Biology Course Map

The attached document is part of a framework that was designed to support the major concepts addressed in the Biology Curriculum of the Georgia Performance Standards through laboratory experiences and field work using the processes of inquiry. This framework is a thematic approach that is divided into the four units outlined below. Within each unit, the unifying themes of cells, organisms, ecology and evolution reoccur. Concept maps are attached to each unit outlining the understandings derived from the standards that are addressed for each of the recurring topics. Whereas these units are written to be stand alone units that may be taught in any sequence, it is recommended that the organization unit be taught first and the equilibrium unit taught last.

Unit One Focus: Organization
Life is organized at all levels from cells to biosphere.

Topics:
- Cell structure and Function
- Evolutionary History
- History of Life
- Classification of Kingdoms
- Ecosystem Structure
- Viruses

Duration (Block): 23 days
Duration (Traditional): 7-9 weeks

Unit Two Focus: Energy Transformations
Energy can be neither created nor destroyed but can be transformed from one form to another as it flows through organisms and ecosystems.

Topics:
- Chemistry of Life
- Function of Organic Molecules
- Photosynthesis
- Cellular Respiration
- Cycles of Matter
- Energy Flow
- Food Chains and Webs

Duration (Block): 22 days
Duration (Traditional): 7-9 weeks

Unit Three Focus: Growth and Heredity
Organisms must be able to grow and reproduce to ensure species survival.

Topics:
- Asexual and Sexual Reproduction
- Cell Growth
- Mendelian Genetics
- DNA and RNA Processes
- Chromosomes and Mutations
- Genetic Engineering
- DNA Technology and Cloning
- Biological Resistance
- Bioethics

Duration (Block): 22 days
Duration (Traditional): 7-9 weeks

Unit Four Focus: Equilibrium
Survival and stability require that living things maintain biological balance at all levels.

Topics:
- Cellular Transport
- Homeostasis
- Natural Selection
- Plant Adaptations
- Animal Adaptations and Behavior
- Succession
- Population Genetics

Duration (Block): 23 days
Duration (Traditional): 7-9 weeks
Safety Issues:

Student safety in science education should always be foremost during instruction.

The Characteristics of Science curriculum standards increases the need for teachers to use appropriate precautions in the laboratory and the field. The guidelines for the safe use, storage and disposal of chemicals must be observed.

To ensure student and teacher safety in the science classroom, it is critical that appropriate safety policies and procedures be established in the classroom and that all students and teachers know and follow appropriate safety guidelines. The Internet and many science vendors can offer support for safety guidelines.

Teaching Strategies:

Lab notebook or Field sketchbook: A notebook that students use to record data, journal on assigned topics and complete assigned drawing activities.

Ticket Out the Door: A commonly used summarizing strategy that is effective as a formative assessment tool. Students are given a short writing assignment on the concept covered in class that is to be turned in as they leave the classroom. These brief glimpses into student understanding may be graded or not. The same strategy can be used as a Ticket In the Door to assess student understanding at the beginning of the class on a concept from the day before or as a check on a homework assignment.

KIM diagrams: A three column table where students can organize technical language to allow better understanding of how they relate to the topic of the day. On a KIM diagram, a key term is listed in the first column, an illustration of the key term in the second column and a student derived meaning written in the third column.

Jigsaw activities: An effective grouping strategy that teachers use to facilitate peer teaching in the classroom. Students are first grouped together to become experts on an assigned topic. Student groups are then reorganized in such a manner that new groups are formed containing one student from each of the expert groups. The experts on each topic then serve as a peer teacher to the other students in the newly formed group.

Cloze: A note taking strategy where students either provide missing terms to complete a paragraph using appropriate language for the topic being addressed, or where students generate a paragraph from a list of appropriate terms.

Gallery or Poster Walk: This is a peer assessment strategy. Students place their work on a wall or other location where it can be reviewed by their peers. Students provide written commentary on the posted work and the original creators are given the opportunity to revise their product.

Teacher note: Students may require training to use appropriate feedback in their commentary.
Flapbook or Flipbook: A type of graphic organizer where students group information in order to see relationships within categories.

10-2 Lecture format: A strategy where teachers limit the introduction of material to a time frame of 10 minutes or less and then students are allowed a 2 minute opportunity to reflect on the material and share what they have learned with their peers.

Glaze the Doughnut: A type of organizer that allows teachers to pre-assess student knowledge or to monitor student progress that resembles a doughnut as one smaller circle is drawn inside another. The big idea is written inside the small circle and the doughnut is “iced” or “glazed” with what the students know about the topic. The information can then be reorganized into tables or organizers.

Name Jar: A strategy to ensure students are randomly selected to answer questions in class. Student names are placed on craft sticks and placed in a jar. During questioning the teacher selects sticks from the jar and the student identified must answer the question. Several blank sticks could be included in which the teacher must answer the questions when they are selected.

KWL: A pre and post assessment strategy often used in classrooms where, at the beginning of the lesson, teachers guide students to identify what they already know about a particular topic and what they need to know about the topic. Following the lesson, the teacher leads students to review what they have learned.

Acrostic: An activity for students to make connections between the language that often accompanies a particular topic. The key term is written vertically on paper and students write words or phrases that relate to that term using the letters that make up the key term.
**ENERGY TRANSFORMATIONS**

Unit Understanding: Energy can be neither created nor destroyed but can be transformed from one form to another as it flows through organisms and ecosystems.

- Most cell functions involve chemical reactions that utilize enzymes that either break down or synthesize compounds. SB1b, SB1c
- Chemical bonds of food molecules contain energy that is released in the process of cellular respiration; the products are used to synthesize needed molecules. SB1b, SB1c, SB3a
- Photosynthetic organisms use sunlight to combine inorganic molecules to form energy storing organic molecules and release oxygen that is vital to most living things. SB3a

**ECOLOGY**

- The process of photosynthesis provides the vital connection between the sun and the energy needs of living systems. SB3a
- Energy flows through ecosystems in one direction from photosynthetic organisms to herbivores to carnivores and decomposers. SB4b
- Carbon and oxygen cycle through the processes of photosynthesis and respiration. SB3a, SB4b
- The atoms and molecules on earth cycle among the living and nonliving components of the biosphere. SB4b
- The distribution and abundance of organisms in populations and ecosystems are limited by the availability of matter and energy and the ability of the ecosystem to recycle materials. SB4a, SB4b

**EVOLUTION**

- The interrelationships and interdependencies of organisms may generate ecosystems that are stable for hundreds or thousands of years. SB5b

**ORGANISMS**

- Organisms both cooperate and compete in ecosystems. SB4a
- Living organisms have the capacity to produce populations of infinite size but are limited as environments and resources are finite. SB5d

**CELLS**

- Most cell functions involve chemical reactions that utilize enzymes that either break down or synthesize compounds. SB1b, SB1c
- Chemical bonds of food molecules contain energy that is released in the process of cellular respiration; the products are used to synthesize needed molecules. SB1b, SB1c, SB3a
- Photosynthetic organisms use sunlight to combine inorganic molecules to form energy storing organic molecules and release oxygen that is vital to most living things. SB3a
### Content and Characteristics of Science for Energy Transformation

#### Content Standards

**SB1. Students will analyze the nature of the relationships between structures and functions in living cells.**

- a. Explain the role of cell organelles for both prokaryotic and eukaryotic cells, including the cell membrane, in maintaining homeostasis and cell reproduction.
- b. Explain how enzymes function as catalysts.
- c. Identify the function of the four major macromolecules (i.e., carbohydrates, proteins, lipids, nucleic acids).
- d. Explain the impact of water on life processes (i.e. osmosis, diffusion).

**SB3. Students will derive the relationship between single-celled and multi-celled organisms and the increasing complexity of systems.**

- a. Explain the cycling of energy through the processes of photosynthesis and respiration.

**SB4. Students will assess the dependence of all organisms on one another and the flow of energy and matter within their ecosystems.**

- a. Investigate the relationships among organisms, populations, communities, ecosystems, and biomes.
- b. Explain the flow of matter and energy through ecosystems by
  - Arranging components of a food chain according to energy flow.
  - Comparing the quantity of

#### Characteristics of Science

**SCSh1. Students will evaluate the importance of curiosity, honesty, and skepticism in science.**

- a. Exhibit the above traits in their own scientific activities.
- b. Recognize that different explanations often can be given for the same evidence.
- c. Explain that further understanding of scientific problems relies on the design and execution for new experiments which may reinforce or weaken opposing explanations.

**SCSh2. Students will use standard safety practices for all classroom laboratory and field investigations.**

- a. Follow correct procedures for uses of scientific apparatus.
- b. Demonstrate appropriate technique in all laboratory situations.
- c. Follow correct protocol for identifying and reporting safety problems and violations.

**SCSh3. Students will identify and investigate problems scientifically.**

- a. Suggest reasonable hypotheses for identified problems.
- b. Develop procedures for solving scientific problems.
- c. Collect, organize and record appropriate data.
- d. Graphically compare and analyze data points and/or summary statistics.
- e. Develop reasonable conclusions based on data collected.
- f. Evaluate whether conclusions are reasonable by reviewing the process and
energy in the steps of an energy pyramid.

- Explaining the need for cycling of major nutrients (C, O, H, N, P).

- Assess and explain human activities that influence and modify the environment such as global warming, population growth, pesticide use and water and power consumption.

**SB5. Students will evaluate the role of natural selection in the development in the theory of evolution.**

- Explain the history of life in terms of biodiversity, ancestry, and rates of evolution.
- Relate natural selection to changes in organisms.

**SCSh4. Students use tools and instrument for observing, measuring, and manipulating scientific equipment and materials.**

- Develop and use systematic procedures for recording and organizing information.

- Use technology to produce tables and graphs.

**SCSh5. Students will demonstrate the computation and estimation skills necessary for analyzing data and developing reasonable scientific explanations.**

- Trace the source on any large disparity between estimated and calculated answers to problems.
- Consider possible effects of measurement errors on calculation.
- Recognize the relationship between accuracy and precision.

- Express appropriate numbers of significant figures for calculated data, using scientific notation where appropriate.

**SCSh6. Students will communicate scientific investigation and information clearly.**

- Write clear, coherent laboratory reports related to scientific investigations.
- Write clear, coherent accounts of current scientific issues, including possible alternative interpretations of the data.
- Use data as evidence to support scientific arguments and claims in written or oral presentations.
- Participate in group discussions of scientific investigation and current scientific issues.

**SCSh7. Students analyze how scientific...**
knowledge is developed. Students recognize that:

a. The universe is a vast single system in which the basic principles are the same everywhere.

b. Universal principles are discovered through observation and experimental verification.

c. From time to time, major shifts occur in the scientific view of how the world works. More often, however, the changes that take place in the body of scientific knowledge are small modifications or prior knowledge. Major shifts in scientific views typically occur after the observation of a new phenomenon or an insightful interpretation of existing data by an individual or research group.

d. Hypotheses often cause scientists to develop new experiments that produce additional data.

e. Testing, revising, and occasionally rejecting new and old theories never ends.

SCSh8. Students will understand important features of the process of scientific inquiry.

Students will apply the following to inquiry learning practices:

a. Scientific investigators control the conditions of their experiments in order to produce valuable data.

b. Scientific researchers are expected to critically assess the quality of data including possible sources of bias in their investigations’ hypotheses, observations, data analyses, and interpretations.

c. Scientists use practices such as peer review and publication to reinforce the integrity of scientific activity and
SCSh9. Students will enhance reading in all curriculum areas by:
   a. Reading in all curriculum areas
      • Read a minimum of 25 grade-level appropriate books per year from a variety of subject disciplines and participate in discussions related to curricular learning in all areas.
      • Read both informational and fictional texts in a variety of genres and modes of discourse.
      • Read technical texts related to various subject areas.
   c. Building vocabulary knowledge
      • Demonstrate an understanding of contextual vocabulary in various subjects.
      • Use content vocabulary in writing and speaking.
      • Explore understanding of new words found in subject area texts.
   d. Establishing context
      • Explore life experiences related to subject area content.
      • Discuss in both writing and speaking how certain words are subject area related.
      • Determine strategies for finding content and contextual meaning for unknown words.
Misconceptions for Energy Transformation:

Students think that:

- Only plants carry out photosynthesis and only animals carry out respiration. Students should understand that, while plants and other photosynthetic organisms such as algae and certain bacteria, are capable of carrying out photosynthesis, all organisms must use some method of obtaining energy from food molecules. Most organisms use cellular respiration, including plants.
- Plants create energy. Students should understand that plants actually “capture” light energy as chlorophyll molecules absorb certain wavelengths of energy that “excites” electrons enough to jump energy levels and transfer energy to other molecules along an electron transport chain. This energy is ultimately stored in the bonds of the organic molecules produced by photosynthesis.
- Plants don’t use oxygen. Students should understand that they utilize oxygen in the process of cellular respiration to convert energy from food into useable forms such as ATP.
- Organisms on the top of an ecological pyramid are more important than those below them. Students should understand that the organisms on top of the pyramid are the top consumers that have no natural predators. The producers in the food chain are responsible for the initial conversion of light energy into useable forms that are transferred along the food chain in smaller amounts as energy is used and lost as heat along the way.
- The bigger the organism, the more energy it has. Students should understand that regardless of the size of the organism, approximately 90% of the energy consumed is used or lost as heat. Only 10% of the energy stored in an organism is available to be transferred to the next trophic level.
- Energy comes directly from food. Students should understand that energy is stored in the chemical bonds between the atoms that make up the molecules that make up food. When bonds are formed energy is stored. Energy is only released when bonds are broken.
- Fish obtain oxygen from water molecules. Students should understand that fish utilize free oxygen dissolved in water that is used for cellular respiration.
Culminating Task for Energy Transformation:

Energy Flow and Transitional Zones of Biomes

Energy Flow through a Food Chain

Objective:
Students will trace the flow of energy through a food chain and determine the amount of energy that passes from one trophic level to a higher trophic level.

Required Information:
Write a creative story about the flow of energy through a food chain from the viewpoint of Marty the Molecule (food molecule). You will need to identify a food chain that occurs in a transitional zone between two established biomes. You need to begin the biome with an autotroph and end with a tertiary consumer in an energy pyramid. Be sure you explain the amount of energy that is passed from one trophic level to the next trophic level. You are to illustrate your food chain by including drawings or pictures with arrows showing the direction of the flow of energy.

Internet Resources for Energy Transformation:

http://www.mhhe.com/biosci/genbio/maderbio6e/activities.mhtml (this site can also be included in Growth/Heredity, Energy Transformations)
http://science.nhmccd.edu/Biol/ap1int.htm (this site has a variety of animations of the metabolic processes. Students could use in presentations or teacher could use as an activator or summarizing activity)
http://www.bioweb.uncc.edu/1110Lab/notes/notes1/labpics/lab2pics.htm (nice illustrations of positive tests for the food nutrients)
http://curriculum.calstatatela.edu/courses/builders/lessons/less/biomes/introbiomes.html (interactive site for biomes, food webs and calculating energy pyramids. Could be used to assist students with energy pyramid and food web activities from the sketchbook journal)
http://www.sciencecourseware.org/BLOL/ (a variety of computer simulation labs)
http://www.uen.org/core/core.do?courseNum=3520 (lesson plans, links, lectures for a variety of biology topics)
http://samson.kean.edu/~breid/enzyme/enzyme.html (5 different enzyme activities … catalase, pepsin, trypsin, lipase, amylase … these could be easily altered to fit the inquiry level of the students/teacher)
http://schools.moe.edu.sg/chijsjc/Biology/Enzyme/enzyme.htm (down and dirty explanation of enzymes and what conditions impact their functions … nice graphs)