

**Biology End of Course Exam 2012 – Study Guide and Review**

	<b>Biological Concept</b>	<b>Resources and Questions</b> <i>When you think about the answers to these questions, think about models that you could develop; diagrams that would demonstrate processes; and functions of parts in relationship</i>
<b>LS1A Matter &amp; Energy in Photosynthesis</b>	I can identify inputs and/or outputs of matter and/or energy in photosynthesis using words and/or chemical formulas (i.e., inputs are carbon dioxide/CO <sub>2</sub> , water/H <sub>2</sub> O, light energy; outputs include glucose/C <sub>6</sub> H <sub>12</sub> O <sub>6</sub> , oxygen/O <sub>2</sub> ). (MC, C)	<p><b>Quick Links for Students:</b> The following links will help you visualize the process of photosynthesis:</p> <ul style="list-style-type: none"> <li>• Carbon Cycle: <a href="http://earthobservatory.nasa.gov/Features/CarbonCycle/page1.php">http://earthobservatory.nasa.gov/Features/CarbonCycle/page1.php</a></li> <li>• Phytoplankton: <a href="http://news.nationalgeographic.com/news/2004/06/0607_040607_phytoplankton.html">http://news.nationalgeographic.com/news/2004/06/0607_040607_phytoplankton.html</a></li> <li>• Carbon Dioxide Uptake: <a href="http://www.atmosphere.mpg.de/enid/1vd.html">http://www.atmosphere.mpg.de/enid/1vd.html</a></li> <li>• Photosynthesis Game: <a href="http://www.atmosphere.mpg.de/enid/1vd.html">http://www.atmosphere.mpg.de/enid/1vd.html</a></li> </ul> <p><b>Essential Ideas:</b></p> <ul style="list-style-type: none"> <li>• Photosynthesis – converts water, carbon dioxide and sunlight into glucose and oxygen</li> <li>• CO<sub>2</sub> comes from the atmosphere, water comes from the soil, energy comes from the sun</li> <li>• Formula is: 6 CO<sub>2</sub> + 6 H<sub>2</sub>O + sunlight → C<sub>6</sub>H<sub>12</sub>O<sub>6</sub> + 6O<sub>2</sub></li> <li>• Occurs in the chloroplasts</li> <li>• uses chlorophyll (green pigment that absorbs all light colors except green which it reflects) to capture sun's energy</li> <li>• Occurs in 2 stages: light independent reaction and light dependent</li> <li>• Occurs in autotrophs (organisms that make their own food)</li> <li>• Rate of Photosynthesis depends on 2 things: light intensity and temperature</li> </ul> <p><b>Reflective Questions for Students:</b></p> <ol style="list-style-type: none"> <li>1. What is the big picture of photosynthesis? What are the inputs and outputs? What is the equation for photosynthesis? What is the purpose of photosynthesis?</li> <li>2. What factors might impact photosynthetic processes?</li> <li>3. What are the characteristics of photosynthetic organisms? What organelles do they all have?</li> <li>4. How is photosynthesis similar to and different from cellular respiration?</li> </ol>
	I can describe the rearrangement of atoms during photosynthesis using the chemical equation for photosynthesis. (MC)	
	I can explain the role of photosynthesis in the life of plants (e.g., photosynthesis is the only source of glucose that provides chemical energy or is incorporated into large molecules). (MC)	
	I can explain the role of photosynthesis in the life of animals (e.g., photosynthesis is the source of the chemical energy animals require to live and grow; photosynthesis provides oxygen). (MC)	

<b>LS1B</b> <b>Cellular Respiration</b>	<p>I can describe cellular respiration as the process cells use to change the energy of glucose into energy in the form of ATP and/or the process that provides the energy source for most living organisms. (MC)</p>	<p><b>Quick Links for Students:</b>  The following links will help you visualize the process of cellular respiration:</p> <ul style="list-style-type: none"> <li>• Carbon Cycle: <a href="http://earthobservatory.nasa.gov/Features/CarbonCycle/page3.php">http://earthobservatory.nasa.gov/Features/CarbonCycle/page3.php</a></li> <li>• Cellular Respiration Application: <a href="http://www.teachersdomain.org/resource/oer08.sci.life.reg.exercise/">http://www.teachersdomain.org/resource/oer08.sci.life.reg.exercise/</a>  <a href="http://www.teachersdomain.org/asset/oer08_vid_exercise/">http://www.teachersdomain.org/asset/oer08_vid_exercise/</a></li> <li>• Cellular Respiration Simulation: <a href="http://www.teachersdomain.org/asset/lsp07_int_cellenergy/">http://www.teachersdomain.org/asset/lsp07_int_cellenergy/</a></li> </ul> <p><b>Essential Ideas:</b></p> <ul style="list-style-type: none"> <li>• Cellular <b>Respiration</b>: cellular breakdown of glucose (using oxygen) to produce carbon dioxide, water and ATP</li> <li>• Process by which the chemical energy of "food" molecules is released and partially captured in the form of <b>ATP</b>. Carbohydrates, fats, and proteins can all be used as fuels in cellular respiration, but <b>glucose</b> is most commonly used as an example to examine the reactions and pathways involved.</li> <li>• Formula is: <math>C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + ATP</math></li> <li>• Glucose needed for cellular respiration is produced by plants.</li> <li>• Occurs in cytoplasm (glycolysis) and mitochondria (Krebs Cycle)</li> </ul> <p><b>Reflective Questions for Students:</b></p> <ol style="list-style-type: none"> <li>1. What is the big picture of cellular respiration? What are the inputs and outputs (both matter and energy)? What is the equation for respiration? What is the purpose of respiration?</li> <li>2. How is it that carbon is an atom that allows organisms to both store and release energy?</li> <li>3. What examples of energy storage and release can you describe in your everyday life?</li> <li>4. How is a forest fire an analogy for cellular respiration?</li> <li>5. What factors might affect the process of cellular respiration?</li> <li>6. What are the characteristics of organisms that undergo anaerobic respiration?</li> </ol>
	<p>I can compare cellular respiration to the burning of fossil fuels (e.g., large carbon-containing compounds are broken into smaller carbon compounds as chemical energy is transformed to different forms of energy in both cellular respiration and combustion of fossil fuels). (MC, CP)</p>	
	<p>I can describe the inputs and/or outputs of matter and/or energy in cellular respiration and/or in combustion (i.e., inputs include glucose or large carbohydrates and oxygen, outputs include carbon dioxide, water, and energy/ATP). (MC, CP, SA)</p>	

<b>LS1C Organelles</b>	<p>I can describe the essential function(s) of structures within cells (i.e., cellular membrane, cell wall, nucleus, chromosome, chloroplast, mitochondrion, ribosome, cytoplasm). (MC, C)</p>	<p><b>Quick Links for Students:</b> Use the following links to explore your understanding of cell organelles and their functioning.</p> <ul style="list-style-type: none"> <li>• A table of organelles, their descriptions, their functions, and plant vs. animal: <a href="http://www.schools.utah.gov/curr/science/sciber00/7th/cells/sciber/orgtable.htm">http://www.schools.utah.gov/curr/science/sciber00/7th/cells/sciber/orgtable.htm</a></li> <li>• An interactive online microscope of slides containing organelles: <a href="https://histo.life.illinois.edu/histo/lab/cells/text.htm">https://histo.life.illinois.edu/histo/lab/cells/text.htm</a></li> <li>• A student-made organelle rap: <a href="http://www.youtube.com/watch?v=Xi9Kp9J4qK4A">http://www.youtube.com/watch?v=Xi9Kp9J4qK4A</a></li> <li>• A clay-animation video about organelles: <a href="http://www.youtube.com/watch?v=n9zqs6acTel&amp;feature=related">http://www.youtube.com/watch?v=n9zqs6acTel&amp;feature=related</a></li> <li>• A tour of the cell: <a href="http://cellsalive.com/cells/cell_model.htm">http://cellsalive.com/cells/cell_model.htm</a></li> </ul> <p><b>Reflective Questions for Students:</b></p> <ol style="list-style-type: none"> <li>1. What are the major organelles in cells? What are the functions of each?</li> <li>2. What are the similarities and differences between plant and animal cells?</li> <li>3. How do the parts of a cell make it function as a system?</li> <li>4. Do plants have mitochondria? (Important link to cellular respiration)</li> <li>5. What are the similarities and differences between eukaryotic and prokaryotic cells?</li> </ol>
<b>LS1D Cell Membrane</b>	<p>I can describe the structure of the cell membrane as a bilayer with embedded proteins capable of regulating the flow of materials into and out of the cell. (MC)</p> <hr/> <p>I can describe the process(es) (i.e., active transport, passive transport, osmosis, facilitated diffusion) that allows substances to pass through the cell membrane. (MC, CP, SA)</p>	<p><b>Quick Links for Students:</b> Use the following links to explore your understanding of the cell membrane and its function.</p> <ul style="list-style-type: none"> <li>• An interactive link regarding cellular transport: <a href="http://www.teachersdomain.org/resource/tdc02.sci.life.cell.membraneweb/">http://www.teachersdomain.org/resource/tdc02.sci.life.cell.membraneweb/</a></li> </ul> <p><b>Essential Ideas:</b></p> <ul style="list-style-type: none"> <li>• Active transport requires energy; passive transport does not.</li> <li>• Osmosis, diffusion, and facilitated transport are examples of passive transport.</li> <li>• Some cellular transport involves proteins that are imbedded in the cellular membrane (active transport and facilitated transport).</li> <li>• Some cellular transport involves small, neutral molecules (ie. CO<sub>2</sub>, H<sub>2</sub>O, O<sub>2</sub>) passively moving though the phospholipid bilayer</li> </ul> <p><b>Reflective Questions for Students:</b></p> <ol style="list-style-type: none"> <li>1. What is the structure of a cell membrane? What molecules does a membrane contain?</li> <li>2. How does the structure of the cell membrane support its functions?</li> <li>3. What is the difference between active transport and passive transport?</li> <li>4. What is facilitated diffusion and give examples in the human body?</li> <li>5. Describe the importance of osmosis.</li> </ol>

<b>LS1E</b>  <b>DNA, Genes, and Protein Synthesis</b>	<p>I can describe the structure of DNA molecules in terms of the four nucleotides (i.e., A, C, G, and T subunits are combined in various sequences).</p>	<p><b>Quick Links for Students:</b>  The following links will help explore your understanding of DNA, proteins, and their functioning.</p> <ul style="list-style-type: none"> <li>• Learn the basics: <a href="http://learn.genetics.utah.edu/content/begin/tour/">http://learn.genetics.utah.edu/content/begin/tour/</a></li> <li>• Build a DNA Model: <a href="http://learn.genetics.utah.edu/content/begin/dna/builddna/">http://learn.genetics.utah.edu/content/begin/dna/builddna/</a></li> <li>• Protein to DNA: <a href="http://learn.genetics.utah.edu/content/begin/dna/">http://learn.genetics.utah.edu/content/begin/dna/</a></li> </ul> <p><b>Essential Ideas:</b></p> <ul style="list-style-type: none"> <li>• Understanding of the components of DNA and how the components fit together.</li> <li>• DNA codes for genes, which code for specific amino acids needed to make a protein.</li> <li>• Proteins are expressed as traits.</li> </ul> <p><b>Reflective Questions for Students:</b></p> <ol style="list-style-type: none"> <li>1. What is the basic structure of DNA (consider a diagram)?</li> <li>2. What is the function of DNA? How is information stored in DNA?</li> <li>3. What is the relationship between DNA, chromosomes, genes, amino acids, proteins, and traits?</li> <li>4. Describe the overall process of protein synthesis (consider a diagram as well).</li> </ol>
	<p>I can describe that the sequence of the four nucleotides in the DNA molecule encodes genetic information.</p>	
	<p>I can describe the relationships among DNA, chromosomes, genes, amino acids, proteins, and/or traits.</p>	
	<p>I can describe that the sequence of the nucleotides in a gene specifies the amino acids needed to make a protein.</p>	
	<p>I can describe inherited traits (e.g., eye color, hair texture, attached earlobes, tongue rolling) and cell functions as primarily determined by the proteins expressed by genes.</p>	
	<p>I can predict the complementary strand of mRNA given the nucleotide sequence in a single strand of DNA.</p>	
	<p>I can describe the steps and/or structures in the process by which gene sequences are copied to produce proteins (e.g., the sequence of nucleotides in DNA determines the sequence of subunits in mRNA assembled in the nucleus, and the mRNA is held by ribosomes in the cytoplasm where amino acids carried by tRNA are assembled into proteins based on the codons in the mRNA sequence).</p>	

<b>LS1F</b> <b>Chemical Reactions in Cells</b>	<p>I can describe that large molecules in food are broken down into smaller molecules by cells to provide energy or building blocks (i.e., proteins into amino acids, carbohydrates into simple sugars, fats into fatty acids, DNA into nucleotides). (MC)</p>	<p><b>Quick Links for Students:</b>  The following links will help you visualize the process:</p> <ul style="list-style-type: none"> <li>• All About Enzymes <a href="http://www.learnerstv.com/animation/biology/Enzymeactivity.swf">http://www.learnerstv.com/animation/biology/Enzymeactivity.swf</a></li> <li>• The Role of Enzymes in Biological Systems <a href="http://faculty.ivytech.edu/~twmurphy/txt_202/enzymes.htm">http://faculty.ivytech.edu/~twmurphy/txt_202/enzymes.htm</a></li> <li>• The role of enzymes in DNA transcription video <a href="http://www.hhmi.org/biointeractive/dna/DNAi_replication_vo2.html">http://www.hhmi.org/biointeractive/dna/DNAi_replication_vo2.html</a></li> <li>• Molecules Build Cells <a href="http://faculty.stcc.edu/AandP/AP/AP1pages/Units1to4/epitissmol/molecule.htm">http://faculty.stcc.edu/AandP/AP/AP1pages/Units1to4/epitissmol/molecule.htm</a></li> <li>• Respiration and Photosynthesis <a href="http://vcell.ndsu.edu/animations/">http://vcell.ndsu.edu/animations/</a></li> </ul> <p><b>Reflective Questions for Students:</b></p> <ol style="list-style-type: none"> <li>1. What are two reasons that large biomolecules are broken down into smaller biomolecules in organisms?</li> <li>2. What are the subunits that the following molecules made from or broken down into: <ol style="list-style-type: none"> <li>a. Proteins</li> <li>b. Fats</li> <li>c. Carbohydrates</li> <li>d. Nucleic acids (DNA)</li> </ol> </li> <li>3. Explain how enzymes break large food molecules down into smaller molecules and how these molecules become available for the cell to make new molecules.</li> <li>4. Describe how the new molecules are different than the original large molecules?</li> <li>5. Describe how a cell can be built from the new molecules mentioned in question 3.</li> <li>6. Use a model to explain why it requires a different enzyme to break a molecule apart than it did to put the molecule together.</li> <li>7. What are the molecules that transfer energy for cell processes?</li> </ol>
	<p>I can describe that cells build large molecules required for cell functions from smaller molecules (i.e., proteins from amino acids, carbohydrates from simple sugars, fats from fatty acids, DNA from nucleotides). (MC)</p>	
	<p>I can describe enzymes as proteins that regulate reactions that break down and/or build molecules needed by cell structures and/or functions. (MC)</p>	
	<p>I can describe that cells transfer chemical energy from food to special molecules (i.e., ATP, fat, carbohydrates) through a process that involves enzymes, to be used later by the cell. (MC)</p>	
	<p>I can describe that chemical energy stored in special molecules (i.e., ATP, fat, carbohydrate) is used by cells to drive cell processes. (MC)</p>	

LS1G  
Enzymes & Other Proteins

I can describe that cells use DNA that forms their genes to encode enzymes and other proteins.

I can describe that cell functions (e.g., cell growth and division, response to the environment) can be regulated by changing the activity of proteins and/or by changing whether and how often particular genes are expressed.

I can describe that changes in the environment can cause changes in the amount and/or activity of proteins (e.g., enzymes) produced by a gene.

**Quick Links for Students:**

Use the following links to explore your understanding of DNA, proteins, and their functioning.

- An interactive link regarding cellular transport:  
<http://www.teachersdomain.org/resource/tdc02.sci.life.cell.membraneweb/>
- What is a Gene? [http://learn.genetics.utah.edu/content/begin/dna/tour\\_gene.html](http://learn.genetics.utah.edu/content/begin/dna/tour_gene.html)
- Gene Control simulation and explanation: <http://learn.genetics.utah.edu/content/epigenetics/control/>
- Lick Your Rat an Inquiry <http://learn.genetics.utah.edu/content/epigenetics/rats/>

**Essential Ideas:**

- Genes encode for enzymes and other proteins.
- Cell functions are regulated by changing the production of proteins.
- Changes in environment can cause changes in the production of enzymes.

**Reflective Questions for Students:**

1. What information do genes carry?
2. What are three types of proteins?
3. How are cellular processes (like cell division, metabolism, cell growth) regulated in the cell?
4. How can a signal from the outside world change a gene's expression?

<b>LS1H</b> <b>Chromosomes and Mitosis</b>	<p>I can describe that genes are carried on chromosomes.</p>	<p><b>Quick Links for Students:</b>  The following links will help you visualize the process of mitosis.</p> <ul style="list-style-type: none"> <li>• Mitosis <a href="http://cellsalive.com/mitosis.htm">http://cellsalive.com/mitosis.htm</a></li> <li>• Mitosis: The Dance of the Chromosomes <a href="http://www.contexo.info/DNA_Basics/Mitosis.htm">http://www.contexo.info/DNA_Basics/Mitosis.htm</a></li> <li>• Mitosis: What is Mitosis? <a href="http://www.microscope-microscope.org/activities/school/mitosis.htm">http://www.microscope-microscope.org/activities/school/mitosis.htm</a></li> <li>• This site contains an activity that allows you to identify the steps of mitosis. <a href="http://learngenetics.utah.edu/">http://learngenetics.utah.edu/</a></li> </ul> <p><b>Essential Ideas:</b></p> <ul style="list-style-type: none"> <li>• Chromosomes are made of DNA which code for genes carried on chromosomes.</li> <li>• Genes contain the genetic information passed from parents to offspring.</li> <li>• Every animal cell contains 2 copies of each chromosome inside the nucleus.</li> <li>• Every cell in the body of an organism contains DNA with all the genetic information of that living organism.</li> <li>• All the animals of the same species have the same number of chromosomes in the nucleus of their cells. Examples: all humans have 46 chromosomes arranged in 23 pairs. Fruit flies have 8 chromosomes arranged in 4 pairs.</li> </ul> <p><b>Reflective Questions for Students:</b></p> <ol style="list-style-type: none"> <li>1. Describe the overall process of mitosis. Address why mitosis occurs, in what types of cells it occurs, and chromosome numbers for parent and daughter cells.</li> <li>2. Using two pair of homologous chromosomes (2 long and 2 short), diagram the four stages of mitosis: pro phase, metaphase, anaphase, and telophase.</li> <li>3. Diagram how DNA replication occurs and mention why DNA replication is an essential part of the cell cycle.</li> </ol>
	<p>I can describe that typical animal cells contain two copies of each chromosome, one from each biological parent, with genetic information that regulates body structure and function.</p>	
	<p>I can describe the process of mitosis (e.g., the genetic information is copied and each of two new cells receives exact copies of the original chromosomes) and/or the product of mitosis (e.g., two cells each with the same number of chromosomes as the original cell).</p>	

<b>LS11</b> <b>Meiosis, Fertilization, and Offspring Variation</b>	<p>I can describe the process of meiosis (e.g., each egg or sperm cell receives only one representative chromosome from each pair of chromosomes found in the original cell) and/or product of meiosis (e.g., egg and sperm cells with only one set of chromosomes).</p>	<p><b>Quick Links for Students:</b>  The following links will help you visualize the process of meiosis.</p> <ul style="list-style-type: none"> <li>• Meiosis: <a href="http://cellsalive.com/meiosis.htm">http://cellsalive.com/meiosis.htm</a></li> <li>• Meiosis: How Chromosomes are passed from Parent to offspring <a href="http://www.contexo.info/DNA_Basics/Meiosis.htm">http://www.contexo.info/DNA_Basics/Meiosis.htm</a></li> <li>• This site contains an activity that allows you to identify the steps of meiosis. <a href="http://learngenetics.utah.edu/">http://learngenetics.utah.edu/</a></li> </ul> <p><b>Essential Ideas:</b></p> <ul style="list-style-type: none"> <li>• Chromosomes are made of DNA, which code for genes carried on chromosomes.</li> <li>• Genes contain the genetic information passed from parents to offspring.</li> <li>• Every animal cell contains 2 copies of each chromosome inside the nucleus.</li> <li>• <b>Every cell</b> in the body of an organism contains DNA with all the genetic information of that living organism.</li> <li>• All the animals of the same species have the same number of chromosomes in the nucleus of their cells. Examples: all humans have 46 chromosomes arranged in 23 pairs. Fruit flies have 8 chromosomes arranged in 4 pairs.</li> <li>• Sex cells have half the number of chromosomes as regular cells so that the right number of chromosomes is formed as they combine with the opposite sex cell.</li> <li>• <b>LIMIT:</b> Students do not need to <b>memorize</b> the every detailed step. Such memorization is likely to cause students to miss the big picture about the purpose and end results of this mitosis.</li> </ul> <p><b>Reflective Questions for Students:</b></p> <ol style="list-style-type: none"> <li>1. How do sex cells differ from regular body cells?</li> <li>2. How are male and female sex cells different from each other?</li> <li>3. How do sex cells become regular cells?</li> <li>4. How is the genetic blueprint that makes you who you are transferred faithfully from one cell to the next?</li> <li>5. Why are the offspring of two parents different than one another?</li> <li>6. What happens when something goes wrong during meiosis?</li> <li>7. How do genetic traits get passed from parent to offspring?</li> <li>8. If two parents are both heterozygous for two traits, what is the chance their offspring be homozygous recessive for both traits?</li> <li>9. How can diseases be passed from parent to offspring?</li> <li>10. A cell is about to divide by meiosis. The cell has 6 chromosomes: 2 Long, 2 medium, and 2 short. Draw in the combinations of chromosomes that would be in the 4 sex cells (sperm or egg) after meiosis.</li> <li>11. If flower color is an incomplete dominant trait, explain how many colors could be present in a population of plant.</li> </ol>
	<p>I can describe that the processes of recombination during meiosis (e.g., segregation, independent assortment) result in a unique combination of genetic information in the egg or sperm cell.</p>	
	<p>I can describe the relationship between the unique combination of genetic information in an egg or sperm cell and the differing characteristics in offspring from a single set of parents.</p>	
	<p>I can describe the process of fertilization as restoring the original chromosome number (e.g., an egg and sperm, each with half the number of chromosomes of the original cell, combine to restore the number of chromosomes from the original cell).</p>	
	<p>I can describe that the process of fertilization allows for variation among offspring from a single set of parents.</p>	
	<p>I can describe possible allele combinations in an egg or sperm cell given a combination of two traits and a parent's genotype for the two traits.</p>	
	<p>I can describe the possible combinations of offspring in a simple Mendelian genetic cross for two traits (e.g., given a Punnett square for two traits, fill in one missing cell).</p>	
	<p>I can describe the possible combinations of offspring in a genetic cross involving codominance or incomplete dominance for a single trait.</p>	



<b>LSZA Transfers and Cycles of Matter &amp; Energy</b>	<p>I can describe the cycle of carbon through ecosystems (e.g., carbon dioxide in air becomes large carbon-containing molecules in the tissues of plants through photosynthesis, these molecules can be cycled to animals that consume the plants, then returned as carbon dioxide to the atmosphere through cellular respiration, combustion, and decomposition). (MC, CP, SA)</p>	<p><b>Quick Links for Students:</b></p> <ul style="list-style-type: none"> <li>This website provides a diagram of the carbon cycle. <a href="http://www.teachersdomain.org/resource/tdc02.sci.phys.matter.ccycle/">http://www.teachersdomain.org/resource/tdc02.sci.phys.matter.ccycle/</a></li> <li>This website provides an explanation and diagrams of the nitrogen cycle. <a href="http://extension.missouri.edu/publications/DisplayPub.aspx?P=WQ252">http://extension.missouri.edu/publications/DisplayPub.aspx?P=WQ252</a></li> <li>This website provides an animation of the nitrogen cycle. <a href="http://www.classzone.com/books/ml_science_share/vis_sim/em05_pg20_nitrogen/em05_pg20_nitrogen.swf">http://www.classzone.com/books/ml_science_share/vis_sim/em05_pg20_nitrogen/em05_pg20_nitrogen.swf</a></li> <li>This website provides an explanation of ecosystems. <a href="http://www.globalchange.umich.edu/globalchange1/current/lectures/kling/ecosystem/ecosystem.html">http://www.globalchange.umich.edu/globalchange1/current/lectures/kling/ecosystem/ecosystem.html</a></li> </ul> <p><b>Reflective Questions for Students:</b></p> <ol style="list-style-type: none"> <li>How is carbon important to living things?</li> <li>How does the carbon cycle connect the environment to living things?</li> <li>Trace a carbon atom from a rotting log in the forest to a black bear in the forest.</li> <li>What role does nitrogen play in living things? What are nitrogen sources in the environment?</li> <li>How does energy move from the sun through living things? As energy moves through an ecosystem, what transformations can be identified?</li> <li>Where and how can energy be stored in living things?</li> <li>How do carbon and nitrogen cycles bring essential elements from the environment to living things?</li> <li>How does each of these cycles link living things to each other?</li> <li>Can these cycles be interrupted? If so, how? And what happens as a result?</li> </ol>
	<p>I can describe examples of matter cycling that can affect the health of an ecosystem (e.g., composting to improve soil quality, crop rotation, worm bins, fertilizer runoff, bioaccumulation). (MC)</p>	
	<p>I can describe the cycle of nitrogen through ecosystems (e.g., nitrogen in air is taken in by bacteria in soil, then made directly available to plants through the soil, and returned to the soil and atmosphere when the plants decompose). (MC, CP)</p>	
	<p>I can describe the transfers and transformations of matter and/or energy in an ecosystem (e.g., sunlight transforms to chemical energy during photosynthesis, chemical energy and matter are transferred when animals eat plants or other animals, carbon dioxide produced by animals by respiration is used by plants and transformed to glucose during photosynthesis). (MC, CP)</p>	

<b>LS2B</b> <b>Population Density</b>	<p>I can describe conditions necessary for populations to increase rapidly (e.g., adequate living and nonliving resources, no disease or predators).</p>	<p><b>Quick Links for Students:</b></p> <ul style="list-style-type: none"> <li>The following link takes you to a site by Annenberg called the “Habitable Planet,” which reviews several key topics that will help you better understand the factors that influence populations. There are five different interactive laboratories but the one on ecosystems is most likely of interest to you. <a href="http://www.learner.org/courses/envsci/interactives/index.php">http://www.learner.org/courses/envsci/interactives/index.php</a></li> <li>This next website discusses how a species can become invasive and impact populations. <a href="http://oceanservice.noaa.gov/education/stories/lionfish/welcome.html">http://oceanservice.noaa.gov/education/stories/lionfish/welcome.html</a></li> </ul> <p><b>Essential Ideas:</b></p> <ul style="list-style-type: none"> <li>Students need to understand how a healthy ecosystem has various components, both living and non-living, that depend on each other and affect one another.</li> <li>Predict the changes in the population size of a species given a quantitative description of an ecosystem (e.g., predator-prey graph; J-curve of carrying capacity of ecosystem available range vs population-size graph).</li> <li>Draw a systems diagram to illustrate and explain why introduced (non-native) species often do poorly and have a tendency to die out, as well as why they sometimes do very well and force out native species.</li> </ul> <p><b>Reflective Questions for Students:</b></p> <ol style="list-style-type: none"> <li>How do populations and the changes in populations affect ecosystems?</li> <li>When you think about the answer to this question, think about models that you could develop and diagrams that would demonstrate the systematic processes occurring. Analyze how the system can change. Make predictions based on feedback mechanisms.</li> <li>How do organisms within an ecosystem affect one another?</li> <li>What factors can affect ecosystems to change them?</li> <li>What happens if one component of an ecosystem changes dramatically?</li> <li>What is carrying capacity and what happens when it is exceeded?</li> <li>A park has a forested area of about five square miles and is home to two types of squirrels: Eastern gray squirrels and Douglas squirrels. A recent ecological survey counted 750 Eastern gray squirrels and 100 Douglas squirrels in the park. Based on the survey, what is the population density of Douglas squirrels in the park?</li> <li>A park squirrel population has increased rapidly in recent years. Describe two possible conditions that would cause the rapid increase in the squirrel population. Explain how each condition would make the squirrel population grow rapidly.</li> </ol>
	<p>I can describe population density and/or the factors that affect population density.</p>	
	<p>I can calculate population density given an area and the number of a given organism within the area.</p>	

<b>LS2C</b> <b>Limiting Factors</b>	<p>I can describe factors that limit growth of plant and/or animal populations in a natural ecosystem</p>	<p><b>Quick Links for Students:</b></p> <ul style="list-style-type: none"> <li>The following website on Population Dynamics provides a simulation:  <a href="http://mvhs.shodor.org/coresims/deerpop/index.php?save=0&amp;disptab=&amp;disp=1&amp;deer_population=10&amp;square_miles=infinite&amp;birth_rate=25&amp;death_rate=10&amp;msg">http://mvhs.shodor.org/coresims/deerpop/index.php?save=0&amp;disptab=&amp;disp=1&amp;deer_population=10&amp;square_miles=infinite&amp;birth_rate=25&amp;death_rate=10&amp;msg</a></li> <li>This next website discusses how a species can become invasive and impact populations.  <a href="http://oceanservice.noaa.gov/education/stories/lionfish/welcome.html">http://oceanservice.noaa.gov/education/stories/lionfish/welcome.html</a></li> <li>The following site has a comprehensive overview of ecosystems.  <a href="http://www.globalchange.umich.edu/globalchange1/current/lectures/king/ecosystem/ecosystem.html">http://www.globalchange.umich.edu/globalchange1/current/lectures/king/ecosystem/ecosystem.html</a></li> </ul> <p><b>Essential Ideas:</b></p> <ul style="list-style-type: none"> <li>Students need to understand how a healthy ecosystem has various components, both living and non-living, that depend on each other and affect one another.</li> <li>Predict the changes in the population size of a species given a quantitative description of an ecosystem (e.g., predator-prey graph; J-curve of carrying capacity of ecosystem available range vs population-size graph).</li> <li>Draw a systems diagram to illustrate and explain why introduced (non-native) species often do poorly and have a tendency to die out, as well as why they sometimes do very well and force out native species.</li> <li>Understand that population growth is limited by the availability of matter and energy in the system.</li> <li>Understand that population growth is limited by the space available.</li> <li>Understand that population growth is affected by competition and predatory organisms.</li> </ul>
	<p>I can explain how a change to a factor (e.g., matter, energy, space, predatory, or competing organisms) would limit the population of a species.</p>	<p><b>Reflective Questions for Students:</b></p> <ol style="list-style-type: none"> <li>Explain, giving examples, how factors can limit the growth of populations.</li> <li>How does a change in the following factors affect a population (space, predator, matter / energy)?</li> <li>How does the introduction of a non-native species affect the populations of native species?</li> <li>Describe conditions that favor population growth.</li> <li>Analyze the effects of human development into wild land areas.</li> <li>A large amount of nitrogen fertilizer is washed into a lake, causing the algae (small photosynthetic organisms) to grow and reproduce rapidly. Eventually, the algae cover the surface of the lake and form a thick mat. Explain how the algae growth may affect other organisms in the lake.</li> </ol>

<p style="text-align: center;"><b>LS2D</b> <b>Population Graphs</b></p>	<p>I can predict the changes in the population size of a species given a quantitative description of an ecosystem (e.g., predator-prey graph; J-curve of carrying capacity of ecosystem; available range vs. population size graph).</p>	<p><b>Quick Links for Students:</b></p> <ul style="list-style-type: none"> <li>The following website explains how mathematical models of ecosystems are used to study invasive species. <a href="http://ibis.colostate.edu/cwis438/Browse/TiledMap/Scene_Basic.php?WebSiteID=12">http://ibis.colostate.edu/cwis438/Browse/TiledMap/Scene_Basic.php?WebSiteID=12</a></li> <li>The Concord Consortium offers several open-ended ecological models for students to explore. This first model is very easy to follow. <a href="http://www.concord.org/activities/experiment-ecosystems">http://www.concord.org/activities/experiment-ecosystems</a></li> </ul> <p><b>Essential Ideas:</b></p> <ul style="list-style-type: none"> <li>Students need to understand how a healthy ecosystem has various components, both living and non-living, that depend on each other and affect one another.</li> <li>Draw a systems diagram to illustrate and explain why introduced (non-native) species often do poorly and have a tendency to die out, as well as why they sometimes do very well and force out native species.</li> </ul> <p><b>Reflective Questions for Students:</b></p> <ol style="list-style-type: none"> <li>How do scientists model changes that can affect ecosystems? (Note: A type of model used in class is a graph)</li> <li>How do scientists use models to predict how organisms within an ecosystem affect one another?</li> <li>How do scientists use models to predict which biotic and abiotic factors affect ecosystems?</li> </ol>
	<p style="text-align: center;"><b>LS2E</b> <b>Biodiversity</b></p>	<p>Given a description of the biodiversity in two ecosystems, I can identify reasons for differences in biodiversity.</p>
<p>I can describe interrelationships of organisms that affect the stability of populations in a given ecosystem (e.g., nutrient cycles, food relationships, use of resources and succession).</p>		
<p>I can describe that biodiversity contributes to the stability of an ecosystem.</p>		

<b>LS2F Sustainability</b>	<p>I can explain scientific concepts and/or findings that relate to a given resource issue (e.g., removal of dams to facilitate salmon spawning in rivers; construction of wind farms; recycling).</p>	<p><b>Quick Links for Students:</b>  <b><i>Understanding Sustainable Development:</i></b></p> <ul style="list-style-type: none"> <li>• International Institute for Sustainable Development <a href="http://www.iisd.org/sd/">http://www.iisd.org/sd/</a>  <a href="http://www.epa.gov/sustainability/basicinfo.htm">http://www.epa.gov/sustainability/basicinfo.htm</a></li> <li>• The economics of sustainability: <a href="http://www.ecy.wa.gov/economy.html">http://www.ecy.wa.gov/economy.html</a></li> <li>• Elwha Research Learning Unit, Elwha River Educational Resources from the Olympic Park Institute provides excellent background information on their projects. The articles are short and easily readable.  <a href="http://www.naturebridge.org/olympic-park/elwha-river-educational-resources">http://www.naturebridge.org/olympic-park/elwha-river-educational-resources</a></li> <li>• Preserving Washington’s Farmland: <a href="http://www.mrsc.org/subjects/planning/farmland.aspx">http://www.mrsc.org/subjects/planning/farmland.aspx</a></li> </ul> <p><b>Essential Ideas</b></p> <ul style="list-style-type: none"> <li>• Sustainable processes include an examination of how we use renewable and nonrenewable resources and how our usage affects future generations to have the resources they need.</li> <li>• Sustainable processes include substituting renewable for nonrenewable resources, recycling, and using fewer resources.</li> <li>• Sustainable development includes understanding the role of public policy.</li> </ul> <p><b>Reflective Questions for Students:</b></p> <ol style="list-style-type: none"> <li>1. What is meant by sustainable development?</li> <li>2. Two farming practices used to increase nitrogen in the soil as a) use a fertilizer that contains nitrogen and b) use animal waste to fertilize the soil. Which farming practice is more sustainable? Why?</li> <li>3. Describe how the stability of populations in a community is related to the sustainability of an ecosystem.</li> <li>4. How have fish habitat restorations projects changed the way we live and work in Washington State?</li> <li>5. Analyze the inputs and outputs of two types of power generation (wind power and nuclear power) and determine which is most sustainable.</li> </ol>
	<p>I can describe how sustainable development could help with a current resource issue (e.g., using renewable rather than nonrenewable resources, using recycled resources).</p>	

<b>LS3A</b> <b>Biological Evolution</b>	<p>I can describe the genetic variability of offspring due to mutations and genetic recombination as allowing some offspring to be better able to survive and produce offspring.</p>	<p><b>Quick Links for Students:</b></p> <ul style="list-style-type: none"> <li>Natural Selection Simulation <a href="http://phet.colorado.edu/en/simulation/natural-selection">http://phet.colorado.edu/en/simulation/natural-selection</a> In this simulation you can control variables to perform simple inquiries. As you design your mini-experiments, record the variables that you are controlling and observe the results. Reset the simulation and vary the variable that you controlled. How does your population of rabbits change? What conclusions can you make and how would you further change the experiment?</li> </ul> <p><b>Essential Ideas:</b></p> <ul style="list-style-type: none"> <li>Similarities within the diversity of existing and fossil organisms are due to natural selection.</li> <li>Prior to Darwin, the widespread belief was that all known species were created at the same time and remained unchanged throughout history.</li> <li>Darwin argued that only biologically inherited characteristics could be passed on to offspring. Some of these characteristics were advantageous in surviving and reproducing. The offspring would also inherit and pass on those advantages and over generations the aggregation of these inherited advantages would lead to a new species.</li> <li>Evolution explains both the similarities of genetic material across all species and the multitude of species existing in diverse conditions on Earth—its biodiversity—which humans depend on for natural resources and other benefits to sustain themselves</li> </ul> <p><b>Reflective Questions for Students:</b></p> <ol style="list-style-type: none"> <li>What role do mutations play in genetic variability? Why is genetic variability an essential component of natural selection / evolution?</li> <li>How does the environment affect the evolution of a species?</li> <li>Why do some offspring survive and others don't in a changing ecosystem?</li> <li>How can population growth be connected to evolution?</li> <li>How do the four factors of biological evolution work together for a species to evolve?</li> <li>Apply the four factors of biological evolution to a species studied in class.</li> </ol>
	<p>I can describe that some traits will improve an individual's survival rates and subsequent reproduction in environments with a finite supply of resources.</p>	
	<p>I can explain biological evolution as the consequence of the interaction of population growth, inherited variability of offspring, a finite supply of resources, and/or natural selection by the environment of offspring better able to survive and reproduce.</p>	
	<p>I can describe how environmental pressure on a population drives natural selection (e.g., warming climate causes extinction of species not able to adapt).</p>	
	<p>I can predict the effect on a population of a given change in inherited variability of offspring, potential for population growth, resources, and/or environmental pressure (e.g., decreased variation in alleles).</p>	

<b>LS3B</b> <b>Random Change</b>	<p>I can describe that changes caused by mutations will often be harmful, but a small minority of mutations will cause changes that allow the offspring to survive longer and reproduce more.</p>	<p><b>Quick Links for Students:</b></p> <ul style="list-style-type: none"> <li>Natural Selection Simulation <a href="http://phet.colorado.edu/en/simulation/natural-selection">http://phet.colorado.edu/en/simulation/natural-selection</a>            In this simulation you can control variables to perform simple inquiries. As you design your mini-experiments, record the variables that you are controlling and observe the results. Reset the simulation and vary the variable that you controlled. How does your population of rabbits change? What conclusions can you make and how would you further change the experiment?</li> <li>Activity on variation <a href="http://learn.genetics.utah.edu/content/variation/sources/">http://learn.genetics.utah.edu/content/variation/sources/</a></li> </ul> <p><b>Essential Ideas:</b></p> <ul style="list-style-type: none"> <li>Information passed from parents to offspring is coded in the DNA molecules that form the chromosomes.</li> <li>In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation.</li> <li>Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation.</li> <li>Environmental factors can cause mutations in genes, and viable mutations are inherited.</li> <li>Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population.</li> <li>Thus the variation and distribution of traits observed depends on both genetic and environmental factors.</li> </ul> <p><b>Reflective Questions for Students:</b></p> <ol style="list-style-type: none"> <li>How do mutations and environment drive evolution?</li> <li>Why do some offspring survive and others do not in a changing ecosystem?</li> <li>How does genetics and the environment work together for the survival of a species?</li> <li>What is the effect of a changing climate on organisms and their evolution?</li> </ol>
	<p>I can predict how a given trait or mutation will allow a species to survive and reproduce in a given environment.</p>	

<b>LS3C</b> <b>Species Diversification</b>	<p>I can explain that species alive today have diverged from a common ancestor (e.g., by interpreting diagram representing an evolutionary tree).</p>	<p><b>Quick Links for Students:</b></p> <ul style="list-style-type: none"> <li>• How organisms diversified over time is a fascinating topic. National Geographic has a short article about how whales diversified over time. <a href="http://newswatch.nationalgeographic.com/2010/02/22/whale_diversity_linked_to_algae/">http://newswatch.nationalgeographic.com/2010/02/22/whale_diversity_linked_to_algae/</a></li> <li>• Recent developments in an emerging field called “evo-devo:” <a href="http://www.pbs.org/wgbh/nova/evolution/what-evo-devo.html">http://www.pbs.org/wgbh/nova/evolution/what-evo-devo.html</a></li> <li>• Understanding Evolution: <a href="http://www.pbs.org/wgbh/evolution/educators/teachstuds/svideos.html">http://www.pbs.org/wgbh/evolution/educators/teachstuds/svideos.html</a></li> </ul>
	<p>I can explain how filling an available niche can allow a species to survive.</p>	<p><b>Essential Ideas</b></p> <ul style="list-style-type: none"> <li>• Genetic information, like the fossil record, provides evidence of evolution.</li> <li>• DNA sequences vary among species, but there are many overlaps and common features; the ongoing branching that produces multiple lines of descent can be inferred from the DNA composition of organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence.</li> <li>• Biodiversity results from the formation of new species (speciation) minus the loss of species (extinction). Biological extinction, being irreversible, is a critical factor in reducing the planet’s natural capital. Humans depend on the living world for the resources and other benefits provided by biodiversity.</li> <li>• Sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth.</li> </ul>
	<p>I can describe that genes in very different organisms can be similar because the organisms all share a common ancestor.</p>	<p><b>Reflective Questions for Students:</b></p> <ol style="list-style-type: none"> <li>1. How is it that there are millions of different species on earth today yet all species descended from a common ancestor?</li> <li>2. How does DNA reveal information and evidence of evolution?</li> <li>3. What is biodiversity, how do humans affect it, and how does it affect humans?</li> <li>4. <b>Why</b> is biodiversity important to the Earth and to humans?</li> </ol>



<b>LS3D</b> <b>Evidence of Evolution</b>	<p>I can explain how the fossil record, anatomical similarities, and/or molecular (DNA) similarities can be used as evidence for the evolutionary development of a given species (e.g., birds, horses, elephants, whales).</p>	<p><b>Quick Links for Students:</b></p> <ul style="list-style-type: none"> <li>• Fossil record shows new body plans of dinosaurs:  <a href="http://www.scientificamerican.com/article.cfm?id=alternative-evolution-dinosaurs-foresaw-contemporary-paleo">http://www.scientificamerican.com/article.cfm?id=alternative-evolution-dinosaurs-foresaw-contemporary-paleo</a></li> <li>• Fossils: <a href="http://www.fossilmuseum.net/fossilrecord.htm">http://www.fossilmuseum.net/fossilrecord.htm</a>  <a href="http://www.fossilmuseum.net/PaleobiologyVFM.htm">http://www.fossilmuseum.net/PaleobiologyVFM.htm</a>    <a href="http://www.pbs.org/wgbh/nova/nature/amber-locations.html">http://www.pbs.org/wgbh/nova/nature/amber-locations.html</a></li> </ul> <p><b>Essential Ideas:</b></p> <ul style="list-style-type: none"> <li>• All living organisms evolved from a common ancestor</li> <li>• Evidence for common ancestry can be drawn from: <ul style="list-style-type: none"> <li>○ Fossil record: age of fossils is partially determined by where they are found in sediment layers (stratification), structures can be compared with current species</li> <li>○ Comparative Anatomy: homologous structures, vestigial structures</li> <li>○ Comparative Embryology: early stages of development follow a common plan, differentiation happen beyond Stage 1</li> <li>○ Comparing DNA sequences: fewer differences, the more related two species are</li> <li>○ Phylogeny: compare the <b>relatedness of species, use cladograms to identify shared traits</b></li> </ul> </li> </ul> <p><b>Reflective Questions for Students:</b></p> <ol style="list-style-type: none"> <li>1. <b>How</b> do genes (DNA) explain how different species are related?</li> <li>2. <b>Why</b> are scientists interested in understanding how closely related organisms are to each other?</li> <li>3. How does the fossil record reveal information and evidence of evolution?</li> <li>4. What can fossils tell us about diversity of organisms in the past and the future?</li> <li>5. How have recent discoveries in Genetics supported Darwin’s original theory of common ancestry?</li> </ol>
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<b>LS3E</b> <b>Relatedness of Organisms</b>	<p>I can describe that scientists infer the degree of evolutionary relationship among organisms using physiological traits, genetic information, and/or the ability of two organisms to produce fertile offspring.</p>	<p><b>Quick Links for Students:</b></p> <ul style="list-style-type: none"> <li>• Geologic Time: <a href="http://eonseepochsetc.com/">http://eonseepochsetc.com/</a></li> <li>• Classification of Vertebrates: <a href="http://anthro.palomar.edu/animal/default.htm">http://anthro.palomar.edu/animal/default.htm</a></li> <li>• Evolutionary relationships: <a href="http://animaldiversity.ummz.umich.edu/site/animal_names/phylogeny_ranks.html">http://animaldiversity.ummz.umich.edu/site/animal_names/phylogeny_ranks.html</a></li> </ul> <p><b>Essential Ideas:</b></p> <ul style="list-style-type: none"> <li>• The time needed for biological evolution is geological time, which shows evidence of life appearing on earth about 4 billion years ago</li> <li>• Classify organisms, using similarities and differences in physical and functional characteristics.</li> <li>• Similarities and differences exist among closely related organisms because they are descended from a common ancestor (e.g., “Darwin’s finches” had different beaks due to food sources on the islands where they evolved).</li> <li>• Cladograms are diagrams that organize species in terms of structural features as they appeared in the evolutionary history</li> <li>• Organisms cannot evolve and form new adaptations to habitat or environmental changes within one generation. Change happens very slowly, or not at all.</li> <li>• Organisms can become extinct if habitat changes quickly</li> </ul> <p><b>Reflective Questions for Students:</b></p> <ol style="list-style-type: none"> <li>1. What physical or behavioral characteristics reveal how living things are related?</li> <li>2. How are related organisms organized on a cladogram? How can you tell which organisms are most closely related? More distantly related?</li> </ol>
	<p>I can describe relationship(s) among organisms based on similarities and/or differences in physical and/or functional characteristics.</p>	
	<p>I can describe the similarities and/or differences (i.e., embryology, homology, analogous structures, genetic sequences) of given organisms in terms of biological evolution (e.g., Darwin's finches had different beaks due to food sources on the islands where they evolved).</p>	
	<p>I can describe the evolutionary relationship between two organisms and/ or identify the organisms that are most closely related given a diagram representing an evolutionary tree.</p>	