Strand: III. Use Scientific Knowledge from the Life Sciences in Real-World Contexts

Content Standard: 1. All students will apply an understanding of cells to the functioning of multi-cellular organisms; and explain how cells grow, develop, and reproduce. (Cells)

Benchmark
Explain how multi-cellular organisms grow, based on how cells grow and reproduce (SCI.III.1.HS.1).

Benchmark Clarification
The cell is the basic unit of life and comes from preexisting cells.
Students will use their knowledge of cell theory to:

- Explain mitosis, meiosis, and differentiation and how they relate to growth in a multi-cellular organism
- Explain that respiration provides energy for making cell components
- Describe how the chemical composition of cells originates from outside the cell, such as the products of digested food, which are used as the building blocks by the cell to synthesize more complex chemicals
- Show how growth of multi-cellular organisms is the result of an increase in the number of cells, not just a change in their size

Key Concepts (voc.)
Specialized functions of cells:

- respiration
- protein synthesis
- mitosis
- meiosis

Basic molecules for cell growth:

- simple sugars
- amino acids
- fatty acids

See Respiration *SCI.III.2.HS.3*.
See Meiosis *SCI.III.3.HS.2*.
See Cells *SCI.III.2.MS.4*.

Basic chemicals, molecules, and atoms:

- water
- minerals
- carbohydrates
- fats and lipids
- nucleic acids
- carbon
- hydrogen
- oxygen
- nitrogen

Cells come only from other cells

Real-World Context
The growth of plants and animals e.g., onion.

Instructional Example SCI.III.1.HS.1

Benchmark Question: How do multi-cellular organisms grow, based on how cells grow and reproduce?
Focus Question: Why are multi-cellular organisms made of many small cells instead of one large cell?

The teacher will give students potato cubes of different sizes (3 cm, 2 cm, 1 cm) to soak in iodine (Lugal's solution) overnight. The next day they should remove the cubes from the iodine and slice them in half to show how far the iodine entered the cube. Students should write an explanation that associates this movement of iodine with the movement of essential materials moving in and out of a cell. The explanation should include these ideas:

1. The smaller the cell, the more efficient the movement of materials is for the whole cell.
2. The more efficient the movement of materials is for the whole cell, the more efficient the cell becomes.

Constructing: (*link to SCI.I.1.HS.1*), (*link to SCI.I.1.HS.2*).

Reflecting: (*link to SCI.II.1.HS.1*).

Resources/References:
Webliography.
http://mtn.merit.edu/mcf/SCI.III.1.HS.1.html

Cell photos.
http://www.cellsalive.net/
Cell types.
http://library.thinkquest.org/3546/

Mitosis.
http://biog-101-104.bio.cornell.edu/BioG101/
http://104/tutorials/celldivision.html/

Mitosis pictures.
http://www.biologylessons.sdsu.edu/classes/lab8.html

Classroom Assessment Example SCI.III.1.HS.1

The teacher will give students a written description and include a visual (e.g., picture, diagram, etc.) of how size limits the efficiency of cells to move basic molecules for cell growth. Students will write a description that relates how molecules moving in and out of the cell affect the ability of a cell to function.

(Give students rubric before activity.)

Scoring of Classroom Assessment Example SCI.III.1.HS.1

Criteria	Apprentice	Basic	Meets	Exceeds
Accuracy of concepts	Explains the concept but in a vague and incomplete way.	Explains some concepts but not the relationship.	Describes the relationship between material movement and cell function.	Describes the relationship with an example or added relevant information.
Completeness of explanation	Explains without supporting details.	Explains with partial supporting details.	Explains with related details from the activity.	Explains with details from the activity and relates to basic molecules.
Effectiveness of visuals	Explains without a visual.	Explains with a visual; missing some components.	Explains with an accurate and complete visual.	Explains with additional examples of visuals.
Correctness of mechanics	Explains with inappropriate vocabulary or grammar.	Explains with partially correct vocabulary and grammar.	Explains with appropriate vocabulary and grammar.	Explains with extended vocabulary and complex sentences.

Strand: III. Use Scientific Knowledge from the Life Sciences in Real-World Contexts

Content Standard: 1. All students will apply an understanding of cells to the functioning of multi-cellular organisms; and explain how cells grow, develop, and reproduce. (Cells)

Benchmark
Compare and contrast ways in which selected cells are specialized to carry out particular life functions (SCI.III.1.HS.2).

Benchmark Clarification
A cell is an integration of organelles, each performing a specific role that allows the cell to sustain life. Some specific tasks include: reproduction, transport, and photosynthesis.

Students will:
- Compare and contrast cells with different functions
- Determine how cells are specialized to perform specific tasks by relating cell structure to cell function
- Observe and explain differences among plant, animal, and bacterial cells

Key Concepts (voc.)
Classifications of organisms by cell type:
- plant
- animal
- bacteria
- selected cells
-

See Photosynthesis *SCI.III.2.MS.3*.
See Reproduction *SCI.III.3.HS.2*.

Selected specialized plant and animal cells:
- red blood cells
- white blood cells
- muscle cells
- nerve cells
- root cells
- leaf cells
- stem cells

Cell parts used for classification:
- organelle
- nucleus
- cell wall
- cell membrane

Specialized functions:

- reproduction
- photosynthesis
- transport

Cell shape

Real-World Context
Specialized plant and animal cells:
- red blood cells
- white blood cells
- muscle cells
- nerve cells
- root cells
- leaf cells
- stem cells
- bacteria

Instructional Example SCI.III.1.HS.2

Benchmark Question: How are selected cells specialized to carry out particular life functions?
Focus Question: How does the physical appearance of a cell indicate the possible function of the cell?

The teacher will have students use pictures of different kinds of specialized cells from books, internet sources, or prepared slides to observe structural differences. Each student will write an explanation of how the overall structure of a cell relates to its function (e.g., a nerve cell.) Students should identify any specific organelles present and relate these organelles to the function of the cell (e.g., chloroplast with photosynthesis in a plant).

Constructing: (*link to SCI.I.1.HS.1*), (*link to SCI.I.1.HS.4*).

Reflecting: (*link to SCI.II.1.HS.1*), (*link to SCI.II.1.HS.2*), (*link to SCI.II.1.HS.3*).

Resources/References:
Webliography.
http://mtn.merit.edu/mcf/SCI.III.1.HS.2.html

Cell pictures.
http://cellsalive.com/

Cell types.
http://library.thinkquest.org/3546/

Respiration.
http://www.purchon.com/biology/respire.htm

Classroom Assessment Example SCI.III.1.HS.2

Each student will design, construct, and label a cell with six or more different structures. Based on the structures used, each student will write a paragraph describing what the cell is able to do.

(**Extension:** Have students design a new kind of cell whose primary function is movement.)

(Give students rubric before activity.)

Scoring of Classroom Assessment Example SCI.III.1.HS.2

Criteria	Apprentice	Basic	Meets	Exceeds
Construction of cell model	Constructs a model with fewer than three accurate labels and structures.	Constructs a model with three to five accurate labels and structures.	Constructs a model with six accurate labels and structures.	Constructs a model with more than six accurate labels and structures.
Explanation of relationship	Explains the relationship between fewer than three structures and the cell's function.	Explains the relationship between three to five structures and the cell's function.	Explains the relationship between six structures and the cell's function.	Explains the relationship between more than six structures and the cell's function.

Strand: III. Use Scientific Knowledge from the Life Sciences in Real-World Contexts

Content Standard: 2. All students will use classification systems to describe groups of living things; compare and contrast differences in the life cycles of living things; investigate and explain how living things obtain and use energy; and analyze how parts of living things are adapted to carry out specific functions. (Organization of Living Things)

Benchmark
Classify major groups of organisms to the kingdom level (SCI.III.2.HS.1).

Benchmark Clarification
Classifications are not etched in stone. They change over time. Many classification systems can be used to organize living things into groups with similar characteristics.

Students will:
- Identify and describe the characteristics used to place organisms into each kingdom (*link to Glossary*)
- Discuss the dynamic (changeable) nature of our classification system

Kingdom: the highest ranking classification of living organisms that falls into one of five major groups: Protista, Animalia, Plantae, Monera, and Fungi

Key Concepts (voc.)
Kingdom categories:
- Protista
- Fungi
- Monera
- Animalia
- Plantae

Characteristics for classification:
- cell wall
- cell membrane
- organelle
- single-celled
- multi-celled

Real-World Contex
Common local representatives of each of the five major kingdoms:
- paramecium
- yeast
- mushroom
- bacteria
- frog
- geranium

Instructional Example SCI.III.2.HS.1

Benchmark Question: How are organisms classified to the kingdom level?
Focus Question: What specific characteristics are used to divide organisms into the major kingdoms?

Using preserved and live organisms and a list of characteristics associated with the major kingdoms, small groups of students will sort the organisms into their appropriate kingdom groups. As a group, students will write a summary of the problems encountered with placing organisms into groups based solely on visible, physical characteristics. As a group, students will generate a list of ideas on other possible ways to classify organisms.

Extension: Students could make taxonomic keys for their specimens.

Constructing: (*link to SCI.I.1.HS.4*), (*link to SCI.I.1.HS.5*).

Reflecting: (*link to SCI.II.1.HS.1*), (*link to SCI.II.1.HS.2*).

Resources/References:
Webliography.
http://mtn.merit.edu/mcf/SCI.III.2.HS.1.html

Family tree.
http://phylogeny.arizona.edu/

Taxonomy.
http://www.ucmp.berkeley.edu/help/taxaform.html

Classroom Assessment Example SCI.III.2.HS.1

The teacher will give each student a set of ten or more organisms (at least one from each kingdom). Each student will classify the organisms into the appropriate kingdom. The student will give orally his or her reasons for the placement of each organism into its kingdom.

(Give students rubric before activity.)

Scoring of Classroom Assessment Example SCI.III.2.HS.1

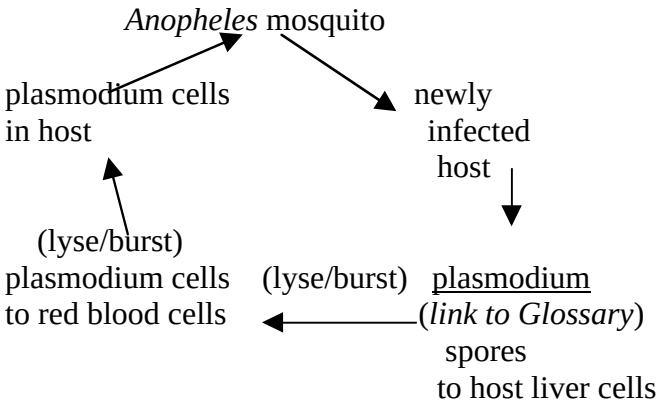
Criteria	Apprentice	Basic	Meets	Exceeds
Correctness of classification	Places six or fewer organisms in the correct kingdom.	Places seven to eight organisms in the correct kingdom.	Places nine organisms in the correct kingdom.	Places more than nine organisms in the correct kingdom.
Accuracy of explanation	Explains accurately the reason(s) for placing six or fewer organisms into their proper kingdoms.	Explains accurately the reason(s) for placing seven or eight organisms into their proper kingdoms.	Explains accurately the reason(s) for placing nine organisms into their proper kingdoms.	Explains accurately the reason(s) for placing more than nine organisms into their proper kingdoms.

Strand: III. Use Scientific Knowledge from the Life Sciences in Real-World Contexts

Content Standard: 2. All students will use classification systems to describe groups of living things; compare and contrast differences in the life cycles of living things; investigate and explain how living things obtain and use energy; and analyze how parts of living things are adapted to carry out specific functions. (Organization of Living Things)

Benchmark
Describe the life cycle of an organism associated with human disease (SCI.III.2.HS.2).

Benchmark Clarification
Many disease-causing organisms have predictable stages in their life cycles. Different organisms have different stages in their life cycles.
For example, malaria is carried by the *Anopheles* mosquito.



Students will:
- Research the life cycle of a disease-causing organism
- Diagram the stages of the life cycle for a human disease-causing organism
- Write a short description of each stage in the organism's life cycle

Plasmodium: a sporazoan (Protista) that is transferred to humans by mosquitoes and produces malarial symptoms of fever and chills

Key Concepts (voc.)
Infection process:
- disease
- parasite
- host
- infection

Observation tools:
- microscope
- hand lens

Real-World Context
Life cycle of organism(s) associated with a human disease(s):

- Lyme disease
  - tick
- malaria
  - mosquito
- parasites

Instructional Example SCI.III.2.HS.2

Benchmark Question: What is the life cycle of an organism that causes human disease?
Focus Question: How does a human disease-causing organism pass through its life cycle? What part does the human host play in perpetuating the life cycle?

Pairs of students will research in the library or on the web the life cycle of an organism causing human disease. Students should put the separate stages of the life cycle on individual cards and practice placing the cards in the proper order. Then they should diagram the life cycle of their organism and report to the class. Each student will write a paragraph comparing the life cycles of two different organisms presented. Each student will list ways that the organisms influence the human host.

Constructing: (*link to SCI.I.1.HS.4*), (*link to SCI.I.1.HS.5*).

Reflecting: (*link to SCI.II.1.HS.6*).

Resources/References:
Webliography.
http://mtn.merit.edu/mcf/SCI.III.2.HS.2.html

Deer Tick Ecology.
http://www.aldf.com/templates/DeerTickEcology.cfm

Deer Tick Lyme Disease- Parasite Life Cycle.
http://www.biosci.ohio-state.edu/~parasite/home.html

Classroom Assessment Example SCI.III.2.HS.2

Each student will report on the life cycle of a disease-causing organism and clearly explain the stages in his or her diagram.

(Give students rubric before activity.)

Scoring of Classroom Assessment Example SCI.III.2.HS.2

Criteria	Apprentice	Basic	Meets	Exceeds
Accuracy of diagram	Diagrams and labels a partially completed life cycle.	Diagrams and labels a life cycle missing one or two components.	Diagrams and labels a complete life cycle.	Draws and labels a complete life cycle with an explanation of each stage. Summarizes the life cycle with additional information accurately.
Completeness of presentation	Summarizes the life cycle with more than two errors.	Summarizes the life cycle with one or two errors.	Summarizes the life cycle accurately.	Speaks with creative or engaging manner.
Effectiveness of presentation	Speaks in an inappropriate or distracting manner.	Speaks unclearly or lacks clarity.	Speaks clearly and to the point.	

Strand: III. Use Scientific Knowledge from the Life Sciences in Real-World Contexts

Content Standard: 2. All students will use classification systems to describe groups of living things; compare and contrast differences in the life cycles of living things; investigate and explain how living things obtain and use energy; and analyze how parts of living things are adapted to carry out specific functions. (Organization of Living Things)

Benchmark
Explain the process of food storage and food use in organisms (SCI.III.2.HS.3).

Benchmark Clarification
Food contains organic compounds, which are needed to support life on Earth. Many different materials are consumed by organisms.

Students will:

- Trace food energy from the Sun, by direct or indirect paths, to all organisms
- Describe how food produced by photosynthesis is distributed to cells as a form of stored energy and then converted to a useful form of energy in a chemical reaction involving oxygen (aerobic respiration)
- Describe how the energy in food can be stored by organisms and used for energy in the future

Key Concepts (voc.)

- cellular respiration
- photosynthesis
- oxygen
- sunlight
- carbon dioxide
- carbohydrate
- fat
- protein
- minerals
- water

See Photosynthesis *SCI.III.2.MS.3*.
See How organisms grow *SCI.III.1.HS.1*.
See How plants store food *SCI.III.2.MS.3*.
See How food and oxygen are distributed to cells *SCI.III.2.MS.4*.
See The Sun as the ultimate source of energy for organisms *SCI.III.5.MS.2*.
See Energy transformations *SCI.IV.2.MS.3*.

Real-World Context
Food storage:

- maple tree; maple sap
- potato; starch
- honeybee; honey
- cow; beef, milk

Energy change:

- weight gain and weight loss
- change in respiration rates with exercise

Instructional Example SCI.III.2.HS.3

Benchmark Question: How is food use in organisms related to food storage?
Focus Question: How much energy is stored in food molecules for future use by organisms?

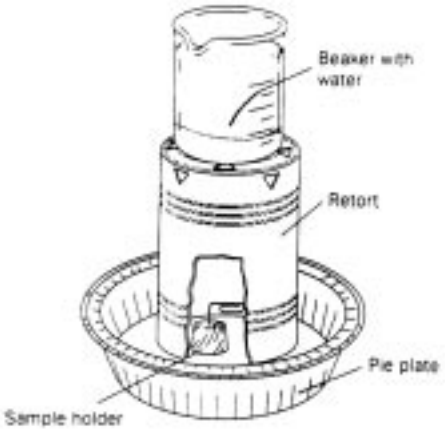
The teacher will give each pair of students a simple calorimeter to measure the amount of heat energy contained in a variety of nuts (i.e., pecans, peanuts, walnuts, etc.).

- Calories = [(* mass of water heated) x (change in temperature)] ÷ (change in mass of the nut).

***** 1 gram of water = 1 ml of water

Each pair of students will compare the calculated calorie values for the different nut samples. They should evaluate which type of nuts stores the most energy. As a class they should discuss how the plant uses this nut energy and how other organisms use the nut for energy.

Extension: Students can measure the calories contained in other common food sources in the same way.



Calorimeter example

Constructing: (*link to SCI.I.1.HS.1*), (*link to SCI.I.1.HS.2*), (*link to SCI.I.1.HS.3*).

Reflecting: (*link to SCI. II.1.HS.1*), (*link to SCI.II.1.HS.2*), (*link to SCI.II.1.HS.3*).

Resources/References:
Webliography.
http://mtn.merit.edu/mcf/SCI.III.2.HS.3.html

Calories.
http://www.accessexcellence.org/AE/AEPC/WWC/1991/food.html

Classroom Assessment Example SCI.III.2.HS.3

The teacher will give each pair of students ten or more labels from prepared foods. Students should find the total calories per serving and the mass of one serving on the label. Then students will divide the calories by the mass to get calories/gram. The students will evaluate which food has the most stored energy. Students should support their answers by ranking the foods in order from the most to the least stored energy.

(Give students rubric before activity.)

Scoring of Classroom Assessment Example III.2.HS.3

Criteria	Apprentice	Basic	Meets	Exceeds
Correctness of evaluation	Ranks correctly seven or fewer labels.	Ranks correctly eight to nine labels.	Ranks correctly ten labels.	Ranks correctly more than ten labels.

Strand: III. Use Scientific Knowledge from the Life Sciences in Real-World Contexts

Content Standard: 2. All students will use classification systems to describe groups of living things; compare and contrast differences in the life cycles of living things; investigate and explain how living things obtain and use energy; and analyze how parts of living things are adapted to carry out specific functions. (Organization of Living Things)

Benchmark
Explain how living things maintain a stable internal environment (SCI.III.2.HS.4).

Benchmark Clarification
An organism's external environment may be changed by weather, global warming, earthquakes, floods, etc., but an organism's internal environment is stable. An organism's stability is maintained by feedback within the different systems.

Students will:
- Describe how an organism's internal environment responds to change
- Explain why an organism's internal environment is stable
- Explain homeostasis (*link to Glossary*)
- Describe the human immune system's response to invading organisms

Homeostasis:the maintenance of physiological stability, for example internal temperature, within a narrow range in spite of environmental changes.

Key Concepts (voc.)
Related systems/cells/chemicals:
- excretory system
- endocrine system
- circulatory system
- hormones
- immune response
- white blood cell
- bacteria
- virus

Factors/mechanisms under control:
- temperature
- disease/infection
- homeostasis

Real-World Context
Mechanisms for maintaining internal stability:
- body temperature
- disease control

Instructional Example SCI.III.2.HS.4

Benchmark Question: How do living things maintain a stable internal environment?
Focus Question: What steps must be taken to maintain a stable system?
Working in groups without any verbal communication, students should maintain a constant temperature of a beaker filled with hot water. Using two beakers of water, one large and one small, a thermometer, cold water, and a heat source, students should maintain the large beaker of water at approximately 50^{o}C. Students then should describe the process their group used to maintain the constant temperature. (If available, use probes and graphing programs; this will give students more accurate feedback.)

Constructing: (*link to SCI. I.1.HS.1*), (*link to SCI. I.1.HS.2*).

Reflecting: (*link to SCI.II.1.HS.1*).

Resources/References:
Webliography.
http://mtn.merit.edu/mcf/SCI.III.2.HS.4.html
Homeostasis.
http://www.britannica.com/5eo/m/metabolic-disease/

Homeostasis with feedback loop.
http://bioserve.latrobe.edu.au/vcebiol/cat1/aos2/u3aos21.html

Classroom Assessment Example SCI.III.2.HS.4

The teacher will explain the Homeostasis Feedback Loop Model (*See resource website)*
Each student will be given a human homeostatic condition (e.g., temperature, sugar level, breathing, etc.). The student will draw and label a diagram of a feedback loop for the assigned condition. Each student will present an oral explanation of the steps in his or her feedback loop diagram.

(Give students rubric before activity.)

Scoring of Classroom Assessment Example III.2.HS.4

Criteria	Apprentice	Basic	Meets	Exceeds
Accuracy of diagram	Draws and labels a diagram with more than two errors.	Draws and labels a diagram with one or two errors.	Draws and labels a diagram of a feedback loop that will function.	Draws and labels a diagram with an explanation of each stage.
Correctness of order	Connects the events with more than one error.	Connects the events with one error.	Connects the events in a complete and accurate manner.	Connects the events in a complete and accurate manner with additional information.

Strand: III. Use Scientific Knowledge from the Life Sciences in Real-World Contexts

Content Standard: 2. All students will use classification systems to describe groups of living things; compare and contrast differences in the life cycles of living things; investigate and explain how living things obtain and use energy; and analyze how parts of living things are adapted to carry out specific functions. (Organization of Living Things)

Benchmark
Describe technology used in the prevention, diagnosis, and treatment of diseases and explain its function in terms of human body processes (SCI.III.2.HS.5).

Benchmark Clarification
Technology is used to prevent, diagnose, and treat diseases.

Students will:
- Identify the types of technology used to maintain health in individuals
- Identify the types of technology used to maintain health in a community
- Assess how technology is used to improve the health of individuals
- Analyze the body's response to medical interventions such as organ transplants, medicines, and inoculations

Key Concepts (voc.)
Available technologies:
- sanitation
- adequate food and water supplies
- inoculation
- antibodies
- biochemistry
- medicines
- organ transplants
-

See Ultrasound/x-ray *SCI.IV.4.HS.4*

Real-World Context
Common contexts for these technologies:
- health maintenance and disease prevention activities:
  - exercise
  - controlled diets
- health monitoring activities:
  - various screening tests for cancer such as pap smear, mammogram, psa, colonoscopy

Instructional Example SCI.III.2.HS.5

Benchmark Question: What technology is used in the prevention, diagnosis, and treatment of diseases?
Focus Question: What activities and technologies support a healthy lifestyle?

Each pair of students will research what is meant by good health, using the library and/or the web. As a class, describe a healthy lifestyle. Based on this information, each student will develop two lists of health maintenance and disease prevention activities: without technology and with technology.

Examples of lifestyle activities:

- Exercise program - heart monitor, exercise equipment, walking
- Diets – cholesterol screening, food supplements, genetically altered food, organic food
- Other life choices – skin care (sunscreen), moisturizer, face lift, liposuction
- Medical evaluations – blood pressure screening, glucose monitor, dental check-ups

Students will present their findings to the class. As a class, students will rank/order these activities from the most important to the least important.

Each student will write a plan to maintain a healthy lifestyle that includes activities and technologies that he or she will use.

Constructing: (*link to SCI.I.1.HS.4*), (*link to SCI.I.1.HS.5*).

Reflecting: (*link to SCI.II.1.HS.3*), (*link to SCI.II.1.HS.5*).

Resources/References:
Webliography.
http://mtn.merit.edu/mcf/SCI.III.2.HS.5.html

Health maintenance.
http://cpmcnet.columbia.edu/texts/gcps/

Health maintenance.
http://www.looksmart.com/eus1/eus65300/eus65303/eus77824/eus541028/eus54861/eus54928/eus70180/r?l&/

Classroom Assessment Example SCI.III.2.HS.5

The teacher will present the following scenario to the class:

You are a physician's assistant. Identify the condition of a patient who needs to change an unhealthy lifestyle. Make a list to be given to the patient of at least three healthy behaviors and their benefits. Also, include any technology that could be used by the patient or practitioner to promote this healthy lifestyle.

Working with a partner, pairs of students will write a dialogue between the patient and the physician's assistant. This dialogue must include an explanation of at least three healthy behaviors, their benefits, and the technology that would be used.

(Give students rubric before activity.)

Scoring of Classroom Assessment Example SCI.III.2.HS.5

Criteria	Apprentice	Basic	Meets	Exceeds
Completeness of list	Identifies condition and zero to one healthy behaviors with appropriate technology.	Identifies condition and two healthy behaviors with appropriate technology.	Identifies condition and three healthy behaviors with appropriate technology.	Identifies condition and four or more healthy behaviors with appropriate technology.
Completeness of dialogue	Conversation is incomplete and/or not believable.	Conversation has main ideas but no details. It is not quite believable.	Conversation has main ideas and some details. It is believable.	Conversation has main ideas, many details, and is very believable.

Strand: III. Use Scientific Knowledge from the Life Sciences in Real-World Contexts

Content Standard: 3. All students will investigate and explain how characteristics of living things are passed on through generations; explain why organisms within a species are different from one another; and explain how new traits can be established by changing or manipulating genes. (Heredity)

Benchmark
Explain how characteristics of living things are passed on from generation to generation (SCI.III.3.HS.1).

Benchmark Clarification
Characteristics of living things are passed on from generation to generation by an organism's genes.

Students will:

- Diagram how the gene pair in one parent will separate and make sex cells that will combine with a sex cell from the other parent to form offspring
- Predict the characteristics of possible offspring, given the gene combinations of the parents
- Trace a trait from generation to generation (e.g., sickle cell anemia)

Key Concepts (voc.)
Traits:

- dominant
- recessive

Genetic material:

- gene pair
- gene combination
- gene sorting

Real-World Context
Common contexts:

- inheritance of a human genetic disease/disorder:
    - sickle cell anemia
- a family tree focused on certain traits
- examining animal or plant pedigrees

Instructional Example SCI.III.3.HS.1

Benchmark Question: How are characteristics of living things passed on from generation to generation?
Focus Question: How can a trait be traced from generation to generation?

Each pair of students will create a pedigree chart based on a given characteristic (attached and free ear lobes, sickle cell anemia, tongue rolling, etc)*. Students should identify dominant and recessive gene combinations (e.g., aa, Aa, AA, A? [can't be determined]) for individuals on the chart.

Extension: Predict the possible gene combinations and physical traits for a cross with one of your offspring and a recessive individual.

***** Teachers should be aware that this only works for single allele traits (not hair color, eye color, etc.).

Constructing: (*link to SCI.I.1.HS.1*), (*link to SCI.I.1.HS.2*).

Reflecting: (*link to SCI.II.1.HS.1*), (*link to SCI.II.1.HS.3*).

Resources/References:
Webliography.
http://mtn.merit.edu/mcf/SCI.III.3.HS.1.html

Gerbil genotypes.
http://www.crwh.freeserve.co.uk/gerbils/gerbils.htm

Classroom Assessment Example SCI.III.3.HS.1

The teacher will give a pedigree chart with phenotypes listed for all individuals to each student. Each student will provide the gene combinations for all individuals (e.g., aa, AA, Aa, A?).

(Give students rubric before activity.)

Scoring of Classroom Assessment Example SCI.III.3.HS.1

The number of correctly identified gene combinations is the student's score.
Meeting the standard is a score of 80% or more.

Strand: III. Use Scientific Knowledge from the Life Sciences in Real-World Contexts

Content Standard: 3. All students will investigate and explain how characteristics of living things are passed on through generations; explain why organisms within a species are different from one another; and explain how new traits can be established by changing or manipulating genes. (Heredity)

Benchmark
Describe how genetic material is passed from parent to young during sexual and asexual reproduction (SCI.III.3.HS.2).

Benchmark Clarification
Genetic material is passed from parent to young during sexual reproduction or asexual reproduction.

Students will:

- Compare and contrast the processes of meiosis (*link to Glossary*) and mitosis (*link to Glossary*)
- Compare and contrast sexual reproduction (*link to Glossary*) and asexual reproduction (*link to Glossary*)
- Explain how DNA replicates
- Explain why sexual reproduction provides greater variation in individuals, and within a population, compared to asexual reproduction

Meiosis: type of cell division that results in daughter cells with the haploid (half) number of chromosomes, occurs during the production of eggs and sperm

Mitosis: type of cell division in which daughter cells receive the exact chromosome number and genetic makeup of the parent cell, occurs during cell growth and repair

Sexual reproduction: reproduction in which the union of two nuclei, usually of different genetic makeup, results in the formation of a single new nucleus

Asexual reproduction: reproduction without sex, without the union of two sets of chromosomes

Key Concepts (voc.)
Types of cell division:

- mitosis
- meiosis

DNA replication, chromosome

Types of reproduction:

- sexual
- asexual

Genetic variation

Tools:

- A-V media
- diagrams showing DNA replication during cell division

Real-World Context
Fruit flies, yeast, reproduction by spores, cloning

Instructional Example SCI.III.3.HS.2

Benchmark Question: How does genetic material pass from parent to young during sexual and asexual reproduction?
Focus Question: How does DNA replicate?

With each student representing a nitrogen base, students will model the replication of DNA. Example: Give students cards with the nitrogen bases of DNA (adenine, guanine, cytosine, thymine). Have one-quarter of the students form a single chain with their bases. Other students should then match their complementary bases to the first strand to form one double strand. The teacher acts as the enzyme to unzip the DNA and form two single strands. The teacher then matches new complementary bases to the bases in the original two strands. Students should compare the two new strands to each other and to the original strand. After replicating DNA, the class will discuss how this replication of DNA relates to cell division.

Constructing: (*link to SCI.I.1.HS.2*), (*link to SCI.I.1.HS.5*).

Reflecting: None

Resources/References:
Webliography.
http://mtn.merit.edu/mcf/SCI.III.3.HS.2.html

Meiosis.
http://www.looksmart.com/eus1/eus53706/eus53712/eus53774/eus330259/eus951709/r?l&/

Mitosis.
http://www.looksmart.com/eus1/eus53706/eus53712/eus53774/eus330259/eus951708/r?1&/

Classroom Assessment Example SCI.III.3.HS.2

With a partner, students will write a story in which a student becomes a nitrogen base. Each pair of students will explain the events, step by step, that happen to the student (nitrogen base) from the beginning to the end of DNA replication. Each pair of students will use their knowledge of this scientific process and appropriate scientific vocabulary in the story.

Extension:

1. Research cloning and present a speech explaining reasons for or against human cloning.
2. Research gene manipulation and present a speech explaining reasons for or against gene manipulation.)

(Give students rubric before activity.)

Scoring of Classroom Assessment Example SCI.III.3.HS.2

Criteria	Apprentice	Basic	Meets	Exceeds
Accuracy of DNA replication	Provides an account of the steps of DNA replication with more than one error.	Provides an account of the steps of DNA replication with one error.	Provides an accurate account of the steps of DNA replication.	Provides an accurate account of the steps of DNA replication with creativity.
Correctness of mechanics	Explains with inappropriate vocabulary or grammar.	Explains with partially correct vocabulary or grammar.	Explains with appropriate vocabulary and grammar.	Explains with extended vocabulary and exceptional grammar.

Strand: III. Use Scientific Knowledge from the Life Sciences in Real-World Contexts

Content Standard: 3. All students will investigate and explain how characteristics of living things are passed on through generations; explain why organisms within a species are different from one another; and explain how new traits can be established by changing or manipulating genes. (Heredity)

Benchmark
Explain how new traits may be established in individuals/populations through changes in genetic material (DNA) (SCI.III.3.HS.3).

Benchmark Clarification

New traits may be established in individuals/populations through changes in genetic material. Students will:

- Show how a mutation (*link to Glossary*) in a nucleotide sequence may show up as a change in the trait of the individual
- Identify mutation-causing factors in the environment
- Debate the positive and negative effects of human manipulation of the DNA
- Show how a beneficial trait would become part of the genetic materials in members of a population

Mutation: an inheritable change in the sequence of bases within a gene

Key Concepts (voc.)
Genetic changes:

- variation
- new gene combinations
- mutation
-

See How new traits become established in populations *SCI.III.4.MS.2*.

Natural and human-produced sources of mutation:

- radiation
- chemical

Real-World Context
Products of genetic engineering:

- medical advances
    - insulin
    - cancer drugs
- agricultural-related products
    - navel oranges
    - new flower colors
    - higher-yield grains
- effects of natural and man-made contamination

Examples of variations due to new gene combinations:

- hybrid organisms
- new plant varieties resulting from multiple sets of genes

Instructional Example SCI.III.3.HS.3

Benchmark Question: How are new traits established in individuals/populations through changes in genetic material (DNA)?
Focus Question: What are the positive and negative effects of agricultural chemicals that may cause mutations?

In small groups of four, students will research agricultural chemicals commonly used on apples, cherries, oranges, corn, wheat, and oats. Two students will take a positive position and two students will take a negative position based on the facts they discover in their research. Each student should represent a specific group. Opposing groups could include parents expecting a child, scientists, agricultural companies, farmers, and local governmental and environmental groups.

Students will debate the positive and negative effects of agricultural chemicals that may cause mutations. The debate will be presented to the class as a forum for a state committee on agricultural chemical use.

Note: Role-plays of this type work best if there is a middle-of-the-road group to help the extremes come to some consensus.

Constructing: (*link to SCI.I.1.HS.4*), (*link to SCI.I.1.HS.5*).

Reflecting: *(link to SCI.II.1.HS.1),* (*link to SCI.I.1.HS.5*), (*link to SCI.II.1.HS.2*), (*link to SCI.II.1.HS.3*), (*link to SCI.II.1.HS.4*), (*link to SCI.II.1.HS.5*), (*link to SCI.II.1.HS.6*), (*link to SCI.II.1.HS.7*).

Resources/References:
Webliography.
http://mtn.merit.edu/mcf/SCI.III.3.HS.3.html

DNA Manipulation.
http://library.thinkquest.org/20830/main.html

Classroom Assessment Example SCI.III.3.HS.3

Each student will pick from a pile of cards marked pro and con for agricultural chemical use that may cause mutations. Each student will write a position paper based on the card that states the position and supports the position with factual information cited in the debate or found in the research.

(Give students rubric before activity.)

Scoring of Classroom Assessment Example SCI.III.3.HS.3

Criteria	Apprentice	Basic	Meets	Exceeds
Clarity of Position	Misstates the card's position.	States the card's position with some vagueness.	States the card's position in a clear manner.	States the card's position in a convincing manner.
Accuracy of position	States the card's position in an inaccurate manner.	States the card's position with one inaccuracy.	States the card's position in an accurate manner.	States the card's position in an accurate and thoughtful manner.
Validity of evidence	States no supporting arguments.	States one to two valid supporting arguments.	States three valid supporting arguments.	States more than three valid supporting arguments.
Correctness of mechanics	Explains with inappropriate vocabulary and grammar.	Explains with partially correct vocabulary and grammar.	Explains with appropriate vocabulary and grammar.	Explains with extended vocabulary and exceptional grammar.

Strand: III. Use Scientific Knowledge from the Life Sciences in Real-World Contexts

Content Standard: 4. All students will explain how scientists construct and scientifically test theories concerning the origin of life and evolution of species; compare ways that living organisms are adapted (suited) to survive and reproduce in their environments; and analyze how species change through time. (Evolution)

Benchmark
Describe what biologists consider to be evidence for human evolutionary relationships to selected animal groups (SCI.III.4.HS.1).

Benchmark Clarification
Biologists have differing opinions about the evidence for human evolutionary relationships with selected animal groups.

Students will:
- Analyze and interpret evidence supporting a progression from a common ancestry (*link to Glossary*)
- List and discuss what biologists consider to be evidence that humans evolved from more primitive forms

Common ancestry: the principle that species have descended from the same forerunner

Key Concepts (voc.)
Common types of evidence used:
- hominid fossils
- vestigial structures
- DNA
- protein structure

Real-World Context

Skeletal comparisons:
- modern human to hominid fossils

Anatomical and biochemical similarities of humans and other higher primates:
- blood proteins

Similarity of early human embryo stages to those of other vertebrates

Vestigial structures:
- appendix
- tail bone

Instructional Example SCI.III.4.HS.1

Benchmark Question: How do biologists evaluate evidence for human evolutionary relationships to selected animal groups?
Focus Question: How do biologists evaluate evidence that humans evolved from more primitive forms of life?

The teacher will present the following scenario:

An evolutionary biologist has been given the following information about the amino acid sequences of a protein (e.g., hemoglobin) found in the following animals.

Working in pairs, students will write an essay explaining how they might compare amino acid sequences and describe the possible evolutionary relationships between two animals.

	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101
Human	THR	LEU	SER	GLU	LEU	HIS	CYS	ASP	LYS	LEU	HIS	VAL	ASP	PRO	GLU
Chimpanzee	THR	LEU	SER	GLU	LEU	HIS	CYS	ASP	LYS	LEU	HIS	VAL	ASP	PRO	GLU
Gorilla	THR	LEU	SER	GLU	LEU	HIS	CYS	ASP	LYS	LEU	HIS	VAL	ASP	PRO	GLU
Rhesus monkey	GLN	LEU	SER	GLU	LEU	HIS	CYS	ASP	LYS	LEU	HIS	VAL	ASP	PRO	GLU
Horse	ALA	LEU	SER	GLU	LEU	HIS	CYS	ASP	LYS	LEU	HIS	VAL	ASP	PRO	GLU
Kangaroo	LYS	LEU	SER	GLU	LEU	HIS	CYS	ASP	LYS	LEU	HIS	VAL	ASP	PRO	GLU

	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116
Human	ASN	PHE	ARG	LEU	LEU	GLY	ASN	VAL	LEU	VAL	CYS	VAL	LEU	ALA	HIS
Chimpanzee	ASN	PHE	ARG	LEU	LEU	GLY	ASN	VAL	LEU	VAL	CYS	VAL	LEU	ALA	HIS
Gorilla	ASN	PHE	LYS	LEU	LEU	GLY	ASN	VAL	LEU	VAL	CYS	VAL	LEU	ALA	HIS
Rhesus monkey	ASN	PHE	LYS	LEU	LEU	GLY	ASN	VAL	LEU	VAL	CYS	VAL	LEU	ALA	HIS
Horse	ASN	PHE	ARG	LEU	LEU	GLY	ASN	VAL	LEU	ALA	LEU	VAL	VAL	ALA	ARG
Kangaroo	ASN	PHE	LYS	LEU	LEU	GLY	ASN	ILE	ILE	VAL	ILE	CYS	LEU	ALA	GLU

Human hemoglobin is being used as the standard for comparison.

Constructing: (*link to SCI.I.1.HS.1*), (*link to SCI.I.1.HS.4*), (*link to SCI.I.1.HS.5*).

Reflecting: (*link to SCI.II.1.HS.2*), (*link to SCI.II.1.HS.4*).

Resources/References:
Basic Evolution.
http://www.indiana.edu/~ensiweb/

Classroom Assessment Example SCI.III.4.HS.1

In small groups, students will construct a tree diagram that shows the evolutionary relationships among the vertebrates investigated in the instructional example. Students will describe their tree and explain the relationships using supporting evidence from the chart given in the instructional example in a presentation to the class.

(Give students rubric before activity.)

Scoring of Classroom Assessment Example SCI.III.4.HS.1

Criteria	Apprentice	Basic	Meets	Exceeds
Accuracy of evolutionary tree diagram	Draws and labels an evolutionary tree with more than two inaccuracies.	Draws and labels an evolutionary tree with one or two inaccuracies.	Draws and labels a complete and accurate evolutionary tree.	Draws and labels a complete evolutionary tree with exceptional quality.
Explanation of evidence	Provides inaccurate evidence for three or more branches based on chart.	Provides inaccurate evidence for two branches based on chart.	Provides accurate evidence for all branches based on chart.	Provides accurate evidence for all branches with explanations.

Strand: III. Use Scientific Knowledge from the Life Sciences in Real-World Contexts

Content Standard: 4. All students will explain how scientists construct and scientifically test theories concerning the origin of life and evolution of species; compare ways that living organisms are adapted (suited) to survive and reproduce in their environments; and analyze how species change through time. (Evolution)

Benchmark
Explain how a new species or variety may originate through the evolutionary process of natural selection (SCI.III.4.HS.2).

Benchmark Clarification
A new species or variety of an organism may originate through the process of natural selection.

Students will:

- Describe how changes within the environment select for survival and reproduction of certain individuals
- Predict how the selection for specific traits might result in the development of a new species
- Relate natural selection to the development of new populations (e.g., a strain of bacteria becoming resistant)
- Identify the differences between inherited and non-inherited traits

Key Concepts (voc.)
Concept of species; how new species or varieties are established:

- natural selection
- inheritable/non-inheritable characteristics
- species variation

Real-World Context
Common contexts:

- Contemporary examples of natural selection:
  - bacteria resistance to antibiotics
  - insect resistance to pesticides
- examples of artificial selection:
  - agricultural-selection to increase production
  - selecting desired traits for pets
- historical examples of naive explanations of evolution such as the Lamarckian explanation of the evolution of the giraffe's long neck

Instructional Example SCI.III.4.HS.2

Benchmark Question: How do new species or varieties originate through the evolutionary process of natural selection?
Focus Question: How are new populations developed through natural selection?
Small groups of students will grow bacterial colonies on agar plates containing a 0.5% concentration of antiseptic*. Students should transfer the surviving bacteria to agar with increasing concentrations of antiseptic agar**. When the maximum concentration is reached (about 15%), some of the original stock colony (0%) will be transferred directly to another plate with the highest concentration (15%). Growth on the two plates with the highest concentration will be analyzed. Students should develop an explanation for the difference between the two plates (A new population developed through natural selection when the surviving bacteria was transferred from plate to plate of increasing concentration)***. Each student will write a lab report demonstrating that he or she has followed the steps of the scientific method.

* Lysol
** Only use purchased bacteria that are acceptable for classroom use.
*** Can be done as a demonstration.

Constructing: (*link to SCI.I.1.HS.4*), (*link to SCI.I.1.HS.5*).

Reflecting: *(link to SCI.II.1.HS.1),* (*link to SCI.I.1.HS.5*), (*link to SCI.II.1.HS.3*), (*link to SCI.II.1.HS.4*), (*link to SCI.II.1.HS.6*), (*link to SCI.II.1.HS.7*).

Resources/References:
Webliography.
http://mtn.merit.edu/mcf/SCI.III.4.HS.2.html

Basic Evolution.
http://www.indiana.edu/~ensiweb/

Scopes Monkey Trial.
http://www.thirteen.org/wnetschool/origlessons/evolution

Classroom Assessment Example SCI.III.4.HS.2

The teacher will present the following scenario:

Suppose that an earthquake separates Michigan from its surrounding states, preventing animals from living together. The white-tailed deer population that lives in Michigan and around its once surrounding states can no longer live together and mate.

Each student will write an essay explaining how two different species of deer may evolve through time in Michigan from the common ancestor, the white-tailed deer now that there are two separate populations.

(Give students rubric before activity.)

Scoring of Classroom Assessment Example SCI.III.4.HS.2

Criteria	Apprentice	Basic	Meets	Exceeds
Correctness of responses	Answers with two correct responses.	Answers with three correct responses.	Answers with four correct responses.	Answers with five correct responses.

Strand: III. Use Scientific Knowledge from the Life Sciences in Real-World Contexts

Content Standard: 5. All students will explain how parts of an ecosystem are related and how they interact; explain how energy is distributed to living things in an ecosystem; investigate and explain how communities of living things change over a period of time; describe how materials cycle through an ecosystem and get reused in the environment; and analyze how humans and the environment interact. (Ecosystems)

Benchmark
Describe common ecological relationships between and among species and their environments (SCI.III.5.HS.1).

Benchmark Clarification

A population's size is an indication of the conditions in the environment.

Students will:
- List biotic (*link to Glossary*) and abiotic (*link to Glossary*) factors in a given environment
- Identify and describe the biotic and abiotic factors that impact and influence a specific population's size
    - Describe possible interactions between two biotic and abiotic factors

Biotic: living or once living (e.g., both a raccoon and a dead raccoon are biotic factors)

Abiotic: nonliving (e.g., wind, temperature, light intensity, soil composition)

Key Concepts (voc.)
- competition
- territory
- carrying capacity
- natural balance
- population
- dependence
- survival
- biotic
- abiotic factors

Real-World Context
- Animals that live in packs or herds and plant colonies:
    - wolvesbison
    - lilies and other bulb plants
    - various forms of algae
    - selected ecosystems

Instructional Example SCI.III.5.HS.1

Benchmark Question: What are the common ecological relationships between and among species and their environments?
Focus Question: What are the abiotic and biotic factors within a given habitat?
The teacher will plan a field trip to habitats near the school (parks, school yard, etc.). Students will work in small groups to conduct a field survey of a local habitat. They will organize the collected information into two data tables: Biotic Factors and Abiotic Factors. Information may include types of plants and animals, density of selected plants and animals, soil profile, soil organisms, percent ground cover, available light, and height of community. Each small group will present their data to the class. Each member of the small group will explain how two factors interact

Note: If you can't go to a habitat, bring the habitat to the classroom through pictures, the web, etc.

Extension: Visit more than one habitat and compare the factors from the different habitats.

Constructing: (*link to SCI.I.1.HS.1*), (*link to SCI.I.1.HS.2*), (*link to SCI.I.1.HS.3*), (*link to SCI.I.1.HS.4*).

Reflecting: (*link to SCI.II.1.HS.1*), (*link to SCI.II.1.HS.6*).

Resources/References:
Webliography
http://mtn.merit.edu/mcf/SCI.III.5.HS.1.html
Biome climate data.
http://www.climate.org/

British Ecological Society.
http://www.demon.co.uk/bes/

Ecology Current Events.
http://www.ecotopia.com/

Ecology Reference Materials.
http://www.gale.com/

General Ecology.
http://www.biogeography.com/

Monitor Ecosystems and Global Change.
http://www.forest.gsfc.nasa.gov/

"Project Globe."
http://www.globe.gov/

Classroom Assessment Example SCI.III.5.HS.1

Working with a partner, students will create a two- or three-dimensional model of a habitat. Each pair of students will label ten or more biotic and abiotic factors with numbers. Each pair of students will make a key of all of the numbered biotic and abiotic factors found in their habitat. Each student will choose one abiotic factor and summarize its effects on the biotic factors in the ecosystem in a paragraph. Each student will choose one biotic factor and summarize its effects on the abiotic factors in the ecosystem in a paragraph. Each pair of students will present their model and individual explanations to the class.

(Give students rubric before activity.)

Scoring of Classroom Assessment Example SCI.III.5.HS.1

Criteria	Apprentice	Basic	Meets	Exceeds
Construction of habitat model	Constructs a model with fewer than eight accurate components.	Constructs a model with eight to nine accurate components.	Constructs a model with ten accurate components.	Constructs a model with more than ten accurate components or with exceptional quality.
Completeness of model	Creates a key with fewer than eight accurately labeled components.	Creates a key with at least eight to nine accurately labeled components.	Creates a key with at least ten accurately labeled components.	Creates a key with more than ten accurately labeled components.
Accuracy of explanation	Explains correctly zero to one effect for either a biotic or abiotic factor.	Explains correctly one effect for each biotic and abiotic factor.	Explains correctly two effects for each biotic and abiotic factor.	Explains correctly three or more effects for each biotic and abiotic factor.

Strand: III. Use Scientific Knowledge from the Life Sciences in Real-World Contexts

Content Standard: 5. All students will explain how parts of an ecosystem are related and how they interact; explain how energy is distributed to living things in an ecosystem; investigate and explain how communities of living things change over a period of time; describe how materials cycle through an ecosystem and get reused in the environment; and analyze how humans and the environment interact. (Ecosystems)

Benchmark
Explain how energy flows through familiar ecosystems (SCI.III.5.HS.2).

Benchmark Clarification
Energy is constantly flowing through an ecosystem. As it flows through the ecosystem, it is changed from one form of energy to another.

Students will:
- Construct the energy relationships in an ecosystem's food web
- Describe how only a fraction of the available energy is used for growth and incorporated in the plant or animal itself at each stage of the food web
- Analyze how energy transformation and the cycling of matter in ecosystems are related

Key Concepts (voc.)
- Participants and relationships:
  - food chain
  - food web
  - energy pyramid
  - energy flow
  - producers
  - consumers
  - decomposers

See Producers *SCI.III.2.MS.3*.
See Conservation of energy *SCI.IV.2.HS.4*.

Real-World Context
Energy pyramids for food chains in selected ecosystems

Instructional Example SCI.III.5.HS.2

Benchmark Question: How does energy flow through familiar ecosystems?
Focus Question: How do plants and animals that are in a habitat fit into a food web or food chain?

Note: Students will write the names of plants and animals from their habitat field trip on index cards. See previous benchmark (*link to SCI.III.5.HS.1*). If the students have not studied a specific habitat, the teacher will generate a list of names of plants and animals for the students to transfer onto index cards.

Pairs of students will create a food web using index cards with the names of given organisms from an ecosystem. Each pair of students will present an explanation of how these organisms interact with and depend on one another to the class.

Extension: Remove one species from the above food web. Explain how this change affects the flow of energy through the food web.

Constructing: (*link to SCI.I.1.HS.1*), (*link to SCI.I.1.HS.4*).

Reflecting: (*link to SCI.II.1.HS.1*), (*link to SCI.II.1.HS.6*).

Resources/References:
Webliography.
http://mtn.merit.edu/mcf/SCI.III.5.HS.2.html

Food Web.
http://www.terraquest.com/galapagos/education/reference/web.html

Lesson Plans.
http://www.hood-consulting.com/amazing/lessons/ecology.html

Lesson Plans.
http://www.s1n.fi.edu/tfi/units/life/habitat/habitat.html

Successional Activity.
http://www.msta-mich.org/publications/meap/succession_lesson.pdf

Classroom Assessment Example SCI.III.5.HS.2

The teacher will give each student a list of ten organisms and their food sources from a single ecosystem. The student will use these organisms to design a food web and will label organisms as consumers, producers, or decomposers.

(Give students rubric before activity.)

Scoring of Classroom Assessment Example SCI.III.5.HS.2

Criteria	Apprentice	Basic	Meets	Exceeds
Construction of food web	Connects fewer than eight organisms to their correct food sources.	Connects eight or nine organisms to their correct food sources.	Connects all ten organisms to their correct food sources.	Connects all ten organisms to their correct food sources in an easily read manner.
Correctness of labels	Labels organisms with more than three errors.	Labels organisms with two or three errors.	Labels organisms with one error.	Labels organisms without errors.

Strand: III. Use Scientific Knowledge from the Life Sciences in Real-World Contexts

Content Standard: 5. All students will explain how parts of an ecosystem are related and how they interact; explain how energy is distributed to living things in an ecosystem; investigate and explain how communities of living things change over a period of time; describe how materials cycle through an ecosystem and get reused in the environment; and analyze how humans and the environment interact. (Ecosystems)

Benchmark
Describe general factors regulating population size in ecosystems (SCI.III.5.HS.3).

Benchmark Clarification
General factors such as habitat, disease, competition, floods, etc. regulate a population's size in an ecosystem.

Students will:

- Predict how specific changes within the environment may increase/decrease a population's size
- Analyze how specific human activities may affect population sizes
- Identify the environmental (biotic or abiotic) factors that may affect the carrying capacity of a population

Key Concepts (voc.)

- carrying capacity
- competition
- parasitism
- predation
- loss of habitat

Real-World Context
Common factors that influence relationships:

- weather
- disease
- predation
- migration

Instructional Example SCI.III.5.HS.3

Benchmark Question: How do general factors regulate population size in an ecosystem?
Focus Question: How does competition affect the carrying capacity of a population?

Students will write predictions of the effects of crowding on the growth of seedlings. In small groups, students will design and carry out an experiment that compares trays with different densities (concentration equally distributed) of plants (e.g., radishes). Students will observe the affects of crowding on the different populations of plants and the abiotic factors for which the plants were competing (e.g., light, water, nutrients, etc.).

Constructing: (*link to SCI.I.1.HS.1*), (*link to SCI.I.1.HS.2*), (*link to SCI.I.1.HS.5*).

Reflecting: (*link to SCI.II.1.HS.1*), (*link to SCI.II.1.HS.6*).

Resources/References:
Webliography.
http://mtn.merit.edu/mcf/SCI.III.5.HS.3.html

Ecological Footprints of Nations.
http://www.ecouncil.ac.cr/rio/focus/report/English/footprint/

Human Population.
http://www.population-awareness.net/

Human Population Study.
http://www.dieoff.org/page110.htm

Classroom Assessment Example SCI.III.5.HS.3

Students will write individual lab reports that describe their experiments and explain the observed effects of crowding on the different populations of plants from the experiments they designed in the instructional example. Abiotic factors for which the plants competed, evidence from the lab to support the explanation, and an explanation of any discrepancies in the data should be included.

(Give students rubric before activity.)

Scoring of Classroom Assessment Example SCI.III.5.HS.3

Criteria	Apprentice	Basic	Meets	Exceeds
Clarity of conclusion	Misstates the conclusion.	States the conclusion with some vagueness.	States the conclusion in a clear manner.	States the conclusion in a convincing manner.
Accuracy of conclusion	States the conclusion in an inaccurate manner.	States the conclusion with one inaccuracy.	States the conclusion in an accurate manner.	States the conclusion in an accurate and thoughtful manner.
Completeness of explanation	Explains with no details from the lab.	Explains with partial details from the lab.	Explains with complete details from the lab.	Explains with details from the lab and relates to real world conditions.
Correctness of mechanics	Explains with inappropriate vocabulary and grammar.	Explains with partially correct vocabulary and grammar.	Explains with appropriate vocabulary and grammar.	Explains with extended vocabulary and exceptional grammar.

Strand: III. Use Scientific Knowledge from the Life Sciences in Real-World Contexts

Content Standard: 5. All students will explain how parts of an ecosystem are related and how they interact; explain how energy is distributed to living things in an ecosystem; investigate and explain how communities of living things change over a period of time; describe how materials cycle through an ecosystem and get reused in the environment; and analyze how humans and the environment interact. (Ecosystems)

Benchmark
Describe responses of an ecosystem to events that cause it to change (SCI.III.5.HS.4).

Benchmark Clarification
External events, natural or man-made, can cause an ecosystem to change in many ways.

Students will:

- Diagram the process of slow changes over time in the environment (ecological succession)
- Predict how an external force affects ecological succession
- Explain the relationship between the stability of an ecosystem and its biodiversity (organisms can adapt, migrate, or die)

Key Concepts (voc.)

- succession
- pioneer
- climate/physical conditions
- introduction of new/different species
- elimination of existing species
- biodiversity
- cataclysmic changes

Real-World Context

- climax forests comprised of:
  - maple
  - beech
  - conifers
- effects of urban sprawl or clear cutting forests
- effects of cataclysmic changes such as the eruption of Mt. St. Helen
- effects of global warming

Instructional Example SCI.III.5.HS.4

Benchmark Question: What are the responses of an ecosystem to events that cause it to change?
Focus Question: What are the changes over time in the environment that occur over time (ecological succession)?

Students will identify the sequence of communities, from pioneer to climax, in a local ecosystem. The teacher can provide pictures for this activity. Pairs of students will construct and explain a two- or three-dimensional representation of each of the stages. They should include in their explanations a name for each stage, important facts about each stage, and an estimate of how long the stage lasts. See Succession Activity (*resource website)* Alternate: Students will identify and discuss the dominant and supporting plants and animals in each stage of succession. They will discuss the other factors that support the plants and animals (e.g., soil profile, soil organisms, organism density, ground cover, percent of sunlight, and height of community).

Constructing: (*link to SCI.I.1.HS.4*), (*link to SCI.I.1.HS.5*).

Reflecting: (*link to SCI.II.1.HS.6*).

Resources/References:
Webliography.
http://mtn.merit.edu/mcf/SCI.III.5.HS.4.html

Biodiversity and Biological Collections.
http://www.biodiversity.uno.edu/

Forest Succession.
http://www.hawthorne.omsi.edu/explore/life/forestpuzzles/cycles/

Invasion of Water Fleas in Great Lakes.
http://www.sciencenetlinks.com/sciupdate/waterfleas.html

Lesson Plans.
http://www.smp.rest.mb.ca/balharm/succession.htm

Species Extinction.
http://www.wri.org/biodiv/extinction.html

Succession Activity.
http://www.msta-mich.org/publications/meap/succession_lesson.pdf

Classroom Assessment Example SCI.III.5.HS.4

The teacher will locate a climax community near the school. The teacher will take students on a field trip to this area. Students will research the changes that have happened in this area or another area like it. The teacher will divide students into small groups. Students will create a timeline for the return of organisms if a fire destroyed the area today. The teacher will provide a list of organisms representative of all stages. See Succession Activity (*resource website*).

(Give students rubric before activity.)

Scoring of Classroom Assessment Example SCI.III.5.HS.4

Criteria	Apprentice	Basic	Meets	Exceeds
Correctness of order	Generates a timeline with four or more inaccuracies.	Generates a timeline with fewer than four inaccuracies.	Generates a timeline with correct order of organisms.	Generates a timeline with correct order of organisms in a clear manner and with pictures.

Strand: III. Use Scientific Knowledge from the Life Sciences in Real-World Contexts

Content Standard: 5. All students will explain how parts of an ecosystem are related and how they interact; explain how energy is distributed to living things in an ecosystem; investigate and explain how communities of living things change over a period of time; describe how materials cycle through an ecosystem and get reused in the environment; and analyze how humans and the environment interact. (Ecosystems)

Benchmark
Describe how carbon and soil nutrients cycle through selected ecosystems (SCI.III.5.HS.5).

Benchmark Clarification
Many materials cycle through an ecosystem. Carbon and soil nutrients are two of these materials.

Students will:
- Analyze the process of how plants take common nutrients and build organic compounds
- Describe how plants and animals use organic compounds for growth, maintenance, and reproduction (include respiration and photosynthesis)
- Illustrate how these compounds are broken down (decomposers) and cycled through the living and non-living parts of the environment

Key Concepts (voc.)
Common nutrients/elements:
- nitrogen
- sulfur
- carbon
- phosphorus
-

See Cell respiration *SCI.III.2.HS.3*.
See Photosynthesis *SCI.III.2.MS.3*.

Inorganic compounds containing nutrients:
- soil minerals
- carbon dioxide

Organic compounds in living communities:
- proteins
- fats
- carbohydrates

Real-World Context
Movement of food materials through various food webs, including decomposition

Instructional Example SCI.III.5.HS.5

Benchmark Question: How do carbon and soil nutrients cycle through selected ecosystems?
Focus Question: How do plants and animals use materials in the processes of photosynthesis and respiration?

Students will work in small groups and write a story explaining how the carbon in carbon dioxide passes from plants to animals, from animals to decomposers, and from decomposers back to plants. Students will include explanations of photosynthesis and cellular respiration in their stories. The teacher will tell them their target audience is a class of upper elementary students. Diagrams or visual aids may be added.

Constructing: (*link to SCI.I.1.HS.4*), (*link to SCI.I.1.HS.5*).

Reflecting: (*link to SCI.II.1.HS.3*).

Resources/References:
Webliography.
http://mtn.merit.edu/mcf/SCI.III.5.HS.5.html

Roles of Microbes.
http://www.sciencenetlinks.com/index.html

Classroom Assessment Example SCI.III.5.HS.5

Each student will write an essay/constructed response based on a carbon dioxide molecule. Each student will trace carbon as it travels within an ecosystem, through the processes of photosynthesis and cellular respiration.

(Give students rubric before activity.)

Scoring of Classroom Assessment Example SCI.III.5.HS.5

Criteria	Apprentice	Basic	Meets	Exceeds
Completeness of essay	Answers with fewer than three key points.	Answers with three correct key points.	Answers with four correct key points.	Answers with more than four correct key points.

Strand: III. Use Scientific Knowledge from the Life Sciences in Real-World Contexts

Content Standard: 5. All students will explain how parts of an ecosystem are related and how they interact; explain how energy is distributed to living things in an ecosystem; investigate and explain how communities of living things change over a period of time; describe how materials cycle through an ecosystem and get reused in the environment; and analyze how humans and the environment interact. (Ecosystems)

Benchmark
Explain the effects of agriculture and urban development on selected ecosystems (SCI.III.5.HS.6).

Benchmark Clarification
Agriculture and urban development have had many effects on ecosystems.

Students will:
- Identify the specific impacts of agriculture, manufacturing, recreation, and urban development on ecosystems
- Research how decisions that impact the environment are made by governments and businesses
- Debate the value of protecting the environment vs. the economic impact of those decisions
- Discuss how natural resources can be protected and at the same time used

Key Concepts (voc.)
Common factors that influence ecosystems:
- pollution of ecosystems
  - fertilizer
  - insecticides
  - other chemicals
  - land management
  - biodiversity
  - sustainability
  - loss of habitat
  -

See Risk/benefit analysis *SCI.IV.1.HS.1*.
See Water pollution *SCI.V.2.HS.2*.

Real-World Context
Common factors that influence ecosystems:
- pollution of ecosystems from:
  - agriculture
  - industry
  - urban development

Instructional Example SCI.III.5.HS.6

Benchmark Question: What are the effects of agriculture and urban development on selected ecosystems?
Focus Question: What is the impact of pollution on an ecosystem?

Students will work in small groups to develop an experiment to determine the impact of a specific pollutant on a specific population of plants and animals. Each student will summarize, discuss, and analyze the effects on an ecosystem in a lab report.

Example:
Predict how different concentrations of phosphate detergents and liquid fertilizer high in nitrogen will affect the growth of duckweed*. Design an experiment to test how different concentrations of nitrates and phosphates affect the growth of Duckweed. Count the number of leaflets in the population at the beginning and the end of the experiment**.

***** Duckweed can be found in most freshwater ponds and can be grown in an aquarium for a long period of time.
****** Any lab dealing with populations of organisms will require monitoring over several days or weeks.

Extension: Students may want to test the effects of *used* motor oil concentrations on the duckweed populations. Remember to dispose of oil at a recycling center.

Constructing: (*link to SCI.I.1.HS.1*), (*link to SCI.I.1.HS.2*), (*link to SCI.I.1.HS.5*).

Reflecting: (*link to SCI.II.1.HS.1*), (*link to SCI.II.1.HS.3*), (*link to SCI.II.1.HS.5*), (*link to SCI.II.1.HS.6*).

Resources/References:
Webliography.
http://mtn.merit.edu/mcf/SCI.III.5.HS.6.html

Human Impact.
http://www.aqua.org/education/teachers/chesapeake.html

Classroom Assessment Example SCI.III.5.HS.6

With a partner, students will create a comic book that illustrates the effects of a selected pollutant on a habitat in their area. The comic book should include both dialogue/captions and illustrations. The book should include the following concepts:

- Source of the pollutant (farm, sewer system, power plant, etc.)
- Mechanism of dispersal for pollutant (e.g., wind, groundwater, etc.)
- Short-term effects on one organism
- Long-term effects on one organism
- Short-term effects on the entire habitat
- Long-term effects on the entire habitat
- Social concerns of humans
- Economic concerns of humans

(Give students rubric before activity.)

Scoring for Classroom Assessment Example SCI.III.5.HS.6

Criteria	Apprentice	Basic	Meets	Exceeds
Completeness of contents	Answers with fewer than three correct responses from list above.	Answers with three correct responses from list above.	Answers with four correct responses from list above.	Answers with more than four correct responses from list above.
Accuracy of concepts	Conveys concepts inaccurately.	Conveys some concepts accurately.	Conveys all concepts accurately.	Conveys all concepts accurately with creativity and quality.