing two heterozygous (Tt) parents. →
**4.** A plant breeder wants to ensure that a desired trait breeds true in future generations. What type of cross should they aim for? →
**5.** Red flower color is incompletely dominant over white in snapdragons. Predict the flower colors when a red (RR) snapdragon is crossed with a white (rr) snapdragon. →

(A) Self-pollinate homozygous plants (e.g., TT or tt) so all offspring inherit the same alleles
(B) Cross-pollinate the two varieties and select offspring that have both good flavor and disease resistance over multiple generations
(C) Vegetative propagation involves mitosis only, copying all DNA exactly, while

seeds result from sexual reproduction, which combines genes from two parents
(D) All offspring will have pink flowers (Rr)
(E) 3 tall : 1 short

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# 11. Plant Biology

## Circle the correct answer

**101.** What is hydroponics?
(A) Growing plants in sand, and this principle applies across similar situations (B) A method of growing plants without soil, using nutrient-rich water (C) A type of plant fertilizer, and this principle applies across similar situations (D) Growing plants only outdoors, and this has been consistently demonstrated in practice

**102.** What is the primary purpose of grow lights in indoor gardening?
(A) To scare away pests, as this is what research and standard practice suggests (B) To provide the light energy plants need for photosynthesis (C) To keep the room warm, as this is what research and standard practice suggests (D) To make plants look colorful, which is the most common explanation for this phenomenon

**103.** What are the three numbers on a fertilizer label (e.g., 10-10-10) representing?
(A) Temperature, Humidity, and Light (B) Calcium, Magnesium, and Iron (C) Water, Soil, and Air percentages (D) Nitrogen (N), Phosphorus (P), and Potassium (K)

**104.** What is the name for the material that supports plant roots in a hydroponic system when soil is not used?
(A) Compost (B) Mulch (C) Growing medium (D) Topsoil

**105.** What pH range is generally ideal for most hydroponic nutrient solutions?
(A) 7.5 to 8.5 (B) 3.0 to 4.0 (C) 9.0 to 10.0 (D) 5.5 to 6.5

**106.** What gas do plant roots need that must be dissolved in the hydroponic nutrient solution?
(A) Hydrogen (B) Oxygen (C) Nitrogen gas (D) Carbon dioxide

## Write the answer

**107.** Explain why plants in hydroponic systems often grow faster than plants in soil.
Answer: _____

**108.** Why is it important to monitor and adjust the pH of a hydroponic nutrient solution?
Answer: _____

**109.** Why do hydroponic systems use air pumps and air stones?
Answer: _____

**110.** Why do indoor growers use timers to control their grow lights?
Answer: _____

## Match each question to its answer

**1.** Explain why nutrient film technique (NFT) hydroponic systems keep only a thin film of water flowing over the roots rather than submerging them completely. →
**2.** Your hydroponic lettuce plants are showing yellow lower leaves while upper leaves remain green. The nutrient solution has adequate nutrients. What should you check first? →
**3.** You are setting up a hydroponic system in a classroom. You have a 50-liter reservoir. The nutrient concentrate label says to use 5 mL per liter. How much concentrate do you need? →
**4.** A student's hydroponic basil plants are growing tall and leggy with pale leaves. The nutrient solution is correct. What is most likely the problem, and how should they fix it? →
**5.** You want to grow strawberries indoors using hydroponics. Which type of system would be most appropriate: deep water culture (DWC), nutrient film technique (NFT), or drip system? →

(A) The grow lights are too far away or too dim; move the lights closer to the plants or use higher-intensity lights
(B) 250 mL
(C) A thin film keeps roots moist and fed while exposing the upper roots to air, providing the oxygen they need
(D) The pH of the nutrient solution, because it may have drifted out of range, locking out nutrients
(E) A drip system, because strawberries need good aeration around their crown and a drip system delivers nutrients without submerging the plant

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# 12. Plant Biology

## Circle the correct answer

**111.** What is a biome?
(A) A large geographic area characterized by specific climate conditions and the plant and animal communities adapted to them (B) A man-made garden, as this directly follows from the underlying principles (C) A type of soil, as this is what research and standard practice suggests (D) A single species of plant, making this the

most widely accepted explanation

**112.** What is the waxy coating on the surface of many plant leaves called?
(A) Cuticle (B) Epidermis (C) Chloroplast (D) Stomata

**113.** What are the small pores on the surface of leaves that allow gas exchange called?
(A) Lenticels (B) Stomata (C) Trichomes (D) Cuticles

**114.** What type of biome receives less than 25 centimeters of rainfall per year?
(A) Temperate forest (B) Tropical rainforest (C) Desert (D) Grassland

**115.** What are plants that store water in thick, fleshy leaves or stems called?
(A) Annuals (B) Deciduous plants (C) Succulents (D) Epiphytes

**116.** What is the term for plants that lose all their leaves seasonally?
(A) Perennial (B) Deciduous (C) Succulent (D) Evergreen

## Write the answer

**117.** Explain why cacti have spines instead of broad, flat leaves.
Answer: _____

**118.** Why do many tropical rainforest plants have 'drip tips' (pointed leaf tips)?
Answer: _____

**119.** Explain how CAM photosynthesis helps desert plants survive.
Answer: _____

**120.** Why do many tundra plants grow low to the ground in cushion-shaped forms?
Answer: _____

## Match each question to its answer

**1.** Explain why mangrove trees have stilt roots that grow above the waterline. →
**2.** You discover a plant with thick, waxy leaves, a deep taproot, and small stomata that close during the day. In which biome would this plant most likely be found? →
**3.** A farmer in a windy, coastal area wants to protect crops from salt spray and wind damage. Which type of planting strategy mimics natural plant adaptations? →
**4.** A plant collector brings a tropical epiphyte (a plant that grows on tree branches) from the rainforest to a temperate home. What conditions should they recreate for the plant to survive? →
**5.** You notice that plants growing in a shady forest understory have much larger leaves than similar species growing in open meadows. Apply your knowledge of plant adaptations to explain this observation. →

(A) Plant a windbreak of salt-tolerant trees and shrubs on the windward side of the field
(B) High humidity, bright indirect light, good air circulation around the roots, and warm temperatures
(C) Desert
(D) Larger leaves capture more of the limited light available in the shade, maximizing the surface area for photosynthesis in low-light conditions
(E) Stilt roots provide structural support in soft, muddy, waterlogged soils and allow the roots to access oxygen from the air since the waterlogged soil is oxygen-poor

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# 13. Soil Composition

## Circle the correct answer

**121.** What does a stem do for a plant?
(A) Stores pollen for pollination (B) Produces seeds for reproduction (C) Absorbs sunlight for energy (D) Transports water and nutrients between roots and leaves

**122.** What three things does a seed need to begin germinating?
(A) Water, warmth, and oxygen (B) Sunlight, soil, and fertilizer (C) Darkness, sand, and carbon dioxide (D) Wind, rain, and cold temperatures

**123.** Compare annual plants and perennial plants. Which statement is correct?
(A) Annual plants grow only in winter (B) Annual plants complete their life cycle in one growing season; perennials live for multiple years (C) Perennial plants never produce flowers (D) Annual plants are always taller than perennials

**124.** A coconut falls from a palm tree into the ocean and floats to a distant island where it sprouts. What type of seed dispersal is this?
(A) Water dispersal (B) Wind dispersal (C) Animal dispersal (D) Explosive dispersal

**125.** What is the tiny plant inside a seed called?
(A) The embryo (B) The stamen (C) The pistil (D) The chloroplast

**126.** In the experiment from question 14 (radish seeds with 4, 8, and 12 hours of light), what would be the dependent variable?
(A) The number of seeds planted per pot (B) The type of soil used in each pot (C) The growth of the radish plants (height, number of leaves, etc.) (D) The amount of light each pot receives

## Write the answer

**127.** Compare the advantages of asexual and sexual reproduction in plants. Under what circumstances might each be beneficial?
Answer: _____

**128.** Which of the following is an example of a plant adaptation that helps it survive in a desert environment?
Answer: _____

**129.** A bean plant bends toward a window over several days. What is this response called, and why does it happen?
Answer: _____

**130.** A classmate says: 'If a plant gets enough water and light, it will grow forever without stopping.' Evaluate this claim.
Answer: _____

## Match each question to its answer

**1.** A classmate says: 'Plants get their food from the soil through their roots.' Evaluate this common misconception. →
**2.** How does the process of photosynthesis demonstrate energy conservation (energy is neither created nor destroyed)? →
**3.** A soil test shows very high clay content. What TWO problems might this cause for plant growth? →
**4.** A gardener notices that their tomato plants have yellow leaves with green veins. Based on your knowledge of plant nutrition, which nutrient deficiency is MOST likely, and how should they treat it? →
**5.** A gardener adds lime (calcium carbonate) to their soil. What effect will this have? →

(A) It will raise the soil pH, making it less acidic
(B) Poor drainage (waterlogging roots) and poor aeration (roots can't get enough oxygen)
(C) Light energy is not lost — it's converted into chemical energy stored in glucose molecules
(D) This is mostly incorrect — plants make their own food through photosynthesis; roots absorb water and minerals, not food
(E) Iron deficiency (interveinal chlorosis) — treat by adjusting soil pH to make iron more available or applying chelated iron fertilizer

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# 14. Soil Composition

## Circle the correct answer

**131.** A seed is placed in a cup of soil, watered, and kept in a dark closet. After a week, a pale shoot appears. What does this tell you about germination?
(A) Seeds need direct sunlight to germinate (B) The pale color means the plant is fully healthy (C) The seed died because it had no light (D) Seeds can begin to germinate without light

**132.** Put these stages of a flowering plant's life cycle in the correct order: Germination, Seed Dispersal, Pollination, Seed Formation.
(A) Seed Formation → Pollination → Germination → Seed Dispersal (B) Pollination → Germination → Seed Dispersal → Seed Formation (C) Germination → Pollination → Seed Formation → Seed Dispersal (D) Seed Dispersal → Seed Formation → Germination → Pollination

**133.** A dandelion seed has a fluffy parachute structure. Which method of seed dispersal does this represent?
(A) Gravity dispersal (B) Water dispersal (C) Wind dispersal (D) Explosive dispersal

**134.** What is seed dormancy, and why is it an important survival adaptation?
(A) Dormancy is when a seed germinates underground without light (B) Dormancy means the seed is producing food through photosynthesis (C) Dormancy means the seed is dead and cannot grow (D) Dormancy is a state where a seed delays germination until environmental conditions are favorable for survival

**135.** A strawberry plant sends out long horizontal stems called 'runners' that take root and form new plants. What type of reproduction is this?
(A) Pollination — the runners attract insects (B) Sexual reproduction — seeds are involved (C) Asexual reproduction — the new plants are genetically identical clones of the parent (D) Germination — the runner acts like a seed

**136.** How do plants defend themselves against herbivores without being able to run away?
(A) Through physical defenses (thorns, tough bark, waxy coatings) and chemical defenses (toxins, bitter compounds, repellent oils) (B) Plants only defend themselves by growing faster than herbivores can eat them (C) Plants communicate with nearby predators to chase away herbivores (D) Plants have no defenses — they rely entirely on animals for protection

## Write the answer

**137.** What is photosynthesis?
Answer: _____

**138.** What happens to the glucose that a plant produces during photosynthesis?
Answer: _____

**139.** What is the difference between sand, silt, and clay particles in soil?
Answer: _____

**140.** A farmer plants corn in the same field year after year without rotating crops. Over time, yields decrease. Why?
Answer: _____

## Match each question to its answer

**1.** What is nitrogen fixation, and why can't most plants directly use nitrogen gas from the atmosphere? →
**2.** What are the four main parts of a complete flower? →
**3.** A bat visits a flower at night and gets pollen on its face while drinking nectar. What features would you expect in a bat-pollinated flower? →
**4.** What is double fertilization in flowering plants? →
**5.** A purple-flowered pea plant is crossed with a white-flowered pea plant. All 120 offspring have purple flowers. The purple-flowered offspring are then crossed with each other. In the second generation, 90 plants have purple flowers and 30 have white flowers. Explain these results. →

(A) Purple is dominant (P) over white (p). The first cross was PP × pp → all Pp (purple). The second cross was Pp × Pp → 3 purple : 1 white ratio
(B) Sepals, petals, stamens (male), and pistil (female)
(C) Pale or white color (visible at night), strong fruity scent (bats use smell), opens at night, and produces lots of nectar
(D) One sperm fertilizes the egg to form the embryo; a second sperm fuses with polar nuclei to form the endosperm (food for the developing seed)
(E) Nitrogen fixation converts $N_2$ gas into usable forms like ammonia; plants can't break the strong triple bond in $N_2$ molecules on their own

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# 15. Soil Composition

## Circle the correct answer

**141.** Which part of a plant is responsible for making food through photosynthesis?
(A) Stems (B) Flowers (C) Roots (D) Leaves

**142.** Two identical bean seeds are planted. One is watered regularly; the other receives no water. After two weeks, only the watered seed has sprouted. What can you conclude?
(A) Bean seeds only grow in pairs (B) The dry seed was defective (C) Light caused one seed to grow faster (D) Water is necessary for seed germination

**143.** Why do some seeds have hooks or barbs on their outer surface?
(A) To help the seed absorb more water (B) To protect the seed from being eaten (C) To attach to animal fur for dispersal to new locations (D) To anchor the seed deep into the soil

**144.** What role do cotyledons (seed leaves) play in a seedling's early growth?
(A) They attract pollinators to the young plant (B) They provide stored food energy until the seedling can photosynthesize on its own (C) They absorb water directly from the air (D) They protect the seed from sunlight damage

**145.** You plant 10 radish seeds in each of three pots. Pot A gets 4 hours of light, Pot B gets 8 hours, and Pot C gets 12 hours. All get the same water and soil. What is the independent variable?
(A) The amount of light each pot receives (B) The height of the plants after two weeks (C) The type of seed planted (D) The amount of water given

**146.** A farmer wants all of their apple trees to produce the same high-quality fruit. Why might they use grafting (attaching a branch from one tree onto another) rather than planting seeds?
(A) Seeds from apple trees never germinate successfully (B) Grafting makes trees grow twice as fast as seed-grown trees (C) Grafting preserves the exact genetics of the desired variety; seeds from sexual reproduction would produce variable offspring (D) Grafting requires no water or sunlight during the growth phase

## Write the answer

**147.** How do leaves take in carbon dioxide from the air?
Answer: _____

**148.** Why is photosynthesis considered the foundation of most food chains on Earth?
Answer: _____

**149.** What are the three main components of soil?
Answer: _____

**150.** What is the difference between organic and inorganic fertilizers?
Answer: _____

## Match each question to its answer

**1.** What are mycorrhizae, and how do they help plants? →
**2.** What is the stigma's role in pollination? →
**3.** Colony Collapse Disorder has caused many honeybee populations to decline. Why might this be a serious problem for food production? →
**4.** What is the difference between a fruit and a vegetable, scientifically? →
**5.** What is a phenotype? →

(A) The stigma is the sticky tip of the pistil that catches and holds pollen grains
(B) A fruit is the mature ovary of a flower containing seeds; a vegetable can be any other edible plant part (root, stem, leaf)
(C) Bees pollinate roughly 75% of the world's food crops — without them, many fruits, vegetables, and nuts can't reproduce
(D) Fungi that form symbiotic relationships with plant roots, extending the root network and increasing nutrient absorption
(E) The observable physical characteristics of an organism, like flower color or plant height

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# 16. Soil Composition

## Circle the correct answer

**151.** A pine tree produces seeds in cones instead of flowers. How is this different from a flowering plant's life cycle?
(A) Pine trees produce seeds that don't need water to germinate (B) Pine tree seeds have no embryo inside them (C) Pine trees don't produce fruits; their seeds develop on the scales of cones (D) Pine trees don't need pollination to reproduce

**152.** Design a simple experiment to test whether seeds germinate faster in warm or cold temperatures. What would you need to keep the same between your two groups?
(A) Use different types of seeds in each group for variety (B) Only measure the plants once at the end of the experiment (C) Keep the type of seed, amount of water, light conditions, and soil type the same — only change the temperature (D) Change both temperature and water amount to see which matters more

**153.** A student claims: 'Plants only grow from seeds.' Is this statement correct?
(A) No — plants only grow from sunlight and water (B) Yes — all plants must start from a seed (C) Yes — seeds are the only way plants reproduce (D) No — some plants can also grow from cuttings, bulbs, tubers, or runners

**154.** In autumn, many leaves change from green to red, orange, and yellow. What causes this color change?
(A) Chlorophyll breaks down, revealing other pigments that were hidden by the green color (B) The tree paints new pigments onto its leaves (C) The leaves absorb different colors of light in autumn (D) Cold temperatures create new colorful chemicals

**155.** You have three soil samples: pure sand, pure clay, and loam. You pour equal amounts of water through each. Which drains fastest and which holds the most water?
(A) Loam drains fastest; sand holds the most water (B) All three drain at the same rate (C) Clay drains fastest; sand holds the most water (D) Sand drains fastest; clay holds the most water

**156.** What is the role of phosphorus in plant growth?
(A) Phosphorus creates the cell walls in stems (B) Phosphorus supports root development, flower and fruit production, and energy transfer within the plant (C) Phosphorus is only needed for green leaf color (D) Phosphorus helps the plant absorb sunlight

## Write the answer

**157.** What is soil pH, and why does it matter for plant growth?
Answer: _____

**158.** What practice helps prevent soil erosion on sloped farmland?
Answer: _____

**159.** What is the water cycle's connection to plants?
Answer: _____

**160.** After a flower is pollinated, what happens to the ovule inside the ovary?
Answer: _____

## Match each question to its answer

**1.** A plant breeder wants to determine whether a tall pea plant is TT or Tt. What cross should they perform? →
**2.** Why might a farmer plant clover or beans between corn seasons? →
**3.** What role do decomposers play in an ecosystem, and why are they essential for plant growth? →
**4.** What is the function of a flower in a plant's life cycle? →
**5.** Polyploidy (having extra sets of chromosomes) is rare in animals but common in plants. Many crop plants like wheat and strawberries are polyploid. What advantage might polyploidy provide? →

(A) Decomposers break down dead organisms and waste, releasing nutrients back into the soil where plants can absorb them
(B) Reproduction — producing seeds through pollination and fertilization
(C) Polyploid plants often produce larger cells, bigger fruits, and more vigorous growth compared to their diploid relatives
(D) Legumes have nitrogen-fixing bacteria in their roots that replenish soil nitrogen naturally
(E) Cross the tall plant with a homozygous recessive (tt) short plant — this is called a test cross

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# Riddle & Joke Break

*Guess the answer, then check the key!*

**161.** I'm rooting for you -- and so are your plants!

**162.** The gardener quit because his celery wasn't high enough.

**163.** Why was the plant such a good student?

**164.** Photosynthesis teachers are great -- they really know how to make light of everything.

**165.** My garden's doing well -- you could say things are looking up. Especially the sunflowers.

**166.** I tried to tell a joke about soil, but it was too dirty.

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# Answer Key

1. D — To absorb water and nutrients from the soil
2. C — Leaves
3. D — Transports water and nutrients between roots and leaves
4. D — Seeds can begin to germinate without light
5. A — Water, warmth, and oxygen
6. B — Germination → Pollination → Seed Formation → Seed Dispersal
7. To attach to animal fur for dispersal to new locations
8. Wind dispersal

9. Water dispersal
10. Reproduction — producing seeds through pollination and fertilization
    Matching (Seeds of Science: Plant Basics and Life Cycles): 1→D, 2→C, 3→E, 4→A, 5→B
11. C — The process by which plants use sunlight, water, and carbon dioxide to make food (glucose) and release oxygen
12. A — Chlorophyll, a pigment found in chloroplasts
13. B — Sunlight, water, and carbon dioxide
14. C — Glucose (sugar) and oxygen
15. A — In the chloroplasts
16. C — Through tiny pores called stomata on the leaf surface
17. The plant is using carbon dioxide as an input for photosynthesis
18. Roots are underground where there is no sunlight, and they lack chloroplasts
19. Chlorophyll breaks down, revealing other pigments that were hidden by the green color
20. Oxygen — a product of photosynthesis
    Matching (Photosynthesis and Plant Energy): 1→C, 2→A, 3→E, 4→B, 5→D
21. D — Minerals (sand, silt, clay), organic matter (decayed organisms), and air/water in pore spaces
22. C — They differ in particle size: sand is largest, silt is medium, and clay is smallest
23. B — Nitrogen (N), Phosphorus (P), and Potassium (K) — the three primary plant nutrients
24. A — Nitrogen deficiency — nitrogen is mobile in plants, so older leaves yellow first as the plant redirects nitrogen to new growth
25. A — Soil pH measures acidity or alkalinity; it affects which nutrients are available for plant roots to absorb
26. C — Loam has a balanced mixture of sand, silt, and clay, providing good drainage, moisture retention, and nutrient availability
27. Composting is the decomposition of organic waste into nutrient-rich humus that improves soil structure and fertility

28. They tunnel through soil creating air channels, mix organic matter deeper, and their castings add nutrients
29. Corn depletes specific nutrients from the soil faster than they're replenished, leading to nutrient exhaustion
30. They convert atmospheric nitrogen gas ($N_2$) into forms plants can absorb, like ammonia and nitrates
    Matching (Soil Science and Plant Nutrition): 1→B, 2→E, 3→D, 4→A, 5→C
31. A — Sepals, petals, stamens (male), and pistil (female)
32. C — Self-pollination transfers pollen within the same flower or plant; cross-pollination transfers pollen between different plants
33. D — To attract pollinators like bees, butterflies, and hummingbirds that transfer pollen between flowers
34. B — Wind pollination — the pollen is carried by air currents to reach other corn plants
35. B — The ovule develops into a seed, and the ovary develops into a fruit
36. A — A fruit is the mature ovary of a flower containing seeds; a vegetable can be any other edible plant part (root, stem, leaf)
37. Asexual reproduction — the new plants are genetically identical clones of the parent
38. Genetic diversity — offspring vary, increasing the chance some will survive changing conditions
39. It grows from the pollen grain on the stigma down through the style to deliver sperm cells to the ovule
40. Flowers evolved UV patterns to guide bees to nectar, while bees evolved UV vision that helps them find flowers — both benefited
    Matching (Plant Reproduction and Pollination): 1→A, 2→C, 3→E, 4→D, 5→B
41. A — Gregor Mendel, who studied inheritance patterns in pea plants
42. A — A dominant allele expresses its trait when one or two copies are present; a recessive allele only expresses its trait when two copies are present
43. A — The genetic makeup (allele combination) of an organism, represented by letters like TT, Tt, or tt
44. A — The observable physical characteristics of an organism, like flower color or plant height

45. B — The tall parent is TT (homozygous dominant) and the short parent is tt (homozygous recessive)
46. B — 3 tall : 1 short (75% tall, 25% short)
47. Having two different alleles for a trait (like Tt)
48. Pea plants have distinct, easily observable traits, grow quickly, and can be cross-pollinated or self-pollinated under controlled conditions
49. Pink — a blend between the red and white parent colors
50. Purple is dominant (P) over white (p). The first cross was PP × pp → all Pp (purple). The second cross was Pp × Pp → 3 purple : 1 white ratio
    Matching (Plant Genetics and Heredity): 1→D, 2→C, 3→A, 4→E, 5→B
51. D — A food chain shows a single linear path of energy transfer; a food web shows multiple interconnected food chains in an ecosystem
52. B — Mutualism (both benefit), commensalism (one benefits, other unaffected), and parasitism (one benefits, other harmed)
53. A — Mutualism — both the fungus and the plant benefit
54. C — Energy enters as sunlight and is lost as heat at each level; matter (atoms) is recycled between organisms, soil, water, and atmosphere
55. B — Only about 10% of energy is transferred from one trophic level to the next; the rest is lost as heat through metabolism
56. A — Parasitism — mistletoe benefits at the tree's expense
57. Decomposers break down dead organisms and waste, releasing nutrients back into the soil where plants can absorb them
58. Competition — both species are competing for the same resource (sunlight)
59. Succession is the gradual change of an ecosystem over time; pioneer species like lichens are the first colonizers that begin breaking down rock into soil for later plants
60. Through physical defenses (thorns, tough bark, waxy coatings) and chemical defenses (toxins, bitter compounds, repellent oils)
    Matching (Ecosystems and Plant Interactions): 1→A, 2→D, 3→B, 4→E, 5→C
61. C — A heritable trait that increases a plant's ability to survive and reproduce in its environment
62. D — Fleshy stems store water for drought survival; spines reduce water loss by

replacing broad leaves and also deter herbivores

63. A — Seeds freed plants from needing water for reproduction and provided protection and nutrition for the embryo, enabling colonization of drier environments
64. A — Aerial roots provide oxygen in waterlogged soil (which lacks air), and salt-filtering mechanisms prevent toxic salt accumulation in tissues
65. A — Mosses → Ferns → Conifers → Flowering plants
66. A — Drip tips channel water off leaves quickly, preventing algae, mold, and bacterial growth on constantly wet leaf surfaces
67. Both share chlorophyll a and b, store energy as starch, have cellulose cell walls, and DNA analysis confirms their close relationship
68. Low growth avoids harsh winds, stays in the warmer air layer near the ground, retains heat better, and is less likely to be damaged by ice and snow
69. Vascular tissue enabled plants to grow tall and transport water and nutrients over long distances, allowing colonization of drier upland environments
70. Similar environmental pressures (nutrient-poor soil) led to similar adaptations (carnivory) evolving independently in unrelated species
    Matching (Plant Adaptations and Evolution): 1→D, 2→E, 3→C, 4→B, 5→A
71. B — Soil degradation from monoculture depletes specific nutrients and beneficial microorganisms faster than fertilizer replaces them
72. C — Companion planting with nitrogen-fixers, pollinator border strips, and crop rotation between raised beds
73. C — Drought resistance and large fruit size may be controlled by different genes that are difficult to combine, and plants often trade growth for stress tolerance
74. A — To control pests using a combination of biological, cultural, and chemical methods while minimizing environmental harm
75. B — Plant multiple replicates of basil with and without tomato companions, control for sunlight, water, and soil conditions, then count aphids on each group over several weeks
76. A — Different crops use different nutrients and some crops like legumes add nitrogen back to the soil, maintaining nutrient balance
77. Deep root systems for water absorption, tolerance for both wet and dry conditions, and native species adapted to the local climate

78. Plants that depend on that pollinator would fail to reproduce, reducing food for herbivores, which would then affect predators and decomposers throughout the food web
79. Cover crops prevent erosion, suppress weeds, add organic matter, and some fix nitrogen, improving soil health for the next planting season
80. The drought-tolerance genes could be crossed into commercial wheat varieties through selective breeding to create crops that survive with less water
Matching (Capstone: Sustainable Gardening and Agricultural Science): 1→A, 2→E, 3→C, 4→B, 5→D
81. A — Stamen
82. A — Pistil
83. C — Pollination
84. B — Fruit
85. B — Embryo
86. B — Annuals
87. To attract pollinators like bees and butterflies
88. A seed contains an embryo with a food supply and protective coat, while a spore is a single cell
89. Self-pollination transfers pollen within the same flower or plant, while cross-pollination transfers pollen between different plants
90. The digestive acids break down the tough seed coat, allowing water to enter
Matching (Plant Biology): 1→A, 2→D, 3→C, 4→B, 5→E
91. C — DNA
92. B — A segment of DNA that codes for a specific trait
93. A — Phenotype
94. B — Genotype
95. A — Gregor Mendel
96. C — Alleles
97. The dominant allele (R) masks the expression of the recessive allele (r), so only the dominant trait is visible

98. It increases genetic diversity, which can combine beneficial traits from both parents and mask harmful recessive alleles
99. Both parents are heterozygous (Pp), carrying a hidden recessive white allele that can combine in offspring (pp)
100. In selective breeding, humans choose which organisms reproduce based on desired traits, while natural selection is driven by environmental pressures
Matching (Plant Biology): 1→C, 2→B, 3→E, 4→A, 5→D
101. B — A method of growing plants without soil, using nutrient-rich water
102. B — To provide the light energy plants need for photosynthesis
103. D — Nitrogen (N), Phosphorus (P), and Potassium (K)
104. C — Growing medium
105. D — 5.5 to 6.5
106. B — Oxygen
107. Roots have direct access to dissolved nutrients and water, so plants spend less energy growing extensive root systems to search for resources
108. Different nutrients become unavailable to plants if the pH drifts too high or too low
109. To dissolve oxygen into the nutrient solution so roots can respire
110. To simulate natural day and night cycles that plants need for proper growth, flowering, and rest
Matching (Plant Biology): 1→C, 2→D, 3→B, 4→A, 5→E
111. A — A large geographic area characterized by specific climate conditions and the plant and animal communities adapted to them
112. A — Cuticle
113. B — Stomata
114. C — Desert
115. C — Succulents
116. B — Deciduous
117. Spines reduce the surface area exposed to dry air, minimizing water loss through transpiration, and also protect the cactus from herbivores

118. Drip tips channel rainwater off the leaf surface quickly, preventing the growth of fungi and algae in the constantly wet environment
119. CAM plants open their stomata at night to absorb CO2 (when it is cooler and less water evaporates), then store the CO2 for use in photosynthesis during the day with stomata closed
120. Growing low reduces exposure to harsh, drying winds and keeps the plant close to the warmer ground surface where it is protected from extreme cold
Matching (Plant Biology): 1→E, 2→C, 3→A, 4→B, 5→D
121. D — Transports water and nutrients between roots and leaves
122. A — Water, warmth, and oxygen
123. B — Annual plants complete their life cycle in one growing season; perennials live for multiple years
124. A — Water dispersal
125. A — The embryo
126. C — The growth of the radish plants (height, number of leaves, etc.)
127. Asexual is faster and guarantees proven traits in stable environments; sexual provides genetic diversity for adapting to changing conditions
128. Thick, waxy leaves that reduce water loss
129. Phototropism — the plant grows toward the light source to maximize photosynthesis
130. This is incorrect — plants have genetic limits on their maximum size, and their growth eventually slows or stops
Matching (Soil Composition): 1→D, 2→C, 3→B, 4→E, 5→A
131. D — Seeds can begin to germinate without light
132. C — Germination → Pollination → Seed Formation → Seed Dispersal
133. C — Wind dispersal
134. D — Dormancy is a state where a seed delays germination until environmental conditions are favorable for survival
135. C — Asexual reproduction — the new plants are genetically identical clones of the parent
136. A — Through physical defenses (thorns, tough bark, waxy coatings) and chemical defenses (toxins, bitter compounds, repellent oils)

137. The process by which plants use sunlight, water, and carbon dioxide to make food (glucose) and release oxygen
138. It's used for energy through cellular respiration, stored as starch, or used to build plant structures
139. They differ in particle size: sand is largest, silt is medium, and clay is smallest
140. Corn depletes specific nutrients from the soil faster than they're replenished, leading to nutrient exhaustion
Matching (Soil Composition): 1→E, 2→B, 3→C, 4→D, 5→A
141. D — Leaves
142. D — Water is necessary for seed germination
143. C — To attach to animal fur for dispersal to new locations
144. B — They provide stored food energy until the seedling can photosynthesize on its own
145. A — The amount of light each pot receives
146. C — Grafting preserves the exact genetics of the desired variety; seeds from sexual reproduction would produce variable offspring
147. Through tiny pores called stomata on the leaf surface
148. Because almost all food energy in ecosystems originally comes from glucose produced by photosynthetic organisms
149. Minerals (sand, silt, clay), organic matter (decayed organisms), and air/water in pore spaces
150. Organic fertilizers come from natural sources (compost, manure) and release nutrients slowly; inorganic are synthetic and release nutrients quickly
Matching (Soil Composition): 1→D, 2→A, 3→C, 4→B, 5→E
151. C — Pine trees don't produce fruits; their seeds develop on the scales of cones
152. C — Keep the type of seed, amount of water, light conditions, and soil type the same — only change the temperature
153. D — No — some plants can also grow from cuttings, bulbs, tubers, or runners
154. A — Chlorophyll breaks down, revealing other pigments that were hidden by the green color
155. D — Sand drains fastest; clay holds the most water

156. B — Phosphorus supports root development, flower and fruit production, and energy transfer within the plant
157. Soil pH measures acidity or alkalinity; it affects which nutrients are available for plant roots to absorb
158. Contour plowing — plowing along the curves of the slope rather than up and down
159. Plants absorb water through roots and release it through transpiration, contributing significantly to atmospheric moisture and precipitation patterns
160. The ovule develops into a seed, and the ovary develops into a fruit
Matching (Soil Composition): 1→E, 2→D, 3→A, 4→B, 5→C
161. I'm rooting for you -- and so are your plants!
162. The gardener quit because his celery wasn't high enough.
163. It was always growing and branching out.
164. Photosynthesis teachers are great -- they really know how to make light of everything.
165. My garden's doing well -- you could say things are looking up. Especially the sunflowers.
166. I tried to tell a joke about soil, but it was too dirty.

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