Course #:	**SC-44**	**Grade Level:**	**10-12**
Course Name:	**Biology**	**Level of Difficulty:**	**Average to High**
Prerequisites:	**None**	**# of Credits:**	**1**

Strand 1: Inquiry Process

"Science as inquiry is basic to science education and a controlling principle in the continuing organization and selection of students' activities. Students at all grade levels and in every domain of science should have the opportunity to use scientific inquiry and develop the ability to think and act in ways associated with inquiry…" **(National Science Education Standards, 1995).**

Inquiry Process establishes the basis for students' learning in science. Students use scientific processes: questioning, planning and conducting investigations, using appropriate tools and techniques to gather data, thinking critically and logically about relationships between evidence and explanations, and communicating results.

Concepts

Concept 1: Observations, Questions, and Hypotheses
- **Formulate predictions, questions, or hypotheses based on observations. Evaluate appropriate resources.**

Concept 2: Scientific Testing (Investigating and Modeling)
- **Design and conduct controlled investigations.**

Concept 3: Analysis, Conclusions, and Refinements
- **Evaluate experimental design, analyze data to explain results and propose further investigations. Design models.**

Concept 4: Communication
- **Communicate results of investigations.**

Students should know and be able to…

Concept Number	Concept	PO No.	Performance Objective	Vocabulary	Notes/Integration/ Resources
S1C1	**Observations, Questions, and Hypotheses**	**1**	**Evaluate scientific information for relevance to a given problem.**		Labs including • Hypothesis Writing • Predicting
		2	**Develop questions from observations that transition into testable hypotheses.**		
		3	**Formulate a testable hypothesis.**	hypothesis	
		4	**Predict the outcome of an investigation based on prior evidence, probability, and/or modeling (not guessing or inferring).**	predictions	

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Students should know and be able to…					
Concept Number	**Concept**	**PO No.**	**Performance Objective**	**Vocabulary**	**Notes/Integration/ Resources**
S1C2	**Scientific Testing (Investigating and Modeling)**	**1**	**Demonstrate safe and ethical procedures (e.g., use and care of technology, materials, and organisms) and behavior in all science inquiry.**		
		2	**Identify the resources needed to conduct an investigation.**		
		3	**Design an appropriate protocol (written plan of action) for testing a hypothesis:** ▪ **Identify dependent and independent variables in a controlled investigation.** ▪ **Determine an appropriate method for data collection (e.g., using balances, thermometers, microscopes, spectrophotometer, using qualitative changes).** ▪ **Determine an appropriate method for recording data (e.g., notes, sketches, photographs, videos, journals (logs), charts, computers/calculators).**	variable, dependent variable, independent variable, controlled experiment, qualitative, quantitative	
		4	**Conduct a scientific investigation that is based on a research design.**		
		5	**Record observations, notes, sketches, questions, and ideas using tools such as journals, charts, graphs, and computers.**	data	

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Concept Number	**Concept**	**PO No.**	**Performance Objective**	**Vocabulary**	**Notes/Integration/ Resources**
S1C3	**Analysis and Conclusions, and Refinements**	**1**	***Interpret data that show a variety of possible relationships between variables, including:*** ▪ ***positive relationship*** ▪ ***negative relationship*** ▪ ***no relationship***		
		2	**Evaluate whether investigational data support or do not support the proposed hypothesis.**		
		3	**Critique reports of scientific studies (e.g., published papers, student reports).**		
		4	**Evaluate the design of an investigation to identify possible sources of procedural error, including:** ▪ **sample size** ▪ **trials** ▪ **controls** ▪ **analyses**		
		5	**Design models (conceptual or physical) of the following to represent "real world" scenarios.** ▪ **carbon cycle** ▪ **water cycle** ▪ **phase change** ▪ **collisions**		
		6	**Use descriptive statistics to analyze data, including:** ▪ **mean** ▪ **frequency** ▪ **range** **(see MHS-S2C1-10)**	data, mean, frequency, range	
		7	**Propose further investigations based on the findings of a conducted investigation.**		

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Concept Number	**Concept**	**PO No.**	**Performance Objective**	**Vocabulary**	**Notes/Integration/ Resources**
S1C4	**Communication**	**1**	**For a specific investigation, choose an appropriate method for communicating the results.**	experimental design inference	
		2	**Produce graphs that help communicate data. (See MHS-S2C1-02)**		
		3	**Communicate results clearly and logically.**		
		4	**Support conclusions with logical scientific arguments.**		

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Strand 2: History and Nature of Science

***Knowledge of the nature of science is central to the understanding of the scientific enterprise*" (National Assessment of Educational Progress, 2000).**

Scientific investigation grows from the contributions of many people. History and Nature of Science emphasizes the importance of the inclusion of historical perspectives and the advances that each new development brings to technology and human knowledge. This strand focuses on the human aspects of science and the role that scientists play in the development of various cultures.

Concepts

Concept 1: History of Science as a Human Endeavor
- **Identify individual, cultural, and technological contributions to scientific knowledge.**

Concept 2: Nature of Scientific Knowledge
- **Understand how science is a process for generating knowledge.**

Students should know and be able to…

Concept Number	Concept	PO No.	Performance Objective	Vocabulary	Notes/Integration/ Resources
S2C1	**History of Science as a Human Endeavor**	**1**	**Describe how human curiosity and needs have influenced science, impacting the quality of life worldwide.**		
		2	***Describe how diverse people and/or cultures, past and present, have made important contributions to scientific innovations.***		
		3	**Analyze how specific changes in science have affected society.**		
		4	**Analyze how specific cultural and/or societal issues promote or hinder scientific advancements.**		

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Students should know and be able to…					
Concept Number	**Concept**	**PO No.**	**Performance Objective**	**Vocabulary**	**Notes/Integration/ Resources**
S2C2	**Nature of Scientific Knowledge**	**1**	**Specify the requirements of a valid, scientific explanation (theory), including that it be:** ▪ **logical** ▪ **subject to peer review** ▪ **public** ▪ **respectful of rules of evidence**		Career Project
		2	**Explain the process by which accepted ideas are challenged or extended by scientific innovation.**		
		3	**Distinguish between pure and applied science.**		
		4	**Describe how scientists continue to investigate and critically analyze aspects of theories.**		

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Strand 3: Science in Personal and Social Perspectives

Science in Personal and Social Perspectives emphasizes developing the ability to design a solution to a problem, to understand the relationship between science and technology, and the ways people are involved in both. Students understand the impact of science and technology on human activity and the environment. This strand affords students the opportunity to understand their place in the world – as living creatures, consumers, decision makers, problem solvers, managers, and planners.

Concepts

Concept 1: Changes in Environments
- **Describe the interactions between human populations, natural hazards, and the environment.**

Concept 2: Science and Technology in Society
- **Develop viable solutions to a need or problem.**

Concept 3: Human Population Characteristics
- **Analyze factors that affect human populations.**

Students should know and be able to…

Concept Number	Concept	PO No.	Performance Objective	Vocabulary	Notes/Integration/ Resources
S3C1	**Changes in Environments**	**1**	**Evaluate how the processes of natural ecosystems affect, and are affected by, humans.**		
		2	**Describe the environmental effects of the following natural and/or human-caused hazards:** ▪ **flooding** ▪ **drought** ▪ **earthquakes** ▪ **fires** ▪ **pollution** ▪ **extreme weather**		
		3	**Assess how human activities (e.g., clear cutting, water management, tree thinning) can affect the potential for hazards.**		

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Students should know and be able to…

Concept Number	Concept	PO No.	Performance Objective	Vocabulary	Notes/Integration/ Resources
S3C1 (cont.)		**4**	**Evaluate the following factors that affect the quality of the environment:** ▪ **urban development** ▪ **smoke** ▪ **volcanic dust**		
		5	**Evaluate the effectiveness of conservation practices and preservation techniques on environmental quality and biodiversity.**		
S3C2	**Science and Technology in Society**	**1**	**Analyze the costs, benefits, and risks of various ways of dealing with the following needs or problems:** ▪ **various forms of alternative energy** ▪ **storage of nuclear waste** ▪ **abandoned mines** ▪ **greenhouse gases** ▪ **hazardous wastes**		
		2	**Recognize the importance of basing arguments on a thorough understanding of the core concepts and principles of science and technology.**		
		3	**Support a position on a science or technology issue.**		
		4	**Analyze the use of renewable and nonrenewable resources in Arizona:** ▪ **water** ▪ **land** ▪ **soil** ▪ **minerals** ▪ **air**		
		5	**Evaluate methods used to manage natural resources (e.g., reintroduction of wildlife, fire ecology).**		

Students should know and be able to…					
Concept Number	**Concept**	**PO No.**	**Performance Objective**	**Vocabulary**	**Notes/Integration/ Resources**
S3C3	**Human Population Characteristics**	**1**	**Analyze social factors that limit the growth of a human population, including:** ▪ **affluence** ▪ **education** ▪ **access to health care** ▪ **cultural influences**	tolerance curve, acclimation, conformances, regulators, niche, dormancy, fundamental niche, realized niche, generalist, specialist, logistics, model, carrying capacity, logistic growth model, density dependent, density independent, inbreeding, developed/developing countries, population density, dispersion, emigration, birth rate, death rate, limiting factor, mortality rate, life expectancy, Survivorship curves, growth rate, immagration	
		2	**Describe biotic (living) and abiotic (nonliving) factors that affect human populations.**		
		3	**Predict the effect of a change in a specific factor on a human population.**		

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Strand 4: Life Science

***"The fundamental goal of life sciences is to attempt to understand and explain the nature of life"* (NAEP 2000).**

Life Science expands students' biological understanding of life by focusing on the characteristics of living things, the diversity of life, and how organisms and populations change over time in terms of biological adaptation and genetics. This understanding includes the relationship of structures to their functions and life cycles, interrelationships of matter and energy in living organisms, and the interactions of living organisms with their environment.

Concepts

Concept 1: The Cell
- **Understand the role of the cell and cellular processes.**

Concept 2: Molecular Basis of Heredity
- **Understand the molecular basis of heredity and resulting genetic diversity.**

Concept 3: Interdependence of Organisms
- **Analyze the relationships among various organisms and their environment.**

Concept 4: Biological Evolution
- **Understand the scientific principles and processes involved in biological evolution.**

Concept 5: Matter, Energy, and Organization in Living Systems (Including Human Systems)
- **Understand the organization of living systems, and the role of energy within those systems.**

Students should know and be able to…

Concept Number	Concept	PO No.	Performance Objective	Vocabulary	Notes/Integration/ Resources
S4C1	**The cell**	**1**	**Describe the role of energy in cellular growth, development, and repair.** – Describe the cell cycle – Differentiate between surface area and volume as a cell grows – Explain the sources of energy used by the cell	Interphase, mitosis, surface area, volume, mitochondria, chloroplasts, cellular respiration, photosynthesis	

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Concept Number	**Concept**	**PO No.**	**Performance Objective**	**Vocabulary**	**Notes/Integration/ Resources**
S4C1 (cont.)		**2**	**Compare the form and function of prokaryotic and eukaryotic cells and their cellular components.** – Compare the basic differences between prokaryotic and eukaryotic cells – Illustrate a prokaryote (bacterium) and eukaryote (animal vs. plant) cell identifying the five major organelles – Identify three major differences between an animal and plant cell (cell wall, chloroplast, vacuole) – distinguish between the cell (plasma) membrane and cell wall – Describe the structure and function of the nucleus – Define organelle and describe the function of other major cell organelles (e.g. ribosomes, mitochondria)	prokaryote, eukaryote, bacterium, plasma (cell) membrane, cell wall, cytoplasm, organelle, nucleus, nucleus envelope, nucleolus, chromosome, chromatin, DNA, endoplasmic reticulum, ribosomes, Golgi apparatus, cytoskeleton, lysosomes, perriphreal proteins, internal proteins, fluid mosaic model, cristau, microfilaments, microtubules, nucleus matrix, nucleus cytosol thylakoids	Plant vs., animal cell lab (onion skin cells vs. human cheek cells) Preparation ofwet mounts of several plant and animal cells Projects Cell analogy Bacteria
		3	**Explain the importance of water to cells** – Describe the importance of water as being a good solvent – Describe water's heat capacity in its ability to heat and cool	diffusion, osmosis, solvent, capillary action, homeostasis, cohesion	

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Concept Number	**Concept**	**PO No.**	**Performance Objective**	**Vocabulary**	**Notes/Integration/ Resources**
S4C1 (cont.)		**4**	**Analyze mechanisms of transport of materials (e.g., water, ions, macromolecules) into and out of cells:** ▪ **passive transport** ▪ **active transport** – passive transport – active transport – compare and contrast passive & active transport – compare and contrast diffusion & osmosis – describe concentration gradient, isotonic, hypotonic and hypertonic solutions – predict the direction of water molecule movement through a membrane given various solute concentrations – describe facilitated diffusion – compare endocytosis with exocytosis	passive transport, diffusion, equilibrium, solute, solvent, solution, concentration gradient, osmosis, osmotic pressure, hypertonic, hypotonic, isotonic, selectively permeable, facilitated diffusion, active transport, chemiosmosis, endocytosis, phagocytosis, pinocytosis, exocytosis, homeostasis, turgor pressure, plasmolysis, turgor pressure, carries proteins, ion channels, sodium potassium pump	Egg Lab: Student Design
		5	**Describe the purpose and process of cellular reproduction.** – Identify the stages of mitosis (prophase, metaphase, anaphase, telophase) – Identify the major cell organelles involved in mitosis (e.g. centioles, spindle fibers, chromatids, centromeres) – Relate the function of cellular reproduction to growth and repair	eukaryotic, mitosis, chromosomes, centromeres, Centrioles, cell cycle, spindle fibers, cell plate, interphase, prophase, metaphase, anaphase, telophase, histomes, nonhistomes, centromere, homologous chromosomes, sex chromosomes, diploid, haploid, cytokimesis, Interphase – phases, polar fibers, cleavage furrows, kimetochone	

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Concept Number	Concept	PO No.	Performance Objective	Vocabulary	Notes/Integration/ Resources
S4C2	**Molecular Basis of Heredity**	**1**	**Analyze the relationships among nucleic acids (DNA, RNA), genes, and chromosomes.** – Compare and contrast DNA with RNA; include where they are located and their roles in the cell – Explain nucleotides, genes, and chromosomes. Categorize them in order of smallest to largest. Relate the concept of gene to the sequences of nucleotides in DNA. – Distinguish between chromosomes, chromatin, and chromatids – Describe the differences of cytokinesis between plant & animal cells	nucleotides A, C, G, T, adenine, cytosine, guanine, thymine, phosphate, sugar, nucleotide	Project: Travel brochure 3D-models of nucleic acid and protein synthesis
		2	**Describe the molecular basis of heredity, in viruses and living things, including DNA replication and protein synthesis.** – List the nucleotides of DNA & RNA – Explain how nucleotides form a universal code that allows for the uniqueness of individual organism (e.g. viruses, prokaryotes, eukaryotes) – Describe how the structure of DNA enables it to reproduce itself accurately – Describe the steps involved in the process of DNA replication – Describe the process of protein synthesis – Compare and contrast transcription and translation	replication, translation, transcription, MRNA, TRNA, ribosome, helicase, DNA pdymerase, RIVA pdymerase, purines, pyrimidine, promoto, complementary base, terminatin signal, mutation, codon	Project; Viral disease

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Concept Number	Concept	PO No.	Performance Objective	Vocabulary	Notes/Integration/ Resources
S4C2 (cont.)		**3**	**Explain how genotypic variation occurs and results in phenotypic diversity.** – Explain an allele and where it comes from – Compare and contrast genotype and phenotype – Explain how genotype affects phenotype – Make and use a Punnett square – Determine the genotype and phenotype probability based on the Punnett square outcome – Compare and contrast incomplete and co-dominance – Explain how sex-linked traits are inherited	monohybrid cross, homozygous dominant, homozygous recessive, heterozygous, dehybrid cross, trihybrid cross	project; Family Pedigree
		4	**Describe how meiosis and fertilization maintain genetic variation.** – Describe the two types of gametes and how they unite to from a new and unique organism – Explain how meiosis creates four unique cells that are haploid (n)	gametes, fertilization, zygote, egg sperm, synapsis, tetrad, crossing-over, genetic recombination, independent assortment, spermatogenasis, oogenesis, polar bodies	

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Concept Number	**Concept**	**PO No.**	**Performance Objective**	**Vocabulary**	**Notes/Integration/ Resources**
S4C3	**Interdependence of Organisms**	**1**	**Identify the relationships among organisms within populations, communities, ecosystems, and biomes.** - Compare the different levels of biological organization used in ecology (e.g. 1st trophic level, 2nd trophic level, 3rd trophic level) - Explain the difference between a niche and a habitat - Compare and contrast the different types of symbiotic relationships (e.g. parasitism, mutualism, commensalisms)	abiotic factor, autotroph, biome, biotic factor, biosphere, commensalisms, community, consumer, decomposer, ecology, ecosystem, environment, food chain, food, web, habitat, heterotroph, mimicry, commensalism, mutualism, niche, organism, parasitism, population, population density, producer, symbiotic relationship, trophic level, ecological pyramids, ectoparasite, endoparasite, character displacement, resource partitioning, competitive exclusion	Project; Succession
		2	**Describe how organisms are influenced by a particular combination of biotic (living) and abiotic (nonliving) factors in an environment.** - Distinguish between biotic and abiotic factors in an environment - Examine how organisms are affected by biotic and abiotic factors in an environment	adaptation, biodiversity, climate, climax community, desert, greenhouse gas, hazardous waste, interrelationships, limiting factor, photosynthesis, primary succession, succession	
		3	**Assess how the size and the rate of growth of a population are determined by birth rate, death rate, immigration, emigration, and carrying capacity of the environment.** - Compare and contrast exponential and linear population growth (e.g. S and J shaped curves) - Predict effects of environmental factors on population growth - Relate reproductive rates of different populations of organisms (e.g. bacteria cells vs. large mammals) to models of population growth - Identify potential problems that can be caused by immigration and emigration	age structure, carrying capacity, demography, density-independent, density-dependent, emigration exponential growth, extinct, immigration, linear growth, preservation, , pioneer species, climax community	

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Concept Number	**Concept**	**PO No.**	**Performance Objective**	**Vocabulary**	**Notes/Integration/ Resources**
S4C4	**Biological Evolution**	**1**	**Identify the following components of natural selection, which can lead to speciation:** ▪ **potential for a species to increase its numbers** – (e.g. J-shaped curve) ▪ **genetic variability and inheritance of offspring due to mutation and recombination of genes** ▪ **finite supply of resources required for life** – e.g. limiting factors such as space, food, water, mated) ▪ **selection by the environment of those offspring better able to survive and produce offspring**	carrying capacity, evolution, exponential growth, limiting factors, natural selection	On-line lessons for students and other resources for teachers at *www. PBS.org/evolution*
		MPS	– Be able to explain the mechanism of natural selection in a population by describing the cause and effects of the component parts	uniformitarianism, fitness, adaptive advantage	

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Concept Number	**Concept**	**PO No.**	**Performance Objective**	**Vocabulary**	**Notes/Integration/ Resources**
S4C4 (cont.)		**2**	**Explain how genotypic and phenotypic variation can result in adaptations that influence an organism's success in an environment.** – Explain how genotype affects phenotype – Demonstrate how an adaptation that best matches an environment is naturally selected	adaptation, reproductive success/fitness	On-line lessons for students and other resources for teachers at www.PBS.org/evolution
		3	**Describe how the continuing operation of natural selection underlies a population's ability to adapt to changes in the environment and leads to biodiversity and the origin of new species.** – Recognize that populations evolve (not individuals) – Relate allelic frequency and gene pool – Compare and contrast natural selection and evolution	allele, allele frequency, gene pool	

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Concept Number	**Concept**	**PO No.**	**Performance Objective**	**Vocabulary**	**Notes/Integration/ Resources**
S4C4 (cont.)		**4**	**Predict how a change in an environmental factor (e.g., rainfall, habitat loss, non-native species) can affect the number and diversity of species in an ecosystem.** – Describe biotic and abiotic factors in an environment – Show how a change in one population of organisms (e.g. jackrabbits) can affect another population of organisms (e.g. coyotes)	abiotic, biotic	On-line lessons for students and other resources for teachers at www. PBS.org/evolution
		5	**Analyze how patterns in the fossil record, nuclear chemistry, geology, molecular biology, and geographical distribution give support to the theory of organic evolution through natural selection over billions of years and the resulting present day biodiversity.** – Examine how radioactive decay is used to date fossils – Identify patterns of geographic isolation, reproductive isolation, and adaptive radiation – Compare and contrast relative dating an radioactive dating – Compare and contrast convergent and divergent evolution	radioactive dating, relative dating, isotope, adaptation, geographic isolation, reproductive isolation, adaptive radiation	Website – The Demise of Frosty the Snowman
		6	**Analyze, using a biological classification system (i.e., cladistics, phylogeny, morphology, DNA analysis) the degree of relatedness among various species.** – Construct/organize a group of species suing cladistics and build a resulting dichotomous key – Analyze relationships among organisms using DNA analysis – Compare and contrast analogous and homologous structures	vestigial organs, embryological development, characteristic, cladistics, classification system, classify, domain archaea, domain Bacteria, domain Fukacya, systematics, phylogmetic tree, morphology, bastula, blastopore, cladogram	

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Students should know and be able to…					
Concept Number	**Concept**	**PO No.**	**Performance Objective**	**Vocabulary**	**Notes/Integration/ Resources**
S4C5	**Matter, Energy, and Organization in Living Systems (including Human Systems)**	**1**	**Compare the processes of photosynthesis and cellular respiration in terms of energy flow, reactants, and products.** - Summarize the relationship between autotrophs and hetertrophs - Identify the eukaryotic cell organelle where each to the two processes takes place - Relate chlorophyll to the process of photosynthesis - Explain the importance of our sun to the formation of biochemical energy - List the 4 requirements for photosynthesis to occur (sunlight, chlorophyll, water, carbon dioxide) - List the requirements for cellular respiration to occur (oxygen, glucose & enzymes) - Compare and contrast the chemical equations for photosynthesis and aerobic respiration and examine the cellular uses for each - Examine the importance of photosynthesis and respiration to the carbon cycle	autotrophs, heterotrophs, biochemical pathway, grama, stoma, accessory pigments, carotenoids, primary electron acceptor, carbon fixation, ATP, ADP, photosystem I and II, C_4 pathway, CAM pathway	

Students should know and be able to…					
Concept Number	**Concept**	**PO No.**	**Performance Objective**	**Vocabulary**	**Notes/Integration/ Resources**
S4C5 (cont.)		**2**	**Describe the role of organic and inorganic chemicals (e.g., carbohydrates, proteins, lipids, nucleic acids, water, ATP) important to living things.** – Differentiate between organic and inorganic compounds – Diagram how the water molecule is an excellent solvent – Describe how monomers make up polymers (i.e. carbohydrates, proteins, and nucleic acids) – Compare and contrast the four main kinds of organic compounds (i.e. carbohydrates, proteins, lipids, nucleic acids) – Analyze how organisms' utilize carbohydrates, proteins, lipids, and nucleic acids for metabolism, structure, and function – Summarize the interaction between an enzyme and its substrate – Outline the importance of the molecule ATP to organisms – List foods that contain carbohydrates, proteins, and lipids	organic, inorganic, monomers, polymers, carbohydrates, proteins, lipids, nucleic acid, enzyme, ATP, cohesion, adhesion, capilarity, hydrogen bond, polar/polarity, marcromolecule, condensation reaction, fractional groups, hydrolysis, carboxyl group, amino group, peptide bonds, dipeptide bond, plypeptide ond, hychophobic, hypophobic, triglyceride, phospholysid, transputation, precipitation, nitrification, ammonification, dimitrafication, combustion, nitrogen fixation	
		3	**Diagram the following biogeochemical cycles in an ecosystem:** ▪ **water** ▪ **carbon** ▪ **nitrogen** – explain what is meant by a biogeochemical cycle – construct a diagram that shows the pathways taken by each of the 3 cycles – analyze how the oxygen-carbon cycle is driven by photosynthesis – analyze the importance of decomposers to the carbon and nitrogen cycles – See S3C1PO1		

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Students should know and be able to…					
Concept Number	**Concept**	**PO No.**	**Performance Objective**	**Vocabulary**	**Notes/Integration/ Resources**
S4C5 (cont.)		**4**	**Diagram the energy flow in an ecosystem through a food chain.**		
		5	**Describe the levels of organization of living things from cells, through tissues, organs, organ systems, organisms, populations, and communities to ecosystems.** – Identify the increasing levels of organization	cells, tissue, organs, organisms, populations, communities, ecosystems, biomes, gross primary productivity, net primary productivity, trophic level, consumers	