Produced by the National Center for Science Education

Content Benchmarks
(Life Sciences)

Georgia Biology Curriculum:
"The Georgia Chemistry [sic] Curriculum is designed to provide students the necessary tools to be proficient in biology. *The Council for Basic Education* and *Project 2061's Benchmarks for Science Literacy* were used as a guide to determine appropriate content and process skills for students."
–GaBioCur.pdf, downloaded from http://www.glc.k12.ga.us/spotlight/gps2.htm

Comparison of the 2004 Draft Georgia Biology Curriculum document, GaBioCur.pdf, downloaded from http://www.glc.k12.ga.us/spotlight/gps2.htm to *Standards for Excellence in Education: A Guide for Parents, Teachers and Principals for Evaluating and Implementing Standards for Education* (1998) Council for Basic Education, Washington, D.C., 286 pp

Each comparison has the format:
Draft item [page reference]
SEE text [page reference]

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Omissions from the SEE text are highlighted in [**red**], within square brackets.

Co-Requisite – Content

Benchmark
Every cell is covered by a membrane that controls what enters and leaves the cell. In all but quite primitive cells, a complex network of proteins within them provides organization and shape and, for animal cells, movement. Within the cell are specialized parts for the transport of materials, energy capture and release, protein building, waste disposal, information feedback, and even movement. In addition to these basic cellular functions common to all cells, most cells in multi-cellular organisms perform some special functions that others do not. The work of the cell is carried out by the many different types of molecules it assembles, **such as** proteins **and enzymes**. Protein molecules are long, usually folded chains made from 20 different kinds of amino acid molecules. The function of each protein molecule depends on its specific sequence of amino acids, and the chain's shape is a consequence of attractions among the chain's parts. The genetic information in DNA molecules provides instructions for assembling protein molecules. The code used is almost the same for all life forms. Complex interactions among the different kinds of molecules in the cell cause distinct cycles of activities, such as growth and division. Cell behavior can also be affected by molecules from other parts of the organism or even other organisms. Gene mutation in a cell can result in uncontrolled cell division, called cancer. Exposure of cells to certain chemicals and radiation increases mutations and thus increases the chance of cancer. Most cells function best within a narrow range of temperature and acidity. At

very low temperatures, reaction rates are too slow. High temperatures and extremes of acidity can irreversibly change the structure of most protein molecules. Even small changes in acidity can alter the molecules and how they interact. Both single cells and multi-cellular organisms have molecules that help to keep the cell's acidity within a narrow range. A living cell is composed of a small number of chemical elements, mainly carbon, hydrogen, nitrogen, oxygen, phosphorus, and sulfur. Carbon, because of its small size and four available bonding electrons, can join to other carbon atoms in chains and rings to form large, complex molecules.

SB1. Students will be familiar with the structures and functions of living cells.
[Draft p. 7]

18. Students will be familiar with the structure, functions, and ***reproduction*** *of living cells.*
[SEE p. 245]
By the end of grade 12:
a. Every cell is covered by a membrane that controls what enters and leaves the cell. In all but quite primitive cells, a complex network of proteins within them provides organization and shape and, for animal cells, movement.
b. Within the cell are specialized parts for the transport of materials, energy capture and release, protein building, waste disposal, information feedback, and even movement. In addition to these basic cellular functions common to all cells, most cells in multicellular organisms perform some special functions that others do not.
*c. The work of the cell is carried out by the many different types of molecules it assembles, [****mostly****] proteins. Protein molecules are long, usually folded chains made from 20 different kinds of aminoacid molecules. The function of each protein molecule depends on its specific sequence of amino acids, and the chain's shape is a consequence of attractions among the chain's parts.*
d. The genetic information in DNA molecules provides instructions for assembling protein molecules. The code used is almost the same for all life forms.
e. Complex interactions among the different kinds of molecules in the cell cause distinct cycles of activities, such as growth and division. Cell behavior can also be affected by molecules from other parts of the organism or even other organisms.
f. Gene mutation in a cell can result in uncontrolled cell division, called cancer. Exposure of cells to certain chemicals and radiation increases mutations and thus increases the chance of cancer.
g. Most cells function best within a narrow range of temperature and acidity. At very low temperatures, reaction rates are too slow. High temperatures and extremes of acidity can irreversibly change the structure of most protein molecules. Even small changes in acidity can alter the molecules and how they interact. Both single cells and multicellular organisms have molecules that help to keep the cell's acidity within a narrow range.
h. A living cell is composed of a small number of chemical elements, mainly carbon, hydrogen, nitrogen, oxygen, phosphorus, and sulfur. Carbon, because of its small size and four available bonding electrons, can join to other carbon atoms in chains and rings to form large, complex molecules. [SEE p. 246]

Benchmark

An Austrian monk, Gregor Mendel, provided evidence for inheritance mechanisms. Other

scientists identified the genetic code found in DNA and characteristics associated with the DNA codes. Recent discoveries include the genome sequences of humans and other organisms. New gene combinations may make little difference, may produce organisms with new and perhaps enhanced capabilities, or may lead to detrimental effects. The sorting and recombination of genes in sexual reproduction result in a great variety of possible gene combinations in the offspring of any two parents. The information passed from parents to offspring is coded in DNA molecules. Genes are segments of DNA molecules. Inserting, deleting, or substituting DNA segments can alter genes. An altered gene may be passed on to every cell that develops from it. Gene mutations can be caused by such things as radiation and chemicals. When they occur in sex cells, the mutations can be passed on to offspring. The many body cells in an individual can be very different from one another, even though they are all descended from a single cell and thus have essentially identical genetic information. Different parts of that genetic information are used in different types of cells and are influenced by the cell's environment and past history.

SB2. Students will understand how biological traits are passed on to successive generations. [Draft p. 8]

17. Students will understand how biological traits are passed on to successive generations. *[SEE p. 243]*

By the end of grade 12:

a. New gene combinations may make little difference, may produce organisms with new and perhaps enhanced capabilities, or may lead to detrimental effects.

b. The sorting and recombination of genes in sexual reproduction result in a great variety of possible gene combinations in the offspring of any two parents.

c. The information passed from parents to offspring is coded in DNA molecules.

d. Genes are segments of DNA molecules. Inserting, deleting, or substituting DNA segments can alter genes. An altered gene may be passed on to every cell that develops from it.

e. Gene mutations can be caused by such things as radiation and chemicals. When they occur in sex cells, the mutations can be passed on to offspring.

f. The many body cells in an individual can be very different from one another, even though they are all descended from a single cell and thus have essentially identical genetic information. Different parts of that genetic information are used in different types of cells and are influenced by the cell's environment and past history. *[SEE p. 244]*

Benchmark

Structure relates to function. Organs and organ systems function together to provide homeostasis in organisms. The functioning of organs depends upon multiple organ systems.

SB3. Students will understand the relationship between structure and function of organs and organ systems. [Draft p. 9]

[No equivalent located in SEE]

Benchmark

The degree of similarity in the DNA sequences of organisms or species can be used to estimate how closely they are related to each other, which often closely matches their classifications based on anatomical similarities. **Living organisms are both similar and different from each other. The structure and functions of living organisms change at different organization levels.**

SB4. Students will be aware of the diversity of living organisms and how they can be compared scientifically. [Draft p. 9]

16. Students will be aware of the diversity of living organisms and how they can be compared scientifically.
By the end of grade 12:
*[**a. The variation of organisms within a species increases the chances that some members of the species will survive under changed environmental conditions, and a great diversity of species increases the chance that at least some living things will survive even if there are large changes in the environment.**]*
b. The degree of similarity in the DNA sequences of organisms or species can be used to estimate how closely they are related to each other, which often closely matches their classifications based on anatomical similarities. [SEE p. 242]

Benchmark

Ecosystems can be reasonably stable over thousands of years. As any population of organisms grows, it is held in check by one or more environmental factors: depletion of food or nesting sites, increased loss to increased numbers of predators, or parasites. If a disaster such as flood or fire occurs, the damaged ecosystem is likely to recover in stages that eventually result in a system similar to the original one. Like many complex systems, ecosystems tend to have cyclic fluctuations around a state of rough equilibrium. In the long run, however, ecosystems always change when climate changes or when one or more new species appear as a result of migration or local **changes over time**.

SB5. Students will be aware of the dependence of all organisms on one another and their environments. [Draft p. 10]

19. Students will be aware of the dependence of all organisms on one another and their environments. [SEE p. 247]
By the end of grade 12:
a. Ecosystems can be reasonably stable over thousands of years. As any population of organisms grows, it is held in check by one or more environmental factors: depletion of food or nesting sites, increased loss to increased numbers of predators, or parasites. If a disaster such as flood or fire occurs, the damaged ecosystem is likely to recover in stages that eventually result in a system similar to the original one.
*b. Like many complex systems, ecosystems tend to have cyclic fluctuations around a state of rough equilibrium. In the long run, however, ecosystems always change when climate changes or when one or more new species appear as a result of migration or local [**evolution**].*
[SEE p. 248]

Benchmark

At times, environmental conditions are such that plants and marine organisms grow faster than decomposers can recycle them back to the environment. Layers of energy-rich organic material have been gradually turned into great coal beds and oil pools by the pressure of the overlying earth. By burning these fossil fuels, people are passing most of the stored energy back into the environment as heat and releasing large amounts of carbon dioxide. The amount of life any environment can support is limited by the available energy, water, oxygen, and minerals and by the ability of ecosystems to recycle the residue of dead organic materials. Human activities and technology can change this flow and reduce or increase the fertility of the land. The chemical elements that make up the molecules of living things pass through food webs and are combined and recombined in different ways. At each link in a food web, some energy is stored in newly made structures, but much is dissipated into the environment as heat. Continual input of energy from sunlight keeps the process going.

SB6. Students will understand the cycling of matter and the flow of energy through systems of living things. [Draft p. 11]

20. Students will understand the cycling of matter and the flow of energy through systems of living things. [SEE p. 249]
By the end of grade 12:
a. At times, environmental conditions are such that plants and marine organisms grow faster than decomposers can recycle them back to the environment. Layers of energy-rich organic material have been gradually turned into great coal beds and oil pools by the pressure of the overlying earth. By burning these fossil fuels, people are passing most of the stored energy back into the environment as heat and releasing large amounts of carbon dioxide.
b. The amount of life any environment can support is limited by the available energy, water, oxygen, and minerals and by the ability of ecosystems to recycle the residue of dead organic materials. Human activities and technology can change this flow and reduce or increase the fertility of the land.
c. The chemical elements that make up the molecules of living things pass through food webs and are combined and recombined in different ways. At each link in a food web, some energy is stored in newly made structures, but much is dissipated into the environment as heat. Continual input of energy from sunlight keeps the process going. [SEE p. 250]

Benchmark

There are historical scientific models of change, such as those of Lamarck, Malthus, Wallace, Buffone, and Darwin. Evidence from fossil, molecular biology, and anatomical structures suggest relationships among organisms. As climatic conditions change, organisms that do not adapt die off; those organisms suitably adapted survive. Over time, the proportion of individuals that have advantageous characteristics will increase. Heritable characteristics can be observed at molecular and whole-organism levels in structure, chemistry, and behavior. Natural selection leads toorganisms that are well suited for survival in particular

environments. Chance alone can result in thepersistence of some heritable characteristics having no survival or reproductive advantage for theorganism. When an environment changes, the survival value of some inherited characteristics maychange.

SB7. Students will be familiar with the development of living organisms and their changes over time, including inherited characteristics that lead to survival of organisms and their successive generations. [Draft p. 11]

*21. Students will be familiar with the [**evolution of life on earth and understand the arguments for natural selection as a scientific explanation of biological evolution**]. [SEE p. 251]*
By the end of grade 12:
*[**a. The scientific problem that led to the theory of natural selection was how to explain similarities within the great diversity of existing and fossil organisms. Prior to Charles Darwin's work in the nineteenth century, the most widespread belief was that all known species were created at the same time and remained unchanged throughout history. Some scientists also believed that features an individual acquired during its lifetime could be passed on to its offspring, thereby improving the species' ability to survive. In his book Origin of Species, published in the mid-1800s, Darwin argued that only biologically inherited characteristics could be passed on to offspring. The book's quick success came from its clear and understandable argument, including its comparison of natural selection to the selective breeding of animals in wide use at the time, and the massive array of supporting biological and fossil evidence it assembled.**
b. Later support for Darwin's idea of biological evolution has come from the rediscovery of the genetics experiments of an Austrian monk, Gregor Mendel, the identification of genes and how they are sorted in reproduction, and the discovery that the genetic code found in DNA is the same for almost all organisms. Most scientists in the twentieth century accept Darwin's basic idea, although they differ about the details of the process and how rapidly evolution of species takes place. The idea of evolution has also led to religious controversies over its implications.
c. Life on earth is thought to have begun as simple, one-celled organisms about 4 billion years ago. During the first 2 billion years, only single-cell microorganisms existed, but once cells with nuclei developed about a billion years ago, increasingly complex multicellular organisms evolved.
d. Evolution builds on what already exists, so the more variety there is, the more there can be in the future. But evolution does not necessitate long-term progress in some fixed direction. Evolutionary changes appear to be like the growth of a bush: Some branches survive from the beginning with little or no change, many die out altogether, and others branch repeatedly, sometimes giving rise to more complex organisms.
e. Molecular evidence supplements the anatomical evidence for evolution and provides additional detail about the sequence in which various lines of descent branched off from one another.
f. The evolutionary mechanism provided by natural selection depends on the variation in heritable characteristics that exists within every species. Some of these characteristics give individuals an advantage over others in surviving and reproducing, and theadvantaged offspring, in turn, are more likely than others to survive and reproduce.] *Over time, the proportion of individuals that have advantageous characteristics will increase.*
g. Heritable characteristics can be observed at molecular and whole-organism levels in

structure, chemistry, and behavior.
h. Natural selection leads to organisms that are well suited for survival in particular environments. Chance alone can result in the persistence of some heritable characteristics having no survival or reproductive advantage for the organism. When an environment changes, the survival value of some inherited characteristics may change. *[SEE p. 252-253]*

Comparison of the 2004 Draft Georgia 7th Grade – Life Science Curriculum document, from 6-8Sci.pdf, downloaded from
http://www.glc.k12.ga.us/spotlight/gps2.htm
to
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Co-Prerequisite-Content [sic]

Benchmark

Organisms are often grouped into plants, which use sunlight to make their own food, and animals, which consume energy-rich foods. Some kinds of organisms cannot be neatly classified as either plants or animals, and many of them are microscopic. Similarities among organisms, including their anatomical features, are used to infer how closely related the organisms are. Biologists consider details of internal and external structures to be more important in classifying organisms than behavior or general appearance. Animals and plants have a great variety of physical features and internal structures that contribute to their ability to make or find food and reproduce. For sexually reproducing organisms, a species comprises all organisms that can mate with one another to produce fertile offspring.

S7L1. Students will be aware of the diversity of living organisms and how they can be compared scientifically. [Draft p. 19]

16. Students will be aware of the diversity of living organisms and how they can be compared scientifically.
By the end of grade 8:
a. Organisms are often grouped into plants, which use sunlight to make their own food, and animals, which consume energy-rich foods. Some kinds of organisms cannot be neatly classified as either plants or animals, and many of them are microscopic.
b. Similarities among organisms, including their anatomical features, are used to infer how closely related the organisms are. Biologists consider details of internal and external structures to be more important in classifying organisms than behavior or general appearance.
c. Animals and plants have a great variety of physical features and internal structures that contribute to their ability to make or find food and reproduce.
d. For sexually reproducing organisms, a species comprises all organisms that can mate with one another to produce fertile offspring. [SEE p. 242]

Benchmark

In some kinds of organisms, all the genes come from a single parent, whereas in organisms that have sexes, typically half of the genes come from each parent. An inherited trait of an individual can be determined by one or by many genes and a single gene can influence more than one trait. Selective breeding for particular traits has resulted in new varieties of cultivated plants and domestic animals.

S7L2. Students will understand how biological traits are passed on to successive generations. [Draft p. 20]

17. Students will understand how biological traits are passed on to successive generations.
By the end of grade 8:
a. In some kinds of organisms, all the genes come from a single parent, whereas in organisms that have sexes, typically half of the genes come from each parent.
*[**b. In sexual reproduction, a single specialized cell from a female merges with a specialized cell from a male. As the fertilized egg, carrying genetic information from each parent, multiplies to form the complete organism with about a trillion cells, the same genetic information is copied in each cell.**]*
c. An inherited trait of an individual can be determined by one or by many genes, and a single gene can influence more than one trait.
d. Selective breeding for particular traits has resulted in new varieties of cultivated plants and domestic animals. [SEE p. 243]

Benchmark

All living things are composed of cells, from just one to many millions, whose details usually are visible only through a microscope. Different body tissues and organs are made up of different kinds of cells. Cells continually divide to make more cells for growth and repair. Various organs and tissues function to serve the cells' need for food, air, and waste removal. Many of the basic functions of organisms—such as extracting energy from food and getting rid of waste—are carried out within cells. Cells function similarly in all living organisms. Water, which accounts for about two-thirds of the weight of cells, gives cells many of their properties.

S7L3. Students will be familiar with the structure, functions, and reproduction of living cells. [Draft p. 21]

18. Students will be familiar with the structure, functions, and reproduction of living cells.
By the end of grade 8:
*a. All living things are composed of cells, from just one to many millions, whose details usually are visible only through a microscope. Different body tissues and organs are made up of different kinds of cells. [**The cells in similar tissues and organs in other animals are similar to those in human beings but differ somewhat from cells found in plants.**]*
b. Cells continually divide to make more cells for growth and repair. Various organs and tissues function to serve the cells' need for food, air, and waste removal.
c. Many of the basic functions of organisms—such as extracting energy from food and getting rid of waste—are carried out within cells. Cells function similarly in all living organisms.

d.Water, which accounts for about two-thirds of the weight of cells, gives cells many of their properties. [SEE p. 245]

Benchmark

In all environments—freshwater, marine, forest, desert, grassland, mountain, and others—organisms with similar needs may compete with one another for resources, including food, space, water, air, and shelter. The growth and survival of organisms depend on the physical conditions in the particular environment. Two types of organisms may interact with one another in several ways: They may be in a producer/consumer, predator/prey, or parasite/host relationship, or one organism may scavenge or decompose another. Relationships may be competitive or mutually beneficial. Some species have become so adapted to each other that neither could survive without the other.

S7L4. Students will be aware of the dependence of all organisms on one another and their environments. [Draft p. 22]

19. Students will be aware of the dependence of all organisms on one another and their environments.
By the end of grade 8:
a. In all environments—freshwater, marine, forest, desert, grassland, mountain, and others—organisms with similar needs may compete with one another for resources, including food, space, water, air, and shelter. The growth and survival of organisms depend on the physical conditions in the particular environment.
b. Two types of organisms may interact with one another in several ways: They may be in a producer/consumer, predator/prey, or parasite/host relationship, or one organism may scavenge or decompose another. Relationships may be competitive or mutually beneficial. Some species have become so adapted to each other that neither could survive without the other. [SEE p. 247]

Benchmark

Food provides the fuel and the building material for all organisms. Plants use the energy from light to make sugars from carbon dioxide and water, releasing oxygen. The sugars are food that plants use immediately or store for later use. Organisms that eat plants break down the plant structures to produce the materials and energy they need to survive. Plant-eating organisms are consumed by other organisms and so on. Energy can change from one form to another in living things. Animals get energy from oxidizing their food, releasing some of its energy as heat. Almost all food energy comes originally from sunlight. All organisms are part of and depend on two main interconnected global food webs of plants and animals, one in the ocean and one on land. One includes microscopic ocean plants, the animals that feed on them, and finally the animals that feed on those animals. The other web includes land plants, the animals that feed on them, and the animals that feed on those animals. The cycles continue indefinitely because organisms decompose after death to return food material to the environment. Over a long time, matter is transferred from one organism to another repeatedly and between organisms and their physical environment. As in all material systems, the total amount of matter remains constant, even though its form and location change.

S7L5. Students will understand the cycling of matter and the flow of energy through systems of living things. [Draft p. 23]

20. Students will understand the cycling of matter and the flow of energy through systems of living things. [SEE p. 249]
By the end of grade 8:
a. Food provides the fuel and the building material for all organisms. Plants use the energy from light to make sugars from carbon dioxide and water, releasing oxygen. The sugars are food that plants use immediately or store for later use. Organisms that eat plants break down the plant structures to produce the materials and energy they need to survive. Plant-eating organisms are consumed by other organisms, and so on.
b. Energy can change from one form to another in living things. Animals get energy from oxidizing their food, releasing some of its energy as heat. Almost all food energy comes originally from sunlight.
c. All organisms are part of and depend on two main interconnected global food webs of plants and animals, one in the ocean and one on land. One includes microscopic ocean plants, the animals that feed on them, and finally the animals that feed on those animals. The other web includes land plants, the animals that feed on them, and the animals that feed on those animals. The cycles continue indefinitely because organisms decompose after death to return food material to the environment.
d. Over a long time, matter is transferred from one organism to another repeatedly and between organisms and their physical environment. As in all material systems, the total amount of matter remains constant, even though its form and location change.
*[**e. Water is a solvent. As it passes through the water cycle, it dissolves minerals and gases and carries them to the oceans.**] [This moved to S6E3] [SEE pp. 249-250]*

Benchmark

Individual organisms with certain traits are more likely than others to survive and have offspring. Changes in environmental conditions can affect the survival of individual organisms and entire species. Small differences between parents and offspring can accumulate (through selective breeding) in successive generations so that descendants are very different from their ancestors. The basic idea of biological **changes** is that the earth's present-day species developed from earlier, distinctly different species. Many thousands of layers of sedimentary rock provide evidence for the history of the earth and for the history of changing life forms whose remains are found in the rocks. More recently formed rock layers are more likely to contain fossils resembling existing species.

S7L6. Students will be familiar with the development of living organisms and their changes over time, including inherited characteristics that lead to survival of organisms and their successive generations.
[Draft p. 24]

*21. Students will be familiar with the [**evolution of life on earth and understand the arguments for natural selection as a scientific explanation of biological evolution.**]*
By the end of grade 8:

a. Individual organisms with certain traits are more likely than others to survive and have offspring. Changes in environmental conditions can affect the survival of individual organisms and entire species.
b. Small differences between parents and offspring can accumulate (through selective breeding) in successive generations so that descendants are very different from their ancestors.
*c. The basic idea of biological [**evolution**] is that the earth's present-day species developed from earlier, distinctly different species.*
*d. Many thousands of layers of sedimentary rock provide evidence for the [**long**] history of the earth and for the [**long**] history of changing life forms whose remains are found in the rocks. More recently formed rock layers are more likely to contain fossils resembling existing species.*
[SEE p. 251]