Table of Contents for *CAMPBELL BIOLOGY 9e AP* Edition* Highlighted with Concepts Included in the AP Biology Curriculum Framework

NOTE: *Highlighted concepts address topics that are included in the Learning Objectives for the new AP course; other sections may be used at the teacher's discretion to provide background information and supporting examples for the core concepts.*

1. Introduction: Themes in the Study of Life

NOTE: *While the Curriculum Framework does not directly address the overarching themes and scientific methods in Chapter 1, this would logically be an important part of the Science Practices portion of the new AP course.*

KEY CONCEPTS

1.1 Themes make connections between the concepts of biology
1.2 The Core Theme: Evolution accounts for the unity and diversity of life
1.3 In studying nature, scientists make observations and form and test hypotheses
1.4 Science benefits from a cooperative approach and diverse viewpoints

Unit 1 The Chemistry of Life

2. The Chemical Context of Life

NOTE: *While the Curriculum Framework does not address the topics in Chapter 2, teachers will need to cover this content if their students do not have a strong background in basic chemistry.*

KEY CONCEPTS

2.1 Matter consists of chemical elements in pure form and in combinations called compounds
2.2 An element's properties depend on the structure of its atoms
2.3 The formation and function of molecules depend on chemical bonding between atoms
2.4 Chemical reactions make and break chemical bonds

3. Water and the Fitness of the Environment

KEY CONCEPTS

3.1 Polar covalent bonds in water molecules result in hydrogen bonding
3.2 Four emergent properties of water contribute to Earth's fitness for life
3.3 Acidic and basic conditions affect living organisms

4. Carbon and the Molecular Diversity of Life

KEY CONCEPTS

4.1 Organic chemistry is the study of carbon compounds
4.2 Carbon atoms can form diverse molecules by bonding to four other atoms
4.3 A small number of chemical groups are key to the functioning of biological molecules

5. The Structure and Function of Large Biological Molecules

KEY CONCEPTS

5.1 Macromolecules are polymers, built from monomers
5.2 Carbohydrates serve as fuel and building material
5.3 Lipids are a diverse group of hydrophobic molecules
5.4 Proteins have many structures, resulting in a wide range of functions
5.5 Nucleic acids store, transmit, and help express hereditary information

Unit 2 The Cell

6. A Tour of the Cell

KEY CONCEPTS

6.1 To study cells, biologists use microscopes and the tools of biochemistry
6.2 Eukaryotic cells have internal membranes that compartmentalize their functions
6.3 The eukaryotic cell's genetic instructions are housed in the nucleus and carried out by the ribosomes
6.4 The endomembrane system regulates protein traffic and performs metabolic functions in the cell
6.5 Mitochondria and chloroplasts change energy from one form to another
6.6 The cytoskeleton is a network of fibers that organizes structures and activities in the cell

6.7 Extracellular components and connections between cells help coordinate cellular activities

7. Membrane Structure and Function

KEY CONCEPTS

7.1 Cellular membranes are fluid mosaics of lipids and proteins
7.2 Membrane structure results in selective permeability
7.3 Passive transport is diffusion of a substance across a membrane with no energy investment
7.4 Active transport uses energy to move solutes against their gradients
7.5 Bulk transport across the plasma membrane occurs by exocytosis and endocytosis

8. An Introduction to Metabolism

KEY CONCEPTS

8.1 An organism's metabolism transforms matter and energy, subject to the laws of thermodynamics
8.2 The free-energy change of a reaction tells us whether or not the reaction occurs spontaneously
8.3 ATP powers cellular work by coupling exergonic reactions to endergonic reactions
8.4 Enzymes speed up metabolic reactions by lowering energy barriers
8.5 Regulation of enzyme activity helps control metabolism

9. Cellular Respiration and Fermentation

KEY CONCEPTS

9.1 Catabolic pathways yield energy by oxidizing organic fuels
9.2 Glycolysis harvests chemical energy by oxidizing glucose to pyruvate
9.3 After pyruvate is oxidized, the citric acid cycle completes the energy-yielding oxidation of organic molecules
9.4 During oxidative phosphorylation, chemiosmosis couples electron transport to ATP synthesis
9.5 Fermentation and anaerobic respiration enable cells to produce ATP without the use of oxygen
9.6 Glycolysis and the citric acid cycle connect to many other metabolic pathways

10. Photosynthesis

KEY CONCEPTS

10.1 Photosynthesis converts light energy to the chemical energy of food
10.2 The light reactions convert solar energy to the chemical energy of ATP and NADPH
10.3 The Calvin cycle uses the chemical energy of ATP and NADPH to reduce CO_2 to sugar
10.4 Alternative mechanisms of carbon fixation have evolved in hot, arid climates

11. Cell Communication

KEY CONCEPTS

11.1 External signals are converted to responses within the cell
11.2 Reception: A signaling molecule binds to a receptor protein, causing it to change shape
11.3 Transduction: Cascades of molecular interactions relay signals from receptors to target molecules in the cell
11.4 Response: Cell signaling leads to regulation of transcription or cytoplasmic activities
11.5 Apoptosis integrates multiple cell-signaling pathways

12. The Cell Cycle

KEY CONCEPTS

12.1 Most cell division results in genetically identical daughter cells
12.2 The mitotic phase alternates with interphase in the cell cycle
12.3 The eukaryotic cell cycle is regulated by a molecular control system

Unit 3 Genetics

13. Meiosis and Sexual Life Cycles

KEY CONCEPTS

13.1 Offspring acquire genes from parents by inheriting chromosomes
13.2 Fertilization and meiosis alternate in sexual life cycles
13.3 Meiosis reduces the number of chromosome sets from diploid to haploid
13.4 Genetic variation produced in sexual life cycles contributes to evolution

14. Mendel and the Gene Idea

KEY CONCEPTS

14.1 Mendel used the scientific approach to identify two laws of inheritance
14.2 The laws of probability govern Mendelian inheritance
14.3 Inheritance patterns are often more complex than predicted by simple Mendelian genetics
14.4 Many human traits follow Mendelian patterns of inheritance

15. The Chromosomal Basis of Inheritance

KEY CONCEPTS

15.1 Mendelian inheritance has its physical basis in the behavior of chromosomes
15.2 Sex-linked genes exhibit unique patterns of inheritance
15.3 Linked genes tend to be inherited together because they are located near each other on the same chromosome
15.4 Alterations of chromosome number or structure cause some genetic disorders
15.5 Some inheritance patterns are exceptions to the standard chromosome theory

16. The Molecular Basis of Inheritance

KEY CONCEPTS

16.1 DNA is the genetic material
16.2 Many proteins work together in DNA replication and repair
16.3 A chromosome consists of a DNA molecule packed together with proteins

17. From Gene to Protein

KEY CONCEPTS

17.1 Genes specify proteins via transcription and translation
17.2 Transcription is the DNA-directed synthesis of RNA: a closer look
17.3 Eukaryotic cells modify RNA after transcription
17.4 Translation is the RNA-directed synthesis of a polypeptide: a closer look
17.5 Mutations of one or a few nucleotides can affect protein structure and function
17.6 While gene expression differs among the domains of life, the concept of a gene is universal

18. Regulation of Gene Expression

KEY CONCEPTS

18.1 Bacteria often respond to environmental change by regulating transcription
18.2 Eukaryotic gene expression is regulated at many stages
18.3 Noncoding RNAs play multiple roles in controlling gene expression
18.4 A program of differential gene expression leads to the different cell types in a multicellular organism
18.5 Cancer results from genetic changes that affect cell cycle control

19. Viruses

KEY CONCEPTS

19.1 A virus consists of a nucleic acid surrounded by a protein coat
19.2 Viruses replicate only in host cells
19.3 Viruses, viroids, and prions are formidable pathogens in animals and plants

20. Biotechnology

KEY CONCEPTS

20.1 DNA cloning yields multiple copies of a gene or other DNA segment
20.2 DNA technology allows us to study the sequence, expression, and function of a gene
20.3 Cloning organisms may lead to production of stem cells for research and other applications
20.4 The practical applications of DNA technology affect our lives in many ways

21. Genomes and Their Evolution

KEY CONCEPTS

21.1 New approaches have accelerated the pace of genome sequencing
21.2 Scientists use bioinformatics to analyze genomes and their functions
21.3 Genomes vary in size, number of genes, and gene density
21.4 Multicellular eukaryotes have much noncoding DNA and many multigene families
21.5 Duplication, rearrangement, and mutation of DNA contribute to genome evolution
21.6 Comparing genome sequences provides clues to evolution and development

Unit 4 Mechanisms of Evolution

22. Descent with Modification: A Darwinian View of Life

KEY CONCEPTS

22.1 The Darwinian revolution challenged traditional views of a young Earth inhabited by unchanging species
22.2 Descent with modification by natural selection explains the adaptations of organisms and the unity and diversity of life
22.3 Evolution is supported by an overwhelming amount of scientific evidence

23. The Evolution of Populations

KEY CONCEPTS

23.1 Genetic variation makes evolution possible
23.2 The Hardy-Weinberg equation can be used to test whether a population is evolving
23.3 Natural selection, genetic drift, and gene flow can alter allele frequencies in a population
23.4 Natural selection is the only mechanism that consistently causes adaptive evolution

24. The Origin of Species

KEY CONCEPTS

24.1 The biological species concept emphasizes reproductive isolation
24.2 Speciation can take place with or without geographic separation
24.3 Hybrid zones reveal factors that cause reproductive isolation
24.4 Speciation can occur rapidly or slowly and can result from changes in few or many genes

25. The History of Life on Earth

KEY CONCEPTS

25.1 Conditions on early Earth made the origin of life possible
25.2 The fossil record documents the history of life
25.3 Key events in life's history include the origins of single-celled and multicelled organisms and the colonization of land
25.4 The rise and fall of groups of organisms reflect differences in speciation and extinction rates

25.5 Major changes in body form can result from changes in the sequences and regulation of developmental genes
25.6 Evolution is not goal oriented

Unit 5 The Evolutionary History of Biological Diversity

26. Phylogeny and the Tree of Life

KEY CONCEPTS

26.1 Phylogenies show evolutionary relationships
26.2 Phylogenies are inferred from morphological and molecular data
26.3 Shared characters are used to construct phylogenetic trees
26.4 An organism's evolutionary history is documented in its genome
26.5 Molecular clocks help track evolutionary time
26.6 New information continues to revise our understanding of the tree of life

27. Bacteria and Archaea

KEY CONCEPTS

27.1 Structural and functional adaptations contribute to prokaryotic success
27.2 Rapid reproduction, mutation, and genetic recombination promote genetic diversity in prokaryotes
27.3 Diverse nutritional and metabolic adaptations have evolved in prokaryotes
27.4 Molecular systematics is illuminating prokaryotic phylogeny
27.5 Prokaryotes play crucial roles in the biosphere
27.6 Prokaryotes have both beneficial and harmful impacts on humans

NOTE: *Although few diversity and plant topics are specifically described in the new Curriculum Framework, many are suggested as examples. Individual teachers may select from the many possible ways to illustrate a process and therefore choose to teach a number of concepts that follow.*

28. Protists

KEY CONCEPTS

28.1 Most eukaryotes are single-celled organisms
28.2 Excavates include protists with modified mitochondria and protists with unique flagella
28.3 Chromalveolates may have originated by secondary endosymbiosis

28.4 Rhizarians are a diverse group of protists defined by DNA similarities
28.5 Red algae and green algae are the closest relatives of land plants
28.6 Unikonts include protists that are closely related to fungi and animals
28.7 Protists play key roles in ecological communities

29. Plant Diversity I: How Plants Colonized Land

KEY CONCEPTS

29.1 Land plants evolved from green algae
29.2 Mosses and other nonvascular plants have life cycles dominated by gametophytes
29.3 Ferns and other seedless vascular plants were the first plants to grow tall

30. Plant Diversity II: The Evolution of Seed Plants

KEY CONCEPTS

30.1 Seeds and pollen grains are key adaptations for life on land
30.2 Gymnosperms bear “naked” seeds, typically on cones
30.3 The reproductive adaptations of angiosperms include flowers and fruits
30.4 Human welfare depends greatly on seed plants

31. Fungi

KEY CONCEPTS

31.1 Fungi are heterotrophs that feed by absorption
31.2 Fungi produce spores through sexual or asexual life cycles
31.3 The ancestor of fungi was an aquatic, single-celled, flagellated protist
31.4 Fungi have radiated into a diverse set of lineages
31.5 Fungi play key roles in nutrient cycling, ecological interactions, and human welfare

32. An Overview of Animal Diversity

KEY CONCEPTS

32.1 Animals are multicellular, heterotrophic eukaryotes with tissues that develop from embryonic layers
32.2 The history of animals spans more than half a billion years
32.3 Animals can be characterized by “body plans”
32.4 New views of animal phylogeny are emerging from molecular data

33. An Introduction to Invertebrates

KEY CONCEPTS

33.1 Sponges are basal animals that lack true tissues
33.2 Cnidarians are an ancient phylum of eumetazoans
33.3 Lophotrochozoans, a clade identified by molecular data, have the widest range of animal body forms
33.4 Ecdysozoans are the most species-rich animal group
33.5 Echinoderms and chordates are deuterostomes

34. The Origin and Evolution of Vertebrates

KEY CONCEPTS

34.1 Chordates have a notochord and a dorsal, hollow nerve cord
34.2 Craniates are chordates that have a head
34.3 Vertebrates are craniates that have a backbone
34.4 Gnathostomes are vertebrates that have jaws
34.5 Tetrapods are gnathostomes that have limbs
34.6 Amniotes are tetrapods that have a terrestrially adapted egg
34.7 Mammals are amniotes that have hair and produce milk
34.8 Humans are mammals that have a large brain and bipedal locomotion

Unit 6 Plant Form and Function

35. Plant Structure, Growth, and Development

KEY CONCEPTS

35.1 Plants have a hierarchical organization consisting of organs, tissues, and cells
35.2 Meristems generate cells for primary and secondary growth
35.3 Primary growth lengthens roots and shoots
35.4 Secondary growth increases the diameter of stems and roots in woody plants
35.5 Growth, morphogenesis, and differentiation produce the plant body

36. Resource Acquisition and Transport in Vascular Plants

KEY CONCEPTS

36.1 Shoot and root adaptations for acquiring resources evolved in vascular plants

36.2 Different mechanisms transport substances over short or long distances
36.3 Transpiration drives the transport of water and minerals from roots to shoots via the xylem
36.4 The rate of transpiration is regulated by stomata
36.5 Sugars are transported from sources to sinks via the phloem
36.6 The symplast is highly dynamic

37. Soil and Plant Nutrition

KEY CONCEPTS

37.1 Soil contains a living, complex ecosystem
37.2 Plants require essential elements to complete their life cycle
37.3 Plant nutrition often involves relationships with other organisms

38. Angiosperm Reproduction and Biotechnology

KEY CONCEPTS

38.1 Flowers, double fertilization, and fruits are unique features of the angiosperm life cycle
38.2 Flowering plants reproduce sexually, asexually, or both
38.3 Humans modify crops by breeding and genetic engineering

39. Plant Responses to Internal and External Signals

KEY CONCEPTS

39.1 Signal transduction pathways link signal reception to response
39.2 Plant hormones help coordinate growth, development, and responses to stimuli
39.3 Responses to light are critical for plant success
39.4 Plants respond to a wide variety of stimuli other than light
39.5 Plants respond to attacks by herbivores and pathogens

Unit 7 Animal Form and Function

40. Basic Principles of Animal Form and Function

KEY CONCEPTS

40.1 Animal form and function are correlated at all levels of organization
40.2 Feedback control loops maintain the internal environment in many animals

40.3 Homeostatic processes for thermoregulation involve form, function, and behavior
40.4 Energy requirements are related to animal size, activity, and environment

NOTE: *Although only a few human systems topics are specifically described in the new Curriculum Framework, many are suggested as examples. Individual teachers may select from the many possible ways to illustrate a process and therefore choose to teach a number of concepts that follow.*

41. Animal Nutrition

KEY CONCEPTS

41.1 An animal's diet must supply chemical energy, organic molecules, and essential nutrients
41.2 The main stages of food processing are ingestion, digestion, absorption, and elimination
41.3 Organs specialized for sequential stages of food processing form the mammalian digestive system
41.4 Evolutionary adaptations of vertebrate digestive systems correlate with diet
41.5 Feedback circuits regulate digestion, energy storage, and appetite

42. Circulation and Gas Exchange

KEY CONCEPTS

42.1 Circulatory systems link exchange surfaces with cells throughout the body
42.2 Coordinated cycles of heart contraction drive double circulation in mammals
42.3 Patterns of blood pressure and flow reflect the structure and arrangement of blood vessels
42.4 Blood components contribute to exchange, transport, defense, and disease
42.5 Gas exchange occurs across specialized respiratory surfaces
42.6 Breathing ventilates the lungs
42.7 Adaptations for gas exchange include pigments that bind and transport gases

43. The Immune System

KEY CONCEPTS

43.1 In innate immunity, recognition and response rely on traits common to groups of pathogens
43.2 In adaptive immunity, receptors provide pathogen-specific recognition
43.3 Adaptive immunity defends against infection of both body fluids and cells

43.4 Disruptions in immune system function can elicit or exacerbate disease

44. Osmoregulation and Excretion

KEY CONCEPTS

44.1 Osmoregulation balances the uptake and loss of water and solutes
44.2 An animal's nitrogenous wastes reflect its phylogeny and habitat
44.3 Diverse excretory systems are variations on a tubular theme
44.4 The nephron is organized for stepwise processing of blood filtrate
44.5 Hormonal circuits link kidney function, water balance, and blood pressure

45. Hormones and the Endocrine System

KEY CONCEPTS

45.1 Hormones and other signaling molecules bind to target receptors, triggering specific response pathways
45.2 Feedback regulation and antagonistic hormone pairs are common in endocrine systems
45.3 The hypothalamus and pituitary play a central role in endocrine regulation
45.4 Endocrine glands respond to diverse stimuli in regulating homeostasis, development, and behavior

46. Animal Reproduction

KEY CONCEPTS

46.1 Both asexual and sexual reproduction occur in the animal kingdom
46.2 Fertilization depends on mechanisms that bring together sperm and eggs of the same species
46.3 Reproductive organs produce and transport gametes
46.4 The interplay of tropic and sex hormones regulates mammalian reproduction
46.5 In placental mammals, an embryo develops fully within the mother's uterus

47. Animal Development

KEY CONCEPTS

47.1 Fertilization and cleavage initiate embryonic development
47.2 Morphogenesis in animals involves specific changes in cell shape, position, and survival
47.3 The developmental fate of cells depends on maternal factors and inductive signals

48. Neurons, Synapses, and Signaling

KEY CONCEPTS

48.1 Neuron organization and structure reflect function in information transfer
48.2 Ion pumps and ion channels establish the resting potential of a neuron
48.3 Action potentials are the signals conducted by axons
48.4 Neurons communicate with other cells at synapses

49. Nervous Systems

KEY CONCEPTS

49.1 Nervous systems consist of circuits of neurons and supporting cells
49.2 The vertebrate brain is regionally specialized
49.3 The cerebral cortex controls voluntary movement and cognitive functions
49.4 Changes in synaptic connections underlie memory and learning
49.5 Many nervous system disorders can be explained in molecular terms

50. Sensory and Motor Mechanisms

KEY CONCEPTS

50.1 Sensory receptors transduce stimulus energy and transmit signals to the central nervous system
50.2 The mechanoreceptors responsible for hearing and equilibrium detect moving fluid or settling particles
50.3 The senses of taste and smell rely on similar sets of sensory receptors
50.4 Light-absorbing pigments underlie vision throughout the animal kingdom
50.5 The physical interaction of protein filaments is required for muscle function
50.6 Skeletal systems transform muscle contraction into locomotion

51. Animal Behavior

KEY CONCEPTS

51.1 Discrete sensory inputs can stimulate both simple and complex behaviors
51.2 Learning establishes specific links between experience and behavior
51.3 Selection for individual survival and reproductive success can explain most behaviors
51.4 Inclusive fitness can account for the evolution of behavior, including altruism

Unit 8 Ecology

52. An Introduction to Ecology and the Biosphere

KEY CONCEPTS

52.1 Earth's climate varies by latitude and season and is changing rapidly
52.2 The structure and distribution of terrestrial biomes are controlled by climate and disturbance
52.3 Aquatic biomes are diverse and dynamic systems that cover most of Earth
52.4 Interactions between organisms and the environment limit the distribution of species

53. Population Ecology

KEY CONCEPTS

53.1 Dynamic biological processes influence population density, dispersion, and demographics
53.2 The exponential model describes population growth in an idealized, unlimited environment
53.3 The logistic model describes how a population grows more slowly as it nears its carrying capacity
53.4 Life history traits are products of natural selection
53.5 Many factors that regulate population growth are density dependent
53.6 The human population is no longer growing exponentially but is still increasing rapidly

54. Community Ecology

KEY CONCEPTS

54.1 Community interactions are classified by whether they help, harm, or have no effect on the species involved
54.2 Diversity and trophic structure characterize ecological communities
54.3 Disturbance influences species diversity and composition
54.4 Biogeographic factors affect community diversity
54.5 Pathogens alter community structure locally and globally

55. Ecosystems and Restoration Ecology

KEY CONCEPTS

55.1 Physical laws govern energy flow and chemical cycling in ecosystems
55.2 Energy and other limiting factors control primary production in ecosystems
55.3 Energy transfer between trophic levels is typically only 10% efficient
55.4 Biological and geochemical processes cycle nutrients in ecosystems
55.5 Restoration ecology restores degraded ecosystems to a more natural state

56. Conservation Biology and Global Change

KEY CONCEPTS

56.1 Human activities threaten Earth's biodiversity
56.2 Population conservation focuses on population size, genetic diversity, and critical habitat
56.3 Landscape and regional conservation seek to sustain entire biotas
56.4 Earth is changing rapidly as a result of human actions
56.5 Sustainable development seeks to improve human lives while conserving biodiversity

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