

CHAPTER 35

PLANT STRUCTURE, GROWTH, AND DEVELOPMENT

Learning objectives

The Plant Body

1. Describe and compare the three basic organs of vascular plants. Explain how these basic organs are interdependent.
2. List the basic functions of roots. Describe and compare the structures and functions of fibrous roots, taproots, root hairs, and adventitious roots.
3. Describe the basic structure of plant stems.
4. Describe and distinguish between the leaves of monocots and eudicots.
5. Describe the three tissue systems that make up plant organs.
6. Describe and distinguish between the three basic cell types of plant tissues. For each tissue, describe one characteristic structural feature and explain its functional significance.
7. Explain the functional relationship between a sieve-tube member and its companion cell.

The Process of Plant Growth and Development

8. Distinguish between determinate and indeterminate growth. Give an example of each type of growth.
9. Distinguish between annual, biennial, and perennial plants.
10. Explain this statement: "In contrast to most animals, which have a stage of embryonic growth, plants have regions of embryonic growth."
11. Distinguish between the primary and secondary plant body.
12. Describe in detail the primary growth of the tissues of roots and shoots.
13. Describe in detail the secondary growth of the tissues of roots and shoots.
14. Name the cells that make up the tissue known as wood. Name the tissues that comprise the bark.

CHAPTER 36

RESOURCE ACQUISITION AND TRANSPORT IN VASCULAR PLANTS

Learning objectives:

Resource Acquisition by Land Plants

1. Explain how mycorrhizae enhance uptake of materials by roots.

General Principles of Transport in Plants

2. Define osmosis and water potential. Explain how water potential is measured.
3. Explain how solutes and pressure affect water potential.
4. Explain how the physical properties of plant cells are changed when the plant is placed into solutions that have higher, lower, or the same solute concentration.
5. Define the terms flaccid, plasmolyze, turgor pressure, and turgid.
6. Explain how aquaporins affect the rate of water transport across membranes.
7. Distinguish between the symplast and the apoplast.
8. Define bulk flow and describe the forces that generate pressure in the vascular tissue of plants.
9. Relate the structure of sieve-tube cells, vessel cells, and tracheids to their functions in bulk flow.

Absorption of Water and Minerals by Roots

10. Explain what routes are available to water and minerals moving into the vascular cylinder of the root.
11. Explain how the endodermis functions as a selective barrier between the root cortex and vascular cylinder.

Transport of Xylem Sap

12. Explain how transpirational pull moves xylem sap up from the root tips to the leaves.
13. Explain this statement: "The ascent of xylem sap is ultimately solar powered."

The Control of Transpiration

14. Explain the importance and costs of the broad external surface area and extensive inner surface area of many leaves.
15. Discuss the factors that may alter the stomatal density of a leaf.
16. Describe the role of guard cells in photosynthesis-transpiration.
17. Explain how and when stomata open and close.

Translocation of Phloem Sap

18. Define and describe the process of translocation. Trace the path of phloem sap from a primary sugar source to a sugar sink.
19. Describe the process of sugar loading and unloading.
20. Define pressure flow. Explain the significance of this process in angiosperms.

CHAPTER 37

SOIL AND PLANT NUTRITION

Learning objectives

The Role of Soil in Plant Nutrition

15. Define soil texture and soil composition.
16. Explain how soil is formed.
17. Name the components of topsoil.
18. Describe the composition of loams and explain why they are the most fertile soils.
19. Explain how humus contributes to the texture and composition of soils.
20. Explain how the presence of clay in soil helps prevent the leaching of mineral cations.

Nutritional Requirements of Plants

21. Describe the ecological role of plants in transforming inorganic molecules into organic compounds.
22. Define the term 'essential nutrient'.
23. Explain how hydroponic culture is used to determine which minerals are essential nutrients.
24. Distinguish between macronutrient and micronutrients
25. Name the nine macronutrients required by plants.
26. List the eight micronutrients required by plants and explain why plants need only minute quantities of these elements.

Symbioses

27. Summarize the ecological role of each of the following groups of bacteria.
 - a. ammonifying bacteria
 - b. denitrifying bacteria
 - c. nitrogen-fixing bacteria
 - d. nitrifying bacteria
28. Define nitrogen fixation.
29. Understand the term symbiosis
30. Understand the symbiotic relationship between a legume and its mutualistic nitrogen-fixing bacteria.
31. Explain the symbiotic relationship between a plant and mycorrhizal fungi.
32. Distinguish between ectomycorrhizae and arbuscular mycorrhizae.

CHAPTER 38

ANGIOSPERM REPRODUCTION AND BIOTECHNOLOGY

Learning objectives

Flowers, Double Fertilization, and Fruits

1. In general terms, explain the nature of with alternation of generations in angiosperms.
2. List the four floral parts in order from outside to inside a flower (sepals, petals, anthers, and carpels)
3. From a diagram of an complete flower, correctly label the following structures and describe the function of each structure:
 - a. Sepal
 - b. Petals
 - c. Stamen (filament and anther)
 - d. Carpel (style, ovary, ovule, and stigma)
4. Distinguish between:
 - a. Complete and incomplete flowers
 - b. Microspores and megaspores
5. Explain by which generation, structure, and process spores are produced.
6. Explain by which generation, structure, and process gametes are produced.
7. Describe the production and structure of the male gametophyte of a flowering plant.
8. Describe the development of an embryo sac and explain the fate of each of its cell
9. Distinguish between pollination and fertilization.
10. Outline the process of double fertilization. Explain the adaptive advantage of double fertilization in angiosperms.
11. Describe the fate of the ovule and ovary after double fertilization. Note where major nutrients are stored as the embryo develops.
12. Describe the development and function of the endosperm. Distinguish between liquid endosperm and solid endosperm.
13. Explain how a monocot and dicot seed differ.
14. Explain how a fruit forms.

CHAPTER 40

BASIC PRINCIPLES OF ANIMAL FORM AND FUNCTION

Learning objectives:

Animal Form and Function

1. Distinguish between anatomy and physiology.
2. Explain how physical laws constrain animal form.
3. Use examples to illustrate how the size and shape of an animal's body affect its interactions with the environment.
4. Describe the challenges and benefits that come with complex animal form.
5. Define the terms tissue, organ, and organ system. Name the four main categories of tissues.
6. Be aware of the nature of collagenous fibers, elastic fibers, and reticular fibers.
7. Describe the functions of macrophages and fibroblasts within connective tissue.
8. From micrographs or diagrams, correctly identify the following animal tissues, explain how their structure relates to their functions, and note examples of each type.
 - a. Epithelial tissue
 - b. Connective tissue
 - i. Loose connective tissue
 - ii. Cartilage
 - iii. Fibrous connective tissue
 - iv. Adipose tissue
 - v. Blood
 - vi. Bone
 - c. Muscle tissue
 - i. Skeletal muscle
 - ii. Cardiac muscle
 - iii. Smooth muscle
 - d. Nervous tissue
 - i. Neuron
 - ii. Glial cell
9. Compare and contrast the nervous and endocrine systems with respect to specificity of target cells and speed and duration of response.

Regulating the Internal Environment

10. Distinguish between regulators and conformers for a particular environmental variable. Explain how an animal may be both a regulator and a conformer.
11. Define homeostasis. Describe in general terms how an animal maintains homeostasis.
12. Distinguish between positive and negative feedback mechanisms. Which type of mechanism contributes to homeostasis?
13. Define thermoregulation. Explain in general terms how endotherms and ectotherms manage their heat budgets.

The Bioenergetics of Animals

14. Define bioenergetics.
15. Describe the basic sources of chemical energy and their fate in animal cells.

16. Define biosynthesis.
17. Define metabolic rate and explain how it can be determined for animals.
18. Define basal metabolic rate (BMR) and standard metabolic rate (SMR) and be aware of the broad categories of animals to which each term applies.
19. Describe, in broad terms, how the energy budgets of small and large endotherms differ.
20. Describe, in broad terms, how the energy budgets of ectotherms and endotherms of similar size differ. Define torpor, hibernation, and daily torpor.

CHAPTER 41

ANIMAL NUTRITION

Learning objectives

Nutritional Requirements of Animals

1. List and briefly describe the three dietary categories of animals.
2. Name the three nutritional needs that must be met by an animal's diet.
3. Define essential nutrients. Describe the four classes of essential nutrients.
4. Distinguish between water-soluble and fat-soluble vitamins. Explain why megadoses of fat-soluble vitamins are more dangerous than equally large doses of water-soluble vitamins.

Overview of Food Processing

5. Define and compare the four main stages of food processing.
6. Compare intracellular and extracellular digestion.
7. Distinguish between a complete digestive tract and a gastrovascular cavity.

The Mammalian Digestive System

8. Describe the common processes and structural components of the mammalian digestive system.
9. Compare *where* and *how* the major types of macromolecules are digested and absorbed within the mammalian digestive system.
10. Explain how the small intestine is specialized for digestion and absorption.
11. Compare the uptake of an amino acid and a fatty acid in the small intestine. Trace the path of each molecule following its uptake.
12. Describe the major functions of the large intestine.

Evolutionary Adaptations of Vertebrate Digestive Systems

13. Describe the roles of symbiotic microorganisms in vertebrate digestion.

Homeostatic Mechanisms and Energy Balance

14. Explain *where* and *in what form* energy rich molecules may be stored in the human body.

CHAPTER 42

CIRCULATION AND GAS EXCHANGE

Learning objectives

Circulatory Systems of Animals

1. Describe how the need for circulatory and respiratory systems changes with increasing animal body size.
2. Explain how a gastrovascular cavity functions in part as a circulatory system.
3. Distinguish between open and closed circulatory systems. List the three basic components common to both systems.
4. Discuss the advantages of open and closed circulatory systems.
5. List the structural components of a vertebrate circulatory system and relate their structure to their functions.
6. Describe the general relationship between metabolic rates and the structure of the vertebrate circulatory system.
7. Using diagrams, compare and contrast the circulatory systems of fish, amphibians, non-bird reptiles, and mammals or birds.
8. Distinguish between a pulmonary and pulmocutaneous circuit.
9. Distinguish between pulmonary and systemic circuits and explain the functions of each.
10. Compare the hearts of vertebrates with double circulation to those of vertebrates with a single circuit.
11. Define a cardiac cycle, distinguish between systole and diastole, and explain what causes the first and second heart sounds.
12. List the heart valves in a human heart, describe their location, and explain their functions.
13. Describe the origin and pathway of the impulses from the SA node in the normal human heart.
14. Explain how the pace of the SA node can be modulated by nerves, hormones, body temperature, and exercise.

The Structure and Arrangement of Blood Vessels

15. Relate the structures of capillaries, arteries, and veins to their functions.
16. Explain why blood flow through capillaries is substantially slower than blood flow through arteries and veins.
17. Define blood pressure and describe how it is measured.
18. Define cardiac output and describe two factors that influence it.
19. Explain how blood returns to the heart
20. Explain how blood flow through capillary beds is regulated.
21. Explain how osmotic pressure and hydrostatic pressure regulate the exchange of fluid and solutes across capillary walls.
22. Describe the composition of lymph and explain how the lymphatic system helps the normal functioning of the circulatory system. Explain the role of lymph nodes in body defense.

The Components of Blood

23. Describe the composition and functions of plasma.
24. Relate the structure of erythrocytes to their function.
25. List the functions of leukocytes.
26. Describe the function of platelets. Outline the sequence of events that occurs during blood clotting.
27. Outline the formation of erythrocytes from their origin from stem cells in the red marrow of bones to their destruction by phagocytotic cells.

Gas Exchange in Animals

28. Define gas exchange and distinguish between a respiratory medium and a respiratory surface.
29. Describe the general requirements for a respiratory surface and list a variety of respiratory organs that meet these requirements.
30. Describe respiratory adaptations of aquatic animals.
31. Describe the advantages and disadvantages of air as a respiratory medium and explain how insect tracheal systems are adapted for efficient gas exchange in a terrestrial environment.
32. For the human respiratory system, describe the movement of air through air passageways to the alveolus, listing the structures that air must pass through on its journey.
33. Compare positive and negative pressure breathing. Explain how respiratory movements in humans ventilate the lungs.
34. Distinguish between tidal volume, vital capacity, and residual volume.
35. Compare the respiratory systems of birds and mammals, explaining the greater efficiency of oxygen exchange in birds.
36. Explain how breathing is controlled in humans.
37. Describe the adaptive advantage of respiratory pigments in circulatory systems.
38. Distinguish between hemocyanin and hemoglobin as respiratory pigments.
39. Describe how carbon dioxide is picked up at the tissues and carried in the blood.

CHAPTER 44 OSMOREGULATION

AND EXCRETION

Learning objectives:

An Overview of Osmoregulation

1. Define osmoregulation and excretion.
2. Define osmolarity and distinguish among isoosmotic, hyperosmotic, and hypoosmotic solutions.
3. Distinguish between osmoregulators and osmoconformers.
4. Distinguish between stenohaline and euryhaline animals, and explain why euryhaline animals include both osmoconformers and osmoregulators.
5. Discuss the osmoregulatory strategies of marine animals.
6. Explain how the osmoregulatory problems of freshwater animals differ from those of marine animals.
7. Describe anhydrobiosis as an adaptation that helps tardigrades and nematodes to survive periods of dehydration.
8. Describe some adaptations that reduce water loss in terrestrial animals.
9. Explain why osmoregulation has an energy cost. Describe some of the factors that affect this cost.
10. Describe the ultimate function of osmoregulation. Explain how hemolymph and interstitial fluids are involved in this process.
11. Explain the role of transport epithelia in osmoregulation and excretion.

Variation in Excretory Systems

12. Describe the production and elimination of ammonia. Explain why ammonia excretion is most common in aquatic species.
13. Compare the strategies to eliminate waste as ammonia, urea, or uric acid. Note which animal groups are associated with each process and why a particular strategy is adaptive for a particular group.
14. Compare the amounts of nitrogenous waste produced by endotherms and ectotherms, and by predators and herbivores.
15. Describe the key steps in the process of urine production.
16. Describe how a flame-bulb (protonephridial) excretory system functions.
17. Explain how the metanephridial excretory tubule of annelids functions. Compare the structure to the protonephridial system.
18. Describe the Malpighian tubule excretory system of insects.

The Vertebrate Kidney

19. Using a diagram, identify and state the function of each structure in the mammalian excretory system.
20. Distinguish between cortical and juxtamedullary nephrons.
21. Using a diagram, identify and describe the function of each region of the nephron.
22. Describe and explain the relationships among the processes of filtration, reabsorption, and secretion in the mammalian kidney.
23. Explain how the loop of Henle enhances water conservation by the kidney by functioning as a countercurrent multiplier system.
24. Describe variations in nephron structure and function that equip the kidneys of different vertebrates for osmoregulation in various habitats.
25. Explain the significance of the juxtamedullary nephrons of birds and mammals.
26. Explain how the feeding habits of the South American vampire bat illustrate the versatility of the mammalian kidney.
27. Describe the nervous and hormonal controls involved in the regulation of kidney function.

CHAPTER 45

HORMONES AND THE ENDOCRINE SYSTEM

Learning objectives:

Chemical Signals and Their Modes of Action

1. Distinguish between hormones and local regulators..
2. Define and give an example of a neurohormone.
3. List the three major classes of molecules that function as hormones.
4. Explain what changes may be triggered by a signal transduction pathway initiated by the binding of a water-soluble hormone to a receptor in the plasma membrane of a target cell.
5. Discuss how different target cells exposed to the same hormone may respond in diverse ways.
6. Describe the nature and location of intracellular receptors for hormones that pass easily through cell membranes. Explain how their role compares to the signal-transduction pathway noted above, and describe the changes they are likely to trigger within the target cell.

The Vertebrate Endocrine System

7. Describe an example of a simple hormone pathway with negative feedback.
8. Distinguish between alpha and beta cells in the pancreas and explain how their antagonistic hormones (insulin and glucagon) regulate carbohydrate metabolism.
9. Explain how the hypothalamus and pituitary glands interact and how they coordinate the endocrine system.
10. Describe the location of the pituitary. List and explain the functions of the hormones released from the anterior and posterior lobes.
11. Explain the role of tropic hormones in coordinating endocrine signaling throughout the body.
12. Note the location of the parathyroid glands and describe the hormonal control of calcium homeostasis.
13. List the hormones of the adrenal medulla, describe their functions, and explain how their secretions are controlled.
14. List the hormones of the adrenal cortex and describe their functions.

CHAPTER 46

ANIMAL REPRODUCTION

Learning objectives:

Overview of Animal Reproduction

1. Distinguish between asexual and sexual reproduction.
2. List and describe four mechanisms of asexual reproduction.
3. Explain the “two-fold” cost of sex. Describe current hypotheses about the advantages of sex.
4. Describe factors that may control the timing of reproductive events.
5. Describe an animal life cycle that alternates between asexual and sexual reproduction.
6. Define parthenogenesis and describe the conditions that favor its occurrence. Give examples of invertebrate and vertebrate species that use this form of reproduction.
7. Explain how hermaphroditism may be advantageous to animals that have difficulty encountering a member of the opposite sex.
8. Explain the adaptive advantages of reproductive systems with sex reversal.

Mechanisms for Fertilization

9. Describe mechanisms that increase the probability of successful fertilization in organisms that use external fertilization.
10. Explain the function of pheromones in mate attraction.
11. Describe various ways in which animals may protect developing embryos.
12. Describe the basic structure of male and female reproductive systems.

Human Reproduction and Pregnancy

13. Using a diagram, identify and state the function of each component of the reproductive system of the human male.
14. Using a diagram, identify and state the function of each component of the reproductive system of the human female.
15. Describe the two physiological reactions common to sexual arousal in both sexes.
16. Describe the four phases of the human sexual response cycle.
17. Describe oogenesis. Describe spermatogenesis and the structure and function of mature sperm.
18. Describe three major differences between oogenesis and spermatogenesis.
19. Describe the stages of the human female reproductive cycle.
20. Explain how the uterine cycle and ovarian cycle are synchronized in female mammals. Describe in detail the functions of the hormones involved.
21. Describe human menopause. Describe a possible evolutionary explanation for human menopause.
22. Compare menstrual cycles and estrous cycles.
23. Explain the role of embryonic hormones during the first few months of pregnancy.
24. Describe the changes that occur in the mother and the developing embryo during each trimester of a human pregnancy.
25. Define conception, gestation, and parturition.
26. Describe the control of lactation.

27. List the various methods of contraception. Explain how each method works and how effective it is.
28. Describe techniques that allow us to learn about the health and genetics of a fetus.
29. Explain how *in vitro* fertilization and intracytoplasmic sperm injection may assist with conception.

CHAPTER 47

ANIMAL DEVELOPMENT

Learning objectives

The Stages of Embryonic Development in Animals

1. Compare the concepts of preformation and epigenesis.
2. List two key functions of fertilization.
3. Describe the acrosomal reaction and explain how it ensures that gametes are conspecific.
4. Describe the cortical reaction.
5. Explain how the fast and slow blocks to polyspermy function sequentially to prevent multiple sperm from fertilizing the egg.
6. Describe the changes that occur in an activated egg and explain the importance of cytoplasmic materials to egg activation.
7. Compare fertilization in a sea urchin and a mammal.
8. Describe the general process of cleavage.
9. Explain the importance of embryo polarity during cleavage. Compare the characteristics of the animal hemisphere, vegetal hemisphere, and gray crescent in amphibian embryos.
10. Describe the formation of a blastula in sea urchin, amphibian, and bird embryos. Distinguish among meroblastic cleavage, holoblastic cleavage, and the formation of the blastoderm.
11. Describe the product of cleavage in an insect embryo.
12. Describe the process of gastrulation and explain its importance. Explain how this process rearranges the embryo. List adult structures derived from each of the primary germ layers.
13. Compare gastrulation in a sea urchin, a frog, and a chick.
14. Describe the formation of the notochord, neural tube, and somites in a frog.
15. Describe the significance and fate of neural crest cells. Explain why neural crest cells have been called a “fourth germ layer”.
16. List and explain the functions of the extraembryonic membranes in reptile eggs.
17. Describe the events of cleavage in a mammalian embryo. Explain the significance of the inner cell mass.
18. Explain the role of the trophoblast in implantation of a human embryo.
19. Explain the functions of the extraembryonic membranes in mammalian development.

The Cellular and Molecular Basis of Morphogenesis and Differentiation in Animals

20. Describe the significance of changes in cell shape and cell position during embryonic development. Describe the role of the cytoskeleton in these cellular processes.
21. Describe the process of convergent extension.
22. Describe the locations and functions of cell adhesion molecules.
23. Describe the role of the extracellular matrix in embryonic development.
24. Describe the two general principles that integrate our knowledge of the genetic and cellular mechanisms underlying differentiation.
25. Describe the process of fate mapping and the significance of fate maps.

26. Describe the two important conclusions that have resulted from the experimental manipulation of parts of embryos and the use of fate maps.
27. Explain how the three body axes are established in early amphibian and chick development.
28. Explain the significance of Spemann's organizer in amphibian development.
29. Explain what is known about the molecular basis of induction.
30. Explain pattern formation in a developing chick limb, including the roles of the apical ectodermal ridge and the zone of polarizing activity.
31. Explain how a limb bud is directed to develop into either a forelimb or hind limb.

CHAPTER 48

NEURONS, SYNAPSES, AND SIGNALING

Learning objectives:

An Overview of Nervous Systems

1. Name the three stages in the processing of information by nervous systems.
2. Distinguish among sensory neurons, interneurons, and motor neurons.
3. List and describe the major parts of a neuron and explain the function of each.
4. Describe the function of glia.

The Nature of Nerve Signals

5. Define a membrane potential and a resting potential.
6. Describe the factors that contribute to a membrane potential.
7. Explain why the membrane potential of a resting neuron is typically between -60 and -80 mV.
8. Explain the role of the sodium-potassium pump in maintaining the resting potential.
9. Describe the characteristics of an action potential. Explain the role of voltage-gated ion channels in this process.
10. Explain how an action potential is propagated along an axon.
11. Describe the factors that affect the speed of action potentials along an axon and describe adaptations that increase the speed of propagation. Describe saltatory conduction.

The Synapse

12. Distinguish between an electrical synapse and a chemical synapse.
13. Describe the structures of a chemical synapse and the events that lead to the release of neurotransmitters into the synaptic cleft.
14. Explain the integrative role of the axon hillock.
15. Identify and describe the functions of any neurotransmitters elaborated on in lecture.

CHAPTER 49

NERVOUS SYSTEMS

Learning objectives:

Vertebrate Nervous Systems

1. At a basic level only, compare and contrast the nervous systems of the following animals and explain how variations in design and complexity relate to their phylogeny, natural history, and habitat: hydra, planarian, clam, squid, and vertebrate.
2. Compare the structures and functions of the central nervous system and peripheral nervous system.
3. Explain how the spinal cord produces reflex movement.
4. Distinguish between the white and gray matter of the central nervous system.
5. List the types of glia and their functions.
6. Distinguish between the three divisions of the autonomic nervous system.

The Vertebrate Brain

7. Describe the structures and functions of the following brain regions: medulla oblongata, pons, midbrain, cerebellum, thalamus, epithalamus, hypothalamus, and cerebrum.

The Cerebral Cortex

8. Describe our current understanding of human consciousness.

CHAPTER 52

AN INTRODUCTION TO ECOLOGY AND THE BIOSPHERE

Learning objectives

The Scope of Ecology

33. Define ecology.
34. Describe the relationship between ecology and evolutionary biology.
35. Distinguish between abiotic and biotic components of the environment.
36. Distinguish among organismal ecology, population ecology, community ecology, ecosystem ecology, and landscape ecology.
37. Clarify the difference between ecology and environmentalism.

Interactions between Organisms and the Environment Limit the Distribution of Species

38. Define biogeography.
39. Distinguish between the potential and actual range of a species.
40. Explain how habitat selection may limit distribution of a species within its range of suitable habitats.
41. Describe, with examples, how biotic and abiotic factors may affect the distribution of organisms.
42. List the four abiotic factors that are the most important components of climate.
43. Distinguish between macroclimate and microclimate patterns.
44. Provide an example of a microclimate.

Aquatic Biomes

45. Define each layer in a stratified aquatic biome: photic zone, aphotic zone, benthic zone, abyssal zone.
46. Describe briefly the characteristics of the major aquatic biomes: lakes, wetlands, streams, rivers, estuaries, intertidal biomes, oceanic pelagic biomes, coral reefs, and marine benthic biomes.

Terrestrial Biomes

47. Define a climograph.
48. Give an example of a biome characterized by periodic disturbance.
49. Describe the characteristics of a few major terrestrial biomes: tropical forest, desert, savanna, chaparral, temperate grassland, coniferous forest, temperate broadleaf forest, and tundra.

CHAPTER 53

POPULATION ECOLOGY

Learning objectives

Characteristics of Populations

1. Distinguish between density and dispersion of a population.
2. Explain how ecologists may estimate the density of a species.
3. Describe conditions that may result in clumped dispersion, uniform dispersion, and random dispersion of individuals in a population.
4. Explain how a life table is constructed.
5. Distinguish between a life table and a reproductive table.
6. Describe the characteristics of populations that exhibit Type I, Type II, and Type III survivorship curves.

Life Histories

7. Define and distinguish between semelparity and iteroparity. Explain what factors may favor the evolution of each life history strategy.

Population Growth

8. Compare the exponential model of population growth with the logistic model.
9. Explain environment's carrying capacity.
10. Distinguish between r -selected populations and K -selected populations.

Population-Limiting Factors

11. Explain how density-dependent and density-independent factors may affect population growth.
12. Explain, with examples, how biotic and abiotic factors may work together to control a population's growth.

Human Population Growth

13. Describe the history of human population growth.
14. Compare the age structures of Italy, Afghanistan, and the United States. Describe the possible consequences for each country.
15. Describe the problems associated with estimating Earth's carrying capacity for the human species.
16. Explain how an ecological footprint can be calculated for an individual or country. Describe the possible currencies of this calculation.

CHAPTER 54 - COMMUNITY ECOLOGY

Learning objectives

Interspecific Interactions

1. List the categories of interspecific interactions. Explain how each interaction affects the survival and reproductive success of the two species involved.
2. State the competitive exclusion principle.
3. Define an ecological niche and restate the competitive exclusion principle using the niche concept.
4. Explain how interspecific competition may lead to resource partitioning.
5. Distinguish between fundamental and realized niche.
6. Distinguish among parasitism, mutualism, and commensalism.

Community Structure

7. Explain the relationship between species richness and relative abundance and explain how both contribute to species diversity.
8. Distinguish between a food chain and a food web.
9. Summarize two hypotheses that explain why food chains are relatively short. Explain the experimental evidence that supports the energetic hypothesis.
10. Explain how dominant and keystone species exert strong control on community structure. Describe an example of each.
11. Explain how a foundation species may facilitate the survival and reproduction of other species.

Disturbance and Community Structure

12. Define stability and disturbance.
13. Describe the intermediate disturbance hypothesis. Explain why moderate levels of disturbance may create conditions that foster greater species diversity than low or high levels of disturbance.
14. Distinguish between primary and secondary succession.
15. Describe how species that arrive early in succession may facilitate, inhibit, or tolerate later arrivals.
16. Describe an example of humans acting as agents of disturbance.

Biogeographic Factors Affect Community Biodiversity

17. Explain why species richness declines along an equatorial-polar gradient.
18. Define the species-area curve.
19. Explain how species richness on islands varies according to island size and distance from the mainland.

CHAPTER 55 ECOSYSTEMS

Learning objectives

Physical Laws Govern Ecosystems

1. Describe the fundamental relationship between autotrophs and heterotrophs in an ecosystem.
2. Explain how decomposition connects all trophic levels in an ecosystem.

Primary Production in Ecosystems

3. Explain why the amount of energy used in photosynthesis is so much less than the amount of solar energy that reaches Earth.
4. Define and compare gross primary production and net primary production.
5. Define and compare net primary production and standing crop.
6. Compare net primary production in specific marine, freshwater, and terrestrial ecosystems.

Secondary Production in Ecosystems

7. Explain why energy is said to flow rather than cycle within ecosystems.
8. Explain what factors may limit primary production in aquatic ecosystems.
9. of the following pairs of terms:
 - a. primary and secondary production
 - b. production efficiency and trophic efficiency
10. of net production and a pyramid of biomass.

The Cycling of Chemical Elements in Ecosystems

11. Explain why nutrients are said to cycle rather than flow within ecosystems.
12. Describe the four nutrient reservoirs and the processes that transfer the elements between reservoirs.
13. Name the main processes driving the water cycle.
14. Name the major reservoirs of carbon.
15. Describe the nitrogen cycle and explain the importance of nitrogen fixation to all living organisms. Name three other key bacterial processes in the nitrogen cycle.
16. Describe the phosphorus cycle and explain how phosphorus is recycled locally in most ecosystems.
17. Explain how decomposition affects the rate of nutrient cycling in ecosystems.
18. Describe how net primary production and the rate of decomposition vary with temperature and water availability.

CHAPTER 56

CONSERVATION BIOLOGY AND RESTORATION ECOLOGY

Learning objectives

The Biodiversity Crisis

1. Distinguish between conservation biology and restoration biology.
2. Describe the three levels of biodiversity.
3. List the three major threats to biodiversity and give an example of each.

Conservation at the Population and Species Levels

4. Explain how an extinction vortex can lead to the extinction of a small population. .

Conservation at the Community, Ecosystem, and Landscape Levels

5. Define biodiversity hot spots and explain why they are important.
6. Explain why natural reserves must be functional parts of landscapes.
7. Define restoration ecology and describe its goals.
8. Explain the importance of bioremediation and biological augmentation of ecosystem processes in restoration efforts.
9. Describe the process of adaptive management.
10. Describe the concept of sustainable development.