AP Biology

Semester A Summary:

In this course, the student will gain a foundation in the Life Sciences by focusing on four major themes: 1) how evolution drives the diversity and unity of life; 2) how life uses free energy to maintain homeostasis; 3) how living systems store, retrieve, transmit, and respond to information; and 4) how biological systems interact with each other. These themes are supported by a broad range of biological subdisciplines including biochemistry, molecular biology, cell biology, genetics, physiology, and ecology. The student will use practical experimentation to develop inquiry and reasoning skills to explore these themes throughout the course. This course effectively prepares the student for success on the AP® Biology exam by promoting the deductive reasoning and experimental interpretation skills emphasized in the AP curriculum.

Semester A Outline

1. **Course Overview**
    1. Getting Started in AP Biology
        - Analyze the structure and content of the AP Biology course
        - Identify course expectations and how to be successful in the course
        - Identify the materials you will use
        - Determine a plan for preparing for the AP exam
2. **Lab Safety, Equipment, and Scientific Methods**
    1. Lab Safety, Equipment, and Scientific Methods
        - Perform safe laboratory practices
        - Identify common laboratory equipment
        - State the four steps of a typical scientific method (observation, hypothesis, experimentation, conclusion) and describe how they are employed
        - Define the independent and dependent variable in a given experiment and analyze what controls are needed to increase the validity of the experiment
        - Plan and carry out your own investigation using scientific methods
3. **The Chemistry of Life**
    1. Introduction to Chemistry
        - Evaluate how all life is built on common chemical foundations.
        - Differentiate matter, elements, and compounds.
        - Identify the subatomic differences that determine the properties of different elements and molecules.
        - Differentiate between different atomic interactions including covalent bonding, noncovalent interactions, and ionic bonding.
        - Identify the changes that occur during chemical reactions.
    2. Water
        - Identify the intramolecular and intermolecular interactions of water molecules
        - Identify why water is essential for all life on Earth

- Identify how the properties of water contribute to biological processes
- Differentiate between acids and bases

3. Carbon
    - Identify why carbon is found in all life on Earth
    - Recognize how the diversity of hydrocarbons results from the valence of carbon atoms
    - Identify common functional groups found in biological macromolecules, including hydroxyl, carbonyl, carboxyl, amino, sulfhydryl, phosphate, and methyl groups
    - Identify how various biological polymers are synthesized
4. Carbohydrates
    - Identify the structural characteristics of carbohydrates
    - Identify how carbon-based polymers are synthesized.
    - Identify common carbohydrates found in biological systems
    - Identify how carbohydrates contribute to the function of biological systems
5. Lipids
    - Identify the structural characteristics of lipids
    - Identify common lipids found in biological systems
    - Identify the contribution of lipids to the function of biological systems
6. Proteins
    - Identify the structural characteristics of polypeptides
    - Identify a peptide bond
    - Identify common polypeptides found in biological systems
    - Identify how polypeptides contribute to the function of biological systems
7. Nucleic Acids
    - Identify the structural characteristics of nucleic acids
    - Identify common nucleic acids found in biological systems
    - Identify how nucleic acids contribute to the function of biological systems
8. Unit Review
    - Differentiate the chemical elements found in living things, and identify how they assemble to form larger molecules
    - Identify how the properties of water and carbon make them essential to life
    - Categorize the four classes of biological macromolecules and identify their functions
9. Unit Test
    - Differentiate the chemical elements found in living things and identify how they assemble to form larger molecules
    - Identify how the properties of water and carbon make them essential to life
    - Categorize the four classes of biological macromolecules and identify their functions

4. **Biological Macromolecules Lab**
    1. Biological Macromolecules Lab
        - Define dehydration synthesis and hydrolysis
        - Use models to explain what atomic changes happen to the molecules involved during each reaction
        - Describe the structural characteristics of carbohydrates, proteins, lipids, and nucleic acids
        - Use biochemical assays to identify the macromolecules present in a sample
5. **The Cell**
    1. Prokaryotic and Eukaryotic Cells
        - Identify how microscopes are used to study cells
        - Evaluate differences between prokaryotic and eukaryotic cell structure

2. Subcellular Structures
    - Relate the structures of soluble intracellular components to their functions
    - Relate the structures of organelles to their functions
    - Relate the structure of the nucleus to its functions
    - Relate the structures of the endomembrane system to their functions
    - Relate the structure of extracellular components and connections between cells to their functions
3. The Plasma Membrane
    - Identify major components of the plasma membrane
    - Relate the structure of the plasma membrane to its function
    - Describe the selective permeability of the plasma membrane to various classes of molecule
4. Membrane Transport Mechanisms
    - Analyze the movement of molecules across the plasma membrane in diffusion
    - Analyze the movement of molecules across the plasma membrane in facilitated diffusion
    - Analyze the movement of molecules across the plasma membrane in active transport
    - Analyze the movement of molecules across the plasma membrane in bulk transport
5. Cell Signaling
    - Differentiate between local and long-distance signaling molecules as well as signaling molecules that act at the cell surface and those that act at intracellular receptors
    - Differentiate between the different types of cell-surface receptors, including G protein-coupled receptors, receptor tyrosine kinases, and ligand-gated ion channels
    - Analyze common signal transduction strategies, including phosphorylation cascades, cAMP, calcium, DAG, and IP3
    - Identify cellular responses to signaling molecules and strategies to regulate these responses
    - Summarize the purpose, regulation, and results of apoptosis
6. The Cell Cycle
    - Define the purpose of mitosis
    - Identify the events of interphase
    - Identify the events of mitosis
7. Regulation of the Cell Cycle
    - Identify the cell cycle checkpoints and explain how they regulate the cell cycle
    - Identify strategies that can be used by cells to regulate their cell cycle, including density-dependent inhibition and anchorage dependence
    - Analyze the importance of control over the cell cycle
8. Unit Review
    - Define a cell based on the cell theory
    - Identify the ways in which cells transport materials through their membranes using passive transport (diffusion), facilitated diffusion, active transport, and bulk transport
    - Identify the major cell organelles and subcellular structures in prokaryotic and eukaryotic (plant and animal) cells and state the function of each
    - Identify the steps by which cells respond to internal and external signals
    - Identify the steps of cellular reproduction

9. Unit Test
    - Describe the current definition of a cell, based on the Cell Theory
    - Explain how cells transport materials through their membranes using passive transport (diffusion), facilitated diffusion, active transport and bulk transport.
    - Describe the major cell organelles and subcellular structures in prokaryotic and eukaryotic (plant and animal) cells and state the function of each.
    - Explain the steps by which cells respond to internal and external signals.
    - Describe the steps of cellular reproduction

6. **Cell Structure Lab**
    1. Cell Structure Lab
        - Identify the structure of cells and their unique functions
        - Analyze the cellular processes that maintain homeostasis
7. **Cell Cycle Lab**
    1. Cell Cycle Lab
        - Describe the events of the cell cycle
        - Construct a model that explains the events of each stage in mitosis
        - Construct a model that explains the events of each stage in meiosis, including crossing over
        - Use data to demonstrate the outcome of errors in cellular reproduction
8. **Mid-Semester Check**
    1. Mid-Semester Review
        - Review the chemical elements found in living things and the unique roles of carbon and water in life
        - Review the major biological macromolecules (carbohydrates, proteins, lipids, nucleic acids) as well as their subcomponents, functions, and synthesis
        - Review the structure and function of the cell and cell organelles, including how the structure of the cell membrane connects with the movement of molecules across membranes
        - Review cell signaling methods and their functions
        - Review the cell cycle
    2. Mid-Semester Check
        - Identify which chemical elements and macromolecules form structures within a cell.
        - Identify where biological polymers are found in cells and how they contribute to the function of subcellular structures
        - Identify the special properties of water and their causes, based on the molecular structure of water
        - Identify and state the function of the major cell organelles and structures
        - Identify and properly order the steps by which cells respond to internal and external signals
9. **Metabolism**
    1. The Energy of Life
        - Define entropy and identify the laws of thermodynamics
        - Identify how enzymes regulate metabolic reactions and how enzyme processes are, themselves, regulated through feedback mechanisms
        - Explain the relationship between ATP and endergonic and exergonic reactions
    2. Glycolysis and the Citric Acid Cycle
        - Identify that ways in which catabolic pathways can yield energy
        - Identify and order the steps of glycolysis, including the steps in which energy is fixed as ATP
        - Define oxidation and phosphorylation and identify where these processes occur during the citric acid cycle and electron transport chain

3. Electron Transport and Chemiosmosis
    - Identify how ATP is synthesized by phosphorylation and chemiosmosis during the electron transport chain
4. Fermentation and Other Energy Pathways
    - Identify the mechanisms possessed by organisms that allow some to fix energy when oxygen is absent
    - Define surface area-to-volume ratio and identify how changing the surface-to-volume ratio of cells affects its ability to take in needed compounds and release dangerous wastes.
5. Chloroplasts, Chlorophyll, and the Light Reactions
    - Identify the structure of chlorophyll and its importance to photosynthesis
    - Identify how photosynthetic organisms use light, including pigments and wavelengths, to absorb energy
    - Identify the interrelationships between cellular respiration and photosynthesis
6. Photosynthesis: The Light-Independent Reactions
    - Identify how carbon fixation occurs during the Calvin cycle
    - Identify the transfer of electrons and energy gradients that occur during the light-independent reactions
    - Identify the impact of light, temperature, and humidity in altering rates of photosynthesis
7. Unit Review
    - Explain how cells use free energy during metabolism to maintain homeostasis
    - Describe the steps of cellular respiration, including glycolysis, the Krebs cycle, and the electron transport chain
    - Differentiate anaerobic respiration from aerobic respiration and describe how surface-to-volume ratios affect these processes in cells
    - Describe the steps of photosynthesis, including the light-dependent and light-independent reactions
    - Compare photosynthesis to cellular respiration and explain the processes that occur in each
8. Unit Test
    - Explain how cells use free energy during metabolism to maintain homeostasis
    - Describe the steps of cellular respiration, including glycolysis, the Krebs cycle and the electron transport chain
    - Differentiate anaerobic respiration from aerobic respiration and describe how surface-to-volume ratios affect these processes in cells
    - Describe the steps of photosynthesis including the light-dependent and light-independent reactions.
    - Compare photosynthesis to cellular respiration and explain the processes that occur in each

10. **Cellular Respiration Lab**
    1. Cellular Respiration Lab
        - Apply the scientific method to explain the production of gases during respiration

11. **Photosynthesis Lab**
    1. Photosynthesis Lab
        - Explain the major processes involved in photosynthesis and the factors that influence the rate of photosynthesis in live plants
        - Analyze the relationship between the reactants and products of photosynthesis

- Plan an investigation with variables that affect the rate of photosynthesis in plant tissue

12. **Meiosis and Inheritance**
    1. Meiosis and Sexual Reproduction
        - Analyze how offspring acquire traits from their parents
        - Describe the formation of sex cells through the process of meiosis
        - Analyze the behavior of chromosomes during the human life cycle
    2. Impact of Sexual Life Cycles on Evolution
        - Identify how genetic variation arises through meiosis
        - Identify how genetic variation leads to the formation of new species
        - Differentiate between the various sexual life cycles exhibited by living things
    3. Mendel, Probability, and Inheritance
        - Analyze Mendel's experiments and identify how they led to current understanding of inheritance
        - Relate the laws of probability to Mendel's ideas about patterns of inheritance
        - Identify how inheritance of traits resulting from one or two genes can be illustrated using Punnett squares
    4. Mendelian and Non-Mendelian Heredity
        - Identify the role of the environment in the expression of phenotype
        - Identify alternatives to Mendel's rules of inheritance
        - Identify human traits that follow Mendel's patterns of inheritance
        - Analyze how sex linkage leads to variations of genotypes and phenotypes
        - Evaluate the importance of X-gene inactivation in mammals
    5. Chromosomal Inheritance and Disorders
        - Identify how variations in chromosome number occur
        - Analyze how variations of chromosome number lead to genetic disorders
        - Identify the chromosomal events that result in non-Mendelian inheritance patterns
    6. DNA Replication and Chromosomes
        - Summarize the efforts involved in the discovery of DNA as the hereditary material (original)
        - Analyze the structure of a DNA molecule
        - Identify how chromosomes form from a strand of DNA
        - Analyze the process of DNA replication and identify the importance of proofreading and repair during DNA replication
        - Analyze the implication of telomeres in the replication of DNA and the aging of an organism
    7. Unit Review
        - Describe the steps involved with meiosis and gamete formation
        - Differentiate between meiosis and mitosis and explain how meiosis results in genetic variation
        - Analyze the chromosomal basis of inheritance and explain how it leads to Mendelian patterns of inheritance
        - Predict the offspring of Mendelian and non-Mendelian genetic crosses using Punnett squares
        - Explain how gene replication proofreading and error-correction occurs.
    8. Unit Test
        - Describe the steps involved with meiosis and gamete formation
        - Differentiate between meiosis and mitosis and explain how meiosis results in genetic variation
        - Analyze the chromosomal basis of inheritance and explain how it leads to Mendelian patterns of inheritance

- Predict the offspring of Mendelian and non-Mendelian genetic crosses using Punnett squares
- Explain how gene replication proofreading and error-correction occurs

13. **Mendelian Genetics Lab**
    1. Mendelian Genetics Lab
        - Predict the genotype and phenotypes of parents and offspring using Punnett squares from one- and two-trait Mendelian crosses
        - Calculate the probabilities of genotypes and phenotypes for offspring given the parents
        - Perform Punnett square analysis for non-Mendelian genes, such as codominant, incomplete dominant, and X-linked traits
        - Identify the possible parents given the genotype and/or phenotype of an individual

14. **Gene Expressions and Biotechnology**
    1. Transcription
        - Identify the evidence supporting the Central Dogma
        - Identify how information from the genome is expressed as protein
        - Identify the molecular events that occur during initiation, elongation, and termination of transcription
        - Identify how transcripts can be post-translationally processed, including splicing, 5′-capping, and polyadenylation
    2. Translation
        - Identify the structure, function, and synthesis of aminoacyl-tRNA
        - Define codon and anti-codon
        - Identify the molecular events that occur during initiation, elongation, and termination of translation
        - Distinguish between possible post-translational processing and targeting events
        - Distinguish between different types of mutation, including silent, missense, nonsense, and frameshift mutations
    3. Regulation of Gene Expression
        - Identify how models of repressible and inducible operons, as well as positive gene regulation, can be used to predict gene expression
        - Identify how chromatin modification such as histone modification, DNA methylation, and epigenetic inheritance can regulate gene expression in eukaryotes
        - Identify how regulation of transcription initiation by promoters, enhancers, and transcription factors can regulate gene expression in eukaryotes
        - Identify how post-transcriptional regulation such as RNA processing, translation initiation, mRNA degradation, protein processing, and protein degradation can regulate gene expression in eukaryotes
        - Identify the role of noncoding RNAs such as miRNAs, siRNAs, and ncRNAs in regulating gene expression in eukaryotes
    4. Gene Programs
        - Identify how genetic programs can coordinate the development of multicellular organisms
        - Identify how cell signaling pathways coordinate embryonic development, including cytoplasmic determinants and inductive signals
        - Identify how sequential regulation of gene expression results in terminal differentiation of cells
        - Identify how the body plan of multicellular organisms is established by cell signaling molecules

- Identify how the dysregulation of oncogenes and tumor-suppressor genes can result in oncogenesis

5. DNA Tools and Biotechnology
    - Identify modern technologies used to sequence DNA, including the Sanger reaction and next-generation sequencing
    - Identify restriction digest and PCR techniques used to clone DNA fragments into plasmids, as well as the techniques used to express recombinant DNA from cloned DNA
    - Identify how techniques such as in situ hybridization, RT-PCR, DNA microarrays, RNAi, and GWAS can be used to study gene function
    - Identify techniques used to clone organisms and grow stem cells in research
    - Identify the applications and ethical considerations of biotechnology in medicine, forensic science, and agriculture
6. Genomes and Their Evolution
    - Identify how modern techniques are used to study entire genomes, including comparing, variations in genome size, number of genes, and gene density
    - Define noncoding DNA such as transposable elements and repetitive DNA and explain how they contribute to phenotype
    - Identify how gene families arise through duplication and mutation
    - Identify alternations in chromosomal structure including duplication, rearrangement, and mutation
    - Identify how genomic evidence of conserved genes can explain how related organisms are different
7. Unit Review
    - Describe the steps of transcription and translation
    - Define gene regulation and describe where, when, and how gene expression is controlled within cells
    - Compare and contrast how different genes are expressed and regulated among prokaryotes and eukaryotes
    - Define mutation and describe how it can affect the evolution of a population
    - Apply biotechnological techniques to bioengineering problems
8. Unit Test
    - Describe the steps of transcription and translation
    - Define gene regulation and describe where, when, and how gene expression is controlled within cells
    - Compare and contrast how different genes are expressed and regulated among prokaryotes and eukaryotes
    - Define mutation and describe how it can affect the evolution of a population
    - Apply biotechnological techniques to bioengineering problems

15. **Biotechnology Lab**
    1. Biotechnology Lab
        - Apply the scientific method to identify genetically similar organisms using simulated biotech methods such as restriction enzyme analysis of DNA and gel electrophoresis
        - Develop a strategy to genetically engineer new corn plants with specific attributes
        - Describe the methods of bioengineering techniques using simulations, such as the genetic engineering techniques used to create insect or herbicide-tolerant plants
16. **Semester Review and Exam**
    1. Semester Review

- Review the definition of elements and molecules and how they form important macromolecules used by cells
- Review the structure and function of the parts of a cell, cell organelles and the cell membrane
- Review the metabolic processes of cells, including cellular respiration and photosynthesis
- Review the steps of the cell cycle and differentiate the processes of mitosis and meiosis
- Review the mechanisms of inheritance, including both Mendelian and non-Mendelian inheritance patterns, as well as how genes are expressed

2. Semester Exam
   - Describe the elements, molecules and macromolecules that make up living things
   - Identify the function of cellular organelles and the cell membrane
   - Describe how cells use energy through metabolism
   - Explain the function of the cell cycle and differentiate the processes of mitosis and meiosis
   - Describe the genetic structures and processes that affect inheritance

Semester B Summary:

In this course, the student will gain a foundation in the Life Sciences by focusing on four major themes: 1) how evolution drives the diversity and unity of life; 2) how life uses free energy to maintain homeostasis; 3) how living systems store, retrieve, transmit, and respond to information; and 4) how biological systems interact with each other. These themes are supported by a broad range of biological subdisciplines including biochemistry, molecular biology, cell biology, genetics, physiology, and ecology. The student will use practical experimentation to develop inquiry and reasoning skills to explore these themes throughout the course. This course effectively prepares the student for success on the AP® Biology exam by promoting the deductive reasoning and experimental interpretation skills emphasized in the AP curriculum.

Semester B Outline

1. **Course Overview**
   1. Getting Started in AP Biology
      - Analyze the structure and content of the AP Biology course
      - Identify course expectations and how to be successful in the course
      - Identify the materials you will use
      - Determine a plan for preparing for the AP exam
2. **Mechanisms of Evolution**
   1. The Theory of Natural Selection
      - Evaluate how the Darwinian revolution challenged traditional views of a young Earth inhabited by unchanging species
      - Define descent with modification by natural selection
      - Evaluate how descent with modification explains the adaptations of organisms and the unity and diversity of life
      - Summarize the scientific evidence that supports evolution
   2. The Evolution of Populations
      - Identify how natural selection, genetic drift, and gene flow alters allele frequencies in a population

- Identify how the Hardy-Weinberg equation can be used to test whether a population is evolving

3. Mechanisms of Evolution
    - Identify how natural selection, genetic drift, and gene flow alter allele frequencies in a population
    - Identify natural selection as the only mechanism that consistently causes adaptive evolution
    - Evaluate the role of sexual selection in evolutionary change
4. The Origin of Species
    - Define the biological species concept in terms of reproductive isolation
    - Identify how speciation can occur both with or without geographic separation
    - Define hybrid zones and identify ways in which they form.
    - Analyze how speciation can occur rapidly or slowly and can result from changes in few or many genes
5. The History of Life on Earth
    - Identify the conditions on early Earth that made the origin of life possible
    - Identify how the fossil record documents the history of life
    - Identify the key events in life's history including the origins of unicellular and multicellular organisms and the colonization of land
6. The Rise and Fall of Species
    - Identify how the rise and fall of groups of organisms reflect differences in speciation and extinction rates
    - Identify how changes in body form can result from changes in the sequences and regulation of developmental genes
    - Evaluate the statement that evolution is not goal oriented
7. Phylogeny
    - Define a phylogeny and identify what information a phylogeny can display
    - Identify examples of morphological and molecular data that are used to construct phylogenies
    - Analyze how shared characters are used to construct phylogenetic trees
8. Unit Review
    - Define the theory of natural selection and its subcomponents and how selection is detected using Hardy-Weinberg equilibrium
    - Describe and give an example of each mechanism of evolution (mutation, natural selection, gene flow, genetic drift)
    - Describe the history of life on Earth and identify evidence for the current understanding of this history
    - Define speciation and describe the methods through which speciation occurs, including examples
    - Define a phylogeny, the evidence used to create phylogenies and how phylogenies are used to determine ancestors, descendants, and evolutionary relationships
9. Unit Test
    - Define the theory of natural selection and its subcomponents and how selection is detected using Hardy-Weinberg equilibrium
    - Describe and give an example of each mechanism of evolution (mutation, natural selection, gene flow, genetic drift)
    - Describe the history of life on Earth and identify evidence for the current understanding of this history.
    - Define speciation and describe the methods through which speciation occurs, including examples.

        - Define a phylogeny, the evidence used to create phylogenies and use how phylogenies are used to determine ancestors, descendants, and evolutionary relationships.

3. **Darwinian Evolution Lab**
    1. Darwinian Evolution Lab
        - Use Hardy-Weinberg calculations to determine if a population is in equilibrium or is under a selective pressure
4. **Phylogeny Lab**
    1. Phylogeny Lab
        - Use data to build a cladogram
        - Use evidence from the comparison of DNA sequences through BLAST to deduce evolutionary relationships between organisms
5. **The Evolutionary History of Biological Diversity**
    1. Characteristics of Life
        - List the common characteristics exhibited by all living things
        - Identify the traits of viruses that makes them considered nonliving things
        - Evaluate the importance of phylogenies in determining relationships between organisms
        - Classify organisms into their taxonomic levels according to physical traits and evolutionary histories
    2. Prokaryotes versus Eukaryotes
        - Compare the structures of prokaryotic and eukaryotic organisms
        - Identify the methods prokaryotes use for reproduction
        - Identify the specific mechanisms prokaryotes have for obtaining energy
        - Define how prokaryotes have adapted and radiated to occupy diverse lineages
        - Identify the ways in which prokaryotes are beneficial and harmful to humans
    3. Plants, Fungi, and Animals
        - Identify how plants have adapted for life on land
        - Identify the relationship between fungi and animals
        - Classify the various groups of plants and animals
        - Evaluate the importance of fungi to an ecosystem
        - Identify how animal diversity has evolved over time
    4. Seeded Versus Seedless Plants
        - Classify the structures of plants as belonging to either seeded or seedless plants
        - Identify the major events in the evolution of seeded and seedless plants
        - Identify the characteristics and examples of the major groups of seeded and seedless plants
    5. Invertebrates Versus Vertebrates
        - Classify the major events that have led to the development of vertebrate and invertebrate organisms
        - Identify the characteristics of different vertebrate and invertebrate organisms
    6. Unit Review
        - Compare organisms across the three domains of life and explain why viruses do not fit any of these classifications
        - Distinguish prokaryotes from each other and unicellular eukaryotes
        - Categorize eukaryotes into kingdoms and identify similarities and differences that exist within a kingdom
    7. Unit Test
        - Compare organisms across the three domains of life and explain why viruses do not fit any of these classifications

- Distinguish prokaryotes from each other and unicellular eukaryotes
- Categorize eukaryotes into kingdoms and identify similarities and differences that exist within a kingdom

6. **Unicellular Organisms Lab**
    1. Unicellular Organisms Lab
        - Test hypotheses using the scientific method to explore how unicellular organisms share properties of life with multicellular organisms
        - Identify the characteristics of living organisms and contrast that traits possessed by protists versus bacteria
        - Identify interactions between unicellular organisms and multicellular organisms
7. **Multicellular Organisms Lab**
    1. Multicellular Organisms Lab
        - Explain the unity and diversity of life by observing and comparing similarities between phyla of multicellular organisms
        - Identify the traits of each phylum of multicellular organisms
        - Categorize organisms into the correct phylum
8. **Mid-Semester Check**
    1. Mid-Semester Review
        - Review how environmental factors can affect gene frequency in a gene pool
        - Review the conditions that can result in speciation
        - Review Hardy-Weinberg equilibrium and the mechanism of evolution
        - Review evolutionary relationships between organisms
        - Review prokaryotes and eukaryotes and the differences between them
    2. Mid-Semester Check
9. **Animal Form and Function**
    1. General Anatomy and Physiology
        - Analyze the ways in which different levels of animal organization—cells, tissues, organs, and systems—work together
        - Analyze how negative and positive feedback maintain homeostasis in animals
        - Identify the various adaptations used by organisms to regulate internal body temperature
        - Identify the ways in which energy requirements differ from animal to animal
    2. Nutrition
        - Identify the nutrients that animals obtain from their diets, including chemical energy, organic molecules, and essential nutrients
        - Identify the steps in which food is digested by animals
        - Identify the function of organs used by animals in food digestion
        - Differentiate between different animal digestive systems
        - Analyze the feedback mechanisms used by animals to regulate animal nutrition
    3. Circulation and Gas Exchange
        - Identify the function of the circulatory system in the exchange of gases, nutrients, and wastes
        - Identify adaptations of the heart, blood vessels, and blood components to facilitate the movement of gases, nutrients, and wastes
        - Analyze how the respiratory system exchanges gases and wastes
        - Identify the adaptations of the lungs and blood components that allow them to exchange gases and wastes
    4. Immune System
        - Identify the function of the innate immune system

- Identify how barrier defenses, cellular defenses, antimicrobial peptides, and inflammatory responses facilitate innate immunity
- Analyze the function of the adaptive immune system
- Differentiate cell-mediated and humoral defenses in adaptive immunity

5. Excretion
    - Summarize the importance of osmoregulation in the maintenance of homeostasis
    - Differentiate between the different types of nitrogenous wastes produced by animals of different evolutionary descent
    - Identify adaptations of the excretory system to facilitate osmoregulation
    - Analyze the humoral mechanisms that regulate kidney function
6. Endocrine System
    - Analyze the mechanisms by which the endocrine system regulates cell signaling
    - Identify the negative and positive feedback strategies employed by various endocrine system glands
    - Identify the function of various endocrine glands in the maintenance of homeostasis
7. Reproduction and Development
    - Identify the ways by which asexual and sexual reproduction occur in animals
    - Evaluate how various reproductive organs facilitate animal reproduction
    - Evaluate the role of hormones in the reproduction in mammals
    - Analyze the steps by which embryos develop within placental mammals
    - Identify the signaling pathways that regulate morphogenesis and cell fate specification
8. Nervous System
    - Identify the structures and specialized membrane proteins found in neurons
    - Summarize the mechanisms by which neurons establish resting and action potentials
    - Summarize the mechanisms by which neurons utilize chemical signaling to communicate
    - Analyze how neuronal circuits and synaptic connections are organized in the nervous system
    - Analyze how the vertebrate brain is organized and identify the function of various brain regions
9. Sensory and Motor Mechanisms
    - Identify the organization of sensory and motor systems in the peripheral and central nervous system
    - Identify the function and adaptations of mechanoreceptors in hearing and equilibrium
    - Identify the function and adaptations of photoreceptors in vision
    - Identify the function and adaptations of chemoreceptors in taste and smell
    - Analyze the function and adaptations of the musculoskeletal system in facilitating movement
    - Identify the function and adaptations of the skeleton in facilitating movement
10. Behavior
    - Identify different behaviors exhibited by organisms in response to communication or the environment
    - Differentiate between learned and innate behaviors
    - Identify mechanisms by which selective pressure can act on animal behaviors
11. Unit Review

- Describe animal physiology and analyze how animals are adapted to their niches on Earth
- Analyze how the digestive, circulatory, respiratory, immune, excretory, and endocrine systems interact to maintain homeostasis in animals
- Explain how animals develop and utilize common signaling pathways in their development
- Compare behavior among different animals and explain how behavior arises in animals through electrochemical signaling in the nervous system

12. Unit Test
    - Describe animal physiology and analyze how animals are adapted to their niches on Earth
    - Analyze how the digestive, circulatory, respiratory, immune, excretory, and endocrine systems interact to maintain homeostasis in animals
    - Explain how animals develop and utilize common signaling pathways in their development
    - Compare behavior among different animals and explain how behavior arises in animals through electrochemical signaling in the nervous system

10. **Digestion, Circulation, and Respiration Lab**
    1. Digestion, Circulation, and Respiration Lab
        - Outline the structures of the digestive system and list a function for each one
        - Outline the flow of blood through the circulatory system and describe the oxygenation levels throughout the system
        - Explain the changes in the respiratory system after exercise

11. **Excretion and Nervous System Lab**
    1. Excretion and Nervous System Lab
        - Describe how the cells, tissues, and organs of the nervous system explain how humans perceive and respond to their environment
        - Describe how the cells, tissues, and organs of the excretory system explain the composition of urine

12. **Ecology**
    1. Introduction to Ecology
        - Identify the factors that cause Earth's climate to vary and change
        - Distinguish between terrestrial and aquatic biomes and identify the characteristics of each
        - Identify how interactions between organisms and their environment impact the distribution of species
        - Analyze how ecological change and evolution impact each other over time
    2. Populations
        - Identify the biotic and abiotic factors that affect population density, dispersion, and demographics
        - Distinguish between the exponential and logistical models of population growth
        - Evaluate the current status of human population growth
    3. Communities and Diversity
        - Define all community level interactions, including symbiosis, competition, herbivory and predation, and facilitation and inhibition
        - Identify the factors that characterize biological communities
        - Analyze the factors that affect the diversity of biological communities
    4. Ecosystems and Energy
        - Identify the physical laws that govern the flow of energy and chemicals within ecosystems
        - Identify the factors that control primary production in ecosystems

- Identify the processes by which water and nutrients cycle through an ecosystem
- Analyze how ecologists can restore a damaged ecosystem

5. Conservation and Global Change
   - Identify how human activities affect biodiversity and global climate
   - Distinguish between population conservation, landscape conservation, and regional conservation
   - Evaluate how sustainable development can conserve biodiversity while improving human lives
6. Unit Review
   - Explain how individual interactions among organisms result in changes in populations
   - Explain how different populations interact in communities and ecosystems
   - Analyze the benefits and costs of strategies used to preserve ecosystems
7. Unit Test
   - Explain how individual interactions among organisms result in changes in populations
   - Explain how different populations interact in communities and ecosystems
   - Analyze the benefits and costs of strategies used to preserve ecosystems

13. **Ecology Lab**
    1. Ecology Lab
       - Describe the ecological relationships present in natural ecosystems by creating a model ecosystem
       - Apply the scientific method to observe the cycling of matter in an actual ecosystem during a field walk
14. **Semester Review and Full-Length Practice Exam**
    1. Biochemistry and Cell Biology Review
       - Review the roles water and carbon play in all forms of life
       - Review how cells maintain homeostasis using organelles, the cell membrane, biochemical macromolecules, and signal transduction
       - Review the equations for photosynthesis and cellular respiration
    2. Cell Cycle, Heredity, and Gene Expression Review
       - Review the steps of the cell cycle and the differences between mitosis and meiosis
       - Review Mendelian and non-Mendelian inheritance patterns, including how to predict genotypes and phenotypes using Punnett square analysis
       - Review the structure of DNA, the discovery of DNA as the hereditary molecule, and the process of DNA replication
       - Review the processes of transcription and translation and the regulation of gene expression
       - Review common methods and techniques used in biotechnology
    3. Evolution and Biological Diversity Review
       - Review how to use Hardy-Weinberg equilibrium to detect evolution in a population
       - Review the mechanisms of evolution and the ways in which speciation occurs
       - Review what phylogenies show about evolutionary relationships, and how they are constructed using a variety of evidence
       - Review the differences in characteristics between the three domains of life and viruses
       - Review the characteristics and classification of various eukaryote groups, including fungi, plants, invertebrates, and vertebrates
    4. Anatomy, Physiology, and Ecology Review

- Review the structure and function of animal tissues, organs, and organ systems
- Review the principles of population, community, and ecosystem ecology and describe the relationships among organisms and between organisms and abiotic factors that occur at each level of ecology

5. Full-Length Practice Exam

15. **Semester Project: Research Paper**
    1. Hypothesizing and Gathering Data
        - Propose a scientific hypothesis
        - Perform a well-controlled experiment to test your hypothesis
        - Summarize collected information statistically (e.g., averages) and using a labeled graph or table
    2. Analyzing Data and Creating Your Paper
        - Analyze collected data for trends
        - Explain data trends
        - Conclude whether the hypothesis is true
16. **Semester Review and Exam**
    1. Semester Review
        - Review the components and function of the Hardy-Weinberg equation, the mechanisms of evolution, and the construction of phylogenetic trees
        - Review theories on the origin of life and the characteristics and evolution of the prokaryotes, eukaryotes, and archaea as well as their subgroups
        - Review the structure and function of animal cells, tissues, organs, and organ systems
        - Review the principles of population, community, and ecosystem ecology
        - Review the relationships among organisms, and between organisms and abiotic factors, that occur at each level of ecology
    2. Semester Exam

