**Massachusetts Adult Basic Education Science**

**Curriculum Framework**

 **Life Science Strand**

**Massachusetts Department of**

**Elementary and Secondary Education**

 **Adult and Community Learning Services**

**December 2013**

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**Acknowledgements**

Just as scientific discovery involves the collaboration of many talented and inquisitive people, so, too, does the development of a curriculum document like this one.

Michele Bahr, a scientist with 20 years of research experience at the Marine Biological Laboratory in Woods Hole, Massachusetts, worked closely with a team of Massachusetts ABE subject matter experts to develop the Life Science Strand and Benchmarks.

The team included:

Aliza Ansell, Mehrnoush Bakhshandeh, Lenore Balliro, Christina Cronin, Doreen DiBasio-Erwin, Ben Fox, Roxanne Heller, Linda Matys O’Connell, Maura McCabe, and Helen Rowell.

Staff from the Department of Elementary and Secondary Education (ESE) also contributed to the process, including the following: Anne Serino, Janet Nicholas, Jane Schwerdtfeger, and Olivia Steele from the Adult and Community Learning Services unit, and Joyce Bowen and Jake Foster from the Office of Mathematics, Science, and Technology Engineering (OMSTE).

**Introduction**

“Learn from yesterday, live for today, hope for tomorrow. The important thing is to not stop questioning.”
― [Albert Einstein](http://www.goodreads.com/author/show/9810.Albert_Einstein), [*Relativity: The Special and the General Theory*](http://www.goodreads.com/work/quotes/2638443)

**Background and rationale**The purpose of this document is to present the 2013 Life Science Strand of the Massachusetts ABE Science Framework. We hope this is a useful tool to help teachers do life science in the classroom—that is, to inspire curiosity about the natural world, to encourage inquiry about issues relevant to adult learners’ lives, and to enhance critical thinking and problem solving skills by using the scientific method. Actively doing science – through observations, experiments, and other hands-on activities—helps bring everyday experiences into focus. Topics such as health, nutrition, pollution, and global warming provide ways in to learning about scientific concepts and processes. Hands-on activities that teach scientific concepts are adaptable to every learning level: even students with limited English and literacy abilities can build speaking and reading skills through the experiential learning approach to scientific discovery.

In addition to its inherent value in adult learners’ lives, there is another reason for integrating science into the adult basic education and ESOL curriculum. DESE requires all diploma recipients, including adults, to demonstrate competency in science. The MCAS and the MCAS Appeals Portfolio assess science as a competency. High School equivalency also tests for scientific understanding, content, and interpreting concepts. Studying science is an important component for adult learners to reach their work, life, and education goals.

**Who developed the life science strand, benchmarks and related content?**

Michele Bahr, a scientist with 20 years of research experience at the Marine Biological Laboratory, Woods Hole, MA, worked closely with a team of Massachusetts ABE subject matter experts to develop the Life Science Strand and Benchmarks. The team included Aliza Ansell, Mehrnoush Bakhshandeh, Lenore Balliro, Christina Cronin, Doreen DiBasio-Erwin, Ben Fox, Roxanne Heller, Linda Matys O’Connell, Maura McCabe, and Helen Rowell. Staff from the Department of Elementary and Secondary Education (ESE) also contributed to the process. These included Anne Serino, Janet Nicholas, Jane Schwerdtfeger, and Olivia Steele from the Adult and Community Learning Services unit and Joyce Bowen and Jake Foster from the Office of Mathematics, Science, and Technology Engineering (OMSTE).

Much of the content in the life science strand is extrapolated from the MA K-12 Curriculum Frameworks and MCAS released test items. In addition, the National Research Council’s *A Framework for K-12 Science Education, Next Generation Science Standards*, and other state standards were also consulted. The Next Generation Science Standards are K-12 science standards rich in content and arranged in a coherent manner across disciplines. These standards focus on a deeper understanding and application ofcontent than the often fact-driven standards currently in use in states. Skills such as critical thinking and inquiry-based problem solving promote science- based skills while providing students with an internationally benchmarked science education.

**What are the basics of science?**
The three main schools of science consist of Biology, Physical Sciences and Earth and Space Science; many of these sciences overlap in their topics. The main focus of life science is Biology, the study of [living organisms](http://en.wikipedia.org/wiki/Living_organism) (including [microorganisms](http://en.wikipedia.org/wiki/Microorganism), [plants](http://en.wikipedia.org/wiki/Plant), [animals](http://en.wikipedia.org/wiki/Animal), and [human beings](http://en.wikipedia.org/wiki/Human_being)). The life sciences also include the study of genetics and incorporate bioethics, the study of controversial topics in biology and medicine. Issues such as genetic engineering, cloning, and screening for prenatal defects are in the news daily and can spark the interest of adult learners as they approach complex scientific topics.

**What is the value of studying life science?**

Adult learners are concerned about their own and their family’s health and environment. Informed decisions about these areas arise from studying science. For example, understanding what an “empty calorie” means can lead to decisions about healthier food choices. Researching the negative health consequences of lead paint, often found in older housing, can help students explore various protections available to them. Understanding the 'how' and 'why' of things has helped humans develop cures for diseases, protect wildlife and plant life, predict and prepare for climate extremes, and so much more. Adult learners can identify their own science related questions and use the scientific inquiry process to help answer them. In addition, an increasing number of careers require some knowledge of science. Many learners currently wish to earn a high school equivalency credential in order to access a post-secondary program of study. Training for 21st Century jobs require some fundamental science knowledge.

**What are the ways to incorporate science into an ABE Curriculum?**

ABE teachers do not have to be trained scientists to incorporate science content into most levels of ABE and ESOL classes, although a strong science background is important for teaching scientific content at the high school equivalency level. Teachers can integrate science content into existing reading, writing, math and ESOL classes that are appropriate for their learning levels. Articles with scientific content, adapted from newspapers, magazines, or textbooks, can be adapted for most reading levels—from basic ABE through high school equivalency credential. For low-literate and beginning English language learners, teachers can introduce vocabulary through simple hands-on activities illustrating scientific concepts, building the language experience approach into their teaching methods. The standards and benchmarks that follow provide guidance on selecting topics for various grade level equivalencies (GLEs).

This document offers a guide—through the identification of essential questions, standards, and benchmarks—for teachers to begin doing science in their classes. In addition, the appendices provides teachers with current resources—some on the web, some in their communities—that offer opportunities to learn science using the most recent research methodology and technology.

**How is this document organized?**

Understanding the structure of this document may take a bit of time, but no one expects teachers to memorize the numbering system of the benchmarks. The important thing to keep in mind as you explore this life science strand is how it can guide you in teaching science to your own students.

Though the topics are arranged numerically from 1-5, teachers do not need to follow the topics sequentially. Your real guide to selecting topics remains with your students. Once you discover meaningful areas to explore, you can go to that topic in this life science strand. For example, you might jump right to topic 4—Ecology—as you begin the autumn cycle, when the weather is good and classes can occasionally take place outside to explore the environment. With that said, here’s a brief explanation of how the document is organized. As you use it, it will become clearer.

First, the document is organized by **topics.** These topics include: Cell Biology, Genetics, Anatomy and Physiology, Ecology, and Evolution & Biodiversity. Each **topic** presents a **standard**. Standards are what learners should know and be able to do within a specific content area. Beneath the standards are **benchmarks.** Benchmarks are descriptions of what a student should be able to do at that grade level equivalency.

For example, topic 1 is cell biology. The standard under that topic is *Learners will be able to compare specific structures and functions that make cells distinctive using diagrams, illustrations, visual images and/or models, etc*. One of the benchmarks for 0-3.9 grade level equivalency (GLE) is: *By the end of this level learners will . . . Identify the cell as the basic structure for life.* Each of the standards will include more than one benchmark. Benchmarks are presented to cover three levels of knowledge for each topic: Level 1 and 2 which is appropriate for ABE and ESOL learners; Level 3-4, which is appropriate for pre-ASE; and Level 5-6, which is appropriate

for ASE learners.

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| **Benchmarks for LEVELS 1 and 2****BEGINNING ADULT BASIC EDUCATION** 0-3.9 GLE and SPL 0-3 | **Benchmarks forLEVELS 3 and 4****low intermediate/ high intermediate education**4.0 - 8.9 GLE and SPL 4-5 | **Benchmarks forLEVELS 5 and 6****ADULT SECONDARY EDUCATION****9.0 - 12.9 GLE and SPL 5-7** |

The standardsand benchmarks included in this document are intended to provide a guideline for ABE and ESOL teachers to determine what the adult learner needs to know in life science at every level, whether ABE or ESOL.

You will notice that each benchmark is accompanied by an essential question. Essential questions guide the inquiry process for the material in that strand. Benchmarks help to answer the essential questions.

**What resources are available to help ABE teachers teach science?**A variety of science museums and other institutions across Massachusetts offer resource libraries with lesson plans and materials for teaching life sciences. Organizations like the Technical Education Resource Center (TERC) and the Discovery Museum use inquiry-based approaches based on prevailing theories and methods for teaching science. Some offer free professional development—individually and in small groups—for teachers. In addition, many of these museums offer on-site visits to schools and programs to model and facilitate hands-on learning. Teachers and programs can organize field trips for small or larger groups, and arrange for a trained science educator to facilitate a tour and activities. Some museums, like the Boston Museum of Science, offer reduced rates to programs whose students meet eligibility criteria. Museums are often overlooked resources in the ABE field, although K-12 teachers have used them to enhance science learning for years. For more specific information, check out Appendix D for a list of museums across the state.

Professional organizations such as the National Science Teachers Association offer professional development for teachers, including free online modules on life science topics, journals with selected free articles online, and conferences.

In addition, today’s technology offers simulations through the Internet that can be substituted for real science lab experiments. For example, images online of a frog dissection are often clearer than what one would see dissecting a frog in the classroom. (And this saves the frog, too!) Search YouTube sites for science experiments, such as:

[http://www.youtube.com/watch?v=iARB5vWbHscSee YouTube](http://www.youtube.com/watch?v=iARB5vWbHscSee%20YouTube)

**GUIDING PRINCIPLES**Guiding principles are the underlying assumptions about effective learning, teaching, and assessment in life science for adult learners.

In effective science education:

1. Students learn science and work with technology best through inquiry and hands-on explorations.

An understanding and appreciation of science and technology develops as adult learners frame questions of interest to them about the natural world in which they live, then find answers supported by evidence they have collected through hands-on investigation and research. It is in this process of using appropriate technology to help them answer questions or solve problems that learners discover what science is really about.

1. Students and teachers take advantage of resources in their communities and collaborate with scientists in order to answer questions and solve problems.

Many of the museums, aquariums, zoos, and related institutions in Massachusetts offer science-based educational resources for teachers and students. Teachers can make use of their curricula and materials, and students can engage in on-site inquiry based scientific exploration led by professional staff. In addition, teachers can invite community members who make use of scientific inquiry, such as health care professionals or participants in “citizen science” programs to answer students’ questions about how science fits into their work.

1. Students and teachers are willing to take risks when exploring topics in science and technology.

These risks may be those associated with allowing new evidence to challenge previously held beliefs or prejudices or in exploring topics originally seen as too difficult. Adult learners and their teachers may find that in the process of posing questions and seeking answers they have to risk exposing the limits to their knowledge and experience to one another. A classroom in which such risk-taking is respected will immeasurably enhance the learning experience for all.

1. Students and teachers understand when doing science that there is more than one correct

answer, and results are often messy.

In the ABE classroom, as in real life, problems are complex and solutions may vary depending on the communities and their available resources. Unexpected answers are great opportunities for further learning—both in the ABE classroom and in the wider scientific community. In the ABE science class, adult learners develop confidence in their own abilities to be active participants in community problem solving around complex issues.

**HABITS OF MIND**

Habits of mind are the dispositions, tendencies or practices that strengthen and support life-long learning through the study of life science

Curiosity

The heart of science and technology is the invitation to pursue questions about and to find problems to solve in our world. Sometimes curiosity resembles puzzlement or confusion. Other times it resembles fascination, amazement, looking closer, revising ideas, or looking for a better solution.

Open Mindedness

Advances in science and technology depend on openness to new ideas as well as examining these ideas with a critical eye. Scientific theories remain ever open to reconsideration and redesign as new evidence is discovered. Exploring science requires that we sometimes suspend our own assumptions and beliefs, entertain new ideas, and be skeptical of information not supported by good evidence

Creativity

Students, like good scientists, have the capacity to generate novel, imaginative or innovative solutions, products or techniques. Good science teachers encourage learners to look at problems and problem solving from many different angles and nurture creative solutions rather than insisting on one right answer.

Wonder

Like passionate scientists, learners are most engaged when they are intrigued by the world around them. To find beauty in the intricacies of a sea shell, to wonder at the symmetry and strength of a spider’s web, to be inspired by the order in a living system, or to be amazed at the simplicity of a lever feeds our curiosity and imagination.

Confidence

Science is a human endeavor, often filled with uncertainty and ambiguity. It is a process marked by inquiry and should not be viewed as an elite or inaccessible body of knowledge. Teachers and learners both need to approach the exploration in science and technology with confidence that they too can participate in, and in fact enjoy, this unique way of coming to understand our world.

*The most beautiful experience in the world is the experience of the mysterious*.
Albert Einstein

**STANDARDS**Standards are whatlearners should know and be able to do within a specific content area. Standards reflect the knowledge and skills of an academic discipline, and reflect what the stakeholders of educational systems recognize as essential to be taught and learned. The standards provide a clear outline of content and skills so that programs can develop and align curriculum, instruction, and assessments. [[1]](#footnote-1)

**Topic 1: Cell Biology**

Cell Biology is the [study](http://www.biology-online.org/dictionary/Study) of [cells](http://www.biology-online.org/dictionary/Cells), especially their [function](http://www.biology-online.org/dictionary/Function), [structure](http://www.biology-online.org/dictionary/Structure), [components](http://www.biology-online.org/dictionary/Component), [formation](http://www.biology-online.org/dictionary/Formation), [life cycle](http://www.biology-online.org/dictionary/Life_cycle), and their [interaction](http://www.biology-online.org/dictionary/Interaction) with the internal or external [environments](http://www.biology-online.org/dictionary/Environments).

**Standard:** Learners will be able to compare specific structures and functions that make cells distinctive using diagrams, illustrations, visual images and/or models. They will be able to measure processes such as growth rate, identify common needs for the maintenance of life, distinguish methods of reproduction and compare these processes in different types of living organisms.

**Topic 2: Genetics**

Genetics is the [study](http://www.biology-online.org/dictionary/Study) of the [patterns](http://www.biology-online.org/dictionary/Patterns) of [inheritance](http://www.biology-online.org/dictionary/Inheritance) of [specific](http://www.biology-online.org/dictionary/Specific) [traits](http://www.biology-online.org/dictionary/Traits).

**Standard**: Learners will be able to list traits that are common within species or types of organisms and identify variations. They will be able to use tools to predict how traits and variations of traits are passed from one generation to the next.

**Topic 3: Anatomy and Physiology**

Anatomy and Physiology are the study the functions, mechanisms, and activities of [organisms](http://www.biology-online.org/dictionary/Organism) at the [cellular](http://www.biology-online.org/dictionary/Cellular) or [organ](http://www.biology-online.org/dictionary/Organ) [system](http://www.biology-online.org/dictionary/System) level.

**Standard**: Students will be able to diagram the structure and function of different organ systems and compare levels of interrelationships within the human body. Learners will be able to actively participate in decision-making regarding their own health and that of their families. They will be able to compare similarities and differences to other organisms.

**Topic 4: Ecology**

Ecology is the study of the relationships between and among organisms and their environment.

**Standard:** Learners will be able illustrate how ecosystems are dynamic entities composed of organisms and their environment. They will be able to analyze change that might occur as an ecosystem is disrupted. They will be able to trace energy flows within ecosystems, and identify an ultimate source of energy such as the sun.

**Topic 5: Biological Evolution: Unity and Diversity**

Evolution is the study of [change](http://www.biology-online.org/dictionary/Change) in [genetic](http://www.biology-online.org/dictionary/Genetic) [composition](http://www.biology-online.org/dictionary/Composition) of a [population](http://www.biology-online.org/dictionary/Population) over [successive](http://www.biology-online.org/dictionary/Successive) [generations](http://www.biology-online.org/dictionary/Generation), which may be caused by [natural selection](http://www.biology-online.org/dictionary/Natural_selection), [inbreeding](http://www.biology-online.org/dictionary/Inbreeding), [hybridization](http://www.biology-online.org/dictionary/Hybridization), or [mutation](http://www.biology-online.org/dictionary/Mutation).

**Standard:** Learners will be able to provide multiple forms of evidence of the process of evolution as a series of changes, some gradual and some sporadic, that accounts for the present form and function of organisms and natural systems. They will be able to provide explanations of biodiversity, the [existence](http://www.biology-online.org/dictionary/Existence) of a wide [range](http://www.biology-online.org/dictionary/Range) of different [types](http://www.biology-online.org/dictionary/Types) of [organisms](http://www.biology-online.org/dictionary/Organisms) in a [given](http://www.biology-online.org/dictionary/Given) [place](http://www.biology-online.org/dictionary/Place) at a [given](http://www.biology-online.org/dictionary/Given) [time](http://www.biology-online.org/dictionary/Time), can be a benefit to humans and hypothesize how humans might affect biodiversity.

**ESSENTIAL QUESTIONS**

**Topic 1: Cell Biology**

1. What is a cell?
2. How do the cells of living things meet their basic needs?
3. How do cells get and use what they need to live and grow?
4. How do cells divide?
5. What is the role of cells in sexual reproduction?
6. How are viruses different from cells?
7. How do scientists increase their power of observation by using instruments?

 **Topic 2: Genetics**

1. How are the characteristics of one generation related to the previous generation?
2. Why do individuals of the same species vary in how they look, behave and function?
3. How do scientists identify genetic vs. environmental causes of traits and disease?

**Topic 3: Anatomy and Physiology**

1. How are organ systems formed?
2. What organ systems make up the body of an animal?
3. How do the systems of the body work together?
4. How do scientists increase their power of observation by using instruments to diagnose disease and conducting studies to understand both good health practices and effective treatment of disease?

**Topic 4: Ecology**

1. What are the essential components of an ecosystem? How are those components interdependent?
2. What are the essential interactions between living things and the non-living parts of an ecosystem?
3. What are some of the ways that organisms interact with one another within an ecosystem?
4. How can disruptions to an ecosystem affect the organisms within the ecosystem and the processes that occur within it?
5. How do scientists use observation and experimentation to study ecosystems

**Topic 5: Evolution and Biodiversity**

1. How have organisms changed over time? What evidence shows that different species are related?
2. How does evidence from the fossil record support the idea that newer life forms descend from older life forms?
3. How does genetic information provide evidence for evolution?
4. How does the environment influence populations of organisms over multiple generations?
5. What is biodiversity?
6. How does biodiversity affect humans? How do humans affect biodiversity?
7. How do scientists use models to reconstruct evolutionary theory and to predict the likelihood of future events?

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| **LIFE SCIENCE TOPIC 1: CELL BIOLOGY*****Cell Biology*** *is the* [*study*](http://www.biology-online.org/dictionary/Study) *of* [*cells*](http://www.biology-online.org/dictionary/Cells)*, especially their* [*function*](http://www.biology-online.org/dictionary/Function)*,* [*structure*](http://www.biology-online.org/dictionary/Structure)*,* [*components*](http://www.biology-online.org/dictionary/Component)*,* [*formation*](http://www.biology-online.org/dictionary/Formation)*,* [*life cycle*](http://www.biology-online.org/dictionary/Life_cycle)*, and their* [*interaction*](http://www.biology-online.org/dictionary/Interaction) *with the internal or external* [*environments*](http://www.biology-online.org/dictionary/Environments)*.*  |
| ***Standard:*** *Learners will be able to compare specific structures and functions that make cells distinctive using diagrams, illustrations, visual images and/or models. They will be able to measure processes such as growth rate, identify common needs for the maintenance of life, distinguish methods of reproduction, and compare these processes in different types of living organisms.**Please note: The glossary on page 27 provides explanations of specialized scientific terms you may come across in the descriptions of standards and benchmarks.* *GLE refers to grade level equivalency; SPL to ESOL student performance level.*  |
| **Essential questions** | **Benchmarks for LEVELS 1 and 2****BEGINNING ADULT BASIC EDUCATION****(0-3.9 GLE & SPL 0-3)** | **Benchmarks forLEVELS 3 and 4****low intermediate/ high intermediate education****(4.0 - 8.9 GLE & SPL 4-5)** | **Benchmarks forLEVELS 5 and 6****ADULT SECONDARY EDUCATION/BRIDGE TO COLLEGE****(9.0 - 12.9 GLE & SPL 5-7)** |
| **C1** - **What is a cell?** | *By the end of this level learners will . . .***C1.1a** Identify the cell as the basic structure for life. **C1.1b** Using a picture or diagram, explain that cells have parts, including an outer membrane that separates the parts from the environment.**C1.1c** Recognize that some organisms are multicellular while others consist of a single cell. | *By the end of the level, learners will demonstrate previous benchmarks as needed, plus. . .***C1.3a** Review that cells are the basic structures for life. **C1.3b** Illustrate and label the parts of a cell and describe how each part contributes to the basic needs of life. **C1.3c** Give examples of living organisms that are unicellular and examples of living organisms that are multicellular. | *By the end of the level, learners will demonstrate previous benchmarks as needed, plus. . .***C1.5a** Compare and contrast the general structures and degrees of complexity of Eukaryotic, Bacterial and Archaeal cells. |
| **C2 - How do the cells of living things meet basic needs?** | **C2.1a** Identify food and water; a way to dispose of waste, and an environment to live in as needs for both single cell microorganisms and familiar, multi-cellular organisms. | **C2.3a** Outline how the basic functions of organisms, such as extracting energy from food and getting rid of waste, are carried out within cells. Recognize that the way in which cells function is similar in all living things.**C2.3b** Recognize that different body tissues and organs are made of different types of cells in multicellular organisms.**C2.3c** Explain that various organs and tissues function to serve the needs of all cells for food, air, and waste removal. | **C2.5a** Use appropriate scientific vocabulary to expand descriptions of how different functions are carried out in cells to include protein building, storing genetic information, and responding to stimuli.**C2.5b** Identify that more complex multicellular animals have differentiated cells that perform different functions, (e.g., liver cells remove waste, blood cells transport oxygen, nerve cells transfer sensory information to the brain). |
| **C3 -** **How do cells get and use what they need to live and grow?** | **C3.1a** Develop an explanation of why all living things need energy to survive.**C3.1b** Distinguish between plants making their own food for energy and animals consuming food for energy. | **C3.3a** Identify that energy derived from the sun is used by plants cells to produce sugars via photosynthesis.**C3.3b** Contrast the process of photosynthesis in plants with the way that animal cells derive their energy from the ingestion of food.**C3.3c** Describe how the molecules from food react with oxygen to provide the energy that is needed to carry out life functions. Explain how this energy is used for building body structures or stored for later use.**C3.3d** Identify cellular respiration as the process by which the chemical energy of food molecules is released. Recognize that all cells, whether plant, animal or microbe, respire. | **C3.5a** Illustrate how energy is transferred when the bonds of food molecules are broken and new compounds with lower energy are formed.**C3.5b** Identify sources for carbon, hydrogen, nitrogen, oxygen, phosphorus and sulfur (C, H, N, O, P and S), the primary elements of which organisms are composed.**C3.5c** Compare nutrition labels to locate and chart major categories of organic molecules (carbohydrates, lipids, proteins).**C3.5d** Describe how the molecules from food react with oxygen or some other electron donor to provide energy that is needed to carry out life functions, build and become incorporated into the body structure, or is stored for later use in plant, animal and microbial cells.  |
| **C4** - **How do cells divide?** | **C.4.1a** Give examples of cells repeatedly dividing to make more cells for different needs (such as new growth or repair.)**C4.1b** Measure growth of an organism and record the results. | **C4.3a** Review that cells repeatedly divide to make more cells for growth or repair (e.g., growth, when cells divide to create bone, or repair, when cells dividing to repair skin.)**C4.3b** Measure growth in an organism and record the results in appropriate units. Translate between different graphic representations of growth.  | **C4.5a** Diagram the steps involved in mitosis, including interphase, prophase, metaphase, anaphase, and telophase.**C4.5b** Measure growth in an organism and record results in appropriate units. Translate between different graphic representations of growth. Compare growth rates under different conditions or between different organisms. |
| **C5 - What is the role of cells in sexual reproduction?** | No benchmark for this level. | **C5.3a** Explain that most eukaryotes have special reproductive cells called gametes and when they unite a zygote is formed. Contrast when and where this occurs in plants and animals. | **C5.5a** Describe how the process of meiosis results in the formation of haploid cells. **C5.5b** Explain the importance of meiosis in sexual reproduction, and how haploid gametes form diploid zygotes through the process of fertilization. |
| **C6** - **How are viruses different from cells?** | **C6.1a** Use books, the internet, or personal experience to identify some human illnesses caused by infection by bacteria and other illnesses caused by infection by viruses. | **C6.3a** Compare diagrams of the structure of a virus and a bacterial cell. Give examples of viral and bacterial diseases. | **C6.5a** Compare and contrast a virus and bacterium in terms of genetic material and reproduction.  |
| **C7** - **How do scientists increase their power of observation by using instruments, including magnification, to view cells and cell structures?**  | **C7.1a** Use a magnifying lens or computer graphics to observe details of common objects that could not be seen without aid. (For example, an insect, stand of hair, portion of a flower, etc.) | **C7.3a** Use a microscope or visual images to observe the details of cellular structures.**C7.3b** Estimate and calculate a change in scale when looking at life size vs. magnified images.**C7.3c** Construct and use models to show things that are inaccessible to human perception without aid (e.g., how cells divide).**C7.3d** Categorize what medical information can be gathered by different methods, e.g., direct observation vs. microscopy. | **C7.5a** Use a high magnification microscope or visual images to examine the structure of cell organelles.**C7.5b** Follow precisely a multistep procedure when taking measurements (e.g., use a taxonomic key to identify organisms). **C7.5c** Generate a scientific argument that could be incorporated into a decision about a socio-scientific issue, (e.g., stem cell research or the use of growth hormones in agriculture). |

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| **LIFE SCIENCE TOPIC 2: GENETICS*****Genetics*** *is the* [*study*](http://www.biology-online.org/dictionary/Study) *of the* [*patterns*](http://www.biology-online.org/dictionary/Patterns) *of* [*inheritance*](http://www.biology-online.org/dictionary/Inheritance) *of* [*specific*](http://www.biology-online.org/dictionary/Specific)[*traits*](http://www.biology-online.org/dictionary/Traits)*.* |
| ***Standard:*** *Learners will be able to list traits that are common within species or types of organisms and identify variations. They will be able to use tools to predict how traits and variations of traits are passed from one generation to the next.**Please note: The glossary on page XX provides explanations of specialized scientific terms you may come across in the descriptions of standards and benchmarks.**GLE refers to grade level equivalency; SPL to ESOL student performance level.* |
| **Essential questions** | **Benchmarks for LEVELS 1 and 2** **Beginning Adult basic** **education****(0-3.9 GLE & SPL 0-3)** | **Benchmarks forLEVELS 3 and 4low intermediate/ high intermediate education****(4.0 - 8.9 GLE & SPL 4-5)** | **Benchmarks forLEVELS 5 and 6ADULT SECONDARY EDUCATION/BRIDGE TO COLLEGE****(9.0 - 12.9 GLE & SPL 5-7)** |
| **G1- How are the characteristics of one generation related to the previous generation?** | *By the end of the level, learners will…***G1.1a** Separate organisms into categories based on characteristics that are either similar or different (e.g., number of legs, eye color, fur type, gender).**G1.1b** Recognize that every organism requires a set of instructions that specifies its traits. Collect data in the classroom on an inherited characteristic (e.g., tongue rolling, ear lobe attachment). | *By the end of the level, learners will demonstrate previous benchmarks as needed, plus…***G1.3a** Understand that when organisms reproduce, they transfer their genetic information to the new individual. Define the passage of information from one generation to another as heredity.**G1.3b** Identify that the cells of all organisms contain one or more chromosomes with genetic information, i.e., genes.**G1.3c** Explain that offspring of sexual organisms receive genetic information for all inherited traits from mothers (via the egg) and fathers (via the sperm). | *By the end of the level, learners will demonstrate previous benchmarks as needed, plus…***G1.5a** Use a model to describe the basic structure of DNA as a double helix with a sugar/phosphate backbone linked by complementary nucleotide pairs (A and G, C and T).**G1.5b** Identify genes as being made of DNA. Outline how genes control the production and regulation of proteins.**G1.5c** Diagram how organisms reproduce to transfer their genetic information to the new individual. In eukaryotes, the new individual receives genetic information from its mother (via the egg) and its father (via the sperm) during meiosis. **G1.5d** Compare how heritable (able to be inherited) characteristics can be observed at molecular and whole organism levels—in structure, chemistry or behavior. |
| **G2- Why do individuals of the same species vary in how they look and function?** | **G2.1a** List ways that offspring are very much alike but not exactly like their parents or siblings. | **G2.3a** Compare the variation in how different organisms look and function because they have inherited different genetic information. Deduce that organisms that are related may end up looking or behaving differently.**G2.3b** Show that the offspring of sexual organisms have two alleles of each gene, one from each parent.**G2.3c** Record data that replicates Mendel’s study of traits to understand how individuals of the same species vary in how they look.**G2.3d** Use appropriate vocabulary to describe how an observed trait depends on the set of alleles the offspring inherits from each parent and whether they are dominant, recessive or codominant.**G2.3e** Use a Punnett Square to predict genotypes and phenotypes of plants. | **G2.5a** Use a computer model to predict genotypes and phenotypes of organisms using Punned Squares or DNA sequences.**G2.5b** Determine how alleles differing in their nucleotide sequence might result in the synthesis of different or even missing proteins that affect an individual’s genotype and phenotype.**G2.5c** Depict how the genetic information contained in chromosomal DNA can sometimes change due to recombination or mutations. **G2.5d** Identify gene mutations as one source of genetic variation and explain how this can lead to a change in an organism’s traits. Recognize that some mutations can be beneficial, some harmful and others have no effect. Some mutations may be caused by radiation and chemicals. |
| **G3 - How do scientists identify genetic vs. environmental causes of traits and diseases?**. | **G3.1a** List some characteristics (traits) that organisms might inherit from their parents. Contrast those with other characteristics that are affected by climate or environment (e.g., nutrition can affect height, longevity, diabetes, or certain diseases.)**G3.1b** Pose a question about heredity and propose likely explanations. | **G3.3a** Analyze the purpose of genetic testing, including defining the problem or question to be resolved (e.g., screening for breast cancer gene)**G3.3b** Judge whether data or a conclusion in a scientific study on pesticide or herbicide uses in an environment is reasonable. Support your judgment with evidence.  | **G3.5a** Analyze the purpose of a scientific study of different medical treatments, specifying the variables that are to be changed, controlled or measured and distinguishing independent from dependent variables.**G3.5b** Assess the extent to which the evidence in a text supports a scientific claim, (e.g., environmental causes of cancer in a population). |

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| **LIFE SCIENCE TOPIC 3: ANATOMY AND PHYSIOLOGY*****Anatomy and Physiology*** *are the study the functions, mechanisms, and activities of* [*organisms*](http://www.biology-online.org/dictionary/Organism) *at the* [*cellular*](http://www.biology-online.org/dictionary/Cellular) *or* [*organ*](http://www.biology-online.org/dictionary/Organ)[*system*](http://www.biology-online.org/dictionary/System) *level.*  |
| ***Standard:*** *Students will be able to diagram the structure and function of different organ systems and compare levels of interrelationships within the human body. Learners will be able to actively participate in decision-making regarding their own health and that of their families and will be able to compare similarities and differences to other organisms.**Please note: The glossary on page 27 provides explanations of specialized scientific terms you may come across in the descriptions of standards and benchmarks.* *GLE refers to grade level equivalency; SPL to ESOL student performance level.* |
| **Essential questions** | **LEVELS 1 and 2****Beginning basic education****(0-3.9 GLE & SPL 0-3)** | **LEVELS 3 and 4****low intermediate/ high intermediate education****(4.0 - 8.9 GLE & SPL 4-5)** | **LEVELS 5 and 6****ADULT SECONDARY EDUCATION/BRIDGE TO COLLEGE****(9.0 - 12.9 GLE & SPL 5-7)** |
| **AP1** - **How are organ systems formed?** | *By the end of the level, learners will.* . .No benchmark at this level. | *By the end of the level, learners will demonstrate previous benchmarks as needed, plus…***AP1.3a** Describe cells as coming together to form tissues, tissues form organs, and organs form systems. | *By the end of the level, learners will demonstrate previous benchmarks as needed, plus…*No benchmark at this level. |
| **AP2 -What systems make up the body of an animal?** | **AP2.1a** Contribute to a discussion, using appropriate scientific vocabulary, about how human body systems (digestive, circulatory, respiratory, nervous, muscular/skeletal, reproductive) work and how common illnesses are associated with each system. \**\*See list of scientific vocabulary and list of common illnesses in appendix B* | **AP2.3a** Contribute to a discussion, using appropriate scientific vocabulary, about how human body systems (digestive, circulatory, respiratory, nervous, muscular/skeletal, reproductive) work and how common illnesses are associated with each system. \* Use input from peers to improve understanding and to expand the use of appropriate science vocabulary\**\*See list of scientific vocabulary and list of common illnesses in appendix B* | **AP2.5a** Contribute to a discussion, using appropriate scientific vocabulary, about how human body systems (digestive, circulatory, respiratory, nervous, muscular/skeletal, reproductive) work and how common illnesses are associated with each system. \* Use input from peers and science articles to improve understanding and to expand the use of appropriate science vocabulary.*\* See list of scientific vocabulary and list of common illnesses in appendix B* |
| **AP3 -** **How do the systems of animals work together to maintain homeostasis?** | **AP3.1a** Match systems of the body that rely on each other: i.e. muscular and skeletal. | **AP3.3a** Explain how systems of the body rely on each other: i.e. muscular and skeletal, circulatory and respiratory, nervous and muscular. | **AP3.5a** Explain how body systems interact (i.e. muscular and skeletal, circulatory and respiratory, nervous and muscular) to maintain homeostasis and why it is important to the well being of the body. |
| **AP4 - How do scientists increase their power of observation by using instruments to diagnose disease and conducting studies to understand both good health practices and effective treatment?** | **AP4.1a** Support or challenge ideas presented in the news media about maintaining good health (e.g., the NYC major trying to limit the size of soda sold to combat obesity.) | **AP4.3a** Categorize what information can be gathered by different technologies (e.g., direct observation, x-rays, magnetic resonance imaging (MRI), computerized axial tomography (cat) scan, and biopsy).**AP4.3b** Record physiological data among classmates in an orderly and systematic way. (e.g., height).**AP4.3c** Expand data collected in the classroom to observe the need for and purpose of replication of data in experiments and scientific research.  | **AP4.5a** Research and evaluate the effects that use of certain substances (e.g., drugs, alcohol) or exposure to environmental factors (e.g., pesticides) may have on the function or development of tissues, organs or systems.**AP4.5b** Record physiological data among classmates in an orderly and systematic way (e.g., heart or breathing rate before and after an activity). Analyze the data and use that analysis of the data to support a physiological explanation. **AP4.**5c Evaluate the validity of explanations in the news media and on the web about scientific claims, especially related to health products, conditions, or behaviors. Evaluate the reliability of information sources.  |

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| **LIFE SCIENCE TOPIC 4: ECOLOGY*****Ecology*** *is the study of the relationships between and among organisms and their environment.*  |
| ***Standard:*** *Learners will be able illustrate how ecosystems are dynamic entities composed of organisms and their environment. They will be able to analyze change that might occur as an ecosystem is disrupted. They will be able to trace energy flows within ecosystems, and identify an ultimate source of energy such as the sun.**Please note: The glossary on page XX provides explanations of specialized scientific terms you may come across in the descriptions of standards and benchmarks.* *GLE refers to grade level equivalency; SPL to ESOL student performance level.* |
| **ESSENTIAL QUESTIONS** | **LEVELS 1 and 2****Beginning basic education****(0-3.9 GLE & SPL 0-3)** | **LEVELS 3 and 4****low intermediate/ high intermediate education****(4.0 - 8.9 GLE & SPL 4-5)** | **LEVELS 5 and 6****ADULT SECONDARY EDUCATION/BRIDGE TO COLLEGE****(9.0 - 12.9 GLE & SPL 5-7)** |
| **E1 - What are the essential components of an ecosystem? How are those components interdependent?** | *By the end of the level, learners will . . .***E1.1a** Give examples of various types of plants and animals living together and depending on one another for things such as food and shelter. **E1.1b** Describe how plants get energy for life directly from the sun. **E1.1c** Understand that while some animals eat other animals for food, all animals are ultimately dependent on plants as their food source. | *By the end of the level, learners will demonstrate previous benchmarks as needed, plus…***E1.3a** Give examples of how different organisms within an ecosystem may compete for the same resources. **E1.3b** Explain that the organisms in an ecosystem require an energy source and that the ultimate source of energy is the sun.**E1.3c** Describe ways that a specific ecosystem has changed in response to physical factors that impinged upon it. Recognize that all ecosystems are ever changing in response to physical factors. | *By the end of the level, learners will demonstrate previous benchmarks as needed, plus….***E1.5a** Use a model to calculate how the number of organisms within a specific ecosystem is limited by the availability of resources within it. **E1.5b** Compare multiple ecosystems to describe the ways in which energy is transferred from primary producers (plants) to consumers (animals) and the loss of energy from one trophic level to another. Diagram how each organism affects many others and is, in turn, affected by others. |
| **E2 - What are the essential interactions between living things and the non-living parts of an ecosystem?**  | **E2.1a** Give examples how different plants and animals in an ecosystem are dependent on many of the same non-living resources, e.g., water, nutrients, air. **E2.1b** Recognize that some animal behaviors are instinctive (e.g., turtles burying their eggs) and others are learned (e.g., humans building fire for warmth).**E2.1c** Recognize plant behaviors such as the seedlings’ stems grow toward light and roots grow downward in response to gravity. | **E2.3a** Compare biotic (living) and abiotic (non-living) portions of different ecosystems. **E2.3b** Outline some ways that living organisms utilize non-living components of the ecosystem in their growth and existence.**E2.3c** Design and carry out an experiment on physical influences on plant growth. Record the data and represent it in graphic form. | **E2.5a** Integrate quantitative information presented graphically about the cyclical nature of many of the processes in an ecosystem with other information in a text. **E2.5b** Explain how the interaction between and among the biotic and abiotic portions of an ecosystem result in changes to the ecosystem. **E2.5c** Use a model to explain how water, carbon, and nitrogen cycle between abiotic resources and organic matter in an ecosystem. **E2.5d** Calculate a household carbon footprint (available from The Nature Conservancy among others). Calculate the effects of changing home energy, transportation, food or recycling patterns. |
| **E3 - What are some of the ways that organisms interact with one another within an ecosystem?** | **E3.1a** Identify plants as the primary source of energy that can be utilized by other organisms within the ecosystem.**E3.1b** Define the relationship between predator/prey.  | **E3.3a** Use a food web to identify and distinguish the roles of producers, consumers, and decomposers in the process of energy transfer in a food web using specific examples.**E2.3b** Explain how dead plants and animals are broken down by other living organisms and how this process contributes to the system as a whole. | **E3.5a** Use appropriate tools (e.g., charts, tables, mathematics, graphs) to analyze relationships between variables that might cause populations within an ecosystem to fluctuate over time. **E3.5b** Construct and use models to show how an increase in population in one species might result in a decline in numbers of another species within an ecosystem.**E3.5c** Describe interactions among and within the organisms in an ecosystem, e.g., parasitism, symbiosis.**E3.5d** Evaluate the evidence that an ecosystem with a large variety of species is more resilient than one with few species. |
| **E4** - **How can disruptions to an ecosystem affect the organisms within the ecosystem and on the processes that occur within it?** | **E4.1a** Give examples of how different organisms might respond to a hypothetical change to their habitat. **E41b** Hypothesize how a manmade change might affect an ecosystem, e.g. clearing land or pollution. | **E4.3a** Predict the effect the overuse of chemical fertilizers might have on a pond ecosystem. **E4.3b** Describe the effects a natural disaster, e.g., lightning strike, hurricane, might have on a specific ecosystem. **E4.3c** Hypothesize how an ecosystem might recover from such an event. | **E4.5a** Hypothesize ways that climate change might affect an ecosystem. **E4.5b** Explain some of the ways different populations within an ecosystem have responded to the introduction of an exotic species into the habitat. **E4.5c** Propose, support and challenge ideas about factors that might limit the growth of a population through discussions or in writing. **E4.5d** Use specific representational forms and notations (graphs, tables, computer programs and mathematical expressions) as means to model global warming, the greenhouse effect and how these processes are affected by the activities of humans. |
| **E5 -** How **do scientists use observation and experimentation to study ecosystems** | **E5. 1a** Formulate questions about how an ecosystem might change over time.**E5. 1b** Recognize that models are representations of processes but are not the real thing, e.g., water use or the cycles of carbon in the environment. | **E5. 3a** Describe what is known or observed about the current state of a specific ecosystem and its condition in the past. **E5. 3b** Integrate information provided by the words in a text with a version of that information expressed graphically (e.g., in a flowchart, diagram, model, graph or table).**E5. 3c** Using published studies, specify variables that are changed, controlled or measured to investigate an ecosystem over time.  | **E5.5a** Explain how an ecologist might use observation to determine a particular phenomenon (e.g., the effects of over-grazing by cattle on a prairie ecosystem). Identify appropriate instruments to collect data. Identify an existing data set relevant to the investigation. **E5.5b** Design an experiment to determine the effects of a pollutant on a plant population. Specify variables to be changed, controlled and measured, and distinguish independent from dependent variables. |

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| **ESSENTIAL QUESTIONS** | **LEVELS 1 and 2 Beginning basic education(0-3.9 GLE & SPL 0-3)** | **LEVELS 3 and 4****low intermediate/ high intermediate education****(4.0 - 8.9 GLE & SPL 4-5)** | **LEVELS 5 and 6****ADULT SECONDARY EDUCATION/BRIDGE TO COLLEGE****(9.0 - 12.9 GLE & SPL 5-7)** |
| **EB1 - How have organisms changed over time? What evidence shows that different species are related?** | *By the end of the level, learners will. . .* **EB1.1a** Recognize that plants and animals go through predictable life cycles that include birth, growth, development, reproduction and death.**Eb1.1b** Sort images to identify the major stages that characterize the life cycle of frogs or butterflies as they go through metamorphosis. | *By the end of the level, learners will demonstrate previous benchmarks as needed, plus. . .***EB1.3b** Compare anatomical similarities and differences among organisms living today to those of organisms from the fossil record.**EB1.3c** Analyze displays of pictorial data to compare patterns of similarity in embryological development across multiple species to identify relationships not evident in the fully formed anatomy. | *By the end of the level, learners will demonstrate previous benchmarks as needed, plus….***EB1.5a** Construct a time line of Earth and use appropriate scientific notation to represent scale involving both biological and geological time. |

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| **LIFE SCIENCE TOPIC 5: EVOLUTION AND BIODIVERSITY*****Evolution*** *is the study of* [*change*](http://www.biology-online.org/dictionary/Change) *in* [*genetic*](http://www.biology-online.org/dictionary/Genetic)[*composition*](http://www.biology-online.org/dictionary/Composition) *of a* [*population*](http://www.biology-online.org/dictionary/Population) *over* [*successive*](http://www.biology-online.org/dictionary/Successive)[*generations*](http://www.biology-online.org/dictionary/Generation)*, which may be caused by* [*natural selection*](http://www.biology-online.org/dictionary/Natural_selection)*,* [*inbreeding*](http://www.biology-online.org/dictionary/Inbreeding)*,* [*hybridization*](http://www.biology-online.org/dictionary/Hybridization)*, or* [*mutation*](http://www.biology-online.org/dictionary/Mutation)*.*  |
| ***Standard:*** *Learners will be able to provide multiple forms of evidence of the process of evolution as a series of changes that accounts for the present form and function of organisms and natural systems. They will be able to provide explanations of biodiversity, explain how biodiversity can be a benefit to humans, and hypothesize how humans might affect biodiversity.**Please note: The glossary on page XX provides explanations of specialized scientific terms you may come across in the descriptions of standards and benchmarks.* *GLE refers to grade level equivalency; SPL to ESOL student performance level* |

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| **EB2 - How does evidence from the fossil record support the idea that newer life forms descended from older life forms?**  | **EB2.1a** Identify plants and animals that once lived on Earth (e.g., dinosaurs) are no longer found anywhere, although others now living (e.g., birds) resemble them in some ways. | **EB2.3a** Provide examples of how the fossil record documents the existence, diversity, extinction, and change over time of many life forms throughout Earth’s history. **EB2.3b** Sketch or use pictures to illustrate why recently deposited rock layers are more likely to contain fossils resembling existing species. | **EB2.5a** Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction and change of life forms throughout the history of the Earth.**EB2.5b** Write arguments to support a substantive claim about evolution with clear reasons and relevant and sufficient fossil evidence. |
| **EB3 - How does genetic information provide evidence for evolution?** | No benchmark at this level. | No benchmark at this level. | **EB3.5a** Identify DNA as the genetic code transferred from ancestor to offspring.**EB3.5b** Write explanatory text to clearly convey that natural selection can only occur if there is variation in the genetic information between organisms of the same species and variation in the gene expression of that genetic information as a trait.**EB3.5c** Identify sexual reproduction as one source of both the continuity of traits and of genetic variation among individuals of a population. Identify genetic mutation as another source of variation within a population. |
| **EB4 - How does the environment influence populations of organisms over multiple generations?** | **EB4.1a** Compare adaptations of body parts, shapes, or behaviors that enable a plant or animal to survive in different environments.**EB4.1b** Give examples of how changes in the environment (drought, cold) have caused some plants and animals to die or move to new locations (migration). | **EB4.3a** Give examples of how inherited characteristics of an organism may change over time as it adapts to changes in the environment that enable future generations to survive (e.g., shape of beak or feet, placement of eyes on head, length of neck, shape of teeth, color).**EB4.3b** Describe historical or potential shifts in environmental conditions and how variation of traits influences how populations of organisms might change in response. | **EB4.5a** Construct an explanation based on evidence that describes how genetic variation in traits can result in individuals with differing characteristics, some of which will give individuals an advantage in surviving and reproducing.**EB4.5b** Construct an explanation based on evidence for how natural selection leads to adaptation of populations. Include a distinction between the survival of individuals vs. long-term survival of populations. |
| **EB5 -** **What is biodiversity?**  | **EB5.1a** Characterize different habitats of the world and identify some of the organisms that are found in these environments | **EB5.3a** Research examples of biodiversity as consisting of different life forms that have adapted to the variety of conditions on Earth and includes genetic variation within a species, species diversity in different habitats and ecosystem diversity. | **EB5.5a** Evaluate competing design solutions for maintaining biodiversity and ecosystem services, water purification, nutrient cycling. |
| **EB6 - How does biodiversity affect humans?** **How do humans affect biodiversity?** | **EB6.1a** Contribute to a discussion about ways in which humans from various cultures use plants for food, shelter, medicine and clothing. | **EB6.3a** Recognize that changes in biodiversity can influence humans’ resources such as food, energy, and medicine as well as ecosystem services such as purification and recycling.**EB6.3b** Gather and synthesize information about technologies that have changed the way humans influence the inheritance of desired traits in organisms (e.g. genetically modifying seeds.) | **EB5.6a** Design, evaluate and refine a solution for reducing the impacts of human activities in the environment and biodiversity. (e.g., using bio fuel, protecting green space for native bird migration.) |
| **EB7 - How do scientists use models to reconstruct evolutionary history and to predict the likelihood of future events?** | **EB7.1a** Interpret simple representations of data, (e.g., a graph of temperature over time).**EB7.1b** Contribute to a discussion with peers about the scientific evidence for change in organisms and ecosystems occurring over time. | **EB7.3a** Use a scientific theory or model to make sense of a natural phenomenon (e.g., how hurricanes develop or creation of canyons by flowing water).**EB7.3b** Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.**EB7.3c** Support a scientific argument about change in organisms or ecosystems occurring over time with appropriate and sufficient evidence and reasoning. | **EB7.5a** Interpret the predictions of a long-term data set and identify the level of confidence in the results. (Data sets available from the National Ocean and Atmospheric Administration, US Geological Survey, NSF Long Term Ecological Research Network, among others.)**EB7.5b** Identify key features of climate change models and limitations in their ability to depict all aspects of phenomena.**EB7.5c** Construct an explanation based on evidence that the process of evolution results from four factors: the potential for a species to increase in number; the heritable genetic variation of individuals in a species due to mutation and sexual reproduction; competition for limited resources; the proliferation of those organisms that better able to survive and reproduce in the environment. |

**APPENDIX A**

**GLOSSARY OF TERMS TO KNOW FOR THE MASSACHUSETTS ADULT AND COMMUNITY LEARNING SERVICES (ACLS) LIFE SCIENCE STRANDS AND BENCHMARKS**

This glossary provides specific vocabulary terms and words to know that will facilitate learning the life science content for the MA ACLS strands and benchmarks. The definitions were taken from the American Heritage Science Dictionary (Houghton Mifflin Company, 2005), the Massachusetts Science and Technology/Engineering Curriculum Framework (October 2006), Ontario Curriculum: Science and Technology (2007) and Contemporary's GED Science (McGraw-Hill Companies, Inc., 2002).

On-Line Glossary Resources include:

[*http://www.merriam-webster.com/dictionary/science*](http://www.merriam-webster.com/dictionary/science)

[*http://en.wikipedia.org*](http://en.wikipedia.org)

[*http://www.everythingbio.com/index.php*](http://www.everythingbio.com/index.php)

| **TERMS TO KNOW** | **DEFINITION** |
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| **ABIOTIC FACTORS** | The physical but non-living features of an ecosystem (e.g., light, atmosphere, soil, water). |
| **ABSORPTION** | The movement of fluid or a dissolved substance across a membrane. |
| **ACTIVE TRANSPORT** | Movement of a molecule through a membrane against its normal concentration gradient, that is, from an area of lower concentration to one of higher concentration. Active transport requires the assistance of a carrier protein and uses energy supplied by ATP. |
| **ADAPTATION**  | The adjustment or changes in behavior, physiology or structure of an organism that make the organism more suited to an environment. |
| **ADENINE** | One of the four bases in the nucleotides of DNA, commonly denoted by the letter “A.” |
| **ALLELE** | Any of the possible forms in which a gene from a specific trait can occur. In almost all animal cells, two alleles from each gene are inherited, one from each parent. |
| **ALVEOLI** | Any of the tiny air-filled sacs arranged in clusters in the lungs, in which the exchange of oxygen and carbon dioxide takes place. |
| **AMINO ACIDS** | Small molecules that form the building blocks of protein. |
| **ANATOMY** | The structure of an organism or any of its parts. The scientific study of the shape and structure of organisms and their parts. |
| **ANTHROPOGENIC** | Relating to or resulting from the influence of humans on nature. |
| **ARCHAEA** | Microorganisms that are one of the three Domains of life (along with Bacteria and Eukarya). Like Bacteria, they are one cell, do not have any membrane-bound [organelles](http://en.wikipedia.org/wiki/Organelle) within their cells and their genetic material is typically a single circular [chromosome](http://en.wikipedia.org/wiki/Chromosome) not enclosed in a nucleus. Archaea differ from Bacteria in their cell membranes, and they possess genes and several metabolic pathways that are more closely related to those of Eukaryotes. Archaea and Bacteria were among the first life forms to appear on [Earth](http://en.wikipedia.org/wiki/Earth), and are present in most [habitats](http://en.wikipedia.org/wiki/Habitat) on the planet, as well as in organic matter and the live bodies of plants and animals, providing examples of [mutualism](http://en.wikipedia.org/wiki/Mutualism_%28biology%29) in the digestive tracts of humans, [termites](http://en.wikipedia.org/wiki/Termite) and cockroaches. |
| **ARTERY** | Any of the blood vessels that carry oxygenated blood away from the heart to the body’s cells, tissues, and organs. Arteries are flexible, elastic tubes with muscular walls that expand and contract as the heart pumps blood through the body. |
| **ATOM** | The smallest unit of an element. |
| **ATP** | *Adenosine triphosphate* – An organic compound C10H16N5O13P3, that is composed of adenosine and three phosphate groups. It serves as a source of energy for many metabolic processes. ATP releases energy when it is broken down during cell metabolism. |
| **AUTONOMIC** | Occurring involuntarily; automatic. The part of the vertebrate nervous system that regulates involuntary action, as of the intestines, heart, and glands, and that is divided into the sympathetic nervous system and the parasympathetic nervous system. |
| **AUTOTROPH** | Organism that can capture energy from sunlight or chemicals and use it to produce its own food from inorganic compounds (also called a producer) |
| **BACTERUM (sing.)/****BACTERIA (pl.)** | Microorganisms that are one of the three Domains of Life (along with Archaea and Eukarya). Like Archaea, they are one cell, do not have any membrane-bound [organelles](http://en.wikipedia.org/wiki/Organelle) within their cells and their genetic material is typically a single circular [chromosome](http://en.wikipedia.org/wiki/Chromosome) not enclosed in a nucleus. Bacteria differ from Archaea in their cell membranes. Archaea and Bacteria were among the first life forms to appear on [Earth](http://en.wikipedia.org/wiki/Earth), and are present in most [habitats](http://en.wikipedia.org/wiki/Habitat) on the planet, as well as in organic matter and the live bodies of plants and animals, providing examples of [mutualism](http://en.wikipedia.org/wiki/Mutualism_%28biology%29) in the digestive tracts of humans, [termites](http://en.wikipedia.org/wiki/Termite) and cockroaches.  |
| **BEHAVIOR** | The actions displayed by an organism in response to its environment. |
| **BIODIVERSITY** | The number, variety, and genetic variation of different organisms found within a specified geographic region. |
| **BIOTECHNOLOGY** | Any technique that uses living organisms, or parts of organisms, to make or modify products, improve plants or animals, or to develop microorganisms for specific uses. |
| **BIOTIC FACTORS** | The living components of an ecosystem (e.g., animals, fungi, plants, Bacteria, Archaea). |
| **BONE** | Rigid [organs](http://en.wikipedia.org/wiki/Organ_%28anatomy%29) that constitute part of the [endoskeleton](http://en.wikipedia.org/wiki/Endoskeleton) of [vertebrates](http://en.wikipedia.org/wiki/Vertebrate). They support and protect the various organs of the body, produce [red](http://en.wikipedia.org/wiki/Red_blood_cell) and [white blood cells](http://en.wikipedia.org/wiki/White_blood_cell) and store [minerals](http://en.wikipedia.org/wiki/Mineral). Bone |
| **BONE MARROW** | Soft tissue in bone cavities that produces blood cells. |
| **BRAIN** | The center of the [nervous system](http://en.wikipedia.org/wiki/Nervous_system) in all [vertebrate](http://en.wikipedia.org/wiki/Vertebrate) and most [invertebrate](http://en.wikipedia.org/wiki/Invertebrate) animals. The brain integrates sensory information from inside and outside the body in controlling autonomic function (as heartbeat and respiration), in coordinating and directing motor responses, and in the process of learning.  |
| **CALORIE** | a. The unit of heat equal to the amount of heat required to raise the temperature of 1 kilogram of water by 1°C at 1 atmosphere pressure. Also called *kilocalorie*. b.A unit of energy-producing potential equal to this amount of heat that is contained in food and released upon oxidation by the body.  |
| **CAMOUFLAGE** | Protective coloring or another feature that conceals an animal and enables it to blend into its surroundings. |
| **CAPILLARY** | Any of the tiny blood vessels that connect the smallest arteries to the smallest veins. Capillaries form a network throughout the body for the exchange between blood and tissue cells of oxygen, metabolic waste products, and carbon dioxide. |
| **CARBOHYDRATE** | Any of a large class of organic compounds consisting of carbon, hydrogen, and oxygen, usually with twice as many hydrogen atoms as carbon or oxygen atoms. Carbohydrates are produced in green plants by photosynthesis and serve as a major energy source in animal diets. Sugars, starches, and cellulose are all carbohydrates. |
| **CARBON** **FOOTPRINT** | The impact human activities have on the environment in terms of the amount of greenhouse gases produced, measured in units of carbon dioxide. |
| **CARDIAC MUSCLE** | The striated heart muscle. When this muscle contracts, it pushes blood through the circulatory system. The cardiac muscle is not voluntary. |
| **CARNIVORE** | An animal that feeds chiefly on the flesh of other animals. Carnivores include predators such as lions and alligators, and scavengers such as hyenas and vultures. In a food chain, carnivores are either secondary or tertiary consumers. |
| **CARRYING CAPACITY** | The maximum population size of a given species that an ecosystem can support without reducing its ability to support the same species in the future. |
| **CARTILAGE** | A strong flexible connective tissue that is found in various parts of the body, including the joints, the outer ear, and the larynx. |
| **CELL** | The basic structural and functional units in all living organisms. |
| **CELL DIFFERENTIATION** | A stage of development of a living thing during which specialized cells form. |
| **CELL DIVISION** | A process by which a cell, called the parent cell, divides into two or more cells, called daughter cells. |
| **CELL MEMBRANE**  | The thin membrane that forms the outer surface of the cytoplasm of a cell and regulates the passage of materials in and out of the cell. It is made up of proteins and lipids, and often contains molecular receptors. |
| **CELL THEORY** | The scientific theory that describes the properties of cells:All living organisms are composed of one or more cells;The cell is the basic unit of structure, function, and organization in all organisms;All cells come from preexisting, living cells. |
| **CELL TRANSPORT** | The movement of materials into and out of cells. |
| **CELL WALL** | A cell wall is a tough, usually flexible but sometimes fairly rigid layer that surrounds some types of [cells](http://en.wikipedia.org/wiki/Cell_%28biology%29). |
| **CHARACTERISTIC** | A distinguishing trait or quality of a substance or object. |
| **CHLOROPLAST** | A plastid in the cells of green plants and green algae that contains chlorophylls and carotenoid pigments, and creates glucose through photosynthesis. |
| **CHLOROPHYLL** | Any of a group of green pigments that capture light energy used as the energy source in photosynthesis and that are found in the chloroplasts of plants and other photosynthetic organisms such as cyanobacteria. |
| **CHROMOSOME** | A double stranded DNA molecule that contains a series of specific genes along its length. In prokaryotes, chromosomal DNA is circular, and the entire genome is carried on one chromosome. In most sexually reproducing organisms, chromosomes occur in pairs, with one member of the pair being inherited from each parent.  |
| **CIRCULATORY** **SYSTEM** | The circulatory system is made up of the vessels and the muscles that help and control the flow of the blood around the body. This process is called circulation. The main parts of the system are the heart, arteries, capillaries and veins. |
| **CLADOGRAM** | A branching, treelike diagram in which the endpoints of the branches represent individual species of organisms. It is used to illustrate phylogenetic relationships and to show points at which various species are presumed to have diverged from common ancestral forms. |
| **CLIMATE** | The average course or condition of the weather at a place, usually over a period of years, as exhibited by temperature, wind velocity, and precipitation. |
| **CLONING** | The process of creating identical genetic copies of cells from an original cell. In nature, cloning occurs by asexual reproduction. |
| **COAGULATE** | To change from a fluid to a thickened mass, as in forming a blood clot. |
| **CODON** | The basic unit of the genetic code; a sequence of three adjacent nucleotides in DNA or mRNA that specifies one amino acid. |
| **CODOMINANT** | Relating to two alleles of a gene pair in a heterozygote that are both fully expressed. When alleles for both white and red are present in a carnation, for example, the result is a pink carnation since both alleles are co-dominant. |
| **COLON** | The portion of the digestive tract that is posterior to the stomach or gizzard and extends to the rectum.  |
| **COMMENSALISM** | A type of relationship between two species of a plant, animal, fungus, etc. in [which](http://dictionary.reference.com/browse/which) one lives with, on, or in another without damage to either. |
| **COMMON ANCESTOR** | In [evolutionary biology](http://en.wikipedia.org/wiki/Evolutionary_biology), a group of [organisms](http://en.wikipedia.org/wiki/Organism) share common descent if they developed from the same actual or hypothetical form or stock. Common ancestry between organisms of different species arises during [speciation](http://en.wikipedia.org/wiki/Speciation), in which new species are established from a single ancestral population. Organisms which share a more recent common ancestor are more closely related.  |
| **COMPARATIVE ANATOMY** | The comparative [study](http://www.biology-online.org/dictionary/Study) of [animal](http://www.biology-online.org/dictionary/Animal) [structure](http://www.biology-online.org/dictionary/Structure) with [regard](http://www.biology-online.org/dictionary/Regard) to [homologous](http://www.biology-online.org/dictionary/Homologous) [organs](http://www.biology-online.org/dictionary/Organs) or [parts](http://www.biology-online.org/dictionary/Parts).. |
| **COMPETITION** | The simultaneous demand by two or more organisms for limited environmental resources, such as nutrients, living space or light. |
| **COMPOUND** | Composed of two or more parts, elements, or ingredients. |
| **CONSERVATION OF ENERGY** | The principle that in a system that does not undergo any [force](http://dictionary.reference.com/browse/force) from outside the system, the amount of energy is constant, irrespective of its changes in form. |
| **CONSUMER**  | An organism requiring complex organic compounds for food that it obtains by preying on other organisms or by eating particles of organic matter. |
| **CYTOPLASM** | In [eukaryotic](http://www.biology-online.org/dictionary/Eukaryotic) cells, that part of the [cell](http://www.biology-online.org/dictionary/Cell) between the [cell membrane](http://www.biology-online.org/dictionary/Cell_membrane) and the [nuclear envelope](http://www.biology-online.org/dictionary/Nuclear_envelope). It is the jelly-like substance in a [cell](http://www.biology-online.org/dictionary/Cell) that contains the [cytosol](http://www.biology-online.org/dictionary/Cytosol), [organelles](http://www.biology-online.org/dictionary/Organelle), and inclusions such as glycogen, lipids, crystals and pigments not including the [nucleus](http://www.biology-online.org/dictionary/Nucleus). In Bacteria and Archaea cells that do not have a well-defined [nucleus](http://www.biology-online.org/dictionary/Nucleus), the cytoplasm is simply everything enclosed by the [cell membrane](http://www.biology-online.org/dictionary/Cell_membrane). |
| **CYTOSINE** | One of the four bases in the nucleotides of DNA, commonly denoted by the letter “C.” |
| **CYTOSOL** | The aqueous portion of the cytoplasm. |
| **DARWINISM** | The theory that all living things are descended from a common ancestor and modified by unguided natural processes such as natural selection and random variation. *Also see Neo-Darwinism.* |
| **DEMOGRAPHICS** | A section of the population sharing common characteristics, such as age, sex, class. |
| **DIGESTIVE SYSTEM** | The bodily system concerned with the ingestion, digestion, and absorption of food. |
| **DISEASE** | An abnormal condition of an organism that impairs bodily functions, associated with specific [symptoms](http://en.wikipedia.org/wiki/Symptom) and [signs](http://en.wikipedia.org/wiki/Medical_sign). |
| **DECOMPOSER** | Any of various organisms (e.g., many bacteria and fungi) that return constituents of organic substances to ecological cycles by feeding on and breaking down dead cells. |
| **DIFFUSION** | The passive movement of [molecule](http://www.everythingbio.com/glos/definition.php?ID=1805)s from an area of high [concentration](http://www.everythingbio.com/glos/definition.php?ID=684) to an area of lower [concentration](http://www.everythingbio.com/glos/definition.php?ID=684) until both [concentration](http://www.everythingbio.com/glos/definition.php?ID=684)s are equal.  |
| **DIPLOID** | Having pared sets of chromosomes in a cell or cell nucleus. In diploid organisms that reproduce sexually, one set of chromosomes is inherited from each parent. |
| **DNA** | (*Deoxyribonucleic acid*): A large biological molecule composed of subunits known as nucleotides strung together in long chains. The sequence of these nucleotides contains the information that cells need in order to grow, to divide into daughter cells and to manufacture new proteins. Changes in DNA result in mutations, which may be beneficial, neutral or deleterious to the organism.  |
| **DOMAIN** | The taxonomic category higher than kingdom, defined by the gene sequences and basic mechanisms used to perform fundamental cellular functions; the three domains are the Archaea, Bacteria, and Eukarya. |
| **DOMINANT** | Relating to the form of a gene that expresses a trait, such as hair color, in an individual organism. The dominant form of a gene overpowers the counterpart, or recessive, form located on the other of a pair of chromosomes. |
| **DORMANT** | Being in an inactive state during which growth and development cease and metabolism is slowed, usually in response to an adverse environment.  |
| **DOUBLE HELIX** | The shape that two linear strands of DNA assume when bonded together. |
| **ECOLOGY** | The scientific study of the relationships between living things and their environment. |
| **ECOSYSTEM** | A complex, self-regulating system through which energy and material are transferred, made up of a group of living organisms and their abiotic environment, which interact as a unit. |
| **EGG** | The female sex cell. |
| **ELECTROCHEMICAL SIGNAL** | The nerves communicate with cells through electrochemical signals. |
| **ELEMENT** | A substance composed of atoms that cannot be broken down into simpler substances by chemical means (e.g., iron, sulfur, oxygen). |
| **EMBRYO** | A plant or animal in an early stage of development, generally still contained with the seed, egg, or uterus. |
| **ENDANGERED SPECIES** | A plant or animal species existing in such small numbers that it is in danger of becoming extinct, especially such a species placed in jeopardy as a result of human activity. |
| **ENDOCRINE GLANDS** | Any of various glands, such as the thyroid, adrenal, and pituitary glands, that secrete certain substances or hormones directly into the blood or lymph. |
| **Endoplasmic reticulum** | A [network](http://dictionary.reference.com/browse/network) of tubular membranes within the cytoplasm of the [cell](http://dictionary.reference.com/browse/cell) involved in the transport of materials.  |
| **ENERGY** | The capacity for doing work. |
| **ENVIRONMENT** | The complex of physical, chemical, and biotic factors (e.g., climate, soil, living things) that act upon an organism or an ecological community and ultimately determine their forms and survival. |
| **ENZYME** | A protein that acts as a catalyst, speeding the rate at which a biochemical reaction proceeds but not altering the direction or nature of the reaction. |
| **EPIGENETIC** | The heritable factors affecting the [development](http://www.everythingbio.com/glos/definition.php?ID=835) or function of an [organism](http://www.everythingbio.com/glos/definition.php?ID=2006) that are not associated with its DNA sequence. |
| **ESOPHAGUS** | The muscular tube in vertebrates through which food passes from the pharynx to the stomach. |
| **ESTROGEN** | Any of several major female sex hormones produced primarily by the ovarian follicles of female [mammals](http://dictionary.reference.com/browse/mammals), capable of inducing [estrus](http://dictionary.reference.com/browse/estrus), developing and maintaining secondary female sex characteristics, and preparing the uterus for the reception of a fertilized egg. |
| **EUKARYOTE** | One of the three major Domains of life (along with Archaea and Bacteria). An organism composed of one or more cells that contain a nucleus surrounded by a membrane and whose DNA is bound together into chromosomes by proteins. |
| **EVOLUTION** | The change over time in one or more inherited traits found in [populations](http://en.wikipedia.org/wiki/Populations) of [organisms](http://en.wikipedia.org/wiki/Organisms). Evolution may occur when there is [variation](http://en.wikipedia.org/wiki/Genetic_diversity) of inherited traits within a population. The major sources of such variation are [mutation](http://en.wikipedia.org/wiki/Mutation), [genetic recombination](http://en.wikipedia.org/wiki/Genetic_recombination) and [gene flow](http://en.wikipedia.org/wiki/Gene_flow) or migration between populations.  |
| **EXCRETORY SYSTEM**  | The system in which an organism eliminates waste products that result from metabolic processes. In plants, waste is minimal and is eliminated primarily by diffusion to the outside environment. Animals have specific organs of excretion. In vertebrates, the kidney filters blood, conserving water and other wastes in the form of urine. The skin and lungs, which eliminate carbon dioxide, are also excretory organs. |
| **EXTINCT** | Having no living members. Species become extinct for many reasons, including climate change, disease, destruction of habitat, local or worldwide natural disasters, and development into new species (speciation).  |
| **FALLOPIAN TUBE** | Either of the pair of tubes that carry the egg from the ovary, where it is produced, to the uterus, where it develops. |
| **FAT** | Any of a large number of oily compounds that are widely found in plant and animal tissues, serving mainly as a reserve source of energy. In mammals, fat is deposited beneath the skin and around the internal organs, where it also protects and insulates against heat loss. Fat is a necessary, efficient source of energy. |
| **FERMENTATION** | A metabolic process converting [sugar](http://en.wikipedia.org/wiki/Sugar) to acids, gases and/or [alcohol](http://en.wikipedia.org/wiki/Alcohol) using [yeast](http://en.wikipedia.org/wiki/Yeast) or [bacteria](http://en.wikipedia.org/wiki/Bacteria). |
| **FERTILIZATION** | Fusion of nuclei of egg and sperm. |
| **FIBER** | The parts of grains, fruits, and vegetables that contain cellulose and are not digested by the body. Fiber helps the intestines absorb water, which increases the bulk of the stool and causes it to move more quickly through the colon. |
| **FOLLICLE** | A small cavity, sac or gland. |
| **FOOD CHAIN** | An arrangement of the organisms of an ecological community according to the order of predation, in which each uses the next, usually lower, member as a food source.  |
| **FOOD WEB** | The complex system of interrelated food chains in an environment.  |
| **FOSSIL** | A remnant, impression, or trace of an organism of a past geologic age that has been preserved in the earth’s crust. |
| **FUNGUS (sing.)/****FUNGI (pl.)** | A member of a large group of [eukaryotic](http://en.wikipedia.org/wiki/Eukaryote) organisms that includes microorganisms such as [yeasts](http://en.wikipedia.org/wiki/Yeast) and molds, as well as [mushrooms](http://en.wikipedia.org/wiki/Mushrooms). These organisms are classified as a [kingdom](http://en.wikipedia.org/wiki/Kingdom_%28biology%29), Fungi, and separate from [plants](http://en.wikipedia.org/wiki/Plant), [animals](http://en.wikipedia.org/wiki/Animal), and [bacteria](http://en.wikipedia.org/wiki/Bacteria). One major difference is that fungal cells have [cell walls](http://en.wikipedia.org/wiki/Cell_wall) that contain [chitin](http://en.wikipedia.org/wiki/Chitin), unlike the cell walls of plants, which contain [cellulose](http://en.wikipedia.org/wiki/Cellulose). Fungi perform an essential role in the decomposition of organic matter and have fundamental roles in [nutrient cycling](http://en.wikipedia.org/wiki/Biogeochemical_cycle) and exchange. |
| **GAMETE** | Mature male or female reproductive cell (sperm or ovum) with a haploid set of chromosomes (23 for humans).  |
| **GENERATION** | a) All of the offspring that are at the same stage of descent from a common ancestor. b) The average interval of time between birth of parents and birth of their offspring. c) A form or stage in the life cycle of an organism. |
| **GENE** | The basic unit of hereditary material; the sequence of DNA that codes for a protein or product and thus determines a trait. |
| **GENE EXPRESSION** | The process of producing a [protein](http://www.everythingbio.com/glos/definition.php?ID=2259) from its DNA- and [mRNA](http://www.everythingbio.com/glos/definition.php?ID=4137)-coding sequences. |
| **GENETIC CODE** | The sequence of nucleotides in DNA and RNA that serve as instructions for synthesizing proteins.  |
| **GENETIC VARIATION** | Diversity in a [population](http://www.biology-online.org/dictionary/Population) or [species](http://www.biology-online.org/dictionary/Species) as a result of new [gene](http://www.biology-online.org/dictionary/Gene) combinations. |
| **GENOME** | The entire genetic identify of an individual, including alleles, or gene forms, that do not show as outward characteristics. |
| **GENOMICS** | A branch of genetics that studies organisms in terms of their complete genetic material, including genes and their functions. |
| **GENOTYPE** | The specific allelic composition of a cell, either of the entire cell or more commonly for a certain gene or a set of genes; The genes that any organism possesses. |
| **GLAND** | A cell, group of cells, or organ producing a secretion. |
| **GLUCOSE** | A monosaccharide sugar found in plant and animal tissues. Glucose a product of photosynthesis, mostly incorporated into the disaccharide sugar sucrose rather than circulating free in the plant. Glucose is essential for energy production in animal cells. It is transported by blood and lymph to all the cells of the body, where it is metabolized to form carbon dioxide and water along ATP, the main source of chemical energy for cellular processes. |
| **GREENHOUSE GAS** | An atmospheric gas that allows solar radiation to pass through the atmosphere but absorbs the radiation that Earth emits back to space, thereby trapping heat and making the planet’s surface warmer. These gases include carbon dioxide, water vapor, methane and the fluorocarbons. |
| **GUANINE** | One of the four bases in the nucleotides of DNA, commonly denoted by the letter “G.” |
| **HABITAT** | The place or environment where a plant or animal naturally or normally lives and grows. |
| **HAPLOID** | Sex cells that contain one copy of each chromosome (half the full set of genetic material). The egg and sperm cells of plants and animals are haploid and merge to form a diploid embryo. Human beings have 23 chromosomes in their reproductive cells.  |
| **HEART** | A hollow muscular organ of vertebrate animals that by its rhythmic contraction acts as a force pump maintaining the circulation of the blood |
| **HERBIVORE** | An animal that feeds mainly or only on plants. In a food chain, herbivores are primary consumers. |
| **HEREDITY** | The biological similarity of offspring and parents.  |
| **HETEROTROPH** | An organism or microorganism requiring an organic form of carbon as a carbon source. |
| **HOMEOSTASIS** | The tendency of an organism or cell to regulate its internal conditions, such as the chemical composition of its body fluids, so as to maintain health and functioning, regardless of outside conditions. The organism or cell maintains homeostasis by monitoring its internal conditions and responding appropriately when these conditions deviate from their optimal state |
| **HOMOLOGOUS** | Traits of [organisms](http://en.wikipedia.org/wiki/Organisms) due to descent from a [common ancestor](http://en.wikipedia.org/wiki/Common_descent). Organs as disparate as a bat's wing, a seal's flipper, a cat's limb and a human arm have a common underlying anatomy which was present in their last common ancestor and so therefore are homologous as forelimbs.  |
| **HORMONE** | A chemical substance secreted by the endocrine gland or group of endocrine cells that acts to control or regulate specific physiological processes, including growth, metabolism, and reproduction.  |
| **IMMIGRATION** | The [movement](http://www.biology-online.org/dictionary/Movement) of [organisms](http://www.biology-online.org/dictionary/Organisms) to a [specific](http://www.biology-online.org/dictionary/Specific) [area](http://www.biology-online.org/dictionary/Area), for example, to [downstream](http://www.biology-online.org/dictionary/Downstream) aquatic area from an area further upstream. |
| **IMMUNE SYSTEM** | The cells and tissues involved in recognizing and attacking foreign substances within the body of an animal |
| **INCOMPLETE** **DOMINANCE** | A genetic condition in which a trait is intermediate between two parents. |
| **INFECTIOUS DISEASE** | A disease caused by a microorganism or other agent, such as a bacterium, fungus, or virus that enters the body of an organism. |
| **INHERITANCE** | The process by which traits or characteristics pass from parents to offspring through the genes. |
| **INHERITED TRAITS** | Distinguishing characteristics, including [anatomical](http://en.wikipedia.org/wiki/Anatomy), [biochemical](http://en.wikipedia.org/wiki/Biochemistry) or [behavioral](http://en.wikipedia.org/wiki/Behaviour) characteristics that are passed on from one generation to the next. |
| **INORGANIC** | Not involving organisms or the products of their life processes. Inorganic matter does not contain carbon. |
| **INSOLUBLE** | Incapable of being dissolved. |
| **INSTINCT** | An inherited tendency of an organism to behave in a certain way, usually in reaction to its environment and for the purpose of fulfilling a specific need and not dependent upon the specific details of an individual’s learning experiences. Instinctive behavior develops in the same way for all individuals of the same species, or of the same sex of a species.  |
| **INVASIVE SPECIES** | A [species](http://www.everythingbio.com/glos/definition.php?ID=2541) capable of asserting it[self](http://www.everythingbio.com/glos/definition.php?ID=2461) in communities where it did not naturally occur. Usually a [species](http://www.everythingbio.com/glos/definition.php?ID=2541) not [native](http://www.everythingbio.com/glos/definition.php?ID=3529) to the area. |
| **KIDNEY** | A gland, on each side of the spine that filters the blood and eliminates metabolism waste as urine through the ureters to the bladder. |
| **LARGE INTESTINE** | The wide lower section of the intestine that extends from the end of the small intestine to the anus. The large intestine acts mainly to absorb water from digested materials and solidify feces. In most vertebrate animals, it includes the cecum, the colon and rectum. |
| **LARYNX** | The upper part of the trachea in most vertebrate animals, containing the vocal cords. Sound is produced by air passing through the larynx on the way to the lungs, causing the walls of the larynx to vibrate. |
| **LIFE CYCLE** | The series of stages in form and functional activity through which an organism passes between origin and expiration. |
| **LIGAMENT** | A sheet or band of tough fibrous tissue that connects two bones or holds an organ of the body in place. |
| **LIPID** | Any of a large group of organic compounds that is oily to the touch and insoluble in water. Lipids include fatty acids, oils, waxes, sterols, and triglycerides. They are a source of stored energy and are a component of cell membranes. |
| **LIVER** | The largest gland of the body, situated in the top right portion of the abdominal cavity. The liver plays an essential role in many metabolic processes by regulating the composition and concentration of nutrients and toxic materials in the blood. Its functions include synthesizing bile and blood coagulating factors; acting as the site of metabolism of carbohydrates, proteins and fats; regulating the amount of blood sugar; converting excess glucose to glycogen; removing excess amino acids; storing and metabolizing fats; and detoxifying poisonous substances, worn out red blood cells and other unwanted material. |
| **LUNG** | Either of two spongy organs in the chest of air-breathing vertebrate animals that serve as the organs of gas exchange. Blood flowing through the lungs picks up oxygen from inhaled air and releases car bon dioxide, which is exhaled.  |
| **LYMPH** | A clear to yellowish watery fluid that is found throughout the body. It circulates through body tissues picking up fats, bacteria, and other unwanted materials, and filtering them out through the lymphatic system. |
| **MACROMOLECULE** | A larger molecule, such as a protein, consisting of many smaller molecules. |
| **MAMMAL** | Any of various warm-blooded vertebrate animals of the class Mammalia, including humans, characterized by a covering of hair on the skin and, in the female, milk-producing mammary glands for nourishing the young. |
| **MEIOSIS** | The process in cell division in sexually reproducing organisms that reduces the number of chromosomes from diploid to haploid (half the original number). Meiosis results in four rather than two daughter cells, each with a haploid set of chromosomes. |
| **MEMBRANE** | The thin, flexible layer around a cell or cell part. |
| **MENDALIAN GENETICS** | A set of primary tenets relating to the transmission of [hereditary](http://en.wikipedia.org/wiki/Heredity) characteristics from parent organisms to their offspring; initially derived from the work of [Gregor Mendel](http://en.wikipedia.org/wiki/Gregor_Mendel). |
| **METABOLISM** | The chemical processes by which cells produce the substances and energy needed to sustain life. As part of metabolism, organic compounds are broken down to provide energy. Many metabolic processes are brought about by the action of enzymes. |
| **MICROORGANISM** | Any [organism](http://www.everythingbio.com/glos/definition.php?ID=2006) too small to be seen by the naked eye, e.g., [bacteria](http://www.everythingbio.com/glos/definition.php?ID=278), [virus](http://www.everythingbio.com/glos/definition.php?ID=134)es, protozoa, some [fungi](http://www.everythingbio.com/glos/definition.php?ID=3242), and some [algae](http://www.everythingbio.com/glos/definition.php?ID=238). |
| **MIGRATION** | The seasonal movement of a complete population of animals from one area to another. Migration is usually a response to changes in temperature, food supply, or the amount of daylight. |
| **MIMICRY** | The resemblance of one organism to another or to an object in its surroundings for concealment or protection from predators. |
| **MITOCHONDRIA** | Organelles in eukaryotic cells that convert food into a form of energy usable by the cell. |
| **MITOSIS**   | The process of nuclear division in cells that produces daughter cells genetically identical to each other and to the parent cell. |
| **MOLECULE** | A combination of two or more atoms held together by covalent bonds. A fundamental unit forming a compound. |
| **MONOHYBRID CROSS** | A method of tracking the inheritance pattern of a single trait between two individual organisms. |
| **MORPHOLOGY** | The form and structure of an organism or one of its parts. |
| **MOTOR NEURON** | A nerve cell that passes from the central nervous system or a ganglion (group of nerve cell bodies) and directly or indirectly controls the contraction or relaxation of muscles. |
| **MOUTH** | The natural opening through which food passes into the body of an animal and which in vertebrates is typically bounded externally by the lips and internally by the pharynx and encloses the tongue, gums, and teeth. |
| **MULTIPLE ALLELES** | Multiple alleles mean that there are three or more forms of a gene for a trait. |
| **MUSCULAR/SKELETAL SYSTEM** | The musculoskeletal system provides form, stability, and movement to an organism. It consists of the body's bones (which make up the skeleton), muscles, tendons, ligaments, joints, cartilage, and other connective tissue. |
| **MUTUALISM** | A symbiotic relationship in which each of the organisms benefit. |
| **MUTATION**  | A change in the sequence of one or more nucleotides in DNA. |
| **NATURAL SELECTION** | The process in which organisms better adapted to their environment survive and reproduce at a higher rate than those less adapted, with the result that the survivors' characteristics are more prevalent in subsequent generations. |
| **NEO-DARWINISM** | **T**he modern version of Darwinian evolutionary theory, according to which new variations originate in DNA mutations that provide the raw materials upon which natural selection may act to produce evolutionary change. |
| **NERVOUS SYSTEM** | The system of neurons and tissues that regulates the actions and responses of vertebrates. The nervous system of vertebrates is a complex information processing system that consists mainly of the brain, spinal cord, and peripheral and autonomic nerves.  |
| **NEURON** | A cell of the nervous system. Neurons typically consist of a cell body, which contains a nucleus and receives incoming nerve impulses, and an axon, which carries impulses away from the cell body. |
| **NONINFECTIOUS** | A non-infectious disease is a disease that may be caused by the environment (e.g., skin cancer from the sun’s radiation), what we eat (e.g., food poisoning) or by malnutrition or lack of a nutrient (e.g., scurvy from lack of vitamin C).  |
| **NUCLEIC ACID** | Any of a group of very large polymeric nucleotides that constitute the genetic material of living cells and viruses and that code for the amino acid sequences of proteins. |
| **NUCLEOTIDE**  | The basic building block of [nucleic acids](http://www.biology-online.org/dictionary/Nucleic_acids), such as [DNA](http://www.biology-online.org/dictionary/DNA) and [RNA](http://www.biology-online.org/dictionary/RNA). It is an [organic compound](http://www.biology-online.org/dictionary/Organic_compound) made up of [nitrogenous base](http://www.biology-online.org/dictionary/Nitrogenous_base) (adenine, thymine or uracyl, cytosine, guanine) a [sugar](http://www.biology-online.org/dictionary/Sugar), and a [phosphate group](http://www.biology-online.org/dictionary/Phosphate_group). |
| **NUCLEUS** | The cellular organelle in eukaryotes that contains the genetic material. |
| **NUTRIENT** | A substance that provides nourishment for growth or metabolism. Plants absorb nutrients mainly from the soil in the form of minerals and other inorganic compounds, and animals obtain nutrients from ingested foods. |
| **OFFSPRING** | The product of reproduction; a new organism produced by one or more parents. |
| **OMNIVORE** | An organism that eats both plants and animals. |
| **ORGANELLE** | A cell component that is enclosed within its own membrane and performs specific functions for the cell. Organelles are found only in eukaryotic cells. |
| **ORGANIC** | Involving organisms or the products of their life processes. |
| **ORGANISM** | An individual plant, animal or single-cell life form. |
| **ORGAN**  | A part of the body, such as the heart or stomach, made of several different groups of tissues that work together to perform a specific function or group of functions. |
| **OVARIES** | A pair of female reproductive glands, which hold and develop eggs and produce estrogen and progesterone. |
| **OVERPOPULATION** | The population of an environment by a particular species in excess of the environments carrying capacity. The effects of overpopulation can include the depletion of resources, environmental deterioration, and the prevalence of famine and disease. |
| **OXIDATION** | a) Any process in which oxygen combines with an element or substance, either slowly, as in the rusting of iron, or rapidly, as in the burning of wood b) the process by which electrons are removed from atoms or ions. Electrons are added to atoms or ions by reduction. |
| **PARASITE** | An organism that lives on or in a different kind of organism (the host) from which it gets some or all of its nourishment. Parasites are generally harmful to their hosts, although the damage they do ranges widely from minor inconvenience to debilitating or fatal disease.  |
| **PATHOGEN** | Any disease-producing agent, especially a virus, bacterium or other microorganism. |
| **PHARYNX** | The passage that leads from the cavities of the nose and mouth to the larynx (voice box) and esophagus. Air passes through the pharynx on the way to the lungs, and food enters the esophagus from the pharynx. |
| **PHENOTYPE** |  The detectable outward manifestations of a specific genotype; the physical characteristics of a living organism. |
| **PHOTOSYNTHESIS** | The process by which green plants, algae, diatoms, and certain bacteria make energy for themselves by using the energy of sunlight plus water to convert carbon dioxide into carbohydrates. The process produces oxygen as a byproduct. Photosynthesis produces the oxygen and carbohydrates that all animals need to survive. |
| **PHYLOGENETICS** | The study of [evolutionary](http://en.wikipedia.org/wiki/Evolution) relationships among groups of [organisms](http://en.wikipedia.org/wiki/Organism) (e.g. [species](http://en.wikipedia.org/wiki/Species), [populations](http://en.wikipedia.org/wiki/Population)), which are discovered through [molecular sequencing](http://en.wikipedia.org/wiki/Molecular_sequencing) data and morphological data. Evolution is regarded as a branching process, whereby populations are altered over time and may split into separate branches, [hybridize](http://en.wikipedia.org/wiki/Hybrid_%28biology%29) together, or terminate by [extinction](http://en.wikipedia.org/wiki/Extinction). This may be visualized in a [phylogenetic tree](http://en.wikipedia.org/wiki/Phylogenetic_tree), a hypothesis of the order in which evolutionary events are assumed to have occurred. |
| **PHYSIOLOGY** | A branch of biology that deals with the functions and activities of life or of living matter (as organs, tissues, or cells) and of the physical and chemical phenomena involved. |
| **PLASTID** | Any of several cytoplasmic organelles that contain genetic material, have a double membrane, and are often pigmented, e.g., the chloroplasts of plants are plastids that contain the chlorophyll necessary for photosynthesis. |
| **POPULATION** | A group of individuals of the same species occupying a particular geographic area.  |
| **PREDATION** | Predation describes a [biological interaction](http://en.wikipedia.org/wiki/Biological_interaction) in which a predator (an organism that is hunting) feeds on its prey (the organism that is attacked). |
| **PREDATOR** | An animal that lives by killing and eating other animals or organisms. |
| **PREY** | An [animal](http://www.biology-online.org/dictionary/Animal) being hunted or the [organisms](http://www.biology-online.org/dictionary/Organisms) being eaten. |
| **PRODUCER** | Any of various organisms (e.g., a green plant) that produce their own organic compounds from simple precursors (e.g., carbon dioxide and inorganic nitrogen), and many of which are food sources for other organisms. Producers include green plants and bacteria that produce food through photosynthesis, and certain bacteria that are capable of converting inorganic substances into food through chemosynthesis. |
| **PROGESTERONE** | A hormone that prepares the uterus for the fertilized ovum and maintains pregnancy. |
| **PROTEIN**  | A large molecule composed of one or more chains of amino acids in a specific order. The order is determined by the base sequence of nucleotides in the gene coding for the protein. Proteins are required for the structure, function, and regulation of the body cells, tissues, and organs, and each protein has unique functions. Examples are hormones, enzymes, and antibodies. |
| **PROKARYOTE** | One-cell organism lacking a membrane bound structurally discrete nucleus and other sub-cellular compartments. Bacteria and Archaea are prokaryotes. |
| **PULMONARY** | Of, relating to, affecting, or occurring in the lungs. |
| **PUNNETT SQUARE** | A diagram used to predict all possible gene combinations in a cross of parents |
| **RECESSIVE GENE** | A gene that must be present on both chromosomes in a pair in order for the organism with those genes to show outward signs of a certain characteristic. |
| **RED BLOOD CELL** | Any of the hemoglobin containing cells that carry oxygen to the tissues and are responsible for the red color of vertebrate blood. |
| **RENEWABLE ENERGY SOURCES** | Energy sources that can be replenished by natural processes in a relatively short period of time (e.g., radiant energy from the sun, wind, tide, waves, biomass). |
| **REPRODUCTION**  | The process by which an organism produces future generations of its own kind. |
| **REPRODUCTIVE SYSTEM** | The system of organs involved with animal reproduction, especially sexual reproduction.  |
| **RESOURCE** | In a technological system, the basic technological resources are energy, capital, information, machines and tools, materials, people, and time. |
| **RESPIRATION** | Cellular respiration is the set of the [metabolic](http://en.wikipedia.org/wiki/Metabolism) reactions and processes that take place in [cells](http://en.wikipedia.org/wiki/Cell_%28biology%29) to convert [biochemical energy](http://en.wikipedia.org/wiki/Energy#Energy_and_life) from nutrients into ATP and then release waste products. Nutrients that are commonly used by animal and plant cells in respiration include [sugar](http://en.wikipedia.org/wiki/Sugar), [amino acids](http://en.wikipedia.org/wiki/Amino_acids) and [fatty acids](http://en.wikipedia.org/wiki/Fatty_acids). Molecular oxygen is a common electron acceptor for the electrons released as the chemical bonds of nutrients are broken. In physiology, respiration is the process that enables animals to exchange carbon dioxide, the primary product of cellular respiration, for fresh oxygen. |
| **RESPIRATORY SYSTEM** | The system of organs and structures in which gas exchange takes place, consisting of the lungs and airways in air-breathing vertebrates; gills in fish and many invertebrates; the outer covering of the body in worms; and specialized air ducts in insects. |
| **RESPIRE** | To breath in and out, to inhale and exhale. In cells, to take up oxygen and produce [carbon dioxide](http://dictionary.reference.com/browse/carbon%2Bdioxide) through oxidation |
| **RESPONSE TO STIMULI** | A reaction, such as that of an organism or any of its parts to a specific stimulus. |
| **RNA** | *Ribonucleic acid*, a chemical found in the nucleus and cytoplasm of cells. RNA plays an important role in protein synthesis and other chemical activities of the cell. The structure of RNA is similar to that of DNA. There are several classes of RNA molecules, including messenger RNA, transfer RNA, ribosomal RNA, and other small RNA’s, each serving a different purpose. |
| **RIBOSOME** | A tiny, somewhat mitten-shaped organelle functioning as the site of protein manufacture in a cell. Ribosomes occur in great numbers in the [cell](http://dictionary.reference.com/browse/cell) cytoplasm freely, in small clusters, or attached to the outer surfaces of endoplasmic reticula.  |
| **SCROTUM** | A muscular sac that contains the testes. |
| **SEQUENCING** | Determination of the base order of nucleotides in a DNA or RNA molecule or the order of amino acids in a protein. |
| **SENSORY NEURONS** | A neuron that transmits nerve impulses from a sense organ toward the central nervous system. |
| **SEX-LINKED** | Relating to a gene carried on, or a trait transmitted by a sex chromosome. Color blindness and hemophilia in humans are sex-linked traits. |
| **SKELETAL MUSCLE** | Striated muscle that is usually attached to the skeleton and is usually under voluntary control. Its contraction speed is generally faster than that of smooth muscle. |
| **SMALL INTESTINE** | The long, narrow, coiled section of the intestine that extends from the stomach to the beginning of the large intestine. Nutrients from food are absorbed into the bloodstream from the small intestine.  |
| **SMOOTH MUSCLE**  | A non-[striated muscle](http://en.wikipedia.org/wiki/Striated_muscle) under involuntary control.It is responsible for the contraction of hollow organs such as blood vessels, the gastrointestinal tract and the bladder.  |
| **SPECIATION** | The origin of a new species from an existing one. |
| **SPECIES** | A taxonomic rank of interbreeding organisms capable of producing fertile offspring; a separately evolving lineage that forms a single [gene pool](http://en.wikipedia.org/wiki/Gene_pool). |
| **SPERM** | The male sex cell. |
| **SPINAL CORD** | A major part of the central nervous system that conducts sensory and motor nerve impulses to and from the brain, the spinal cord is a long tube-like structure extending from the base of the brain through the vertebral canal to the upper lumbar region. Enclosed in the protective backbone, it is essentially the 'motorway' to the central nervous system and is involved in the co-ordination of movement.  |
| **STEM CELL** | An unspecialized cell that gives rise to various specialized cells. |
| **STOMACH** | A saclike muscular organ in vertebrate animals that stores and breaks down ingested food. Food enters the stomach from the esophagus and passes to the small intestine through the pylorus. Glands in the stomach secrete hydrochloric acid and the digestive enzyme pepsin.  |
| **SUCCESSION** | The relatively predictable sequence in the composition of biological communities following a natural or human disturbance of their environment.  |
| **SUSTAINABILITY** | The state of a condition or process that can be maintained without interruption, weakening or loss of valued qualities. Sustainability ensures that a population remains within the carrying capacity of its environment. |
| **SYMBIOSIS** | The close and usually obligatory association of two organisms of different species that live together, often to their mutual benefit. |
| **SYSTEM** | A group of interacting, interrelated, or interdependent elements or parts that function together as a whole to accomplish a goal.A group of body organs or structures that together perform one or more vital functions. |
| **TAXONOMY** | The scientific classification of organisms into specially named groups based either on shared characteristics or on evolutionary relationships as inferred from the fossil record or established by genetic analysis. |
| **TENDON** | A band or tough, fibrous, inelastic tissue that connects a muscle to a bone. |
| **TESTES** | Glands in the scrotum that produce sperm. Also known as testicles. |
| **TISSUE** | The large mass of similar cells that make up a part of an organism and perform a specific function. The internal organs and connective structures (including bone and cartilage) of vertebrates, and cambium, xylem, and phloem in plants are made up of different types of tissues. |
| **THYMINE** | One of the four bases in the nucleotides of DNA, commonly denoted by the letter “T.” |
| **TRACHEA** | The tube in vertebrates that leads from the larynx to the bronchial tubes and carries air to the lungs. The trachea is a part of *the respiratory system.* |
| **TRAITS** | An inherited characteristic. |
| **TRANSCRIPTION** | The synthesis of an RNA copy from a sequence of DNA (a gene); the first step in gene expression.  |
| **TRANSLATION** | The process by which RNA makes proteins. |
| **TRANSMISSION** | The [communication](http://www.biology-online.org/dictionary/Communication) of [inheritable](http://www.biology-online.org/dictionary/Inheritable) qualities from [parent](http://www.biology-online.org/dictionary/Parent) to offspring; an incident in which an infectious disease is transmitted. |
| **TROPHIC LEVEL** | The position that an organism occupies in a food chain, i.e., what it eats, and what eats it. |
| **UTERUS** | A special organ in a female placental mammal in which an embryo develops. |
| **VACCINE** | A preparation of a weakened or killed pathogen, such as a bacterium or virus, or of a portion of the pathogen’s structure, that stimulates immune cells to recognize and attack it, especially though antibody production. Most vaccines are given orally or by intramuscular or subcutaneous injection. |
| **VEIN** | Any of the blood vessels that carry blood toward the heart from the body’s cells, tissues, and organs. Veins are thin-walled and contain valves that prevent the backflow of blood. All veins except the pulmonary vein carry blood with low levels of oxygen. |
| **VERTEBRATE** | Any of a large group of animals characterized by having a backbone. Vertebrates have a well-developed body cavity containing a chambered heart, large digestive organs, liver, pancreas, and paired kidneys and their blood contains both red and white corpuscles. |
| **VIRUS** | An extremely small, invasive biological agent consisting of a core of [DNA](http://www.biology-online.org/dictionary/DNA) or [RNA](http://www.biology-online.org/dictionary/RNA) surrounded by a [protein](http://www.biology-online.org/dictionary/Protein) coat. When infected by a virus, a host cell is forced to produce many thousands of identical copies of the original virus at an extraordinary rate. Unlike living organisms, viruses do not have cells that divide; new viruses are assembled in the infected host cell. |
| **VITAMIN** | Any of various organic compounds that are needed in small amounts for normal growth and activity of the body. |
| **WASTE**  | An unusable or unwanted substance or material, such as a waste product. |
| **YEAST** | Eukaryotic [microorganisms](http://en.wikipedia.org/wiki/Microorganism) classified in the [kingdom](http://en.wikipedia.org/wiki/Kingdom_%28biology%29) [Fungi](http://en.wikipedia.org/wiki/Fungus). Yeasts use organic compounds and do not require sunlight to grow. Some species ferment carbohydrates to carbon dioxide (used in baking bread) and alcohol (used in making wine and beer). |
| **ZYGOTE**  | A fertilized egg cell. |

**APPENDIX B**

**LIST OF SCIENTIFIC VOCABULARY AND COMMON ILLNESSES RELEVANT TO LIFE SCIENCE TOPIC 3: ANATOMY AND PHYSIOLOGY**

|  |  |
| --- | --- |
| **AP2.1a**  | **Digestive system**: mouth, esophagus, stomach, small intestine, and large intestine. Relevant diseases or conditions associated with the digestive system include Crohn’s, Celiac, colitis, ulcer.**Circulatory system**: heart, blood, veins, capillaries and arteries.Relevant diseases or conditions associated with the circulatory system include heart disease and high blood pressure.**Respiratory system:**  nose, trachea and lungs.Relevant diseases or conditions associated with the respiratory system include asthma and emphysema.**Nervous system**: brain, spinal cord, nerves.Relevant diseases or conditions associated with the nervous system include multiple sclerosis (MS), Alzheimer’s.**Muscular/Skeletal system**: muscles, bones, tendons and ligaments.Relevant diseases or conditions associated with the muscular/skeletal system include tendonitis, osteoporosis.**Reproductive system**: sperm, egg.Relevant diseases or conditions associated with the reproductive system include sexually transmitted diseases (STDs). |
| **AP2.3a** | **Digestive system:** mouth, pharynx, esophagus, stomach, small intestine, large intestine.Relevant diseases or conditions associated with the digestive system include Crohn’s, celiac, colitis, ulcer.**Circulatory system**: heart, red blood cells, veins, arteries, and capillaries.Relevant diseases or conditions associated with the circulatory system include heart disease and high blood pressure.**Respiratory system**: nose, pharynx, larynx, trachea, lungs, bronchi, alveoli. Relevant diseases or conditions associated with the respiratory system include asthma and emphysema.**Nervous system**: brain, spinal cord, nerves, neurons.Relevant diseases or conditions associated with the nervous system include multiple sclerosis (MS), Alzheimer’s.**Muscular/Skeletal system**: cardiac, smooth and skeletal muscles, bones, cartilage, ligaments, tendons.Relevant diseases or conditions associated with the muscular/skeletal system include tendonitis, osteoporosis.**Reproductive system**: sperm, testes, egg, uterus, fallopian tubes, ovaries. Relevant diseases or conditions associated with the reproductive system include infertility, sexually transmitted diseases (STDs |
| **AP2.5a** | **Digestive system**: mouth, pharynx, esophagus, stomach, small intestine, and large intestine. Explain how the processes that occur in the digestive system convert macromolecules from food into smaller molecules that can be used by cells for energy and for repair and growth. Associated illnesses and conditions: Crohn’s, celiac, colitis, ulcer, Salmonella.**Circulatory system**: heart, arteries, veins, capillaries, red blood cells. Explain how the circulatory system (heart, arteries, veins, capillaries, red blood cells) transports nutrients and oxygen to cells and removes cell wastes. Describe how the kidneys and the liver are closely associated with the circulatory system as they perform the excretory function of removing waste from the blood. Associated Illnesses and conditions: heart disease, high blood pressure, high cholesterol.**Respiratory system:** nose, pharynx, larynx, trachea, lungs, and alveoli Explain how the respiratory system provides exchange of oxygen and carbon dioxide. Describe the interaction of the respiratory system with the circulatory system. Associated Illnesses and conditions: asthma, emphysema, bronchitis, pneumonia. **Nervous system:** brain, spinal cord, motor neurons, and sensory neurons. Explain how the nervous system mediates communication among different parts of the body and mediates the body’s interactions with the environment. Identify the basic unit of the nervous system, the neuron, and explain generally how it functions. Associated Illnesses and conditions: Multiple sclerosis (MS), Alzheimer’s, Tourette’s syndrome, meningitis **Musculoskeletal system:** skeletal, smooth and cardiac muscles, bones, cartilage, ligaments, tendons.Explain how the musculoskeletal system works with other systems to support the body and allow for movement. Recognize that bone marrow found in bones produce blood cells. Associated Illnesses and conditions: tendonitis, osteoporosis, methicillin-resistant *Staphylococcus aureus* (MRSA)**Reproductive system**: sperm, testes, egg, uterus, fallopian tubes, ovaries, embryo.Explain that the reproductive system facilitates the production of an embryo through fertilization of an egg by sperm. Associated Illnesses and conditions: sexually transmitted diseases (STDs), ovarian cancer, testicular cancer, urinary tract infections (UTIs). |

Appendix C

Resources – Books Journals, and Organizations

**General**

American Association for the Advancement of Science, 2001 AND 2007, *Atlas of Science Literacy*, volumes 1 and 2.

# Dodson and Hoagland, 2001, *Exploring The Way Life Works: The Science of Biology*, B. Jones and Bartlett Publishers, Inc.

# NSTA (National Science Teachers Association)*This organization offers many resources for teachers, including FREE “Science Objects,” two-hour on-line interactive, inquiry-based content modules that can help teachers better understand science content. Their site allows you to select modules and store them in a professional development library that you design for yourself.*

NSTA, *The Science Teacher*. NSTA.
*This journal, published by the National Science Teachers Association, offers free selected articles online.*
<http://learningcenter.nsta.org/browse_journals.aspx?journal=tst>

National Institute of Health Curriculum Supplement Series
<http://science.education.nih.gov/customers.nsf/WebPages/CSHome>
*Print and electronic curriculum materials are available in the life sciences.*

TERC (Technical Education Resource Center)
*TERC, located in Cambridge, MA, is a not-for-profit education research and development organization dedicated to improving mathematics, science, and technology teaching and learning*. *TERC has designed user-friendly, inviting science materials for K-12, many of which are suitable for the ABE and ESOL classroom.*
*Check out their website for specific publications*.
<http://www.terc.edu/ourwork/38_science.html>

**Cell Biology**

Skloot, R., 2011, *The Immortal Life of Henrietta Lacks*, Broadway.

Balkwill. F., 1994, *Cells Are Us,* Carolrhoda Books.

Griffin, R., 1986, *The Biology Coloring Book,* Collins Reference.

*This book is accessible for ABE learners, great illustrations with simple and clear text. Covers cells in the human body.*

**Anatomy and Physiology**

Rogers, K., and Henderson, C. 2001, *The Usborne Internet-Linked Library of Science Human Body*, Usborne Publishing LTD., London, England.

**Genetics**

# Bardoe, S. and Smith, J., 2006, *Gregor Mendel: The Friar Who Grew Peas*, Harry N. Abrams.

**Ecology**

Carson, R., 1962, *Silent Spring,*Houghton Mifflin Co.

Peters, C., ed., 2000, “Climate Change,” in *The Change Agent, #27, World* Education, Inc.

http://www.nelrc.org/changeagent/topics.htm

Peters, C., ed., 2011, “Staying Safe in a Toxic World, *The Change Agent, #32, World* Education, Inc.

http://www.nelrc.org/changeagent/topics.htm

Leopold, A., 1986, *A Sand County Almanac*, Ballantine Books.

Beston, H. 2003, *The Outermost House: A Year of Life on the Great Beach of Cape Cod,* Holt Paperbacks.

**Evolution and Biodiversity**

National Academy of Science, 2008, *Science, Evolution and Creationism,* The National Academies Press.

Bybee, R.W., 2004, *Evolution in Perspecti*ve. 2004. National Science Teachers Association Press.

Gould, S.J. 1992, *The Panda’s Thumb: More Reflections in Natural History*, W. W. Norton & Company

Weinber, J., 1995 *The Beak of the Finch*. Vintage.

Appendix D

Community Resources

The following list includes sites all around Massachusetts that are suitable for field trips with students. Check with the sites in your area to see if they offer group discounts or free admission for educational groups.

*Please note: These web sites were checked for accuracy in September 2013. If you find a link that is no longer active, please contact ACLS.*

Amherst College Natural History Museum, Bassett Planetarium and Beneki Natural History Museum

Amherst MA

<https://www.amherst.edu/museums>

Arnold Arboretum

<http://arboretum.harvard.edu/education/childrens-education-programs/>

*Offers nature programs, tours, family activities.*

Blue Hill Observatory and Science Center

Milton MA

<http://www.bluehill.org>

*A great place to learn about weather. Educational tours available.*

Cape Cod Museum of Natural History
Brewster MA
<http://www.ccmnh.org/index.php?name=Sections&req=viewarticle&artid=38>

*Offers educational programs in marine science, environmental and ecological studies, and Cape Cod flora and fauna at its campus on Cape Cod Bay.*

Connecticut River Coordinator’s Office

(Holyoke Dam Fishlift, Turner Falls Fish Ladder, National Salmon Station in Sunderland)

Sunderland MA

<http://www.fws.gov/r5crc/Fish/visit.html>

The Discovery Children’s Museum and Discovery Science Museum

Acton MA

<http://www.discoverymuseums.org/>

*Offers hands-on, inquiry-based exhibits for all ages as well as travelling workshops for teachers.*

Ecotarium
Worcester MA

<http://www.ecotarium.org>

*EcoTarium offers travelling exhibits that come to the classroom*.

Harvard Museum of Natural History

Cambridge, MA

<http://www.harvard.edu/resources-offices/museums>

Harvard Museum of Science and Culture

<http://hmsc.harvard.edu/>

*This museum’s goal is to “foster curiosity and a spirit of discovery in visitors of all ages, enhancing public understanding of and appreciation for the natural world, science, and human cultures.” (From website.) Offers a wide variety of public programs including lectures, talks, drop-in family activities, and classes.*

Massachusetts Dept. of Conservation and Recreation

Urban and State Parks throughout MA

<http://www.mass.gov/dcr>

The Massachusetts AudubonSociety

Wildlife Sanctuaries throughout MA

<http://www.massaudubon.org/Nature_Connection/sanctuaries.php>

*Offers a wide variety of classes, programs, events, and tours.*

Museum of Science

Cambridge, MA

<http://www.mos.org>

*Programs can apply for scholarships when they schedule group visits. Teachers can schedule appointments at The Education Resource Center at the museum where they can review curriculum and classroom resources and participate in individual or small-group professional development.*

New England Aquarium

Boston, MA

<http://www.neaq.org>

*The Teacher Resource Center provides teaching materials, books, posters, curriculum guides, theme-based kits and bio facts, all of which are available by loan. Also offers consultation appointments for teachers*

New England Water Science Center

Water resources of MA

<http://ma.water.usgs.gov/>

Northeast Fisheries Science Center

Woods Hole MA

<http://www.nefsc.noaa.gov/nefsc/woodshole>

Ocean Explorium

New Bedford MA

<http://oceanexplorium.org>

*Offers guided tours and field trip tours at reduced rates.*

Public Health Museum

Tewksbury MA

<http://publichealthmuseum.org>

*Educates the public about public health, houses historical artifacts related to public health.*

Robbins Museum of Archaeology

Middleboro MA

<http://www.massarchaeology.org/museum.htm>

Smith College Botanical Garden
Northampton MA
<http://www.smith.edu/garden/home.html>

South Shore Natural Science Center

Norwell MA

<http://southshorenaturalsciencecenter.org>

*Offers environmental education programs for all ages.*

Springfield Science Museum

Springfield MA

<http://www.springfieldmuseums.org/the_museums/science>

*Dinosaur Hall, planetarium, live animal exhibit, and more.*

The Trustees of Reservations

More than 100 properties of scenic, historical and ecological value throughout MA

<http://thetrustees.org>

TERC - Technical Education Resource Center
<http://www.terc.edu/ourwork/38_science.html>
*TERC has designed user-friendly, inviting science materials for K-12, many of which are suitable for the ABE and ESOL classroom. They also offer professional development in math and science for teachers.*

Waquoit Bay National Estuarine Research Preserve

Waquoit, MA (Cape Cod)

<http://www.waquoitbayreserve.org>

Worcester Think Tank

Worcester MA

<http://www.worcesterthinktank.com>

*An interdisciplinary educational center for young adults.*

Zoo New England

Franklin Park Zoo, Boston, MA and Stone Zoo, Stoneham, MA

<http://www.zoonewengland.org>

*Offers educational resources to teachers for planning inquiry-based classroom activities at every grade level.*

1. The definition for standards is based on a presentation by Regie Stites at the State Adult Education Content Standards Consortia Meeting, October 2004. [↑](#footnote-ref-1)