Seventh Grade Companion Document
7-Unit 3: Structures and Processes of Living Things

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Introduction to the K-7 Companion Document
An Instructional Framework

Overview

The Michigan K-7 Grade Level Content Expectations for Science establish what every student is expected to know and be able to do by the end of Grade Seven as mandated by the legislation in the State of Michigan. The Science Content Expectations Documents have raised the bar for our students, teachers and educational systems.

In an effort to support these standards and help our elementary and middle school teachers develop rigorous and relevant curricula to assist students in mastery, the Michigan Science Leadership Academy, in collaboration with the Michigan Mathematics and Science Center Network and the Michigan Science Teachers Association, worked in partnership with Michigan Department of Education to develop these companion documents. Our goal is for each student to master the science content expectations as outlined in each grade level of the K-7 Grade Level Content Expectations.

This instructional framework is an effort to clarify possible units within the K-7 Science Grade Level Content Expectations. The Instructional Framework provides descriptions of instructional activities that are appropriate for inquiry science in the classroom and meet the instructional goals. Included are brief descriptions of multiple activities that provide the learner with opportunities for exploration and observation, planning and conducting investigations, presenting findings and expanding thinking beyond the classroom.

These companion documents are an effort to clarify and support the K-7 Science Content Expectations. Each grade level has been organized into four teachable units- organized around the big ideas and conceptual themes in earth, life and physical science. . The document is similar in format to the Science Assessment and Item Specifications for the 2009 National Assessment for Education Progress (NAEP). The companion documents are intended to provide boundaries to the content expectations. These boundaries are presented as “notes to teachers”, not comprehensive descriptions of the full range of science content; they do not stand alone, but rather, work in conjunction with the content expectations. The boundaries use seven categories of parameters:

a. **Clarifications** refer to the restatement of the “key idea” or specific intent or elaboration of the content statements. They are not intended to denote a sense of content priority. The clarifications guide assessment.
b. **Vocabulary** refers to the vocabulary for use and application of the science topics and principles that appear in the content statements and expectations. The terms in this section along with those presented

within the standard, content statement and content expectation comprise the assessable vocabulary.

c. **Instruments, Measurements and Representations** refer to the instruments students are expected to use and the level of precision expected to measure, classify and interpret phenomena or measurement. This section contains assessable information.
d. **Inquiry Instructional Examples** presented to assist the student in becoming engaged in the study of science through their natural curiosity in the subject matter that is of high interest. Students explore and begin to form ideas and try to make sense of the world around them. Students are guided in the process of scientific inquiry through purposeful observations, investigations and demonstrating understanding through a variety of experiences. Students observe, classify, predict, measure and identify and control variables while doing “hands-on” activities.
e. **Assessment Examples** are presented to help clarify how the teacher can conduct formative assessments in the classroom to assess student progress and understanding
f. **Enrichment and Intervention** is instructional examples the stretch the thinking beyond the instructional examples and provides ideas for reinforcement of challenging concepts.
g. **Examples, Observations, Phenomena** are included as exemplars of different modes of instruction appropriate to the unit in which they are listed. These examples include reflection, a link to real world application, and elaboration beyond the classroom. These examples are intended for instructional guidance only and are not assessable.
h. **Curricular Connections and Integrations** are offered to assist the teacher and curriculum administrator in aligning the science curriculum with other areas of the school curriculum. Ideas are presented that will assist the classroom instructor in making appropriate connections of science with other aspects of the total curriculum.

This Instructional Framework is NOT a step-by-step instructional manual but a guide developed to help teachers and curriculum developers design their own lesson plans, select useful portions of text, and create assessments that are aligned with the grade level science curriculum for the State of Michigan. It is not intended to be a curriculum, but ideas and suggestions for generating and implementing high quality K-7 instruction and inquiry activities to assist the classroom teacher in implementing these science content expectations in the classroom.

7th Grade Unit 3:
Structures and Processes of Living Things

Content Statements and Expectations

7 – Unit 3: Structures and Processes of Living Things

Big Ideas (Key Concepts)

- All living organisms are composed of cells, from one cell to many cells and they exhibit cell growth and division.
- Specialized cells within multi-cellular organisms form different kinds of tissues and organs and organ systems that function together.
- Photosynthesis transforms light energy to chemical energy making possible the building of key chemical building blocks of living organisms.
- All organisms have a life span and must reproduce in order to continue the species. Reproduction may be asexual or sexual.

Clarification of Content Expectations

Standard: Organization of Living Things

Content Statement – L.OL.M.2

Cell Functions- All organisms are composed of cells, from one cell to many cells. In multicellular organisms, specialized cells perform specialized functions. Organs and organ systems are composed of cells, and function to serve the needs of cells for food, air, and waste removal. The way in which cells function is similar in all living organisms.

Content Expectations

L.OL.07.21 Recognize that all organisms are composed of cells (single cell organisms, multicellular organisms).

Instructional Clarifications

1. All living organisms are composed of cells. Organisms may be composed of just one cell others may consist of many cells.
2. Protists can be observed as examples of single-celled organisms.
3. Plants can be used to observe multicellular structure.

Assessment Clarifications

1. Recognize is to be able to distinguish between organisms that are one-celled and those that are multicellular based on observable characteristics.

L.OL.07.22 Explain how cells make up different body tissues, organs, and organ systems.

Instructional Clarifications

1. Explain is to clearly describe by means of illustrations (drawing), demonstrations, and/or verbally, that:
    a. Tissue consists of cells of similar structure.
    b. Organs are made up of tissues of different types.
    c. Organ systems serve the needs of cells for food, air, and waste removal.
2. The intent is to relate organ systems to their basic cell structure and function (tissues and individual specialized cells). The intent is NOT to address human body systems that are included in fifth grade content expectations (L.OL.05.41, L.OL.05.42). Plants are a practical choice to examine tissues, organs and organ systems.
3. In multicellular organism:
    a. Tissues are composed of groups of similar specialized cells, for example, in animals, muscle, nerve, bone and others. In plants, epidermis, conductive tissue, and distinct photosynthetic layers in leaves.
    b. Organs are composed of different types of tissues. For example, in animals, the heart contains nerve tissue, muscle tissue, and other tissues. In plants, leaves contain conductive tissue, epidermal tissue and layers of photosynthetic tissue.
    c. Organ systems are composed of different organs. For example, the digestive system is composed of esophagus, stomach, small intestine, etc.
    d. Organs and organ systems are composed of cells and function to serve the needs of cells for food, air, water, and waste removal.
4. Excluded: Structure and function of specific tissues and cells within organs (e.g., different types of blood cells or muscle cells.)

Assessment Clarification:

1. The intent is to relate organ systems to their basic cell structure and function (tissues and individual specialized cells). The intent is NOT to address human body systems that are included in fifth grade content expectations (L.OL.05.41, L.OL.05.42). Plants are a practical choice to examine tissues, organs and organ systems.

L.OL.07.23 Describe how cells in all multicellular organisms are specialized to take in nutrients, which are used to make the materials that a cell or organism needs.

Instructional Clarifications

1. Describe is to tell or depict in spoken or written words how nutrients pass through cell membranes by diffusion.
2. Cells in all multicellular organisms have cell membranes that allow some nutrients to pass through to the interior of the cell by diffusion.

3. Nutrients that cannot pass through the membrane by diffusion can be taken into the cell through active transport (uses cell energy).
4. Nutrients taken in by the cell also provide materials to build cell structures and specialized molecules used by the organisms.
5. Exclusion: endocytosis, exocytosis and cell organelles.

Assessment Clarification

1. Student will describe how nutrients pass through cell membranes by and are used to provide energy for work of the cell and materials that the cell needs.

L.OL.07.24 Recognize that cells function in a similar way in all organisms.

Instructional Clarifications

1. Recognize is to be aware that cells function in a similar way in all organisms.
2. Organisms need food, oxygen, and removal of wastes. These needs are actually at the cellular level. Cells perform the same basic life functions in all organisms (take in food, oxygen, and removal of waste).
3. The cells of all organisms require nutrients to provide energy and building materials.
4. Cell functions include general and specialized jobs performed by cells.

Assessment Clarifications

1. Describe basic life functions performed by cells.
2. Recognize that cells function in a similar way in all organisms.

Content Statement - L.OL.M.3

Growth and Development- Following fertilization, cell division produces a small cluster of cells that then differentiate by appearance and function to form the basic tissues of multicellular organisms.

Content Expectations

L.OL.07.31 Describe growth and development in terms of increase of cell number and or cell size.

Instructional Clarifications

1. Describe is to tell or depict in spoken or written words
    a. how division of cells and their subsequent growth leads to an increase in cell number and an increase in the size of multicellular organisms.
    b. how growth in one-celled organisms is due to an increase in cell size.
2. Growth of one-celled organisms is limited to increase in cell size.
3. Growth of multicellular organisms is due to both increase in cell size and increase in cell number.

4. Cells in multicellular organisms increase in cell number by cell reproduction (cell division). A larger multicellular organism has more cells than a smaller organism of the same species.

Assessment Clarifications

1. Describe how division of cells leads to an increase in cell number and an increase in the size of multicellular organisms.
2. Exclusion: The phases of mitosis are excluded at this grade level.
3. Describe how growth in one-celled organisms is due to an increase in cell size.

L.OL.07.32 Examine how through cell division, cells can become specialized for specific functions.

Instructional Clarifications

1. Examine is to investigate how cell division in multicellular organisms leads to the development of specialized tissues, organs and organ systems.
2. Sexually reproducing multicellular organisms begin as a fertilized egg and develop into complex organisms with specialized systems, organs, tissues and cells. As cell division and growth occur, differentiation into specialized cells also occurs.
3. Some cells produced by cell division develop specialized structure and are able to perform particular functions.
4. A variety of specialized cells formed through cell division make up different tissues, performing different functions.
5. Students have difficulty discriminating between cell division, enlargement, and differentiation. They may believe that living things grow because their cells get larger. Students poorly understand the roll of cell differentiation in growth.

Assessment Clarifications

1. Investigate how continued cell division in multicellular organisms leads to the development of specialized tissues, organs and organ systems.
2. Infer that the large number of cells in a multicellular organism, make possible the development of tissues, organs, and organ systems.

Content Statement - L.OL.M.6

Photosynthesis - Plants are producers; they use the energy from light to make sugar molecules from the atoms of carbon dioxide and water. Plants use these sugars along with minerals from the soil to form fats, proteins and carbohydrates. These products can be used immediately, incorporated into the cells of a plant as the plant grows, or stored for later use.

Content Expectations

L.OL.07.61 Recognize the need for light to provide energy for the production of carbohydrates, proteins and fats.

Instructional Clarifications

1. Recognize is to know that sugars produced directly by photosynthesis are used to provide the energy to produce other carbohydrates, proteins and fats.
2. The process of photosynthesis uses light energy to produce simple carbohydrates.
3. Some students mistakenly think:
    a. plants obtain their energy directly from the sun rather than using light energy to produce food.
    b. Plants use heat from the sun as a source of energy for photosynthesis
    c. Sunlight is a food.
    d. Sunlight is composed of molecules.
    e. Sunlight is "consumed" in photosynthesis.
4. Carbohydrates, proteins, and fats need not be described in terms of chemical structure, but students should be familiar with common examples.
    a. Carbohydrates (sugars and starches): potato, corn, wheat bread, maple syrup, beet sugar
    b. Proteins: beans
    c. Fats and oils: olive, sunflower, corn

Assessment Clarification

1. Recognize that light provides the energy for plants to combine materials from air, water, and soil to produce carbohydrates, proteins, and fats.

L.OL.07.62 Explain that carbon dioxide and water are used to produce carbohydrates, proteins, and fats.

Instructional Clarifications

1. Explain is to clearly describe by means of illustrations (drawing), demonstrations, an/or verbally that carbon dioxide and water are used in the process of photosynthesis to make simple carbohydrates.
2. Examples of structural formulae of carbohydrates, proteins, and fats may be used mainly to point out the presence of carbon, hydrogen and oxygen in each. J
3. Plants take energy from light to form higher energy molecules contain carbon, hydrogen, and oxygen (carbohydrates) from lower energy molecules (carbon dioxide and water).
4. Students sometimes think that plants make food for use by animals rather than plants making their own food for use in growth and reproduction.
5. The process of photosynthesis in land plants uses light energy to produce simple carbohydrates from carbon dioxide in the air and water from the soil. Aquatic plants obtain both substances from water.
6. Plants use the sugar made in photosynthesis as the building block to make bigger carbohydrates and fats. With the addition of the minerals from the soil they are bale to make proteins.

Assessment Clarification

1. Explain that the source of carbon, hydrogen, and oxygen found in carbohydrates, proteins and fats produced by plants is carbon dioxide and water.

L.OL.07.63 Describe evidence that plants make, use, and store food.

Instructional Clarifications

1. Describe is to tell or depict in spoken or written words the evidence that plants make, use and store food.
    a. A germinating seed shrivels as the growing seedling uses its stored food.
    b. Plant parts rich in food value are nuts, seeds, roots (carrots, beets) and fruits.
    c. Animals can obtain energy and useful materials by consuming plants or plant parts.
2. Plants grow using light as a source of energy. Plants have specialized food storage structures such as the potato or onion.
3. Plants produce carbohydrates, proteins and fats that serve their own purposes and as food for other organisms.
4. Stored food, such as that in a seed, is used as the seed germinates and begins to grow. Some plants such as carrots store food in a root to support the next season's growth.
5. Plant structures such as roots, tubers, fruits and seeds have high caloric value.

Assessment Clarification

1. Describe evidence that plants make, use and store food. Examples:
    a. A germinating seed shrivels as the growing seedling uses its stored food.
    b. Plant parts rich in food value are nuts, seeds, roots (carrots, beets) and fruits.
    c. Animals can obtain energy and useful materials by consuming plants or plant parts.

Content Statement – P.EN.M.4

Energy Transfer – Energy is transferred from a source to a receiver by radiation, conduction, and convection. When energy is transferred from a source to a receiver, the quantity of energy before the transfer is equal to the quantity of energy after the transfer.

P.EN.07.43 Explain how light energy is transferred to chemical energy through the process of photosynthesis.

Instructional Clarifications

1. Explain is to clearly describe by means of illustrations (drawing, demonstrations, and/or verbally that light energy is stored as chemical energy in sugar molecules in the process of photosynthesis.
2. Plants use light energy to build high-energy sugar molecules (chemical energy) from lower energy molecules (carbon dioxide and water).
3. Some students mistakenly believe that plants feed by absorbing food through their roots.
4. Some students mistakenly believe that energy from sunlight is necessary for photosynthesis and that artificial light cannot drove photosynthetic processes.
5. Details of the photosynthetic process such as the light dependent and light independent reactions are excluded.

Assessment Clarification

1. Explain the energy that plants use to combine materials from air, water, and soil to produce carbohydrates, proteins, and fats is provided by light.

Content Statement - L.HE.M.2

Reproduction- Reproduction is a characteristic of all living systems; because no individual organism lives forever, reproduction is essential to the continuation of every species. Some organisms reproduce asexually. Other organisms reproduce sexually.

Content Expectations

L.HE.07.21 Compare how characteristics of living things are passed on through generations, both asexually and sexually.

Instructional Clarifications

1. Compare is to distinguish between the characteristics and sources of genetic material of young produced by sexual and asexual reproduction.
2. Reproduction, whether sexual or asexual is a requirement for the survival of a species. The genetic material that produces characteristics of living things is passed from generation to generation.
3. Sexually reproduced organisms become adults that closely resemble their parents. Both parents contribute genetic material equally to the offspring.
4. Some students mistakenly believe that daughters inherit most of their characteristics from their mothers and that boys inherit most of their characteristics from their fathers.
5. Organisms produced through asexual reproduction receive genetic material from only one organism and are, therefore, genetically identical to that organism. Cloning, whether natural or artificial, is an example of asexual reproduction.

6. Plants can produce sexually through pollination →fertilization or asexually by a variety of means, e.g., runners, underground stems.

Assessment Clarifications

1. Compare the characteristics of young produced by sexual and asexual reproduction.
2. Compare the sources of genetic material of young produced by sexual and asexual reproduction, i.e., respectively, genetic material from two sources (organisms) and genetic material from one organism.
3. Exclusion: The phases of mitosis and meiosis are excluded at this grade level.

L.HE.07.22 Compare and contrast the advantages and disadvantages of sexual vs. asexual reproduction.

Instructional Clarifications

1. Compare and contrast is to tell or depict in spoken or written words, the advantages of sexual vs. asexual reproduction.
2. Some students mistakenly believe that sexual reproductions occurs in animals and not plants.
3. Sexual reproduction produces variation among offspring. These variations may provide combinations of characteristics helpful to species survival. This variation may also produce combinations of characteristics that are a disadvantage to survival of some species.
4. Students often do not distinguish between sexual and asexual reproduction.
5. Asexual reproduction can produce large numbers of offspring that are identical to the previous generation. These organisms may be at a disadvantage for survival if the environment changes.
6. Asexual reproduction can produce large numbers of offspring that are identical to the previous generation. This can produce a situation where many organisms to take advantage of available resources.
7. Asexual reproduction can be accomplished without the need to find a mate.
8. Some students mistakenly believe that asexual reproduction produces weak offspring and that sexual reproduction produces superior offspring.

Assessment Clarifications

1. Compare and contrast the advantages and disadvantages of sexual vs. asexual reproduction.

Inquiry Process, Inquiry Analysis and Communication, Reflection and Social Implications

Inquiry Processes
S.IP.07.11 Generate scientific questions about cells or plant growth based on observations, investigations, and research.
S.IP.07.12 Design and conduct scientific investigations to study the relationship between cells and tissues (look at different types of plants, examining leaf tissue, root tissue, stem tissue, and compare the structure of specialized cells
S.IP.07.13 Use tools and equipment (hand lens, microscopes, thermometer) appropriate to the scientific investigation.
S.IP.07.14 Use metric measurements in an investigation of plant growth.
S.IP.07.15 Construct charts and graphs from data and observations such as growth in leaf size or height of plants growing under different environmental conditions.
S.IP.07.16 Identify patterns in data collected from plant growth experiments conducted by student groups.
Inquiry Analysis and Communication
S.IA.07.11 Analyze information from data tables and graphs to answer scientific questions on the patterns of relationships between light and or carbon dioxide concentrations in the environment and plant growth.
S.IA.07.12 Evaluate data, claims, and personal knowledge of photosynthesis through collaborative scientific discourse.
S.IA.07.12 Evaluate data, claims, and personal knowledge in distinguishing one celled and multicellular organisms through collaborative scientific discourse (or, about photosynthesis investigation results).
S.IA.07.13 Communicate and defend findings about characteristics passed on through sexual reproduction and asexual reproduction using evidence from observations and investigations.
S.IA.07.14 Draw conclusions from sets of data from multiple trials in a scientific investigation of plant growth under varied environmental conditions.
Reflection and Social Implication
S.RS.07.11 Evaluate the strengths and weaknesses of claims, arguments, and data from plant growth investigations.
S.RS.07.12 Describe limitations in personal and scientific knowledge regarding the ability to study how plants get solar energy.
S.RS.07.13 Identify the need for evidence in making scientific decisions about optimal conditions of light and carbon dioxide for plant growth to provide energy for the production of carbohydrates, proteins and fats.
S.RS.07.14 Evaluate scientific explanations about the process of photosynthesis based on current evidence and scientific principles.
S.RS.07.15 Demonstrate the process of cell division through various illustrations, performances, models, exhibits, and activities.
S.RS.07.16 Design solutions to problems of growing plants in the classroom using technology.
S.RS.07.18 Describe what science and technology can and cannot reasonably contributes to society to address food production for increasing world population.
S.RS.07.19Describe how science and technology have advanced because of the contributions of many people throughout history and across cultures.

Vocabulary

Critically Important- State Assessable	Instructionally Useful
cell cell division cell growth specialized cell tissues organs organ systems photosynthesis sexual reproduction asexual reproduction specialized cell unicellular organism multicellular organism carbon dioxide water carbohydrate protein fat	specialized tissue cell membrane cell function differentiation diffusion osmosis active transport chemical building blocks fertilization heart muscle nerve systems: circulatory, digestive, nervous, skeletal, excretory, muscular genetic material atoms molecules

Instruments, Measurements, Representations

microscopes	Use to examine plant tissues and one-celled organisms, animal tissue slides if available.
representations	Labeled drawings comparing specialized cells in plants
metric ruler	Measure plant growth
representations	Graphic results of plant growth Concept maps relating experimental results to the simplified equation of photosynthesis.

Instructional Framework

The following Instructional Frameworks are an effort to clarify possible units within the K-7 Science Grade Level Content Expectations. The Instructional Frameworks provide descriptions of instructional activities that are appropriate for inquiry science in the classroom and meet the instructional goals. Included are brief descriptions of multiple activities that provide the learner with opportunities for exploration and observation, planning and conducting investigations, presenting findings, and expanding thinking beyond the classroom. The Instructional Frameworks are ***NOT*** *step-by-step instructional manuals, but a guide intended to help teachers and curriculum developers design their own lesson plans, select useful and appropriate resources and create assessments that are aligned with the grade level science curriculum for the State of Michigan.*

Instructional Examples

Cell Functions - L.OL.07.21, L.OL.07.22, L.OL.07.23, L.OL.07.24, L.OL.07.31, L.OL.07.32

Objectives

- Make microscopic observations of cells in a variety of organisms, distinguishing one-celled from multicellular organisms.
- Focus on variety of cell organization and structure (specialization) in different tissues of a plant.
- Relate the growth of organisms to increase in cell size and/or number.

Note: In the study of cells, cell structures and function, and cell division and growth, it is necessary to provide multiple resources for students to view diagrams, models, photos, text information, and virtual demonstrations. Students should also have the opportunity to gain skills in using the microscope to view actual cells within their exploration of cell structure and function.

Engage and Explore

- Prepare multiple slides at microscope station of different cells for students to observe. Slides may include, onion skin (plant), cheek cells (animal), pond water with amoeba or paramecia, and aquatic plants such as elodea.(L.OL.07.21, S.IP.07.11, S.IP.07.12, S.IP.07.13)
- After students have had the opportunity to observe the slides under the microscope, conduct a whole class brainstorming session to gain an understanding of student's ideas about cells. Ask: Can anyone explain what a cell is or does? (S.IA.07.12, S.IA.07.13)

- Make a list of student questions based on their initial observations of the cell slides. (S.IP.07.11)
- Make microscopic examinations of pond water samples observing one-celled protists, algae such a diatoms, and multicellular organisms. Also observe tissue samples from plants (multicellular organisms). Develop criteria for distinguishing between one celled and multicellular organisms. (L.OL.07.21, S.IP.07.11, S.IP.07.12, S.IP.07.13)
- Observe tissues from different parts of a plant comparing the structure of cells from roots, stems, and leaves and/or compare the structure of cells from different regions of a leaf of a flowering plant, e.g., epidermis, photosynthetic layers within the leaf). (L.OL.07.22, L.OL.07.32, S.IP.07.11, S.IP.07.12, S.IP.07.13)

Explain and Define

- Using criteria from student teams, develop consensus criteria to distinguish single-celled organisms from multicellular organisms. (S.IA.07.12, L.OL.07.21)
- Use multiple references sources for students to use to evaluate their initial ideas about cells and cell functions. (S.IA.07.15, L.OL.07.21)
- Use a Venn diagram to compare plant and animal cells. (L.OL.07.24,
- Have students compare and contrast cells of different body tissues, organs, and organ systems. (L.OL.07.22, L.OL.07.23, L.OL.07.24)
- As a class, determine how specialized cells carry out different functions. Divide the class into research teams and assign teams different cells types to research and present findings to the rest of the class. Develop a rubric for information gathering on the team's particular cell type. Include how cells are specialized yet continue to function in a similar way. (S.IA.70.15, L.OL.07.23, L.OL.07.24)
- Explain and define the terms growth and development, and differentiation and specialization. Have student apply the key terms to cells and the specialized cells in their research. (L.OL.07.31, L.OL.07.32)
- Provide Internet sites and reference textbooks that give students a visual representation of cell division, cell growth, and diffusion.

Elaborate and Apply

- Students apply the consensus criteria to the observation of additional organisms.
- Research about and relate specialized cells to general functions such as epidermal cells preventing dehydration, green (chlorophyll containing) cells performing photosynthesis, conductive tissue providing transport.
- Calculate the number of cells produced in one day by cell division of a fertilized egg if cell division occurs every 10 minutes.
- Perform activities that demonstrate diffusion of a substance in water and diffusion and osmosis through a semi-permeable membrane (similar to a cell membrane). (L.OL.07.23, L.OL.07.24, S.IP.07.12)

- Explain the similarities and differences between diffusion and osmosis. Infer the structure of semi-permeable membranes.
- Students perform a series of investigations with chicken eggs whose shells have been dissolved by immersion in vinegar. Eggs are placed in solutions of different salt concentrations. Change in the egg's circumference is used to measure movement of water into and out of the egg. Reference: http://www.sciencespot.net/Pages/classbio.html#Anchor-eggs

Evaluate Student Understanding

Formative Assessment
- Identify microscopic images of organisms as one celled or multicellular and give supporting evidence.
- Relate images of plant cells to their general function.
- Relate growth in multicellular organisms to increase in cell number.
- Make predictions regarding the net diffusion of water given different scenarios of solutions of different types on either side of a semi-permeable membrane.

Summative Assessment
- Compare and resolve differences in classification of organisms among student groups. (L.OL.07.21, S.IA.07.12)
- List criteria for distinguishing one-celled from multicellular organisms. (L.OL.07.21)
- Describe how one-celled and multicellular organisms increase in size. (L.OL.07.21)
- Explain how multicellular organisms can develop more specialized parts and functions than one-celled organisms. (L.OL.07.21)
- Write a paragraph describing how multicellular organisms grow and form specialized cells observed in the investigation, relating the structure of these cells to their function.
- Distinguish between diffusion and osmosis.
- Describe how materials enter and leave cells. Use diagrams with varied concentrations of solutions to predict the movement of water into or out of eggs whose shells have been dissolved.
- Infer and describe the nature of cell membranes and predict the movement of water into and out of cells given different concentrations of internal and external solutions.

Enrichment

- Students use varying concentrations of salt water to perform plasmolysis investigations with fresh onion epidermis in order to estimate the "normal" concentration of dissolved substances within the onion cells.

Intervention

- Students use a graphic organizer similar to a Venn diagram to model movement of substances from a higher concentration to a lower concentration. The intersect portion of the diagram reflects the properties of a semi-permeable membrane (water easily passes through, sugar does not pass through). One side of the diagram "contains" water and the other side "contains" a sugar solution. Students use blank replicates of the diagram to indicate changes of concentration over time, including the change in the amount of water and sugar concentration in the sugar solution side.

Examples, Observations, and Phenomena (Real World Context)

Macroscopic observation of cell growth and specialization is most obvious in germinating seeds and plant seedlings which grow rapidly through cell division and show development of organs such as leaves stems and roots. Combined with microscopic examination of plant tissues, students can infer that growth and development are the result of cell reproduction and specialization.

Healing of minor scrapes and cuts also provides the opportunity to observe cell growth and reproduction and specialization that lead to tissue repair.

Crisping of celery soaked in tap water is a common example of osmosis moving water into plant cells.

Literacy Integration

Reading

R.WS.07.07 in context, determine the meaning of words and phrases including cross cultural expressions, mathematical expressions, scientific procedures, and literary terms using strategies and authentic content-related resources.
R.IT.07.01 analyze the structure, elements, features, style, and purpose of informational genre including persuasive essay, research report, brochure, personal correspondence, autobiography and biography.
R.CM.07.02 retell through concise summarization grade-level narrative and informational text.
R.CM.07.04 apply significant knowledge from grade-level science, social studies, and mathematics texts.
Speaking
S.CN.07.03 present in standard American English if it is their first language. (Students whose first language is not English will present in their developing version of standard American English.)
Select a scientist to read about and give a brief oral report in class.
Reference: *100 Most Popular Scientists for Young Adults: Biographical Sketches and Professional Paths* by Kendall Haven , Donna Clark

Mathematics Integration

N.FL.07.03 Calculate rates of change including speed.
Determine growth over a 24-hour period in the number of cells from a fertilized egg if cell division occurs once every hour.

Instructional Examples

Photosynthesis - L.OL.07.61, PEN.07.43, L.OL.07.62, L.OL.07.63

Objectives

- Explain how the sun supplies living things with the energy they need.
- Describe how plants use light to provide energy for the production of food.
- Describe what happens during the process of photosynthesis.
- Design an investigation to grow plants under different conditions and draw conclusions on plant health, growth, and food production.

Engage and Explore

- Review the students' previous knowledge regarding the plant cell and the difference between a plant and animal cell. Begin the study of photosynthesis by asking the questions, "What would happen if there weren't any plants?" and "What do plants need to grow and survive?" Accept all reasonable ideas at the onset of the unit. To encourage deeper thinking, ask students how plants survive through the winter or through the night. Ask students to predict what would happen to plants if there weren't any sunlight.
- Check for student ideas that relate to the plant's need for sunlight, water, food, and space. Ask the class where plants get their food.
- Through whole class and small group discussion, have students' plan an investigation that will help to answer the class questions about what plants need to survive and how they get their food.
- Have students read about the experiment of scientist Van Helmont and how he discovered that plants do not use soil the same way people use food. (S.RS.07.19,L.OL.07.63)
- Have students explore stations to discover where sugar and starch are stored in different parts of different plants. (use glucose test strips and iodine for indicators) (L.OL.07.62)
- Set up a demonstration in a closed system to show how plants give off oxygen.
- Student groups test the ability of an Elodea plant to photosynthesize with and without light. This familiar activity requires students to seal part of an Elodea plant in a test tube filled with a weak bromthymol blue solution that as been acidified with CO_2 from a student's breath and observe color changes in plants exposed to light and those shielded from light as CO_2 is consumed in the process of photosynthesis. (L.OL.07.61, PEN.07.43, L.OL.07.62, S.IA.07.12, S.IA.07.14)

Explain and Define

- Explain the process of photosynthesis and how plants use CO_2 , water, and light energy to produce glucose (sugar) and oxygen.
- Provide multiple resources for students to evaluate informational text, diagrams, and virtual representations of the process of photosynthesis.
- Use BTB color change to infer the use of CO_2 by plants exposed to light.
- Relate investigation results to the simplified equation of photosynthesis. (L.OL.07.61, PEN.07.43, L.OL.07.62, S.RS.07.13, S.RS.07.14)

Elaborate and Apply

- Design investigations that block light from different parts of the plant (leaves and stems). (L.OL.07.61, L.OL.07.63, S.IP.07.11, S.IP.07.12, S.IP.07.13, S.IP.07.14, S.IP.07.15, S.IP.07.16)
- Students design and perform plant growth investigations that use light as a variable. (L.OL.07.63, PEN.07.43, SIP.07.16, S.IA.07.12, SRS.07.16)
- Students design investigations into food storage in plants and how plants survive through the winter and overnight. Students recognize that plants make, use, and store their own food. (L.OL.07.63, S.IP.07.11, S.IP.07.12, S.IP.07.13, S.IP.07.14, S.IP.07.15, S.IP.07.16)
- Return to the model of plant cells from their previous unit and have students identify the chloroplasts and chlorophyll in the cell. (L.OL.07.21, L.OL.07.61)
- Discuss how plants take in carbon dioxide. Use the underside of a variety of leaves under the microscope to identify the stomata cells of the plant where carbon dioxide enters the plant and oxygen exits the plant. (The stomata cells of the *zebrina* plant (Wandering Jew) are easily recognized under the microscope.) (L.OL.07.61, L.OL.07.62, S.IP.07.13, S.IA.07.12, S.IA.07.13)

Evaluate Student Understanding

Formative Assessment

- Identify the variable in the BTB investigation and create a control for the experiment.
- Explain why starch is tested for in the leaves, though photosynthesis in the leaf produces sugar. . (L.OL.07.63)

Summative Assessment

- Relate all investigation results to the simplified equation of photosynthesis by explaining and defending each team's concept map. (L.OL.07.61, L.OL.07.62)
- In teams of three, create a concept map that relates each component of the simplified equation of photosynthesis to the Elodea plant and the "LIGHTS OUT" investigations. Present the map and defend its representations. (L.OL.07.61, L.OL.07.62, S.IA.07.13)

Enrichment

- Students design and perform plant growth investigations that use carbon dioxide as a variable. The effect of carbon dioxide enrichment on the growth of plants can be investigated in a closed system such as a two-liter soda bottle. Reacting Alka Seltzer or similar products with water can supply carbon dioxide. (L.OL.07.61, , L.OL.07.62, S.IP.07.11, S.IP.07.15, S.IA.07.11, S.RS.07.16, S.RS.07.18)

Intervention

- *Illuminating Photosynthesis* at http://www.pbs.org/wgbh/nova/methuselah/photosynthesis.html#
- This NOVA website produced by WGBH provides both background reading and interactive learning through "puzzlers."

Examples, Observations, and Phenomena (Real World Context)

Today's concern about global climate change generally focuses on the addition of carbon dioxide to the atmosphere but mentions little about how plants trap carbon dioxide and sequester it in the carbon compounds that they synthesize. Global deforestation has reduced the consumption of carbon dioxide by photosynthetic processes.

Literacy Integration

Reading

R.IT.07.01 analyze the structure, elements, features, style, and purpose of informational genre including persuasive essay, research report, brochure, personal correspondence, autobiography and biography.

R.IT.07.02 analyze organizational text patterns including sequential, compare/contrast, and cause/effect.

R.CM.07.04 apply significant knowledge from grade-level science, social studies, and mathematics texts.

Reference: *Illuminating Photosynthesis* at
http://www.pbs.org/wgbh/nova/methuselah/photosynthesis.html#

Writing

W.GN.07.03 formulate research questions using multiple resources, perspectives, and arguments/counter-arguments to develop a thesis statement that culminates in a final presented project using the writing process.

Speaking

S.DS.07.04 plan and deliver a focused, coherent informational presentation using an informational organizational pattern (e.g., theory/evidence, persuasion, sequence) that incorporates persuasive, non-verbal techniques, and provides explanations and descriptions supportive of the presentation's focus and the backgrounds and interests of the audience.

- Present data and conclusions from the investigation of plant growth related to conditions of light.

Mathematics Integration

N.FL.07.07 Solve problems involving operations with integers.

D.RE.07.01 Represent and interpret data using circle graphs, stem and leaf plots, histograms, and box-and-whisker plots, and select appropriate representation to address specific questions.

D.AN.07.02 Create and interpret scatter plots and find line of best fit; use an estimated line of best fit to answer questions about the data.

- Metric measurement of plant growth will be recorded over an extended period. Total and average growth per day will be calculated. Growth over time will be represented with a line graph.

N.FL.07.05 Solve proportion problems using such methods as unit rate, scaling, finding equivalent, fractions, and solving the proportion equation a/b = c/d; know how to see patterns about proportional situations in tables.

- If an average sized tree can produce enough oxygen to support two to three humans, how many average size trees are necessary to provide oxygen for today's estimated world population?

Instructional Examples

Heredity - L.HE.07.21, L.HE.07.22

Objectives

- Observe and distinguish between patterns of inheritance of characteristics of asexually and sexually reproducing organisms.
- Understand that most plants usually reproduce sexually.
- Recognize that organisms produced through asexual reproduction are generally genetically identical.
- Recognize that sexual reproduction introduces genetic variety into the offspring produced.

Engage and Explore

- Ask students if they know how humans and other animals pass on their traits to their offspring. The point of the discussion is not to have students discuss the mechanisms of genes and DNA in detail, but to make sure that students understand that in animals, traits are inherited from both parents. (L.HE.07.21)
- Student teams examine four or five large plants of the same type. Each plant should be slightly different from the others. Ask students to describe how each one is similar and different in terms of height, color, and shape. (L.HE.07.21) Ask students:
  1. Why do the plants not look exactly alike?
  2. Do you think the plants look like their parents?
  3. Do plants even have parents?
- After library or web research on vegetative propagation, students will attempt the propagation at home with cuttings taken from one of the classroom plants. They must write and follow directions for the propagation, and keep a journal that tracks the progress of the plant for approximately six weeks. Comparisons will be made with the classroom plant that is the source of each student's cutting. Driving question: Do asexually produced plants have the same characteristic as the plant from which they are produced by vegetative propagation? (Adapted from Science NetLinks) (L.HE.07.21, L.HE.07.22, S.IP.07.11, S.IP.07.12, S.IP.07.13, S.IP.07.14, S.IP.07.15, S.IP.07.16, S.IA.07.11, S.IA.07.12)

Explain and Define

- Explain and define the distinctions between asexual and sexual reproductions. Include the advantages and disadvantages of each.
- A video of asexual lizard reproduction provides deeper understanding of the distinctions between sexual and asexual reproduction as well as the evolutionary advantage of each. http://www.teachersdomain.org/resources/tdc02/sci/life/repro/asexual/index.html (L.HE.07.22)

Elaborate and Apply

- Have the class discuss and explain the different traits of organisms that are influenced by genetics (reproduction) and environmental influence. Have students identify traits that are passed on through reproduction that enhance the organism's chances to survive. (L.HE.07.21, S.RS.07.11, S.RS.07.12, S.RS.07.13, S.RS.07.14)
- Visit a greenhouse or research facility that is using asexual reproduction in plants to increase food supply and genetically engineer superior plants. Have students conduct research into current science and technology that is being used to alter food crops. (S.RS.07.18)

Evaluate Student Understanding

Formative Assessment

- Distinguish between asexual and sexual reproduction. (L.HE.07.21, L.HE.07.22)
- Distinguish between the variability of characteristics in organisms produced by asexual reproduction and those produced by sexual reproduction. (L.HE.07.21, L.HE.07.22)

Summative Assessment

- Create a Venn diagram of sexual versus asexual reproduction that displays similarities and differences in the types of reproduction, characteristics of offspring compared to parents and advantages and disadvantages of each type of reproduction. (L.HE.07.21, L.HE.07.22)
- Justify that fraternal twins are the result of sexual reproduction and that identical twins are the result of asexual reproduction. (L.HE.07.21, L.HE.07.22)

Enrichment

- Teams of two students read two chapters of *Cloning* by Daniel Cohen. One of the chapters is "History and Hoax." The teacher assigns the other chapter. Teams make presentations to the class providing a "jigsaw" oral book report to the entire class that covers the entire book.

Intervention

- Have students research the characteristics that were passed down from their family members. Have them find out if they have inherited the ability to tongue roll, Vulcan hello, wiggle ears, eye color, hair color, etc. Have students distinguish between the traits that were passed down through genetics and the traits that they have learned.

Examples, Observations, and Phenomena (Real World Context)

A comparison of fraternal (two egg/two sperm) twins and identical (one egg/one sperm) twins is a comparison of characteristics produced by sexual reproduction (fraternal twins) and asexual reproduction (identical twins). Apples are available in a greater variety of types than most other fruits. This is due to the asexual (vegetative propagation) of apple trees on which these apple varieties are produced. This technique consistently produces apple varieties with very similar characteristics of color, taste and texture.

Literacy Integration

Reading

R.CM.07.04 apply significant knowledge from grade-level science, social studies, and mathematics texts.
R.IT.07.01 analyze the structure, elements, features, style, and purpose of informational genre including persuasive essay, research report, brochure, personal correspondence, autobiography and biography.

Writing

W.GN.07.03 formulate research questions using multiple resources, perspectives, and arguments/counter-arguments to develop a thesis statement that culminates in a final presented project using the writing process.

Read write think of science fiction related to cloning is described at: http://www.readwritethink.org/lessons/lesson_view.asp?id=927 A lesson plan asks students to explore the science behind science fiction.
Cloning by Don Nardo (2003)

Mathematics Integration

N.FL.07.07 Solve problems involving operations with integers.

Students calculate and compare the population growth in sexually reproducing and asexually reproducing organism when given the generation time of each.