

Pre-AP Biology Unit Plan

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Unit 1: The Cell

Recommended Time: 3 weeks of a year-long course

One of the requirements in order for something to be considered “alive” is to be composed of one or more cells. The cell is the structural and functional unit of all organisms. Therefore, a study of the cell is necessary in understanding the processes of life. This unit focuses on four essential questions:

1. What are the cellular structures and their related functions that make life possible?
2. How does the cell membrane contribute to the homeostasis of the cell?
3. How do cells communicate with each other?
4. Where do cells come from and what controls cell division?

Guiding pre-AP Objectives	<ol style="list-style-type: none"> 1. Compare & contrast prokaryotic & eukaryotic cells, giving examples of each. 2. Identify the parts of a typical eukaryotic cell and describe their associated functions. 3. Identify the parts of the compound microscope, compute magnification and estimate actual image size based on microscopic measurements. 	
ALCOS	Describe similarities & differences of cell organelles, using diagrams & tables. <ul style="list-style-type: none"> ✓ Identifying scientists who contributed to the cell theory (Examples: Hooke, Schleiden, Schwann, Vircho, van Leeuwenhoek) ✓ Distinguishing between prokaryotic & eukaryotic cells ✓ Identifying various technologies used to observe cells (Examples: light microscope, scanning electron microscope, transmission electron microscope) 	#4
Quality Core	<i>Describe the biological criteria that need to be met in order for an organism to be considered alive.</i>	A.4.a
	<i>Analyze the similarities and differences among (a) plant versus animal cells and (b) eukaryotic versus prokaryotic cells.</i>	B.1.a
	<i>Describe functions of all major cell organelles, including nucleus, ER, RER, Golgi apparatus, ribosome, mitochondria, microtubules, microfilaments, lysosomes, centrioles, and cell membrane</i>	B.1.b
	<i>Illustrate how all cell organelles work together by describing the step-by-step process of the translation of an mRNA strand into a protein and its subsequent processing by organelles so that the protein is appropriately packaged, labeled, and eventually exported by the cell.</i>	B.1.c
	<i>Contrast the structure and function of subcellular components of motility (e.g. cilia, flagella, pseudopodia)</i>	B.1.d
	<i>Safely use laboratory equipment & techniques when conducting scientific investigations (especially microscope for this section)</i>	A.1.f

Teacher NotesProkaryotic/Eukaryotic Cell Venn DiagramPlant/Animal Cell Venn DiagramData Set QuestionNMSI Teacher Training/LTF Lesson: Microscope Measurements

Guiding Pre-AP Objectives	<ol style="list-style-type: none"> 1. Describe the fluid mosaic model of the cell membrane including the structure and function of phospholipids, proteins, cholesterol, and carbohydrates. 2. Compare and contrast active & passive transport (including diffusion, facilitated 	
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	diffusion & osmosis).	
	3. Describe the process of osmosis and predict the direction that water will move across the plasma membrane based on solute concentrations	
ALCOS	Describe the cell processes necessary for achieving homeostasis, including active & passive transport, osmosis, diffusion, exocytosis and endocytosis. ✓ Comparing the reaction of plant and animal cells in isotonic, hypotonic, and hypertonic solutions ✓ Applying the concept of fluid pressure to biological systems (Examples: blood pressure, turgor pressure, bends, strokes)	#2
Quality Core	Explain how the cell membrane controls movement of substances both into and out of the cell and within the cell.	B.1.e.
	Explain how the cell membrane maintains homeostasis.	B.1.f.
	Describe and contrast these types of cell transport: osmosis, diffusion, facilitated diffusion, and active transport.	B.1.g.

Teacher Notes—Cell Membrane Structure

Teacher Notes—Cell Transport

Plasma Membrane Illustration

Osmosis Scenarios

Answer to 1st Osmosis Scenario

NMSI Teacher Training/LTF Lessons: The Fluid Mosaic Membrane
The Gate Keepers
Plasmolysis

Guiding Pre-AP Objectives	1. Describe ways that cells communicate. <i>NOTE: This objective is not found in either the ALCOS or the Quality Core standards but is a critical objective to prepare students for AP Biology. An introduction to cell signaling/communication should be included in a pre-AP biology course.</i>	
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Teacher Notes

Guiding Pre-AP Objectives	1. Illustrate the cell cycle naming and describing each phase 2. Relate cell division to the ratio of surface area to volume. 3. Describe the role of mitotic divisions during growth & repair. 4. Describe the phases of mitosis and cytokinesis.	
ALCOS	Describe the roles of mitotic & meiotic divisions during reproduction, growth & repair of cells.	#6
Quality Core	Describe the process of mitosis	B.1.j.

Teacher Notes

Cell Cycle Microscopy Lab

NMSI Teacher Training/LTF Lessons: Larger is not Always Better
Chromosome Manipulative
Cell Division

Unit 2: Biochemistry

Recommended Time: 2 weeks of a year-long course

Note: It is easy to get bogged down here; consider this unit an introduction to biochemistry and refer to it regularly during the school year versus going in great depth and spending too much time.

In Unit 1, students learned that the cell is the structural and functional unit of all living things. In this unit, students focus on the molecules that compose cells and subsequently, organisms. Introductory biology students should relate the basic chemistry that they learned in 8th grade physical science to the molecules that are most commonly found in cells. The basic chemistry review should be minimized. Of the four macromolecules emphasis should be placed on proteins, especially proteins that act as enzymes. Since the Quality Core emphasizes pH, the effect of pH on enzyme activity will give an opportunity to teach both ENZYMES and the pH scale. The teaching & learning should focus on the following essential questions:

1. What unique properties of water enable it to be the primary component of cells?
2. What organic macromolecules comprise cells and what is the role of each of the molecules?
3. How are the organic macromolecules synthesized and broken down in the cell?
4. What is the structure and function of enzymes and how is their activity affected by changes in pH and temperature?

Guiding Pre-AP Objective	Demonstrate an understanding of atomic structure and bonding with an emphasis on carbon.	
Quality Core	Identify subatomic particles and describe how they are arranged in atoms.	A.5.a.
	Describe the difference between ions and atoms and the importance of ions in biological processes.	A.5.b.
	Compare the types of bonding between atoms to form molecules.	A.5.c.
	Explain the difference between organic and inorganic compounds.	A.5.d.

Teacher Notes

Guiding Pre-AP Objectives	<ol style="list-style-type: none"> 1. Recognize water as the most abundant component of cells. 2. Describe the structure of the water molecule and list its unique properties. 	
Quality Core	Define and explain the unique properties of water that are essential to living organisms.	A.5.i.

Teacher Notes

Properties of Water Video--<http://www.schooltube.com/video/b36a222fcdfe2db9af8/Properties%20of%20Water>

Activity—Properties of Water--

<http://www.district158.org/sdelorenzo/Biology/BioChem/Properties%20of%20Water%20Lab.pdf>

Guiding Pre-AP Objectives	<ol style="list-style-type: none"> 1. List the four organic macromolecules and describe the structure & properties of each. 2. Name, recognize and describe the four levels of PROTEIN structure and explain how a protein's structure is related to its function. 3. Illustrate hydrolysis and dehydration synthesis reactions in the degradation and the synthesis of macromolecules. 4. List the factors that affect the rate of enzyme catalyzed reactions, explaining how each factor changes the rate. 	
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ALCOS	Describe cell processes necessary for achieving homeostasis ✓ Identifying functions of carbohydrates, lipids, proteins, and nucleic acids in cellular activities.	
Quality Core	<i>Describe the general structure and function(s), including common functional groups, of monosaccharides, disaccharides, polysaccharides, carbohydrates, fatty acids, glycerol, glycerides, lipids, amino acids, dipeptides, polypeptides, proteins, and nucleic acids.</i>	A.5.g.
	<i>Describe the function of enzymes, including how enzyme-substrate specificity works, in biochemical reactions.</i>	A.5.h.
	<i>Explain the fundamental principles of the pH scale and the consequences of having different concentrations of hydrogen and hydroxide ions.</i>	A.5.f.

Teacher Notes—Biochemistry Intro

Teacher Notes—Molecules of Life

Teacher Notes—Enzymes & Metabolism

Biomolecules Graphic Organizer

NMSI Teacher Training/LTF Lessons

McMush: Test for the Presence of Biomolecules

Teaching Strategy for Enzymes

The Hydrogen Peroxide Breakdown

Unit 3: Bioenergetics

Recommended Time: 3 weeks of a year-long course

In units 1 & 2, students learned about cells, the structural and functional unit of organisms, and the chemicals that make up those organelles. The study in unit 2 focused on the role of enzymes in living systems in catalyzing the reactions necessary for live processes. Two of the most important of these reactions are cellular respiration and photosynthesis. These two processes are the focus of unit 3. These two reactions provide the energy that all organisms require in order to stay alive and rely on the work of the chloroplast and mitochondria. Photosynthesis converts the radiant energy of sunlight (and artificial light) into the chemical energy of carbohydrates. Then, cellular respiration releases the chemical energy of carbohydrates to reform ATP which cells can use for cellular work. One of the key biological concepts in this unit is that the matter associated with photosynthesis and cellular respiration (carbon dioxide, oxygen, water & carbohydrates) cycles consistently in ecosystems while energy can flow through a system only once and ends up as heat energy which is an unusable form of energy.

The essential questions in this unit are:

1. How does energy flow through an ecosystem from sunlight to producers to consumers?
2. What is the role of ATP in cells?
3. What is the purpose of cellular respiration?
4. What is the purpose of photosynthesis?

Guiding Pre-AP Objective	1. Describe the relationship between ATP and cellular energy.	
ALCOS		
Quality Core	<i>Explain how cells store energy temporarily as ATP.</i>	A.5.j.

Guiding Pre-AP Objectives	1. Write the balanced chemical equation that summarizes cellular respiration. 2. List the three steps of cellular respiration, the reactants and products of each, and where each step occurs in the cell. 3. Compare and contrast aerobic and anaerobic cellular respiration/fermentation. 4. Compare and contrast ethyl alcohol and lactic acid fermentation.	
ALCOS	Identify reactants and products associated with photosynthesis and cellular respiration and the purposes of these two processes.	#3
Quality Core	<i>Identify the cellular sites of and follow through the major pathways of anaerobic and aerobic respiration, compare reactants and products for each process, and account for how aerobic respiration produces more ATP per monosaccharide.</i>	B.1.h.

Teacher Notes

NMSI Teacher Training/LTF Lesson: Yeast and Molasses
Cricket Respiration

Guiding Pre-AP Objectives	1. Name the primary pigments necessary for photosynthesis and explain their role. 2. Write the balanced chemical equation that summarizes photosynthesis. 3. List the two steps of photosynthesis, the reactants and products of each, and where each step occurs in the cell.	
ALCOS	Identify reactants and products associated with photosynthesis and cellular respiration and the purposes of these two processes.	#3
Quality Core	<i>Explain how photosynthetic organisms use the processes of photosynthesis and</i>	B.1.i.

	<i>respiration.</i>	
	<i>Explain the interaction between pigments, absorption of light, and reflection of light.</i>	<i>E.2.c.</i>
	<i>Describe the light-dependent and light-independent reactions of photosynthesis.</i>	<i>E.2.d.</i>
	<i>Relate the products of the light-dependent reactions to the products of the light-independent reactions.</i>	<i>E.2.e.</i>
	<i>Design and conduct an experiment (including the calculations necessary to make dilutions and prepare reagents) demonstrating effects of environmental factors on photosynthesis.</i>	<i>E.2.f.</i>

Teacher Notes

NMSI Teacher Training/LTF Lesson: Picking out the Pigments
 Light, Dark, Does it Really Matter?
 Lights Out

END OF FIRST NINE WEEKS IN A YEAR LONG COURSE

Unit 4: Molecular Genetics

Recommended Time: 4 weeks of a year-long course

In the preceding units, students have learned that in order to be considered “alive” an organism must be composed of one or more cells and must have a constant source of energy to fuel cellular processes. In the next two units, students study a third characteristic of life—the ability to pass information coding for heritable traits from one generation to the next. “Information transfer” is one of the main themes of Advanced Placement biology and the content in the next two units should be framed in that context. In this unit students will explore 4 essential questions:

1. How does the structure of the DNA molecule relate to its role in transferring genetic information from one generation to the next?
2. How does the genetic code found in DNA control inheritable traits?
3. What are the effects of a mutation in the DNA molecule?
4. How do cells synthesize only the proteins needed by a cell?
5. How has the understanding of the DNA molecule led to modern advanced in biotechnology?

Guiding Pre-AP Objectives	1. Cite the essential empirical evidence used to determine the structure and function of DNA including the contributions of Watson, Crick, Franklin, Chargaff, etc. 2. Relate the structure of DNA to its function. 3. Describe the steps in DNA replication. Recognize the names and the functions of enzymes responsible for DNA replication.	
ALCOS	Identify the structure and function of DNA, RNA and protein.	#8
Quality Core	<i>Describe the basic structure & function of DNA, mRNA, tRNA, amino acids, polypeptides and proteins (e.g. replication, transcription, and translation).</i>	C.1.a.
	<i>Determine the experiments of major scientists in determining both the structure of DNA and the central dogma</i>	C.1.b.

Teacher Notes

Guiding Pre-AP Objectives	1. Compare and contrast DNA and RNA, and understand how molecular form relates to each molecule's function. 2. Draw and explain the Central Dogma of Molecular Biology ---Know where transcription occurs, and the role of RNA polymerase ---Know where translation occurs, & the roles of various RNAs in polypeptide synthesis 3. Demonstrate familiarity with the genetic code, and apply the genetic code to translate polypeptides from given DNA sequences.	
ALCOS	Identify the structure and function of DNA, RNA and protein.	#8
Quality Core	<i>Describe the basic structure & function of DNA, mRNA, tRNA, amino acids, polypeptides and proteins (e.g. replication, transcription, and translation).</i>	C.1.a.
	<i>Illustrate how all cell organelles work together by describing the step-by-step process of the translation of an mRNA strand into a protein and its subsequent processing by organelles so that the protein is appropriately packaged, labeled, and eventually exported by the cell.</i>	B.1.c.
	<i>Use mRNA codon charts to determine amino acid sequences of example polypeptides.</i>	C.1.c.

Teacher Notes

LTF Lesson: Proteins, the Essence of Life

Guiding Pre-AP Objectives	1. Recognize different types of point mutations in DNA & describe the resulting changes in polypeptides arising from particular point mutations. Examples include Sickle Cell Anemia, Cystic Fibrosis, and Tay-Sach's disease.	
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ALCOS	Identify the structure and function of DNA, RNA and protein. ✓ Relating ways chance, mutagens, and genetic engineering increase diversity	#8
Quality Core	Use mRNA codon charts to determine the effects of different types of mutations on amino acid sequence and protein structure (e.g. sickle cell anemia resulting from a base substitution mutation.)	C.1.d.

Teacher Notes

Guiding Pre-AP Objectives	1. Using the operon as an example, describe how individual cells regulate the synthesis of proteins.	
ALCOS		
Quality Core	Describe how gene expression is regulated in organisms such that specific proteins are synthesized only when they are needed by the cell (e.g. allowing cell specialization).	C.1.e.

Teacher Notes

LTF Lesson: The trp Operon

Guiding Pre-AP Objectives	1. Articulate an understanding of the significance of biotechnology and its application to society in pharmaceutical development, agriculture, forensics, genetic testing, medicine, and scientific research. 2. Investigate basic laboratory skills used in biotechnology laboratories. ---Emphasis on gel electrophoresis (in the context of investigating Genetically Modified Organisms (GMO). ---Complete the steps involved in the production of a DNA fingerprint. 3. Discuss the role of biotechnology in society including the risks and benefits.	
ALCOS	Identify the structure and function of DNA, RNA and protein. ✓ Listing significant contributions of biotechnology to society, including agricultural and medical practices	#8
Quality Core	Complete a major project relating to recombinant DNA, cloning, or stem cell research.	C.1.n.

Teacher Notes

LTF Lesson: Introduction to Electrophoresis

ASIM/Hudson Alpha Institute Lab: Genetically Modified Food

Unit 5: Mendelian Genetics

Recommended Time: 5 weeks of a year-long course

This unit continues with the big idea of “Information Transfer.” DNA is the organic macromolecule that contains the genetic code that is transcribed and translated to proteins in an organism. In addition, DNA is the material that genes and chromosomes are made of and subsequently, the passage of DNA, in the sperm and egg, from one generation to the next, is the basis for heredity. This unit deals with that concept—the passage of genetic information from parents to offspring. In this unit students will answer essential questions:

1. How do Mendel’s laws describe the basic tenets of inheritance?
2. Why do models of inheritance such as codominance, incomplete dominance, sex-linked inheritance, multiple allelism, gene linkage and polygenic inheritance deviate from Mendel’s understanding of inheritance?
3. How are pedigrees used to make inferences about inheritance patterns?
4. How do sexually reproducing organisms produce sperm and egg that, when combined in fertilization, maintain the correct chromosome number?
5. How does crossing over and independent assortment of chromosomes during meiosis lead to increased variation among offspring?
6. What is the outcome when pairs of chromosomes are portions of chromosomes do not separate properly during meiosis?

Guiding Pre-AP Objectives	<ol style="list-style-type: none"> 1. Apply several genetics terms (e.g. character, trait, allele, homozygous & heterozygous, dominant & recessive, genotype & phenotype) to demonstrate understanding basic concepts of inheritance. 2. Recognize Mendel’s laws (dominance, segregation and independent assortment) and describe how these laws demonstrate the particulate nature of inheritance. 3. Use Punnett Squares to model and analyze the probable outcomes of monohybrid and dihybrid crosses. 	
ALCOS	Apply Mendel’s law to determine phenotypic and genotypic probabilities of offspring. <ul style="list-style-type: none"> ✓ Defining important genetic terms, including monohybrid cross, dihybrid cross, phenotype, genotype, homozygous, heterozygous, dominant trait, recessive trait, incomplete dominance, codominance, and allele ✓ Calculating genotypic and phenotypic percentages and ratios using a Punnett square 	#2
Quality Core	<i>Identify and explain Mendel’s law of segregation and law of independent assortment.</i>	C.1.g.
	<i>Define and provide an example of the following: genotype, phenotype, dominant allele, recessive allele, codominant alleles, incompletely dominant alleles, homozygous, heterozygous and carrier</i>	C.1.i.
	<i>Construct and interpret Punnett squares and pedigree charts (e.g. calculate and predict phenotypic and genotypic ratios and probabilities.)</i>	C.1.k.

Teacher Notes

NMSI Teacher Training/LTF Lesson: Mendel and His Peas
 The Amazing Maize

Guiding Pre-AP Objectives	<ol style="list-style-type: none"> 1. Recognize alternate patterns of inheritance other than “Simple Dominance”, i.e. co-dominance, incomplete dominance, multiple alleles, polygenic inheritance, etc. 2. Explain how gene linkage results in deviations from Mendelian inheritance and the law of independent assortment. 3. Describe how sex is determined and why some traits are described as “sex-linked”. Give examples of sex-linked traits. 	
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ALCOS	Apply Mendel's law to determine phenotypic and genotypic probabilities of offspring. <ul style="list-style-type: none"> ✓ Defining important genetic terms, including monohybrid cross, dihybrid cross, phenotype, genotype, homozygous, heterozygous, dominant trait, recessive trait, incomplete dominance, codominance, and allele ✓ Calculating genotypic and phenotypic percentages and ratios using a Punnett square 	#2
Quality Core	<i>Explain sex-linked patterns of inheritance in terms of some genes being absent from the smaller 'Y' chromosome, and thus makes (XY) having a different chance of exhibiting certain traits than do females (XX).</i>	C.1.j.

Teacher Notes

Guiding Pre-AP Objectives	1. Create pedigrees and analyze them to recognize various patterns of inheritance and determine genotypes of individuals.	
ALCOS	Apply Mendel's law to determine phenotypic and genotypic probabilities of offspring. <ul style="list-style-type: none"> ✓ Interpreting inheritance patterns shown in graphs and charts 	#2
Quality Core	<i>Construct and interpret Punnett squares and pedigree charts (e.g. calculate and predict phenotypic and genotypic ratios and probabilities.)</i>	C.1.k.
	<i>Infer parental genotypes and phenotypes from offspring data presented in pedigree charts and from the phenotypic and genotypic ratios of offspring.</i>	C.1.l.
	<i>Describe the mode of inheritance in commonly inherited disorders (e.g. sickle cell anemia, Down syndrome, Turner's syndrome, PKU)</i>	C.1.m.

Teacher Notes

Guiding Pre-AP Objectives	<ol style="list-style-type: none"> 1. Describe the relationship between genome, chromosome, gene, and allele. 2. Differentiate between somatic cells and gametes including chromosome number (i.e. diploid and haploid/monoploid). 3. Recognize meiosis as one DNA replication followed by genetic recombination & two cell divisions resulting in four unique haploid cells. 4. Describe the process of crossing over between homologous chromosomes during prophase I of Meiosis. 5. Identify the three primary sources of variation—crossing over, independent assortment, and random fertilization—and their evolutionary benefits. 6. Compare and contrast mitosis and meiosis. 7. Describe different types of chromosomal abnormalities. Relate Down syndrome and Turner syndrome to chromosome number & recognize on a karyotype. 	
ALCOS	Describe the roles of mitotic and meiotic divisions during reproduction, growth, and repair of cells. <ul style="list-style-type: none"> ✓ Comparing sperm and egg formation in terms of ploidy ✓ Comparing sexual and asexual reproduction 	#6
Quality Core	<i>Describe the basic process of meiosis.</i>	C.1.f.
	<i>Explain how the process of meiosis reveals the mechanism behind Mendel's conclusions about segregation and independent assortment on a molecular level.</i>	C.1.h.

Teacher Notes 1

Teacher Notes 2

NMSI Teacher Training/LTF Lesson: The Amazing Sperm Race

ASIM/Hudson Alpha: Chromosocks

END OF FIRST SEMESTER OF A YEAR LONG COURSE

Unit 6: Ecology

Recommended Time: 4 weeks of a year-long course

The first five units of study have focused on the UNITY OF LIFE--the traits, characteristics, and attributes that all organisms share including cellular makeup, the need for energy, and information transfer from one generation to the next. This unit, ecology, is a segue unit to begin focusing on the INTERDEPENDENCE of organisms with the environment and each other and then moving on to the DIVERSITY of organisms in subsequent units. The prevailing concept for this unit is the organism as a part of a bigger whole and the impact those relationships have on the organism. In this unit students should explore the following essential questions:

1. What hierarchy describes the organization of ecosystems?
2. How do abiotic factors determine the number and types of organisms that can survive in a particular environment?
3. How is population growth controlled by other factors in the environment?
4. How does variation and adaptation make some organisms better fit for survival in an environmental?
5. How do energy and matter flow through ecosystems (how is energy transferred & matter cycled)?
6. How do ecosystems develop in both primary and secondary succession?

Guiding Pre-AP Objectives	1. List, in order, the levels of organization in the student of ecology.	
ALCOS	Identify cells, tissues, organs, organ systems, organisms, populations, communities, and ecosystems as levels of organization in the biosphere. ✓ Recognizing that cells differentiate to perform specific functions. Examples: ciliated cells to produce movement, nerve cells to conduct electrical charges.	#2
Quality Core	Define and provide examples of biosphere, biome, ecosystem, community, population, species, habitat, and niche.	F.1.a.

Guiding Pre-AP Objectives	1. Describe the interdependence of biotic & abiotic factors in an ecosystem. 2. Identify biomes based on environmental factors, climate (i.e. abiotic factors) and native organisms (i.e. biotic factors). Relate the environmental factors of each biome to the adaptations of the resident flora and fauna.	
ALCOS	Identify biomes based on environmental factors and native organisms. ✓ Example: tundra-permafrost, low humidity, lichens, polar bears	#15
Quality Core	Discuss biotic and abiotic factors that affect land and aquatic biomes.	F.1.b.

Guiding Pre-AP Objectives	1. Use the factors dispersion and density to characterize a population. 2. Compare and contrast density-dependent and density-independent limiting factors in an ecosystem. 3. Draw and explain a common population growth curve identifying the exponential and logistical growth sections and the biological reasons for each. 4. Analyze a survivorship curve to describe the "Life History" of a population.	
ALCOS	Identify density-dependent and density-independent limiting factors that affect populations in an ecosystem. ✓ Examples: Density-dependent-disease, predator-prey relationships, availability of food/water Density-independent—natural disasters, climate	#16
Quality Core	Explain how the amount of life any environment can support is limited by the available	F.1.e.

	<i>matter and energy and by the ability of ecosystems to recycle the residue of dead organic materials.</i>	
	<i>Explain the concept of carrying capacity.</i>	<i>F.1.i.</i>
	<i>Describe the growth of populations, including exponential and logistical growth (e.g. design and conduct an experiment investigating bacterial growth using appropriate calculations.)</i>	<i>F.1.j.</i>

Guiding Pre-AP Objectives	<ol style="list-style-type: none"> 1. Define the different symbiotic relationships within a community and give examples of each. 2. Describe protective adaptations of organisms, including mimicry and camouflage. 	
ALCOS	<p>Identify density-dependent and density-independent limiting factors that affect populations in an ecosystem.</p> <ul style="list-style-type: none"> ✓ Examples: Discriminating among symbiotic relationships, including mutualism, commensalism, and parasitism. 	#16
	<p><i>Note: The following qualifier is from Standard 14 which deals with Biogeochemical cycles.</i></p> <ul style="list-style-type: none"> ✓ Relating natural disasters, climate changes, nonnative species, and human activity to the dynamic equilibrium of ecosystems: Examples: Natural disasters—habitat destruction resulting from tornadoes; Climate changes—changes in migratory patterns of birds; Nonnative species—exponential growth of kudzu and Zebra mussels due to absence of natural controls; Human activity—habitat destruction resulting in reduction of biodiversity, conservation resulting in preservation of biodiversity 	
Quality Core	<i>Describe examples of competition, symbiosis, and predation.</i>	<i>F.1.h.</i>
	<i>Explain how organisms cooperate and compete in ecosystems and how interrelationships and interdependencies of organisms may generate ecosystems that are stable for thousands of years.</i>	<i>F.1.f.</i>

Guiding Pre-AP Objectives	<ol style="list-style-type: none"> 1. Trace the flow of energy through the trophic levels from producers to the quaternary level in food chains, food webs, and energy pyramids. 2. Trace biogeochemical cycles through the environment, including water, carbon, oxygen, and nitrogen. 	
ALCOS	<p>Trace the flow of energy as it decreases through the trophic levels from producers to the quaternary level in food chains, food webs, and energy pyramids.</p> <ul style="list-style-type: none"> ✓ Contrasting autotrophs & heterotrophs ✓ Describing the niche of decomposers ✓ Using the 10% rule to explain the decreasing availability of energy through the trophic levels 	#13
	Trace biogeochemical cycles through the environment, including water, carbon, oxygen and nitrogen.	#14
Quality Core	<i>Discuss the role of beneficial bacteria (e.g. in the recycling of nutrients)</i>	<i>F.1.c.</i>
	<i>Explain how energy flows through ecosystems in one direction, from photosynthetic organisms to herbivores to carnivores and decomposers.</i>	<i>F.1.d.</i>
	<i>Diagram the flow of energy using food webs, food chains, and pyramids (e.g. pyramid of energy, pyramid of biomass, and pyramid of numbers.)</i>	<i>F.1.g.</i>

Guiding Pre-AP	1. Describe the process of ecological succession and the organisms' characteristics in a primary and secondary succession.	
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Objectives		
ALCOS	<i>Note: The following qualifier is from Standard 14 which deals with Biogeochemical cycles.</i> ✓ Describing the process of ecological succession.	
Quality Core	<i>Explain the process of ecological succession, and describe the different communities that result.</i>	<i>F.1.k.</i>

Unit 7: Evolution

Recommended Time: 4 weeks of a year-long course

The previous unit on ecology focused on the interdependence of organisms and the interdependence of organisms and their environment. Because of these biotic and abiotic interactions, some organisms are better “fit” for survival than others and have a competitive edge in the fight for the survival for life. That is the focus of this unit on evolution. This unit provides perhaps the best opportunity of the year to teach students about the nature of science. Students should learn that a “theory” is not just a whim or a thought but rather an overarching explanation that makes sense of evidence from many different fields of science. While the history of life on earth and speciation are important concepts in this unit, the most important concept is natural selection. The essential questions for this unit are:

1. How did life begin on Earth?
2. What is the prevailing explanation of how the organisms inhabiting earth have changed over time?
3. What evidence supports the theory of evolution by natural selection?
4. How do changes in allele frequencies explain adaptation of populations?
5. What is a species and how are new species formed?

Guiding Pre-AP Objectives	<ol style="list-style-type: none"> 1. Describe the fallacies with spontaneous generation and the prevailing explanations of the beginning of life on earth. 2. Relate the theory of evolution to the nature of science. 3. Explain the contributions of other scientists to Darwin’s theory of evolution by natural selection. 4. Describe the tenets of Darwin’s theory of evolution by natural selection. 5. Explain natural selection as the mechanism behind the theory of evolution. 6. Describe the various pieces of scientific evidence that support the theory of evolution. 	
ALCOS	Describe protective adaptations of animals, including mimicry, camouflage, beak type, migration & hibernation. <ul style="list-style-type: none"> ✓ Identifying ways in which the theory of evolution explains the nature and diversity of organisms. ✓ Describing natural selection, survival of the fittest, geographic isolation, and fossil record. 	#12
Quality Core	<i>Describe the experiments of Redi, Needham, Spallanzani, and Pasteur to support or falsify the hypothesis of spontaneous generation.</i>	D.1.a.
	<i>Explain the biological definition of evolution.</i>	D.1.b.
	<i>Differentiate among chemical evolution, organic evolution, and the evolutionary steps along the way to aerobic heterotrophs and photosynthetic autotrophs.</i>	D.1.c.
	<i>Discuss Darwin’s principle of survival of the fittest and explain what Darwin meant by natural selection.</i>	D.1.d.
	<i>Explain the influence of other scientists (e.g. Malthus, Wallace, Lemarck, Lyell) and of Darwin’s trip on HMS Beagle in formulating Darwin’s ideas about natural selection.</i>	D.1.e.
	<i>Contrast Lamarck’s and Darwin’s ideas about changes in organisms over time.</i>	D.1.f.
	<i>Provide examples of behaviors that have evolved through natural selection (e.g. migration, courtship rituals)</i>	D.1.g.
	<i>Explain how natural selection and its evolutionary consequence (e.g. adaptation or extinction) provide a scientific explanation for the fossil record of ancient life-forms and the striking molecular similarities observed among the diverse species of living organisms.</i>	D.1.k.
	<i>Discuss evidence from the fields of geology, biochemistry, embryology, comparative anatomy, and comparative physiology that points to shared evolutionary relationships.</i>	D.1.l.
	<i>Explain how Earth’s life-forms have evolved from earlier species as a consequence of interactions of (a) the potential of a species to increase its numbers and (b) genetic variability of offspring due to mutation and recombinations of DNA.</i>	D.1.m

	<i>Design, perform, and analyze a laboratory simulation of natural selection on a working population (e.g. teacher chooses prey items [hard candy, marshmallows]; students choose feeding adaptation [fork, toothpick, spoon] and hunt; students record results and then change prey or adaptation; and students analyze results using statistical methods)</i>	<i>D.1.h.</i>
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Teacher Notes

NMSI Teaching Training/LTF Lesson: Quackers
 Life in the Cold
 Bean Baby Bunnies (MS Lesson)
 To Live or Not to Live—Adaptations of Plants

Guiding Pre-AP Objectives	1. Explain the evolution of a population based on changes in allele frequencies. <i>Note: This does not appear in either the ALCOS or the Quality Core Standards, however, this is a critical AP topic and an introduction should be made in the pre-AP biology course.</i>	
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Teacher Notes

NMSI Teacher Training/LTF Lesson: Hardy Har Har

Guiding Pre-AP Objectives	1. Discuss the biological species concept and explain how changes in allele frequencies not only leads to adaptation but can also lead to speciation. 2. Describe modes of selection including stabilizing, directional, and disruptive.	
Quality Core	<i>Specifically describe the conditions required to be considered a species (e.g. reproductive isolation, geographic isolation)</i>	<i>D.1.i.</i>
	<i>Describe the basic types of selection, including disruptive, stabilizing, and directional.</i>	<i>D.1.j.</i>
	<i>Distinguish between catastrophism, gradualism, and punctuated equilibrium.</i>	<i>D.1.n.</i>

Teacher Notes

END OF THIRD NINE WEEKS OF A YEARLONG COURSE

Unit 8: Diversity & Classification

Recommended Time: 5 weeks of a year-long course

The final two units of study in the course focus on biodiversity. This unit emphasizes the diversity among the microorganisms including bacteria, protists and fungi as well as a SURVEY of the animal kingdom. Emphasis should be placed on the evolutionary advances (e.g. nuclear membrane, multicellularity, symmetry, etc.) and how these advances are then used to classify or group similar organisms. The study of plants is the focus of Unit 9. The essential questions for this unit are:

1. How are the millions of organisms, current and extinct, organized, grouped and named by scientists?
2. What characteristics differentiate each of the six kingdoms?
3. Why are viruses not considered alive?
4. What are the beneficial and harmful contributions of the bacteria, protists and fungi?
5. What are the primary criteria used to classify members of the animal kingdom?

Guiding Pre-AP Objectives	1. List, in order, the taxonomic groups and how they are used to group organisms.	
ALCOS	Differentiate between the previous five-kingdom and current six-kingdom classification systems. <ul style="list-style-type: none"> ✓ Sequencing taxa from most inclusive to least inclusive in the classification of living things ✓ Identifying organisms using a dichotomous key ✓ Writing scientific names accurately by using binomial nomenclature. 	#9
Quality Core	<i>Explain how organisms are classified into a hierarchy of groups and subgroups based on similarities that reflect their evolutionary relationships.</i>	E.3.a.
	<i>List each of the major levels in the hierarchy of taxa: kingdom, phylum, class, order, family, genus, and species.</i>	E.3.b.
	<i>Explain the binomial nomenclature system.</i>	E.3.c.
	<i>Construct & use a dichotomous taxonomic key.</i>	E.3.d.

Teacher Notes

Guiding Pre-AP Objectives	1. Distinguish between prokaryotes and eukaryotes, noting examples and characteristics of each and relate this characteristic to the six kingdoms. 2. Name the two kingdoms of prokaryotes and describe unique features of the bacteria.	
ALCOS	Differentiate between the previous five-kingdom & current six-kingdom classification system. <ul style="list-style-type: none"> ✓ Identifying ways in which organisms from the Monera, Protista, and Fungi kingdoms are beneficial and harmful <ul style="list-style-type: none"> ○ Beneficial—decomposers ○ Harmful—diseases 	
Quality Core	<i>Distinguish between & among viruses, bacteria and protists, and give examples of each</i>	E.3.e.

Teacher Notes

Guiding Pre-AP Objectives	1. Explain why viruses do not belong to any of the six kingdoms and describe their relationship with cells.	
ALCOS	Differentiate between the previous five-kingdom & current six-kingdom classification	

	system. ✓ Identifying ways in which organisms from the Monera, Protista, and Fungi kingdoms are beneficial and harmful <ul style="list-style-type: none"> ○ Beneficial—decomposers ○ Harmful—diseases ✓ Justifying the grouping of viruses in a category separate from living things	
Quality Core	<i>Distinguish between & among viruses, bacteria and protists, and give examples of each</i>	E.3.e.

Teacher Notes

NMSI Teacher Training/LTF Lesson: Virus Transmission Activity

Guiding Pre-AP Objectives	1. Identify the relationship between structure and function of the eukaryotic kingdoms of living things and explain the acquisition of their evolutionary adaptations as well as the phylogenetic classification of each. 2. Explain the evolutionary importance of Kingdom Protista. 3. List characteristics and give common examples of Kingdom Fungi and describe the ecological and biotechnological importance of the kingdom.	
ALCOS	Differentiate between the previous five-kingdom & current six-kingdom classification system. ✓ Identifying ways in which organisms from the Monera, Protista, and Fungi kingdoms are beneficial and harmful <ul style="list-style-type: none"> ○ Beneficial—decomposers ○ Harmful--diseases 	
Quality Core	<i>Distinguish between & among viruses, bacteria and protists, and give examples of each</i>	E.3.e.
	<i>Explain classification criteria for fungi, plants, and animals.</i>	E.3.f.

Teacher Notes

Guiding Pre-AP Objectives	1. List the characteristics of the Animal Kingdom, distinguish among the inherent characteristics of vertebrates and invertebrates, and identify various taxa of each.	
ALCOS	Classify animals according to type of skeletal structure, method of fertilization and reproduction, body symmetry, body coverings, and locomotion. ✓ Examples: <ul style="list-style-type: none"> ○ Skeletal structure-vertebrates & invertebrates ○ Fertilization—external & internal ○ Reproduction—sexual & asexual ○ Body symmetry---bilateral, radial, asymmetrical ○ Body coverings—feathers, scales, fur ○ Locomotion—cilia, flagella, pseudopodia 	#11
Quality Core	<i>Compare the major divisions of animals</i>	E.3.g.
	<i>Identify major types of animal cells and tissues</i>	E.1.a.
	<i>Describe the major components and functions of physiological systems, including skeletal, muscle, circulatory, respiratory, digestive, urinary, endocrine, nervous, reproductive, and immune.</i>	E.1.b.

Teacher Notes

Teacher Notes

Teacher Notes

NMSI Teacher Training/LTF Lesson:	What an Animal
ASIM Lab:	Animal Survey

Unit 9: Plants

Recommended Time: 3 weeks of a year-long course

Botany is highly valued in the AP Biology course. Students are often very underprepared for the study of plants. That is why "Plants" have been given an entire unit of study in the pre-AP course. The end of the school year is an excellent time to discuss plants as the flowering plants and trees are in full bloom and the deciduous plants have leafed out. This is a great unit to integrate some actual field biology. This is also a great unit to revisit photosynthesis. The essential questions for this unit are:

1. What are the evolutionary advances in each of the major groups of plants?
2. What are the structure and function of each of the four major plant organs?
3. How do fluids move through plants and what is the role of the stomata and transpiration in fluid movement?
4. How does the flower function in plant reproduction?

Guiding Pre-AP Objectives	1. List the four major plant groups, the evolutionary advances and common examples of each group.	
ALCOS	Distinguish between monocots and dicots, angiosperms and gymnosperms, and vascular and nonvascular plants	#10

Teacher Notes

Guiding Pre-AP Objectives	1. Describe the structure and function of the four major plant organs (roots, stem, leaf, flower) and name the three tissue types that comprise these organs. 2. Differentiate between primary & secondary growth and describe the location of the meristematic tissue responsible for the growth. Relate tree rings to plant age and annual rainfall.	
ALCOS	Distinguish between monocots and dicots, angiosperms and gymnosperms, and vascular and nonvascular plants ✓ Describing the histology of roots, stems, leaves and flowers.	#10
Quality Core	<i>Describe the basic mechanisms of plant processes, especially movement of materials and plant reproduction.</i>	E.2.a.
	<i>Explain the functions of unique plant structures, including the cell wall, chloroplasts, and critical parts of the flower and the seed.</i>	E.2.b.

Teacher Notes

Guiding Pre-AP Objectives	1. Explain the role of the leaf in plant gas exchange, including the role of the stomata. 2. Explain the process of fluid transport in plants. Special emphasis is placed on how transpiration moves water through a plant, including the role of the stomata in the explanation. Also, describe fluid transport in the phloem. <i>Note: While there are no direct objectives in either the COS or Quality Core that address these two standards, this is a critical concept to both the understanding of Botany and success on the AP examination.</i>	
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Teacher Notes

NMSI Teacher Training/LTF Lesson: Holey Moley--Examining Stomates

Transpiration: Investigation Water Movement & Evaporation in
Monocots & Dicot Plants
Estimating Leaf Stomata

ASIM Lab:

Guiding Pre-AP Objectives	<ol style="list-style-type: none">1. Draw and label a flower and give the function of the following structures: petal, sepal, stamen, filament, anther, pistil, stigma, style, ovary and ovule. Explain the role of flowers in angiosperm reproductive success.2. Compare and contrast monocots and dicots using the following criteria: number of flower parts, number of cotyledons, stem structure, and leaf venation.	
ALCOS	Distinguish between monocots and dicots, angiosperms and gymnosperms, and vascular and nonvascular plants ✓ Describing the histology of roots, stems, leaves and flowers.	#10

Teacher Notes

NMSI Teacher Training/LTF Lesson:

Seed Germination

Monocots and Dicots, Two Plants with Differences: Examining Stem Structure