Sample Instructional Strategies
2010 Mississippi Science Framework
Grades 5, 8 and Biology I

The Center for Educational and Training Technology at Mississippi State University in partnership with Mississippi teachers offers these sample instructional strategies to aid science teachers in 5th, 8th, and Biology I in planning their instructional strategies using the 2010 Mississippi Science Framework. Created by current Mississippi science teachers based on their classroom experience and understanding of the content objectives, these strategies are designed to give science teachers ideas for addressing the framework objectives. They are not meant to supersede your textbook, pacing guides or other resources nor to be the only strategy or strategies for teaching the objectives. The strategies are available for teachers to adapt or incorporate into units of instruction as needed.

For most content objectives, there are two sample instructional objectives offered to assist teachers in addressing the 2010 Mississippi Science Framework content in more depth. The 2010 Framework includes the Depth of Knowledge (DOK) level for each objective. Therefore when possible, each objective has been written to address the objective at the DOK level of the objective and/or include suggestions for extending the strategy to a higher DOK level. For the most part, strategies addressing Inquiry objectives have been embedded into the strategies for content objectives and are referenced accordingly.

The Center for Educational and Training Technology gratefully acknowledges the efforts of the following outstanding teachers in creating these sample strategies for Mississippi teachers. Using their many years of science classroom experience in Mississippi schools, they have developed strategies that are applicable to your students and your classrooms.

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Instructional Strategies Biology I 2010 Mississippi Science Framework

Comp.	Obj.	PLDs Advanced Proficient Basic
		Inquiry
		Suggested Unit Plan To Fulfill Comp 1, Objectives. a-g. Instruct students in the following manner: Divide students into cooperative groups and have them brain-storm original ideas for science experiments. Closely monitor each group's topic to ensure it can be answered through research and experimentation. If the chosen topics are not suitable for experimentation (i.e., consists of an opinion), lead the students to an understanding of why it is not suitable and allow them to modify the topic until it is testable. Have students carry out the experiments, using the scientific method. Students should demonstrate safe procedures when using pertinent lab equipment during the scientific experiment. Experimental results from the investigations should be shown in a graphic form. Students can then analyze their data to determine if their group's hypothesis was correct. Cooperative groups should then present and defend their experimental design to their peers in oral or written form. Classmates will critique one another's experimental process, expressing the strengths and weaknesses of the experiments.
1		**Apply inquiry-based and problem-solving processes and skills to scientific investigations. Blueprint: 7 OBJ/7 ITEMS**
1	1a.	*Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK2)….* **Proficient** - 1a. Conduct a scientific investigation with accuracy and precision demonstrating safe procedures and proper use and care of laboratory equipment. **Basic** - 1a. Identify and recognize the following in a scientific investigation: safe procedures (safety rules, chemical use and symbols), proper use and care of laboratory equipment (goggles, aprons, compound light microscope, slides, balance, beaker, thermometers, graduated cylinders and rulers). **Strategy 1**: Prior to introducing lab equipment, have students complete a "lab scavenger hunt". Display equipment around the room labeled with the names of each piece of lab equipment. Develop clues and distribute to students. Students should match clues to the appropriate piece of lab equipment. All clues should be answered and all pieces of lab equipment found. Ex. I can heat up chemicals with a single flame (Answer: *Bunsen burner*) Allow students to confirm one another's answers. **Strategy 2**: Assign students a particular safety symbol to research using the textbook, internet, and other available resources. Have each student draw their symbol, write a brief explanation, and teach the symbol and what it means to the class. Set up stations with a specific amount of colored water (for easy visibility) in graduated cylinders, certain objects (blocks, lengths of twine, etc.) to be measured with rulers, balances to measure mass of objects and thermometers for students to read. Have them rotate through stations individually or in small groups as they perform the assigned tasks and record their findings on a data table.

		Strategy 3: Divide students into cooperative groups to conduct a scientific investigation, demonstrating safety procedures and proper care and use of lab equipment as learned in Strategy 1 and 2. See Obj. 4c, Strategy 1 See Obj. 4c, Strategy 2
1	1b.	*Formulate questions that can be answered through research and experimental design. (DOK3)* **Proficient -** 1b. Formulate questions that can be answered through research and experimental design. **Strategy 1**: Several days in advance, inform students that they will be conducting experiments in small groups. Have students brainstorm ideas for questions that they can answer through measurable experimentation. Teacher should approve students' ideas for experiments. Ex. What would happen if… Students will create and turn in supply lists. If needed, offer alternate ideas on materials to use to keep expense to a minimum. After students receive supplies, they are to conduct their experiments following the steps of the scientific method (question or observation, research, hypothesis, experiment, record and analyze data, conclusions, share results). Upon completion of the experiments, students will complete their lab reports and turn them in for a grade. Every detail of their experiment should be included. **Strategy 2**: Using scientific magazines (such as *Science World*) present problems or observations to students and have them form their own hypotheses that are appropriate for investigation using the scientific method. Give students observations or problems and have them discuss in their collaborative groups which are suitable for scientific investigation (i.e. questions that are measurable). Be sure to include some topics that are not fitting for scientific investigation. For example, "English is an easier class than science" is not acceptable for scientific investigation.

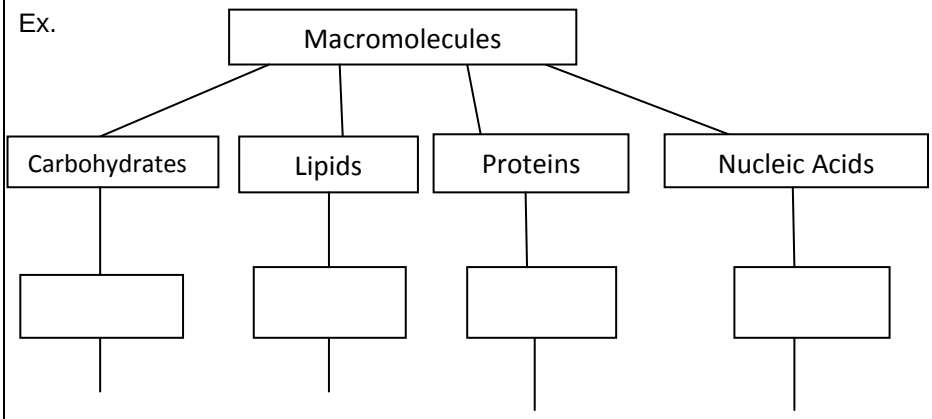
1	1c.	*Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK2)* **Advanced** - 1c. Evaluate a question or hypothesis to develop an experimental design for a scientific investigation. **Proficient** - 1c. Apply the components of scientific processes and methods in classroom and laboratory investigations. **Basic** - 1c. Recognize the components of scientific processes and methods in classroom and laboratory investigations (e.g. hypothesis, experimental design, observations, data analyses, interpretations, theory development). **Strategy 1**: Working in pairs, have students identify a question or hypothesis for investigation and then create experimental scenarios. Instruct them to include dependent/ independent variables, hypotheses, conclusions, etc. **Strategy 2**: Find examples of current scientific investigations (use science magazines or the internet) and have students pick out various parts of the scientific method (hypothesis, variables, observations, etc.). See Obj. 1b, Strategy 1 and 2 See Obj. 2c, Strategy 1 See Obj. 4d, Strategy 1
1	1d.	*Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)* **Advanced** - 1d. Justify a prediction based upon the analysis of a graph or data. **Proficient** - 1d. Analyze graphs. **Basic** - 1d. Construct a graph. **Strategy 1**: Give students completed scientific investigations with several sets of data they can graph (line, bar or circle). As a class, analyze the graphs and justify whether the hypotheses are correct. **Strategy 2**: When students are carrying out experiments (see obj. 1 b strategy 1) have them construct graphs of their findings and explain their graphs to the class justifying their hypotheses. For practice in reading graphs, find graphs in various magazines, books, etc. regarding topics that students find interesting (ex. hunting magazines) and have students study the graphs, identifying the type of graph (bar, line, pie), the title, any legends, and the x-and y-axis. Obtain graphs, charts, and data tables about various topics. Remove some of the pertinent facts and have students analyze the remaining statistics. Then have students predict the missing data based on the trends shown in the graphs. Have them justify (in oral or written form) why they made their predictions. See Obj. 2e, Strategy 1 See Obj. 6d, Strategy 2

1	1e.	*Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)* **Proficient** - 1e. Analyze procedures, data, and conclusions to determine the scientific validity of research. **Strategy 1**: Collect scientific experiments prior to the lesson. Be sure to have similar experiments so students can compare the data, procedures, and conclusions. After reading several experiments, instruct students to write a report showing differences and relationships between the experiments. Ex. Some differences found between experiments might be geographic areas, time frames, populations. Students can then identify the validity and bias of the different researchers. **Strategy 2**: Divide students into cooperative groups and have each group design an experiment with intentional bias. Groups will present these experiments to their classmates, who will then identify the particular bias for each experiment.
1	1f.	*Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)* **Proficient** - 1f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. **Strategy 1**: Give students a completed experiment. Working in groups, ask them to give alternative methods of how the same experiment could be completed. Have them answer questions such as "How could I have done the experiment differently, while achieving the same results?" Instruct students to reflect their ideas in science journals. Ask students the following question: "Based on observations and what they already know, will their alternative method work?" Ask them to justify their answers. If time permits, have students carry out their experiment using their alternative method. After experiments are completed, compare the experiments. Have them answer these questions:"Did they get the same results?" and "What were the similarities and differences?" **Strategy 2**: Provide cooperative groups with scenarios of fictional or true experiments (e.g. experiments by Pasteur, Redi, etc.). Do not give the results of the experiments to the groups. Have groups make predictions of the possible outcomes based on their prior knowledge. Then have students compare their predictions to the results of the actual experiment. Ask students to hypothesize why their predictions might be different from actual results.
	1g.	*Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)* **Proficient** - 1g. Defend a scientific argument in oral, written, and graphic form. **Basic** - 1g. Communicate conclusions based on experiments in oral, written, and graphic form using appropriate terminology.

		Strategy 1: Divide your class into two debate teams. One team will advocate **for** global warming and the other team will be **against** global warming. Each student will research global warming and write a report defending his/her position. Each group (those for and against) will combine their research and devise a plan or strategy to defend their position. All team members should participate in the debate using visual aides to defend their positions. Use a rubric for evaluating assessing arguments, research validity, participation, etc. **Strategy 2**: Provide groups of students with a controversial scientific topic (ask for student input for topics) and have them research and defend their side of the issue. Students should then present their opinion to classmates, using visual aids (graphs, charts, etc.) to support their views.
Comp.	**Obj.**	**PLDs** **Advanced** **Proficient** **Basic**
		Physical Science
2		**Describe the biochemical basis of life and explain how energy flows within and between living systems. Blueprint: 7 OBJ/7 ITEMS**
2	2a.	*Explain and compare with the use of examples the types of bond formation (e.g., covalent, ionic, hydrogen, etc) between or among atoms. (DOK 2)* **Proficient -** 2a. Explain and compare the types of bonds between atoms based on the subatomic particles and their arrangement; connect the importance of ions to biological process. **Basic** - 2a. Identify types of bond formation (e.g. covalent, ionic, hydrogen, etc.) **Strategy 1**: Covalent and ionic bonds are abstract ideas for students to understand. An ionic bond is formed from an attraction between oppositely charged ions; electrons are lost and gained (NaCl- sodium chloride). Covalent bonds are formed from the sharing of electrons between atoms (CO_2- carbon dioxide). After defining the bonds, have students list examples of each and illustrate their structure on the board. Extend the activity by having students role play, either as a whole class or in small groups, some of the molecules. For example, CO_2 (covalent bond): designate students to represent carbon and oxygen atoms. Their arms can represent electrons (or have other classmates represent them). These actions can demonstrate how electrons are shared. If using arms as electrons, they will link together, indicating the shared pairs. If their classmates are the electrons, they will move closer together (standing side by side) to indicate the shared pairs. Allow students to demonstrate several examples to gain a more concrete understanding. The same type of role play can be illustrated using molecules that form ionic bonds. Instead of electrons being shared, they will be lost and gained between the molecules. Following the role playing, discuss the importance of these bond formations in biological processes. For extension, have students choose a bond and research the importance of this bond in the biological process. **Strategy 2**: Have students read in their textbooks about ionic and covalent bonding. Pair students or assign them to cooperative groups and have them create a Venn diagram for ionic and covalent bonding (possible differences: ionic bonds transfer electrons, while covalent bonds share electrons; possible similarities: both types of

		bonds hold atoms together). Students sometimes need additional instruction regarding ionic and covalent bonding. Providing a concrete example may help. For ionic bonding ("opposites attract"), obtain two magnets and use the attraction of the north and south poles of the magnets to represent the fact that in ionic bonds, electrons are transferred from one atom to another, forming positive and negative ions that attract and combine with one another. To demonstrate covalent bonding ("sharing"), have students share an umbrella by both standing under it at the same time. This illustrates how two atoms share electrons. Discuss the importance of ions in the human body. Have students research common ions found in the human body and share their findings with the class.
2	2b.	*Develop a logical argument defending water as an essential component of living systems (e.g., unique bonding and properties including polarity, high specific heat, surface tension, hydrogen bonding, adhesion, cohesion, and expansion upon freezing). (DOK 2)* **Proficient -** 2b. Utilize the properties of water to defend water as an essential component of living systems. **Basic** - 2b. Identify the unique properties of water. **Strategy 1**: Through lecture and discussion, students can gain an insight into some of water's properties such as polarity, bonding principles of hydrogen, adhesion, cohesion, solutes and solvents, etc. After lecture and discussion, have students work in pairs to create a poem, song, or rap that explains the characteristics and properties of water and why it plays an important role in our existence. **Strategy 2**: In order for students to understand that water is an essential component of living things, they must understand some of its properties. Simple experiments/demonstrations/discussions can make these properties easier to comprehend. Ex. To show water's bonding, give students 2 large and 4 small marshmallows and 4-6 toothpicks (take the marshmallows out of the bags for at least 24 hours to allow them to harden so they are easier to work with). First, have them construct a model of water (the large marshmallow represents the hydrogen and the two small marshmallows represent the oxygen, held together by toothpicks-the toothpicks represent covalent bonds. The two "hydrogens" should be on either side of the "oxygen", placed toward one end). Have students show how water molecules combine with one another. Students should make another water molecule and attach the two by placing another toothpick (representing a hydrogen bond) between the large marshmallow of one molecule (the oxygen) and a small marshmallow of another molecule (one of the hydrogens). Ex. A quick and easy way to demonstrate surface tension is to float flecks of black pepper or paper clips on the surface of a petri dish full of water. Ex. Pour colored water (it is easier to observe than clear water) in graduated cylinders and have students observe the meniscus (the slight dip in the center of the water). The meniscus is caused by adhesion (attraction of water to different surfaces, i.e. the side of the graduated cylinder) and cohesion (the ability of water to stick to itself). Ex. Discuss the expansion of water when freezing by using the example of a liquid in a glass bottle or can (such as soda pop) that is left in the freezer and subsequently

		explodes. Warn students not to try this at home unless they plan to clean up the mess that is made! After demonstrating each property, have students choose one property and write reports about how the property makes water essential to human life (ex. how do the properties of cohesion and adhesion affect the human body?)
2	2c. 1c.	*Classify solutions as acidic, basic, or neutral and relate the significance of the pH scale on an organism's survival (e.g., consequences of having different concentrations of hydrogen and hydroxide ions). (DOK 2)* **Proficient -** 2c. Classify solutions as acidic, basic or neutral and relate the significance of an organism's pH to its survival. **Strategy 1**: Chemicals that are considered an acid or base can be determined by their specific pH level (pH level of 0 is very acidic and pH level of 14 is very basic- seen on a pH scale). Have students conduct an experiment to determine pH levels of certain household chemicals. Give students a set of chemicals (drain cleaner, lemon juice, bleach, pure water, baking soda, etc.). Instruct students to create a hypothesis indicating what chemicals they believe would be the acids and which ones would be bases. Tests will be conducted using purchased pH paper (separate piece for each chemical). As each paper is dipped into the chemical, a color is shown and can be compared to a chart given to each student. As students are performing the experiment, results should be recorded and analyzed. In conclusion, a comparison can be made between the hypothesis created and the final results. Questions and discussion can be implemented regarding the relevance of these chemicals and their everyday use based on the experimental results. (Ex. using drain cleaner in toilets and sinks, lemon juice in food, etc.) After the students see how certain solutions can be classified at specific pH levels, explain to students that the control of pH is important to living systems. Enzymes can only function within a very narrow pH range. Remember that enzymes are molecules (RNA/proteins) that act as biological catalysts. They are required for the functioning of any cell. However, when an enzymes environment is changed (pH), it causes a change in the shape of the enzyme or substrate. Enzymes are made to fit with specific substrates for a chemical reaction to be catalyzed. When pH changes the shape of an enzyme, it can no longer fit with its particular substrate. The reaction that the enzyme would have catalyzed cannot occur, causing problems within the cell itself. To help control pH in organisms, we have buffers. They are chemical substances that can neutralize both acids and bases. Complex buffering systems maintain pH levels in healthy bodies because of the bodily fluids that are considered both acidic (stomach acid/urine) and basic (intestinal fluid/blood). Have students brainstorm different substances (that can be taken into the body) that can possibly have an effect on the decreasing and increasing pH levels in our bodies. Chart the ideas and leave options for discussion. **Strategy 2**: Instruct students to create a list of items whose pH they do not know (have them predict what they think the pH is), but are interested in learning. Have students research the pH scale. They should distinguish between acids and bases by ascertaining whether hydrogen or hydroxide ions are released. Common characteristics of acids and bases should also be addressed.

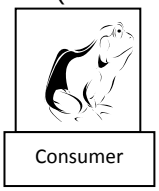
		As an extension, assign students appropriate items to bring from home (those that are safe for transport to school and are harmless). Using pH paper, have students test the pH of the various substances, record both their predictions and their results, and graph the data once the pH is discovered. Students should then report their findings to the class. For follow-up discussion, have students research how the slightly basic (7.4) pH of the human body allows for optimal functioning and discuss processes that can disturb this homeostatic dynamic (i.e. diabetics who develop ketoacidosis).
2	2d.	*Compare and contrast the structure, properties, and principal functions of carbohydrates, lipids, proteins, and nucleic acids in living organisms. (DOK 2)* **Proficient -** 2d. Compare and contrast the four major organic macromolecules in terms of structure, and function in living organisms. **Basic** - 2d. Identify examples of carbohydrates, proteins, lipids, and nucleic acids. **Strategy 1**: Carbohydrates, lipids, proteins, and nucleic acids are macromolecules that make up every living organism. Each macromolecule has a certain function and specific characteristics that make them unique to a living organism. To separate one macromolecule from another, instruct students to create a flow chart/concept map. The chart/map can identify some of the following: - the elements unique to each macromolecule - each function of the macromolecule - the components of each macromolecule Ex.  After completing charts, ask students to volunteer to explain contents of their charts.

		Strategy 2: Instruct students to bring empty wrappers, labels, or containers from their favorite snack or beverage to class. Have students study the nutritional findings and list the macromolecules (carbohydrates, proteins, lipids) found in each snack. Students should be able to create a chart listing the various elements, molecules, and functions of each macromolecule. (ex. tuna label- protein-made of elements carbon, hydrogen, oxygen, and nitrogen; composed of molecules called amino acids held in place by peptide bonds; form cell structures and regulate cell processes.) This is also a good time to discuss portion/serving size of snack foods.
2	2e. 1d.	*Examine the life processes to conclude the role enzymes play in regulating biochemical reactions. (DOK 2)* **Advanced** - 2e. Predict the effect of pH, temperature, and concentration on enzymatic reaction rates. **Proficient** - 2e. Explain the role enzymes play in regulating biochemical reactions. **Strategy 1**: Enzyme action can be illustrated through an activity of breaking flat toothpicks. The students will be simulating the random contact between an enzyme and substrate by breaking toothpicks while their eyes are closed. Hands represent the enzyme with an active site (between fingers and thumbs). The toothpicks are the substrates. The solution is the playing field (desk or table). The object of the activity is to break as many toothpicks as possible in a 2 minute time span. The two minutes will be broken into ten seconds intervals (10 sec, 20 sec, 30 sec, and 60 sec). By breaking the substrates (toothpicks), the students will be able to determine the maximum rate of reaction-the time it takes the enzyme (hands) to find and break the substrate (toothpick). Students will be working in pairs; one will be breaking the toothpicks and the other will be counting and recording the toothpicks that are broken during each interval. The students will break toothpicks individually until time is called. The students will continue the process 3 more times, but with different time increments. The speed of the reaction will lower because the enzyme (hands) will get tired and the substrates (toothpicks) will begin to scatter in the solution (playing field). Breaking the toothpicks at different intervals also shows how concentrations of a substrate affect the rate of an enzymatic reaction. At each interval, there is a decrease in substrate (concentration) for the enzyme to attach. Because enzymes only fit with specific substrates, they have to "search" through the substrate that is left. Therefore, more time will elapse decreasing the reaction rates of the enzyme. After all the substrates (toothpicks) are broken and numbers counted, a class average should be taken. For each time interval, the reaction rates can be calculated based on the number of toothpicks broken and the time it took to break them. Create graphs from the data collected. Many enzymes play a role in regulating biochemical reactions, especially in the human body. After discussing enzymes and their reaction rates, the movie "*Lorenzo's Oil"* can be shown to illustrate how the lack of an enzyme (transporter protein) can affect the body. *"Lorenzo's Oil"* is a true story about a young boy (Lorenzo) who was diagnosed with adrenoluekodystrophy (ALD). His parents set out on a mission to find a treatment, when other doctors had no solution, to save their child from the fast progression of the disease. ALD (also known as Schilder's disease) is a rare inherited disorder that causes progressive brain damage, failure of adrenal glands, and ultimately death at a young

		age. It damages the myelin (insulates nerves) of the nervous system, eventually destroying the nerves causing disability. ALD patients are missing a transporter protein that is essential to life. It carries an enzyme used to break down very long fatty acid chains found in the normal diet. Lacking the protein causes a buildup of very long-chain fatty acids-damaging the brain and adrenal glands. Questions about the movie can be implemented to assess the students' comprehension. **Strategy 2**: Have students, working alone or in cooperative groups, construct models of the "lock and key" analogy of enzymes. Provide various media (poster board, modeling clay, empty boxes, etc.) with which to construct a 3-D representation of the enzyme and substrate. (Students' models should consist of three separate pieces, the enzyme and the substrate [in two pieces], which can be fit together similar to puzzle pieces.) Instruct students to be prepared to demonstrate how the enzyme and substrate fit together and be able to label the reactants and products of the enzyme/substrate reaction. Explain the following to students: 1) As pH increases, so does the activity of the enzyme, until it reaches optimum pH range. After this, it will decrease because the active site will change in shape and it will no longer accept substrates. 2) As the temperature increases, the enzyme activities will increase because there is more energy to speed up the reaction until it reaches the optimum temperature range. After that, the enzyme activities will decrease because of changes to the active site and the substrate will no longer fit. 3) As the concentration of enzyme increases, the enzyme activities will increase because there is more enzyme to react with the substrates; however when enzymes get saturated, the reaction will come to a plateau because eventually all the substrates will have enzymes to react with, and any extra will have no effect on the reaction whatsoever. After this explanation, give students sets of data, indicating the optimum ranges of pH, temperature, and concentration. Have them predict what will happen to the enzyme activity as pH, temperature, and concentration rise and fall.
2	2f.	*Describe the role of adenosine triphosphate (ATP) in making energy available to cells. (DOK 1)* **Advanced** - 2f. Explain how energy from ATP is made available for specific processes in an organism, such as in the sodium-potassium pump. **Proficient** - 2f. Describe the structure and function of ATP and its role in making energy available to the cell. **Strategy 1**: Our cells use chemical energy that is carried by ATP; the molecule that provides the energy for our cells to function (building molecules, transport mechanisms, etc). The energy (broken down by food molecules) within an ATP molecule is released when it loses a phosphate group (bond is easily broken). ATP losing a phosphate will become ADP (adenosine diphosphate), which is a low energy molecule. ADP waits on a phosphate group to once again become ATP for the cell to use. It is a constant cycle so that our cells are receiving the energy needed to carry out its basic functions. To help illustrate the energy being released and stored, have the students role play the different molecules. Three students can be the phosphates and one student can be the adenine and ribose molecule. Have all four of them lock arms as if they were linked together by bonds. The teacher is the energy stored and released in the ATP

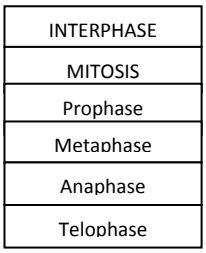
		molecule. As the teacher bursts through the 2nd and 3rd phosphate, the energy Is being released from the ATP molecule and becomes an ADP molecule. When the ATP molecule stores up more energy, the teacher will travel back through the broken phosphates to restore the broken bond to create ATP again. A cell phone, its rechargeable battery, and the actual phone charger will help students visualize the cycle. The phone represents a cell. The battery represents ATP. When the phone is turned on, it represents a cell carrying out its cellular activities. A comparison can be made as to how a cell phone gets its energy from its battery, while a cell receives its energy from ATP. Discuss the fact that when the cell phone battery runs down, the energy used to power the phone is depleted. This energy loss is comparable to ATP being depleted while carrying out our cell's functions (losing the phosphate to release energy). The phone charger can recharge the battery, just like the cell can "recharge" the ADP into ATP by the addition of a phosphate group. Ask students to brainstorm other examples. Explain to the students that organisms have processes that require ATP (energy). For example: In plants, ATP is made available for life functions (photosynthesis) through the process of chemiosmosis. Chemiosmosis uses the concentration gradient of protons to act as potential energy. This potential energy is harnessed by an enzyme called ATP synthase. The energy driving this reaction is provided by movement of protons from inside the thylakoid to the stroma (taking place within the chloroplast). **Strategy 2**: Give students several small plastic interlocking building blocks (like LEGOS) of assorted colors. Be sure there are two large blocks of different colors (for example, red-to represent adenine and yellow-to represent ribose) and three smaller block all of the same color, but different from the colors of the large blocks (for example, blue-to represents the 3 phosphates). Allow students time to study a diagram of an ATP molecule. Ask them to assemble a model of the ATP molecule using their assortment of blocks. (Students should connect three of the small blocks-all of the same color- to the two large blocks.) Discuss how a phosphate bond is broken to release energy as you have students remove one of the small blocks from his/her model. Discuss that the process of removing one small block demonstrates ATP becoming ADP (energy is released to be used by the cell for life processes); when the phosphate is added back (the small block is replaced on the model), the molecule becomes ATP again. This action of breaking down and rebuilding the model mimics how ATP is broken down (in order to release energy) and reconfigured (in order to store energy again) in the cell.
	2g.	*Analyze and explain the biochemical process of photosynthesis and cellular respiration and draw conclusions about the roles of the reactant and products in each. (DOK 3)* **Proficient -** 2g. Analyze and connect the roles of reactants and products in the biochemical process of photosynthesis and cellular respiration. **Strategy 1**: Photosynthesis is the process in which a plant draws in carbon dioxide, water and the sun's energy to make oxygen and glucose (sugar-food for the plant). Cellular respiration in turn breaks down the food molecules produced to create the energy that our cells need to carry out their functions/activities. Both processes use the same molecules and work together for life to exist. To demonstrate how both concepts relate to one another, have students role play

		parts of both equations. As a result of the role play, they will see that the molecules used in photosynthesis are also used in cellular respiration (reactants of photosynthesis are the products of cellular respiration; products of photosynthesis are the reactants of cellular respiration). Different colored construction paper can represent the different molecules (blue: water; red: oxygen; green: hydrogen). On white paper, draw the symbols for the other parts of the equation (yield sign, plus sign, ATP, sunlight). Before students enter the room, write out both equations on the board for reference. As the students enter the room, give them a molecule or part of the equations (students can be more than one of the same molecule). Through questioning and discussion, the students will physically create the equations for both photosynthesis and cellular respiration. As the students are moving around the room, reiterate that the same molecules are being used in both processes. Ask students to identify similarities and differences between the two (energy sources, reactants/products, etc.). **Strategy 2**: As a review for strategy 1, use schematic diagrams to represent the formula for photosynthesis and cellular respiration. (Ex. Using poster boards, create drawings of clouds, label them as CO_2 and O_2, and cut them out. Use a raindrop shape to symbolize water. Geometric shapes can represent glucose and ATP. Sunlight can be signified by a large sun cut-out.) Make several sets of the diagrams and have small groups construct the equation for both photosynthesis and cellular respiration. Encourage students to label the products and reactants for each equation. For a real-life application of anaerobic respiration, lead a class discussion on muscle soreness as related to school sports and exercise. Have students research lactic acid build-up in muscles, the causes, and any possible treatments. To demonstrate anaerobic respiration in yeast, teachers can use a bread machine to make bread in class, leading to discussions of CO_2 formation causing bread to rise, production of alcohol in the cooking process, etc.
Comp.	**Obj.**	**PLDs** **Advanced** **Proficient** **Basic**
		Life Science
3		**Investigate and evaluate the interaction between living organisms and their environment. Blueprint: 3 OBJ/11 ITEMS**
3	3a.	*Compare and contrast the characteristics of the world's major biomes (e.g., deserts, tundra, taiga, grassland, temperate forest, tropical rainforest). (DOK 2)* **Advanced** - 3a. Evaluate the relationship between the adaptations of organisms to the biome in which they live. **Proficient** - 3a. Compare and contrast plant and animal species, climate, and adaptations of organisms found in the world's major biomes. **Basic** - 3a. Identify the major biomes and their characteristics. **Strategy 1**: Each biome of the world has several of its own characteristics. To introduce the activity, collect several pictures that illustrate each biome and put them in random order on a PowerPoint presentation. During the slideshow, students can orally identify the biome that matches the picture. Divide the class into groups and assign each one a certain biome. For their biome, they must:

		- create a background on poster board - develop several animal and plant cut-outs - a list of specific characteristics for their biome (will be cut into strips of paper) - list of adaptations organisms have in their biomes (e.g. animals with white fur in tundra) After all groups are finished, allow groups to place their biomes in the front of the room. Give students the plant and animal cut-outs, the characteristics of the biomes, and adaptations of organisms and instruct them to place the components on the appropriate background. After all the students have placed their components on the backgrounds, the creator of each biome will analyze the completed board for accuracy. Students will then present the biome to the class, explaining the relationship between the organism's adaptations and their survival in the biome. **Strategy 2**: Have students research and assemble a Biome Booklet and/or poster to present to the class. Give students access to computer websites, textbooks, and reference books from the library from which they can gather information to compile a set of facts describing each biome. At the very minimum, required information should include the following: location, climate, examples of flora and fauna (including adaptations that allow them to live there, i.e. spines rather than leaves on a cactus to conserve water in the desert), a picture of the biome (can be drawn by hand or cut from a magazine if student does not have access to computer or copier), and any additional fact that the student finds interesting. After compiling this data, have students create a bar graph comparing the average temperature and rainfall of each biome. Students should also create a map of North America and, using the data they have obtained, label where each biome would be found. Students can also make Venn diagrams to compare and contrast certain biomes, such as the tundra and taiga, or the marine and freshwater biomes.
3	3b.	*Provide examples to justify the interdependence among environmental elements. (DOK 2)* **Proficient -** 3b. Provide examples that demonstrate the interdependence of organisms and their environment (biotic and abiotic). **Strategy 1**: The flow of energy can be understood through a multitude of vocabulary terms. To assess students' understanding of energy flow, form collaborative groups to create a food web on poster board. Print out a variety of familiar organisms (scavengers, decomposers, primary consumers, producers, etc.) from which students can select examples. Provide a rubric that identifies the required material for their projects. Give the following instructions: - create a title - provide a specific number of organisms to use (1 scavenger, 1 decomposer, 3 producers, etc.) - make tabs for each organism (construction/colored paper provided)  - under each tab, label the following: producer or consumer; trophic level; type of consumer (primary/secondary/tertiary and omnivore/carnivore/herbivore) - draw arrows in correct direction to create different food chains

		Strategy 2: Have students (or teacher) produce a power-point presentation or find illustrations of symbiotic relationships such as parasitism, commensalism, and mutualism. Students/small groups can also be assigned one of these types of symbiotic relationships to research and teach to the class. In order to study the role of beneficial bacteria, assign each student /small group a particular type of cheese to research (ex. parmesan, mozzarella, Gouda, etc.). Research should focus on how cheese is made and type of bacteria used. If no dietary restrictions are noted, have a "Cheese Party" and bring samples of various cheeses for the class to sample. Show students pictures of ecosystems and have them identify the biotic and abiotic factors in each picture. Have students journal how abiotic factors affect their lives (ex. Football practice during summer heat wave, effects of Hurricane Katrina, etc.)
	3c.	*Examine and evaluate the significance of natural events and human activities on major ecosystems (e.g., succession, population growth, technology, loss of genetic diversity, consumption of resources). (DOK 2)* **Advanced -** 3c. Predict possible adaptations and impacts that will occur when an organism is introduced in a new environment. **Proficient -** 3c. Evaluate the significance of natural events and human activities on the biosphere. **Strategy 1**: To examine the significance of natural events on the biosphere, provide a power-point presentation to show students pictures of succession (perhaps using photos of the Mississippi gulf coast after Hurricane Katrina as an example of secondary succession). Discuss the natural events in Mississippi such as tornados and floods and the impact they have on the local ecosystem. Invite a local wildlife biologist to speak to students about such topics as succession, consumption of resources, loss of genetic diversity, and population growth. Encourage students to ask questions of the speaker. Students should then write a reflection evaluating the significance of natural events and impact on the biosphere, using the information they gained from the above activities. **Strategy 2**: In order to understand the human impact on the ecosystem, engage students in the following activities by having them research, discuss, and predict. Have students research the current oil spill in the Gulf of Mexico and have them report/ evaluate/predict the projected impact on the ecosystem (using data from previous catastrophes such as the Exxon Valdez, if necessary). Capitalize on students' interests, such as hunting and fishing, to initiate a discussion of population growth and over-consumption of resources due to human activities such as logging and construction. Use wildlife magazines or the internet and have students research what happens to a white-tailed deer population when there is over-crowding in a particular ecosystem. Also have students discuss the impact of the introduction (either intentional or non-intentional) of a non-native species into a new environment (ex. Kudzu, wild hogs, fire ants, etc.) and predict similar scenarios that could occur in the future.

Comp.	Obj.	PLDs Advanced Proficient Basic
4		**Analyze and explain the structures and function of the levels of biological organizations. Blueprint: 4 OBJ/14 ITEMS**
4	4a.	*Differentiate among plant and animal cells and eukaryotic and prokaryotic cells. (DOK 2)* **Proficient** - 4a. Differentiate among types of cells and describe the functions and structures of major cell organelles including cell parts for mobility. **Basic** - 4a. Identify the function of basic cell organelles. **Strategy 1**: Set up several learning stations to include the following: Station #1: "Matching Names to Organelles". Provide large diagrams of both plant and animal cells. Each organelle (word) will be matched appropriately with its structure on the diagrams. Allow students to repeat the process several times, if needed. Station #2: "Create a Venn Diagram comparing Eukaryotic and Prokaryotic Cells". Provide a blank Venn diagram and printed characteristic cards that describe each type of cell. Have students place characteristic cards in appropriate place on Venn diagram. Allow students multiple chances to master the activity. Station #3: "Match Cell Organelle with its Function". A bag of organelles and a bag of functions are provided. Have students match organelle to function. Station #4: "Create a Venn diagram comparing Plant and Animal Cells". Provide a blank Venn diagram and printed characteristic cards that describe each type of cell. Have students place characteristic cards in appropriate place on Venn diagram. Allow students multiple chances to master the activity. Station #5: "Match Mobility to Organism". Provide pictures of one-celled organisms that use a variety of organelles for locomotion (amoeba, paramecium, and euglena) and printed definitions of various types of mobility (cilia, pseudopodia, and flagella). Have students match the picture to the correct type of organelle. **Strategy 2**: Allow students access to magazines and/or computer generated images in order to produce a Cell Analogy Poster. After studying the plant and animal cell organelles, students should gather pictures that represent the function (not shape) of several organelles. Teachers may assign particular organelles or give students the opportunity to choose numerous organelles from a list. A poster will represent an entire cell and the student will place the appropriate organelles in it. Students can choose to represent a plant or animal cell. Students will draw a picture of the appropriate organelle, place the picture representing that particular organelle next to it, and explain (either verbally or in written form) how the chosen picture functions like the organelle. For example, the student might choose to sketch a mitochondrion, glue a picture of a generator next to it, and write a paragraph explaining that the generator produces energy to run appliances, like the mitochondrion produces the ATP energy needed for the cell to work properly.

4	4b.	*Differentiate between types of cellular reproduction. (DOK 1)* **Proficient -** 4b. Differentiate between the types of cellular reproduction and the results of each type. **Strategy 1**: Illustrate the concept of the cell cycle and mitosis using a mini flip chart (foldable). To create the mini flip chart use the following directions: (3 sheets of colored paper are needed) - Lay the first sheet flat on the table - Place the second sheet on top of the first sheet leaving a 1" space from the bottom - Place the third sheet on the second sheet leaving a 1" space from the bottom (of the 2nd sheet). - Fold all 3 sheets toward you leaving a 1" space from the bottom of the top page. (this will create six flaps) Teacher demonstration of each step facilitates this process. On the flaps of the mini flip chart, list the steps of the cell cycle (Interphase and Mitosis). Ex.  Under the interphase flap, have students write the definition of "interphase" and list and describe the 3 stages. Under the mitosis flap, have students define the stages and write an acronym to help them remember the steps in the cycle. Under each phase of mitosis, have students draw a diagram illustrating the phase and write a brief description. On the back of the chart, have students describe and illustrate the last process of the cell cycle, cytokinesis. This particular flip chart (foldable) can be made with more sheets of paper to include flaps for the definition of the cell cycle and for cytokinesis. **Strategy 2**: Teach students to play the "Mitosis Game" to demonstrate the process of cell division in animal cells. Have students form a large circle. Have three students stand in the middle of the circle. Two students hold a card labeled "chromosome", while one student holds a card stating "centriole" (each card should be a different color). Three students stand outside the circle holding corresponding cards (same words on same color of paper). Explain that the circle represents the cell membrane. Have the students outside the "membrane" move into the cell, while explaining that they don't really move into the cell; they are actually **doubled** inside the cell. This represents **INTERPHASE**. Have "chromosomes" and "centrioles" stand beside one another (matching corresponding cards and colors) to represent **PROPHASE**. Have students move to middle of "cell" and stand facing one another to represent **METAPHASE**. Have the "centrioles", which have migrated (or moved) to either side of the cell, pull the "chromosomes" apart (to opposite sides of the cell) to represent **ANAPHASE**. The "cell membrane" should then begin to close in around the two sets of "chromosomes" to represent **TELOPHASE**. Guide the students through the process once, describing all stages as they are demonstrated. Then choose different

		volunteers and have students move through the process independently as the teacher calls out the stages. Have students create a data table listing multiple types of reproduction (mitosis, meiosis, budding, vegetative propagation, etc.). Have students include a column showing the number of offspring created, genetic relationship to parents (exact copy, or combination of genes), if reproduction is sexual or asexual, and any other pertinent data.
4	4c. 1a.	*Describe and differentiate among the organizational levels of organisms (e.g., cells, tissues, organs, systems, types of tissues.) (DOK 1)* **Proficient** - 4c. Differentiate among the organizational levels of organisms. **Strategy 1**: Use an entire plant as an example while reviewing the levels of organization (cells-tissues-organs-systems…). 1) use a microscope to show plant **cells** and **tissues** (create your own wet mount or use a prepared slide) - a portion of a plant can show the different **types of tissues** that it contains 2) Explain the major plant **organs** that make up the entire organism (roots, stems, and leaves) 3) Explain that the plant organs function together as a **system** to help the plant grow and develop; elaborate on some of the functions of the organs (stem-transport system, leaves-photosynthesis, roots- absorption). **Strategy 2**: Collaborate with anatomy teacher (or use internet, anatomy book, or scientific supply company)) to obtain microscope slides, pictures, or computer-generated images of human body cells, tissues, organs, and systems. Have students study the slides or pictures and sketch them in their notebooks, using their notes and textbook to signify the differences among the different levels of organization.
	4d. 1c.	*Explain and describe how plant structures (vascular and nonvascular) and cellular functions are related to the survival of plants (e.g. movement of materials, plant reproduction). (DOK 1)* **Advanced** - 4d. Analyze how plant structures and cellular functions are related to survival of plants. **Proficient** - 4d. Explain and describe how vascular and nonvascular plant structures and cellular functions are related to the survival of plants. **Strategy 1**: The vascular cambium (xylem and phloem) make up the transport system of a plant. (Xylem transports water and minerals and phloem transports food) The xylem and phloem make up the veins of a plant. The following activity can be used as a demonstration or students can work in small groups. Materials needed are as follows: water, food coloring (dark color), a container (graduated cylinder, beaker, flask, etc), white carnation (clipped at base), and celery stalk (clipped at base). Prior to experiment/demonstration, have students hypothesize what they think might occur. Place water and food coloring into two containers. Place a white carnation in one container and the celery stalk in the other. After a period of time, students can see the food coloring being drawn up through both the carnation and celery. Eventually, the color will show through the petals of the carnation and the leaves of the celery. Cut the celery in half horizontally in order for students to see individual veins running through the celery stalk. Have students record their results. Teacher and students will discuss findings and analyze how the xylem and phloem contribute to the survival of plants. Have students compare the results of the experiment/demo with their original hypothesis.

		Strategy 2: Study vascular plant's reproductive processes. To demonstrate vegetative propagation (asexual reproduction), bring cuttings from a houseplant or garden plant, submerge the stems in water, and have the class watch the plant grow roots over several weeks. Students can keep a plant journal and write their observations, make sketches, and measure any root growth and development. In order to observe angiosperms, obtain blooming flowers (lilies work well and local florists will often donate them), and divide the class into cooperative groups. Using the textbook or other resources as a guide, have students observe the external structure of the flower (petals, pistil, anther, stamen, pollen, etc.) used in sexual reproduction. Discuss pollination and how animals/environmental factors, etc. help with the process (bees catch pollen on their legs and transfer to other plants, wind carries the pollen grains). Using a scalpel, have students cut open the ovary and find the ovules. Have students analyze what they have learned about plant structure and write a journal reflection explaining how a plant's structure enables it to survive in its environment.
Comp.	**Obj.**	**PLDs** **Advanced** **Proficient** **Basic**
5		**Demonstrate an understanding of the molecular basis of heredity.** **Blueprint: 4 OBJ/14 ITEMS**
5	5a.	*Analyze and explain the molecular basis of heredity and the inheritance of traits to successive generations by using the Central Dogma of Molecular Biology. (DOK 3)* **Proficient** - 5a. Analyze and explain the molecular basis of heredity and the inheritance of traits to successive generations using the Central Dogma of Molecular Biology. **Basic** - 5a. Label the structure of DNA and explain the differences between DNA and RNA. **Strategy 1**: Protein synthesis (DNA replication, transcription, and translation) can be a difficult process to understand if students are not actively engaged. Students can understand the concept better if they simulate the process using words. To prepare the activity: - create 15-20 sentences (sentences will represent proteins that are made); they can be of any length, factual or fictional (tend to entertain a little better). Students should not have access to the sentences beforehand. Ex. Learning Biology is fun. - DNA template cards must be made using the sentences created (remember to use A, T, C, and G - nucleotide bases). Each word in a sentence represents a separate codon. Ex. Learning Biology is fun DNA template: ACG TAG AAC CAG - Amino Acid cards with anticodons (there are 64) must also be created (remember to use A, U, C, and G as the bases). Some anticodons will not be used in your particular sentences. They will have other words on them as well. The anticodon is written on the front of an index card and the word from the sentence is written on the back. - Remember to include a START and STOP anticodon. (Ex. AUG will always be the START codon and CUC can always be the STOP codon- or period of the sentence) Ex. (START) Learning Biology is fun (period) Anticodon: AUG UGC AUC UUG GUC CUC

		Before students enter the room, place the amino acid cards on the walls of the room with anticodons facing out. The activity: Tell the students that the classroom is a cell. The teacher's desk is the nucleus (that contains the DNA molecules) and each group location is a ribosome. Students should have a piece of paper where they can write their transcribed/ translated information and their finished protein (sentence). Each group will send a student to transcribe a DNA molecule at the nucleus (DNA never leaves the nucleus). They will bring their transcribed DNA to the ribosome where it will be translated by another group member. The translated molecule is now RNA and the anticodons that correspond to the strands are taped around the room. One student from the group will find the matching codons to access the words on the back of them. After finding all matching codons, the words should form a complete sentence (students should confirm sentence with nucleus). If a complete sentence is not made, an error or mutation occurred during transcription or translation. The student must start over. The number of DNA molecules that go through protein synthesis can vary based on amount of time allotted. A goal of 3 molecules can be set and the students can race to see who makes the proteins first. Rules should include the following: - only one group member out of his/her seat at a time - every group member must participate **Strategy 2**: After a class discussion of DNA, base pairing, and the general structure of the molecule, divide the class into cooperative groups. Provide various media (beads, colored paper, colored pencils, etc.) and have students create a model of the double helix of DNA. It is often beneficial to extract actual DNA from a living organism so students can understand that real DNA does not look like the colorful models that they just created. The process is quite simple and uses common household ingredients to extract DNA from strawberries. The following items are needed: rubbing alcohol, ¼ cup measuring cup or beaker, freezer or ice, 3 clear glasses or beakers, bowl or large beaker, 3 strawberries, knife, fork, water, zip-lock style bag (quart size),shampoo or dishwashing soap, salt, spoon, 1 teaspoon measuring spoon, coffee filter, rubber band, and toothpick or wooden skewer. Procedure: 1). Pour 1/4 cup of alcohol into one of the glasses. Place the glass in the freezer or into a bowl of ice to chill. The alcohol must be very cold to extract the DNA. 2). Remove the stems from three strawberries with a knife. Place the strawberries in a Ziploc bag and seal shut. Then use a fork or your fingers to squish the strawberries until they are completely mashed. This should take a few minutes. 3). Put two large pinches of salt into the second glass. Add one cup of tap water. Stir to dissolve the salt. Add two tablespoons of shampoo or dish liquid to the mixture. Stir gently until completely mixed. 4). Open the bag and add about 5 teaspoons of the soapy solution to the mashed fruit. Seal up the bag and mix with your fingers for about 60 seconds, trying not to develop too many soap bubbles. The detergent mixture opens the strawberry cells, releasing the DNA. 5). Place the coffee filter over the third glass and secure it with a rubber band. Pour the mixture into the filter. If the mixture is too thick to flow through, stir in a little more of the soap solution. Let the mixture filter through. This should take about 10 minutes.

		6). Take the filter off and add the ice cold alcohol to the mixture in the glass. After about 5 minutes, you should see a clumpy white substance beginning to form. This is the DNA. The alcohol allows the DNA to float. Use the toothpick or the craft stick to pick up the DNA so you can look at its strands more closely. 7). When you are done, it is safe to pour all leftover liquids and substances down the sink. Throw all trash into the garbage. Read more: How to Extract DNA From a Strawberry | eHow.com http://www.ehow.com/how_5031799_extract-dna-strawberry.html#ixzz0u9REtwnF Have students create a Venn diagram or foldable, comparing and contrasting the function, shape, structure, base pairing, etc. of DNA and RNA. Have students create a chart comparing and contrasting replication, transcription, and translation. Information should include, but not be limited to, where each process occurs in the cell, what each process creates, what organelles and enzymes are involved in each process, etc. Students can also construct a graphic representation of each process, being sure to label appropriate organelles and structures in the picture they create.
5	5b.	*Utilize Mendel's laws to evaluate the results of monohybrid Punnett squares involving complete dominance, incomplete dominance, codominance, sex linked, and multiple alleles (including outcome percentage of both genotypes and phenotypes.) (DOK 2)* **Advanced -** 5b. Predict the results of a given parental dihybrid cross. **Proficient -** 5b. Utilize Mendel's laws and Punnett squares to evaluate results and predict percentage outcomes of monohybrid crosses involving complete dominance, incomplete dominance, codominance, sex-linked, and multiple alleles. **Strategy 1**: Have students practice a variety of genetic crosses. Vocabulary is a key factor in understanding and figuring out each cross (homozygous, heterozygous, dominant, recessive, etc). Introduce students to simple practice problems and expand as they master each one. Ex. A white flower (W) is dominant over a purple flower (w). A homozygous white flower is crossed with a homozygous purple flower. WW x ww = 100% White After explaining the difference between codominance and incomplete dominance (no recessive alleles), have students practice problems associated with both. Ex. A red snapdragon (RR) is crossed with a white snapdragon (WW). What are the possible genotypic and phenotypic outcomes for its offspring? RR x WW= 100% Pink

		Strategy 2: After teaching students how to represent a traditional genetic cross using monohybrid Punnett squares, divide the class into cooperative groups and assign them one (or all, depending on time frame) of the following topics: complete dominance, incomplete dominance, codominance, sex-linked traits, and multiple alleles. Using the internet, textbook, or appropriate reference books from the library, have students give a simple explanation of their topic(s), being sure to include real-life examples (ex: incomplete dominance-one allele is not completely dominant over the other; in certain flowers, crossing a white colored flower with a red colored flower creates a pink flower). Have groups share their findings with the class. Allow other students to take notes, adding additional information to their own research. Construct a dihybrid cross on the board for students to observe. Place them in collaborative groups and have them predict the phenotype and genotype of the offspring shown in the cross.
5	5c.	*Examine inheritance patterns using current technology (e.g., pedigrees, karyotypes, gel electrophoresis). (DOK 2)* **Advanced** - 5c. Analyze a pedigree to determine unknown traits and genotypes in past or future generations. **Proficient** - 5c. Examine inheritance patterns using current technology. **Strategy 1**: Have each student create a pedigree of his/her family, tracing a trait (factual or fictional) through their family tree for several generations. If they choose to follow an actual trait observed within their family, then students may need to research. When their pedigree is finished, they will put together a series of questions that correspond to their pedigree. Ex. How many generations are represented? How many women are or could be a carrier of the trait? How many men are or could be a carrier of the trait? When pedigrees and questions are finished, the pedigrees with questions will be distributed to random classmates. Those classmates will read the pedigree and answer the questions that follow. Pedigrees and questions should be turned in for evaluation. Students will have a 2 part grade: their pedigree and their degree of competence when analyzing a classmate's pedigree by answering questions (showing that they can interpret genotypes from past generations and predict traits and genotypes of future generations). **Strategy 2**: Use the internet, anatomy books, or reference books to find pictures of abnormal karyotypes. Make copies for students, create a power-point presentation, or display images using an LCD projector. Have students use their notes or textbook to determine what makes the karyotype abnormal. For example, a person with Down syndrome would have three chromosomes at chromosome # 21, rather than the normal two. (Down syndrome is also discussed in obj. 5 d.) Set up a scenario of a crime scene, using different gel electrophoresis samples from various characters in the scene (suspect, victim, etc) to show how this technique can separate DNA into bands, which could be used for identification of a DNA fragment.

	5d.	*Discuss the characteristics and implications of both chromosomal and gene mutations. (DOK 2)* **Proficient** - 5d. Describe the characteristics and implications of both chromosomal and gene mutations. **Basic** - 5d. Identify types of chromosomal and gene mutations. **Strategy 1**: Have the students work in groups to research a genetic disease or disorder caused by a mutation (Down's Syndrome, Tay-Sachs, Cystic Fibrosis, etc.). Using the information they obtained, have them design an informational pamphlet, power-point presentation, or other visual that they can present to the class. Students can also be required to write a more traditional research paper. The following information should be included in the project: - background information about the disorder (history, origin of disorder, when and how discovered, - characteristics and symptoms of the disorder (how is it diagnosed, occurrence at birth, distinctive features, etc) - possible treatments/prognosis - indicate if the disorder is hereditary - pictures of disorder or disease (be sensitive to classmates who may have personal experience with these disorders) **Strategy 2**: To demonstrate the significance of gene mutations in animals, write the sentence "The dog bit the cat" on the board. Change the "t" in cat to an "r" (making the sentence read "The dog bit the car"). Have students make the connection that changing one letter can change the meaning of the sentence, while changing one base in the DNA sequence of an organism (**substitution**) can cause a mutation. Rewrite the sentence, omitting any spaces between words ("Thedogbitthecat") and have students read it, three letters at a time. Then, remove one letter (removing the "g" leaves the sentence as follows:"The dobitthecat"). Have students re-read the sentence, three letters at a time. Discuss which mutation is modeled (**deletion**). Teachers can also add another letter to the middle of the sentence ("Thedogxbitthecat") to demonstrate another **frame-shift mutation**, known as insertion.
Comp.	**Obj.**	**PLDs Advanced Proficient Basic**
6		**Demonstrate an understanding of principles that explain the diversity of life and biological evolution. Blueprint: 5 OBJ/7 ITEMS**
6	6a.	*Draw conclusions about how organisms are classified into a hierarchy of groups and subgroups based on similarities that reflect their evolutionary relationships. (DOK 2)* **Advanced** - 6a. Given an organism, predict its evolutionary relationship to other given species. **Proficient** - 6a. Draw conclusions about how organisms are classified into hierarchy of groups and sub groups based on similarities that reflect their evolutionary relationships (including body plans and methods of reproduction). **Basic** - 6a. List the taxonomic levels from broadest to specific and place organisms into the correct kingdom based on characteristics.

		Strategy 1: Reproduction is a basic characteristic for living things. It is essential for a species to survive and pass genetic information to future generations. There are two types of reproduction: sexual and asexual. Sexual reproduction involves the production of offspring through meiosis and the union of a sperm and an egg which produces genetically different offspring. Asexual reproduction involves the production of offspring from one single parent which produces identical offspring. To identify what type of reproduction different organisms go through and how they are defined, have your students create two identical foldables. They will be creating one for types of sexual reproduction and the other for types of asexual reproduction. To make the foldable, fold a piece of colored paper lengthwise (hotdog style) with open side to your right. Using a pair of scissors, cut horizontal slits to the fold on each one to make several flaps. Try to make the flaps of equal size. The numbers of flaps vary depending on the number of topics covered. Ex. SEXUAL Conjugation Fertilization Pollination ASEXUAL Budding Binary Fission Regeneration Vegetative Propagation Under each flap on the foldable, they can list characteristics, definitions, and examples of organisms/groups, etc. **Strategy 2**: Assign cooperative groups a specific kingdom to research, using the internet, textbook, and reference books as resources. Students should construct a chart about their specific kingdom, using the following headings: prokaryotic or eukaryotic, multicellular or unicellular, autotrophic or heterotrophic, means of reproduction, means of locomotion (movement) and examples of organisms found in the kingdom. Groups can present their findings to the class and then distribute copies of the charts to their classmates to include in their notebooks and use as a reference when studying. For extension for Strategy 1 and Strategy 2: Give students a graphic depiction of evolutionary relationships (ex. cladogram, fan-like diagram, phylogenetic tree, etc., found in textbooks, internet) of a particular organism. Have students predict that organism's evolutionary relationship to the other organisms on the diagram.
6	6b.	*Critique data (e.g., comparative anatomy, biogeography, molecular biology, fossil record, etc.) used by scientists (e.g., Redi, Needham, Spallanzani, Pasteur) to develop an understanding of evolutionary processes and patterns. (DOK 3)* **Proficient -** 6b. Critique data used by scientists (e.g. Redi, Needham, Spallanzani, and Pasteur) to explain evolutionary processes and patterns.

		Strategy 1: Have students work in groups. Assign students a scientist (Redi, Needham, Pasteur, etc.) to research so they can develop an article suitable for publishing in a fictional magazine or newspaper. Group members can assume the following roles: editor, writer, proof reader, illustrator (graphics, presentation, etc.) Allow time for research and explain rubric for grading. Include personal information about the scientists (biography, childhood, education, etc.) and the scientists' methods and patterns of evolution (philosophies, mentors, data analyzed, etc.) **Strategy 2**: See Strategy 1. After research, divide the class into teams to critique the data and philosophies of the scientists. Students should then debate as to which data provides the best evidence to understand evolutionary processes.
6	6c.	*Research and summarize the contributions of scientists, (including Darwin, Malthus, Wallace, Lamarck, and Lyell) whose work led to the development of the theory of evolution. (DOK 2)* **Proficient** - 6c. Analyze research in relation to the contributions of scientists whose work led to the development of the theory of evolution. **Basic** - 6c. Summarize the contributions of scientists whose work led to the development of the theory of evolution. **Strategy:** Assign small groups a scientist (Darwin, Malthus, Wallace, Lamarck and Lyell) and have students research (using computer, textbook, reference books) each one's contributions to the development of the theory of evolution. Have students include scientist's country of origin, time frame when studies occurred, most famous experiments/contributions, and one fact that the group finds interesting. Have each group present their findings to the class, using at least one visual aide. Allow time for students to take notes on information presented by their classmates.
6	6d. 1d.	*Analyze and explain the roles of natural selection, including the mechanisms of speciation (e.g., mutations, adaptations, geographic isolation) and applications of speciation (e.g., pesticide and antibiotic resistance). (DOK 3)* **Proficient** - 6d. Analyze and explain the role of natural selection in speciation and applications of speciation. **Basic** - 6d. Identify examples that demonstrate the role that natural selection, speciation, diversity, adaptation, and extinction play in evolution. **Strategy 1**: Natural selection and Darwin's idea of artificial selection can be illustrated by demonstrating actions that contribute to the "survival" of candy. Selection of organisms over time changes the population of living things (as will be shown in the selection of candy). Before class begins, put a variety of candy in a bowl or large container. Candy should include a variety of popular and unpopular kinds. The candy should be of different sizes, shapes, and flavors. These characteristics indicate the different traits within the population of candy. As class begins, pass around the bowl of candy allowing students to choose a piece. Continue until the bowl is about half empty. As the bowl is being passed around, initiate a discussion on variation using the following questions:" What is variation?" "Why is variation significant?" Ask students for examples of variation (using examples from classmates-height, weight, etc.). Display the bowl of candy and examine the remaining pieces. Record the types and amount of candy left in the bowl on the

		board. Have students compare the original candy to what is left in the bowl. Ask the students to identify the traits that their selected candy contains. List their answers on the board (ex.sweet flavor, popular brand, etc.). Explain that those traits led to the removal of certain candies. Now ask students to list traits of the candy that was not selected (ex. undesirable flavor, small size, etc.). These traits contributed to the "survival" of the candy. The different traits that characterized the candy caused some candy to be eaten and some to "survive". Natural selection illustrates the same idea with individuals in a population. Every individual has unique traits; some traits will help an individual survive (large in size, coloring, odor, etc) and some traits do not (small in size, weak, etc.) **Strategy 2**: In order to demonstrate adaptations, use different sized binder clips or plastic forks that have been modified (one, two, or all prongs removed) to represent a "bird's beak". Pour a variety of dried ingredients (corn, different types of beans, peas, etc.) into one (or several) plastic boxes. The dried ingredients represent "bird food". Distribute a "beak" to each student and give them a specified time period (30 seconds to 1 minute) to use their "beaks" to gather "food" which they will transfer into their "stomach" (a plastic cup). Students should then compare the type and amount of "food" gathered by each type of "beak". Create a graph showing which type of "beak" caught the most food or create a graph comparing the type of food caught with each "beak". Discuss which "beaks" were most successful and discuss which animals would survive if the food supply changed. Use students' findings to analyze how environment and food can play a role in speciation. Have students investigate MRSA (methicillin-resistant Staphylococcus aureus-also known as "staph infection") to learn how bacteria develop antibiotic resistance. Have them share their research with the class in a brief presentation. Lead a class discussion extrapolating on the likelihood of this resistance and/or "change" occurring in other organisms, including organisms that are more and less complex than bacteria.
	6e.	*Differentiate among chemical evolution, organic evolution, and the evolutionary steps along the way to aerobic heterotrophs and photosynthetic autotrophs. (DOK 2)* **Proficient** - 6e. Differentiate among chemical evolution, organic evolution, and the evolutionary steps along the way to aerobic heterotrophs and photosynthetic autotrophs. **Strategy**: Have students, in groups, research the 3 different eras (Paleozoic, Mesozoic, and Cenozoic) that impacted the ideas associated with chemical and organic evolution of both plants and animals that we study today. Answer questions such as the following: What ideas were developed within each era? What was studied and evaluated? How was data collected? Who collected the data? Where specifically was data collected? For what purpose was the data being collected? Was the data collection accidental or intentional? After researching eras and their impact, students will present findings to the class. Encourage creativity in the presentations. Ex. Role play (as specific scientists), skits (tell a story), poems, songs, create advertisements, PowerPoint, video, music with songs, etc. Assessments will be based on group evaluations and a rubric.