Gateway Biology I Learner Expectations and Performance Indicators

Course Description

Biology I is a course that introduces students to the world of living things. The students explore the following:

- basic life processes at the molecular, cellular, systemic, organismal, and ecological levels of organization within the biosphere;
- interdependence and interactions within the environment to include relationships, behavior, and population dynamics;
- cultural and historical scientific contributions of men and women;
- evidence that supports biological evolution; and
- current and emerging technologies.

It is expected that students will experience the content of Biology I through an inquiry approach. Using available technology, students will investigate the world around them. Biology I will provide the student with knowledge, prerequisite skills, and habits of mind needed for daily living and ethical decision making. This course provides a foundation for advanced biological studies and personal career choices.

Standard Number: 1.0 Cells

Standard:

The student will investigate the structures and functions of the cell membrane, cellular organelles, and component biomolecules related to the major cell processes.

Learning Expectations:

The student will

- 1.1 compare and contrast the chemistry of biomolecules and investigate their roles in cell structure and metabolism.
- 1.2 explore and compare the organelles of different cell types.
- 1.3 probe the composition of the cell membrane and its significance to homeostasis.
- 1.4 analyze the various cell processes.

Performance Indicators State:

As documented through state assessment,

at Level 1, the student is able to

- identify major cell organelles, given a diagram.
- distinguish between plant and animals cells, given diagrams or scenarios.
- predict the movement of water molecules across the cell membrane, given solutions of different concentrations.
- sequence a series of diagrams depicting the movement of chromosomes during mitosis.
- compare and contrast the cell cycle in plant and animal cells, given a diagram or description.

at level 2, the student is able to

- distinguish among proteins, carbohydrates, lipids, and nucleic acids, given structural diagrams (formulas).
- identify a positive test for carbohydrates and lipids when given an experimental procedure, data, and results.
- distinguish between active and passive transport, given examples of different molecules.
- evaluate the role of meiosis in maintaining genetic variability and continuity, given a scenario.
- determine the number of chromosomes following mitosis or meiosis, given the number of chromosomes in the original cell.
- recognize the significance of homeostasis to the viability of human and other organisms, given the definition of homeostasis.

at level 3, the student is able to

- identify the biomolecules responsible for communicating, responding, regulating, and reproducing in the cell.

Performance Indicators Teacher:

As documented through teacher observation,

at Level 1, the student is able to

- demonstrate appropriate use and care of compound microscopes.
- examine plant and animal cells using compound microscopes.
- create a 3D model of a typical cell.
- prepare wet mount slides.
- demonstrate molecular movement across a semi-permeable membrane.
- model or observe the movement of chromosomes during mitosis in plant and animal cells.
- model or observe the movement of chromosomes during meiosis in plant and animals cells.

- research careers related to the study of cells, such as, microscopist, cytologist, oncologist, medical technician, and biochemist.
- write a persuasive essay, supported by current scientific journals, relating certain lifestyle choices to a particular disease.
- create a time line that traces the development of microscopes and correlates this information to discoveries in cytology.

at Level 2, the student is able to

- construct a model of each of the biomolecules given a structural diagram.
- conduct an experiment to identify carbohydrates and lipids.
- prepare a slide using proper staining technique.
- record nutritional intake for one week, calculating daily caloric intake for each biomolecule, and evaluate the diet to develop an improvement plan.
- calculate the ratio of cell surface area to cell volume.

at Level 3, the student is able to

- design and conduct a controlled experiment to observe enzymatic actions and identify possible sources of experimental error.
- conduct a test to detect the presence of proteins.

Sample Task:

Egg Membrane Experiments: Decalcify eggs overnight by covering them with vinegar. The next morning, gently rub the eggs to loosen the shell. 1) Hypertonic solution experiment: dissolve two parts Karo syrup and one part water, place one egg in solution and store under refrigeration; maximum shriveling will occur in twelve hours. 2) Hypotonic solution experiment: fill a beaker with water; place one egg in the water and store at room temperature; the egg will demonstrate maximum stretching in ten hours. 3) Isotonic solution experiment: store two eggs in one part Karo syrup and two parts water solution. Minor adjustments in syrup and water may be necessary to maintain normal size. 4) Diffusion experiment: place an egg in isotonic solution; add 2 or 3 drops of blue food coloring to the solution, the dye will penetrate the egg within 30 minutes.

Integration/Linkages

microscope, homeostasis, chemistry, physical science, meiosis, heredity, mitosis, art, mathematics, lifetime wellness, nutrition, history, research and writing, careers

Standard Number: **2.0 Interactions**

Standard:

The student will investigate the interactions of organisms within their environment through different relationships, population dynamics, and patterns of behavior.

Learning Expectations:

The student will

- 2.1 compare and contrast the different types of symbiotic relationships.
- 2.2 distinguish between abiotic and biotic factors in an environment.
- 2.3 analyze the flow of energy in an ecosystem using energy and biomass pyramids.
- 2.4 analyze innate and learned behaviors and relate this to the survival of the organism.
- 2.5 investigate the roles of producers, consumers, and decomposers in an ecosystem.
- 2.6 examine the effects of human activity on ecosystems.

Performance Indicators State:

As documented through state assessment,

at Level 1, the student is able to

- identify commensalism, parasitism, and mutualism, given a scenario with examples.
- classify organisms as producers, consumers, or decomposers, given their behavior and environment.

at Level 2, the student is able to

- identify abiotic and biotic factors, given a description or an illustration of an ecosystem.
- make inferences about how environmental factors would affect population growth, given a scenario.
- examine the energy flow and loss through the trophic levels of an ecosystem, given an illustration of an energy pyramid.
- determine the effects of human activities on ecosystems, given a scenario.
- analyze and interpret population growth curves, given graphs.

at Level 3, the student is able to

- distinguish between a learned and an innate behavior, given a description of that behavior in a scenario.

Performance Indicator Teacher:

As documented through teacher observation,

at Level 1, the student is able to

- compare and contrast the three types of symbiotic relationships: parasitism, mutualism, and commensalism.
- recognize the general conditions necessary to maintain an ecosystem by constructing a model of an ecosystem.
- describe the niche and habitat of an organism in an ecosystem.
- recognize the kinds of organisms found at the base of a food chain.
- identify the producers, consumers, and decomposers in a food chain.
- observe an outdoor habitat, identifying the abiotic and biotic factors, types of populations, producers, consumers, and decomposers.
- research careers that relate to the environment, such as urban planner, forester, park ranger, environmental engineer, and environmental lawyer.

at Level 2, the student is able to

- use current publications to research examples where human influence has changed an ecosystem; communicate findings through written and/or oral presentation.
- investigate the impact of parasites on human population.
- investigate the effects of acid rain on the environment.
- maintain a model of an ecosystem.
- illustrate the flow of energy through an ecosystem.
- collect data, construct and interpret population graphs to determine if the population is stable, increasing, or declining.

at Level 3, the student is able to

- investigate the behaviors and adaptations of selected organisms, and relate these to the survival of the species.
- analyze human population graphs to infer the impact on global resources, as well as economic and political systems.
- investigate factors that influence Hardy-Weinberg equilibrium.
- research and evaluate the economic and political impact of recycling on nonrenewable resources.

Sample Task:

The students will choose an ecosystem that they would like to simulate. The will design a mini ecosystem that will support at least three types of plants and animals from that ecosystem. They will observe the ecosystem daily and add water as needed. The students will observe the ecosystem inhabitants and note their behavior and growth. The students will also look for interaction between organisms and for changes that may occur.

Integration/Linkages:

energy transfer, ecology, biogeochemical cycles, mathematics/graphing, health, evolution, mutations, adaptations, immunology, physical science, geography, populations, ecology, genetics, politics, economics, natural resources, recycling, careers, sociology, research and writing

Standard Number: 3.0 Photosynthesis and Respiration

Standard:

The student will compare and contrast the biochemical processes involved in the transfer of energy during photosynthesis and respiration, and analyze the major biogeochemical cycles in the biosphere.

Learning Expectations:

The student will

- 3.1 compare and contrast the light dependent and light independent reactions of photosynthesis.
- 3.2 investigate the relationship between the processes of photosynthesis and respiration.
- 3.3 analyze the carbon, oxygen, nitrogen, and water cycles in the biosphere.
- 3.4 distinguish between aerobic and anaerobic respiration.

Performance Indicators State:

As documented through state assessment,

at Level 1, the student is able to

- identify the reactants and products of photosynthesis and respiration, given the equations.
- identify the cell organelle in which photosynthesis occurs, given a diagram of a plant.
- interpret a diagram of the oxygen-carbon dioxide cycle, given a diagram.

at Level 2, the student is able to

- distinguish between aerobic and anaerobic respiration in terms of the presence or absence of oxygen and ATP produced.
- relate the interdependence of the processes of photosynthesis and respiration to living organisms, given a diagram or a description.

at Level 3, the student is able to

- recognize the transfer of energy from respiration to cellular work, given an equation or diagram of the ATP cycle.

Performance Indicators Teacher:

As documented through teacher observation,

at Level 1, the student is able to

- identify and explore the chloroplasts in a leaf such as *Elodea.*
- construct a model or a diagram of the oxygen-carbon dioxide cycle.
- model or illustrate the paths of water, oxygen, nitrogen, and carbon dioxide through a plant.
- research careers that relate to photosynthesis and respiration, such as horticulturist, brewer, environmentalist, paper manufacturer, and agricultural extension agent.

at Level 2, the student is able to

- construct charts comparing reactants, products, and energy transfer during photosynthesis and respiration.
- demonstrate that oxygen is released during photosynthesis through a laboratory investigation.
- sequence the major events of cellular respiration and anaerobic respiration.
- investigate the importance of fermentation to the pharmaceutical, agricultural, and food and beverage industries.

at Level 3, the student is able to

- produce concept maps of the major events occurring in the light dependent and light independent reactions.
- compare the efficiency of aerobic and anaerobic respiration.

Sample Task:

Oxygen Production in Photosynthesis: Prepare three test tubes, one of each of the following: well aerated water, boiled and cooled water, and boiled and cooled water with 2 cc of a .25% sodium bicarbonate solution. Place a 3-inch twig of *Elodea*, cut end up, in each test tube. Tie the *Elodea* to a glass rod to keep it in place. Expose the tubes to full light intensity and allow to stand for several minutes. Count the bubbles released in each test tube for five minutes. Record results. Repeat the procedure, but place the tubes in darkness or cover with aluminum foil. The rate of the carbohydrates made depends on factors such as

temperature, light intensity, carbon dioxide, and water concentration. The rate of photosynthesis can be determined by noting the materials entering the reaction and determining an end product, such as oxygen.

Integration/Linkages:

interaction of organisms, physical science/equations and hydrolysis, ecology, diversity, adaptations, C3, C4, CAM, microscopes, graphs, mathematics, research and writing, chemistry, careers, physical science, concept maps

Standard Number: 4.0 Genetics and Biotechnology

Standard:

The student will investigate the concepts of genetics and heredity, different methods of reproduction, patterns of inheritance, and genetic disorders; as well as, explore and evaluate DNA technologies from both a scientific and ethical perspective.

Learning Expectations:

The student will

- 4.1 investigate the structure and molecular composition of DNA and RNA.
- 4.2 relate the structure of DNA and RNA to the processes of replication and protein synthesis.
- 4.3 compare and contrast the asexual and sexual reproductive strategies used by organisms.
- 4.4 apply the principles of Menedelian inheritance to make predictions for offspring.
- 4.5 examine modes of inheritance involving sex linkage, co-dominance, incomplete dominance, multiple alleles, and polygenic traits.
- 4.6 investigate the causes and effects of mutations.
- 4.7 identify the causes and effects of genetic diseases in plants and animals.
- 4.8 investigate the scientific and ethical ramifications of genetic engineering, recombinant DNA, selective breeding, hybridization, cell and tissue culture, transgenic animals, and DNA fingerprinting.

Performance Indicators State:

As documented through state assessment,

at Level 1, the student is able to

- distinguish between asexual and sexual methods of reproduction, using a scenario.
- identify the dominant trait, given the results of a monohybrid cross in a scenario.
- determine the genotype and phenotype of a monohybrid cross, given a Punnet square.
- relate changes in the DNA instructions to cause mutations, given diagrams.

at Level 2, the student is able to

- recognize the two major functions of DNA as replication and protein synthesis, given diagrams showing strands of bases with a complimentary strand.
- identify the sex chromosomes in humans and recognize inheritance patterns that are sex-linked, using a pedigree.
- analyze modes of inheritance including co-dominance, incomplete dominance, polygenic, and multiple alleles using genetic problems or Punnet Squares.
- describe and analyze DNA fingerprinting using an illustration of DNA bands.
- analyze a series of DNA bases to determine the sequence which demonstrates a mutation.
- determine the probability of having a child with cystic fibrosis, sickle cell anemia, or Tay Sachs if both parents are carriers, given the scenario or genetic problem.

at Level 3, the student is able to

- differentiate the processes of transcription and translation, given diagrams.
- analyze a dihybrid cross, given a completed Punnet square to determine the probability of a particular trait.

Performance Indicators Teacher:

As documented through teacher observation,

at Level 1, the student is able to

- construct a model of DNA.
- construct a monohybrid cross, given a genetic problem.
- distinguish between dominant and recessive traits, given the results of a monohybrid cross.
- research careers in genetics, such as, lab technician, forensic pathologist, livestock breeder, medical doctor, and reproductive endocrinologist

at Level 2, the student is able to

- identify a DNA molecule when given a choice of several representations.
- construct a chart comparing DNA with RNA for shape, functions, and molecular make-up.
- model the processes of replication, transcription, and translation.
- construct a dihybrid cross to predict genotypic and phenotypic ratios.
- use a microscope or hand lens to diagram and label different types of reproductive cells.
- participate in a classroom debate regarding the scientific and ethical issues surrounding current emerging DNA technologies and/or the Human Genome Project.
- model the process of recombinant DNA.

at Level 3, the student is able to

- manipulate a model of DNA to show different types of mutations.
- analyze/construct a karotype and identify abnormalities for chromosome number, deletions, and translocations.
- research a position paper defending views of the ethics of a chosen group of DNA technologies.
- apply an ethical model to evaluate current and future DNA technologies.

Sample Task:

DNA Gumdrop Lab: Students will prepare a model of a segment of DNA using large and small marshmallows, gumdrops of four different colors, and toothpicks. Give each student a specific base triplet sequence to model. Students will connect the large marshmallows (representing sugar molecules) alternately with the small marshmallows (representing phosphate groups) to represents the "sides" of the DNA. The marshmallows are connected with toothpicks (representing bonds). Assign each of the four bases a color. For example, cytosine might be red and guanine might be yellow. Connect the bases (in the order given in their base triplet sequence) to the sugar groups of one side. Connect the complementary base to the initial bases with toothpicks and then connect them to the sugar on the opposite side. The DNA model may be twisted if the students are careful. Students may exchange models and write the sequences. After studying RNA, students may use their model, divide and then model RNA using a color for uracil.

Integration/Linkages:

biological evolution, mitosis, meiosis, cell, math, probability, statistics, Hardy-Weinberg, microscope, art, research and writing, chemistry, careers, debate, adult living, lifetime wellness, physical science, communication

Standard Number: **5.0 Diversity**

Standard:

The student will investigate the diversity of organisms by analyzing taxonomic systems, exploring diverse environments, and comparing life cycles.

Learning Expectations:

The student will

- 5.1 establish criteria for designing a system of classification and compare historically relevant systems of classification used in Biology.
- 5.2 infer the types of organisms native to specific major biomes.
- 5.3 integrate a comparative study of plant and animal anatomical structures so as to recognize relationships among organisms related to structural components, symmetry, metamorphosis, and alternation of generations.

Performance Indicators State:

As documented through state assessment,

at Level 1, the student is able to

- infer animals or plants indigenous to an environment, given pictures or diagrams of the organisms and a description of the environment.
- infer the biome in which an animal or plant lives, given a description of the organism and pictures of various biomes.
- infer the relatedness of different organisms using the Linnean system of classification, given pictures of a variety of different plants or animals and a key to classification of organisms.

at Level 2, the student is able to

- determine the genus and species of an organism, given a dichotomous key containing descriptions of the characteristics of each classification level.
- determine whether an insect undergoes complete or incomplete metamorphosis, given pictures or diagrams of the insect in its stages of development.
- infer the body symmetry of an organism, given a diagram or picture of the organism.
- predict the function of a system or organ, given structural descriptions, whether in the earthworm, crayfish, frog, or human.

at Level 3, the student is able to

- predict the function of an organ, given a description of its component tissues.
- compare and contrast life cycles of various organisms to include alternation of generations, given pictorial representations.

Performance Indicators Teacher:

As documented through teacher observation,

at Level 1, the student is able to

- develop a rationale for a system of classification, given a group of objects to classify.
- examine plant and animal specimens and compare and contrast their structure, symmetry, and life cycles.
- illustrate or construct a biome for specific plant and animal species by determining the needs of the organisms.
- predict the types of plants and animals indigenous to a biome by determining the characteristics of the biome.
- research careers that relate to diversity, such as farmer, zookeeper, pest control consultant, entomologist, taxonomist, lab technician, naturalist, and botanist.

at Level 2, the student is able to

- relate the advantages and disadvantages of various classification systems, including the Aristotelian, Linnean, and DNA sequencing systems.
- model or observe the stages of complete and incomplete metamorphosis.
- model or observe body plans with asymmetry, radial, and bilateral symmetry.
- observe or illustrate the alternation of generations in a plant or animal species.
- predict the function of a system or organs give the characteristics of the organs contained within that system.
- classify a group of organisms given a dichotomous key with characteristics of the organisms.

at Level 3, the student is able to

- perform comparisons using DNA sequencing to determine relatedness of different organisms.

- compare and contrast the organs and organ system of various species of plants and animals as related to their structural components and the functions of the organs and systems.

Sample Task:

16 Bean Soup Classification: After discussing the characteristics used to determine different groups, such as age, grade level, first letter of the alphabet, etc., explain to students that classification is an arbitrary method of grouping things. At your local grocer obtain a bag of 16-bean soup mix with a variety of 16 different types of beans included. Divide your students into groups of three or four, and give each group about 1 cup of beans of different kinds. Instruct the groups to design their own system of classifying the objects you have given them. They must write out qualifications for each of their units of classification. Have each group report their system to the class, and then allow the class to adapt a system of classification for the beans. Discuss the rationale used in systems of classification (i.e. color, shapes, numbers of parts, symmetry, etc.). Relate this to the methods used by Aristotle, Linneus, and the DNA base sequencing method of determining relatedness of different organisms. Students may be evaluated by looking for some of these rationales: 1) method of grouping defined (shapes, colors, size, etc), 2) provide explanation for groupings, 3) develop a key to the groupings.

Integration/Linkages:

tessellating in mathematics, evolutionary trends in plants and animals, Fibonacci sequences in mathematics, genetics, geography, research and writing, careers, ecology, entomology, anatomy and physiology, history

Standard Number: 6.0 Biological Evolution

Standard:

The student will investigate the process of natural selection and examine the evidence for biological evolution.

Learning Expectations:

The student will

- 6.1 interpret and evaluate the evidence for biological evolution in the fossil record.
- 6.2 investigate how natural selection, mutation, and adaptation impact a species.

- 6.3 recognize the contributions of scientists, including Darwin, to the concept of evolution.
- 6.4 apply current knowledge of DNA and comparative anatomy to provide evidence for biological evolution.

Performance Indicators State:

As documented through state assessment,

at Level 1, the student is able to

- differentiate between the relative age of various fossils in sedimentary rock, given a diagram of rock strata.
- predict how environmental changes will encourage or discourage the formation of a new species or extinction of an existing species, given a written scenario.

at Level 2, the student is able to

- transfer knowledge of divergent evolution, as in Darwin's finches, to determine why species with a common ancestor have adapted differently, given a diagram of the various species.
- compare homologous structures in species to determine the relatedness of certain species, given diagrams or pictures of each.
- differentiate between natural selection and selective breeding, given a scenario.

at Level 3, the student is able to

- recognize the relatedness of species using DNA strands.

Performance Indicators Teacher:

As documented through teacher observation,

at Level 1, the student is able to

- compare and contrast the processes of fossil formation.
- construct mock fossils using casts and molds.
- collect and/or observe various fossils and relate them to biogeographical changes.
- research careers that relate to biological evolution, such as farmers, field biologist, geologist, archeologist, epidemiologist, and anthropologist.

at Level 2, the student is able to

- calculate the approximate age of a fossil, given the amount of Carbon-14 atoms found in the fossil and the half-life of Carbon-14.
- compare and contrast the homologous and analogous structures of organisms to demonstrate relatedness.
- analyze a graph of population distribution of peppered moths as their environment changed.
- predict the role of mutation in population change.

at Level 3, the student is able to

- develop a diorama or time line that depicts change of organisms through time.
- collect data from local or regional records regarding population counts of a specific species found in the area and hypothesize what events might affect populations.

Sample Task:

Given a specific biome of the world, select a natural event that might affect the organisms living in the biome. With this knowledge, predict what adaptations would become more important than they seemed in the past. Design a "new" organism that might appear because of the adaptations that might be necessary. Draw the organism and give it a name. Present your organism to the class and explain why you think it might have formed and what traits are evident.

Integration/Linkages:

genetics/inheritance of traits, diversity of life, mathematics/calculations, graphing and time lines, microscopy, physical science, geology, populations, history, genetics, geography, earth science, bacteria, disease