Curriculum Map: Honors Keystone Biology

Course: KEYSTONE BIOLOGY Subtopic: Biology

Grade(s): 9

Course Description:	Honors Keystone Biology students learn basic concepts including biochemistry, microbiology, cell energetics, cell division, genetics, ecology, populations, and evolution. Students explore concepts and themes associated with living organisms, structure and function, inheritance, and changes in living forms over time. Students are challenged to think critically, solve problems, and know that biology is an essential addition to their general education. Students are assessed using the concepts and competencies from the PA Keystone Biology Exam.
Course Textbooks, Workbooks, Materials Citations:	Postlethwait, John H., and Janet L. Hopson. Modern Biology. Orlando: Holt, Rinehart and Winston, 2006. Print.
Curriculum Map Author(s):	Mr. Michael Dunham Mr. Eric Moore Mr. David Macar
Date of Last Revision to this Curriculum Map:	April 26, 2013

Unit: Unit 1: Scientific Method

Unit/Module Description:	Students explore the method and practices in scientific inquiry and investigation. Focus is placed on applying scientific thinking processes, tools, and technologies in the study of various scientific theories and investigations. Students distinguish between hypothesis, inference, law, theory, principle, fact, and observation while designing and performing laboratory experiments.
Unit/Module Big Ideas:	1. During laboratory investigations students develop experiments with both a control and experimental group. 2. Students understand the scientific method as a process for experimentation that is used to explore observations and answer questions. 3. Students analyze data and draw conclusions by developing and interpreting graphs and models.
Unit/Module Essential Questions:	1. Explain and construct examples illustrating a hypothesis, theory, fact, law, observation, and inference? 2. What is the difference between a manipulated variable and a responding variable in a controlled experiment? 3. How would you create a comparison of the steps to the scientific method when analyzing two separate experiments? 4. How can sample size and the placebo effect impact the validity of an experiment?
Unit/Module Key Terminology & Definitions :	1. Scientific facts- statements that are indisputable. Facts do not make generalizations. Accurate measurements are examples of scientific facts. 2. Scientific principles or laws- concise statements that explain a phenomenon that always occurs predictably under a specific set of circumstances. Most often, laws involve mathematical equations, such as the ideal gas law equation (PV =nRT). 3. Hypothesis- a statement that provides a possible explanation to a specific phenomenon. It is based on observations and previous research. In order to be valid, a hypothesis must be testable. Only a statement that is subject to disproval, or falsification, can qualify as a scientific hypothesis. And if the evidence does not support the claim, a hypothesis can be rejected. 4. Scientific theory- a broad explanation of a set of related observations or events. Scientific theories often incorporate many interrelated hypotheses and laws, and they provide a general mechanism for how all of the different factors work together. Scientific theories must be able to explain past events as well as predict future occurrences or future observations. Therefore, theories can never be proven because there always exists a possibility, even if the probability is highly unlikely, that a future event will not conform to the theory.

5. Peer review- fellow scientists working in the same field of study have their chance to voice any concerns about the experimental methods and results. Peer review and journal publication are used to reinforce the integrity of scientific investigations and reported data.

6. Controlled Experiment- Compares the results of an experiment between two (or more) groups.

7. Experimental group- Group being tested or receiving treatment. (ex: new drug)

8. Control group- "Normal" group. Should be identical to experimental group in every way except one: it does not receive the treatment (i.e.: no drug, or given the original drug or a placebo).

9. Placebo- A sugar pill or other "fake" treatment given to the control group so subjects do not know which group they are in.

10. Independent Variable- Variable that is being tested (ex: new drug). In a graph the independent variable is always plotted on the X axis.

11. Dependent Variable- Variable that is measured at the end of an experiment; the results (ex: does patient get better?) The dependent variable is always plotted on the Y axis.

Unit/Module Student Learning Outcomes:

Concepts

1. Recognize that the scientific method provides scientists and non-scientists with a structured method of analyzing observations and interpreting results in any problem solving situation.
2. Recognize that scientific literature and experiments must undergo peer revision in order to be upheld as valid.
3. Assess the validity of statistical data interpretations presented in graphical form.

Competencies

1. Explain the requirements for a valid experiment and develop an example that meets those requirements.
2. Describe the difference between a theory, hypothesis, law, observation, fact, inference, and principle.
3. Explain and cite examples of how communication in science can help prevent dishonesty and bias.
4. Create and interpret digital spreadsheet data using tables, graphs, etc.
5. Pose questions and provide evidence-based explanations about understanding and observations of biological phenomena and processes.
6. Select and use appropriate tools and techniques when designing and conducting experiments related to the biological sciences and then communicate an analysis of the findings using various types of media.
7. Provide examples for when it is correct to use the terms scientific principle, scientific theory, scientific law, fact, and belief.
8. Identify and describe various ways models are used to explain, interpret, and predict biological phenomenon/systems.
9. Select and use appropriate tools and techniques when designing and conducting experiments related to the biological sciences and then communicate an analysis of the findings using various types of media.

STANDARDS

STATE: Pennsylvania SAS Keystone Anchors (2010)

BIO.B.3.3.1 (Advanced) Distinguish between the scientific terms: hypothesis, inference, law, theory, principle, fact, and observation.

Lesson Topic: Core Lesson 1: Scientific Method

Core Lesson/Topic Description: Students explore the method and practices in scientific inquiry and investigation. Focus is placed on applying scientific thinking processes, tools, and technologies in the study of various scientific theories and investigations. Students distinguish between hypothesis, inference, law, theory, principle, fact, and observation while designing and performing laboratory experiments.

Core Lesson/Topic Big Ideas:

1. During laboratory investigations students develop experiments with both a control and experimental group.
2. Students understand the scientific method as a process for experimentation that is used to

explore observations and answer questions.
3. Students analyze data and draw conclusions by developing and interpreting graphs and models.

Core Lesson/Topic Essential Questions:

1. Explain and construct examples illustrating a hypothesis, theory, fact, law, observation, and inference?
2. What is the difference between a manipulated variable and a responding variable in a controlled experiment?
3. How would you create a comparison of the steps to the scientific method when analyzing two separate experiments?
4. How can sample size and the placebo effect impact the validity of an experiment?

Core Lesson/Topic Key Terminology & Definitions:

1. Scientific facts- statements that are indisputable. Facts do not make generalizations. Accurate measurements are examples of scientific facts.

2. Scientific principles or laws- concise statements that explain a phenomenon that always occurs predictably under a specific set of circumstances. Most often, laws involve mathematical equations, such as the ideal gas law equation (PV =nRT).

3. Hypothesis- a statement that provides a possible explanation to a specific phenomenon. It is based on observations and previous research. In order to be valid, a hypothesis must be testable. Only a statement that is subject to disproval, or falsification, can qualify as a scientific hypothesis. And if the evidence does not support the claim, a hypothesis can be rejected.

4. Scientific theory- a broad explanation of a set of related observations or events. Scientific theories often incorporate many interrelated hypotheses and laws, and they provide a general mechanism for how all of the different factors work together. Scientific theories must be able to explain past events as well as predict future occurrences or future observations. Therefore, theories can never be proven because there always exists a possibility, even if the probability is highly unlikely, that a future event will not conform to the theory.

5. Peer review- fellow scientists working in the same field of study have their chance to voice any concerns about the experimental methods and results. Peer review and journal publication are used to reinforce the integrity of scientific investigations and reported data.

6. Controlled Experiment- Compares the results of an experiment between two (or more) groups.

7. Experimental group- Group being tested or receiving treatment. (ex: new drug)

8. Control group- "Normal" group. Should be identical to experimental group in every way except one: it does not receive the treatment (i.e.: no drug, or given the original drug or a placebo).

9. Placebo- A sugar pill or other "fake" treatment given to the control group so subjects do not know which group they are in.

10. Independent Variable- Variable that is being tested (ex: new drug). In a graph the independent variable is always plotted on the X axis.

11. Dependent Variable- Variable that is measured at the end of an experiment; the results (ex: does patient get better?) The dependent variable is always plotted on the Y axis.

Core Lesson/Topic Student Learning Outcomes:

Concepts

1. Recognize that the scientific method provides scientists and non-scientists with a structured method of analyzing observations and interpreting results in any problem solving situation.
2. Recognize that scientific literature and experiments must undergo peer revision in order to be upheld as valid.
3. Assess the validity of statistical data interpretations presented in graphical form.

Competencies

1. Explain the requirements for a valid experiment and develop an example that meets those

requirements.
2. Describe the difference between a theory, hypothesis, law, observation, fact, inference, and principle.
3. Explain and cite examples of how communication in science can help prevent dishonesty and bias.
4. Create and interpret digital spreadsheet data using tables, graphs, etc.
5. Pose questions and provide evidence-based explanations about understanding and observations of biological phenomena and processes.
6. Select and use appropriate tools and techniques when designing and conducting experiments related to the biological sciences and then communicate an analysis of the findings using various types of media.
7. Provide examples for when it is correct to use the terms scientific principle, scientific theory, scientific law, fact, and belief.
8. Identify and describe various ways models are used to explain, interpret, and predict biological phenomenon/systems.
9. Select and use appropriate tools and techniques when designing and conducting experiments related to the biological sciences and then communicate an analysis of the findings using various types of media.

Unit: Unit 2: Cells and Cell Processes - The Chemical Basis of Life

Unit/Module Description: While biology is the study of life, the basis for understanding life rests in an understanding of the materials that make up living things. Students explore the basic biochemistry of water and life. By understanding the chemistry of life, and the molecules that are used to build all living things, students gain an appreciation of the complexities of life even on the most fundamental levels.

Unit/Module Big Ideas:
1. Life is a product of the organization and interaction of matter.
2. Organisms share common characteristics of life.
3. Structure is related to function at all biological levels of organization.
4. Organisms obtain and use energy to carry out their life processes.

Unit/Module Essential Questions:
1. What forms of matter are characteristic of living things and provide examples of how each is useful for life?
2. How is matter organized into atoms, molecules, macromolecules, tissues, organs, and organisms?

Unit/Module Key Terminology & Definitions :
1. Electron – a negatively charged subatomic particle with the mass of 1/1840th the mass of a proton
2. Element – a pure substance that consists of only one type of atom
3. Isotope – atoms of the same element that differ only in the number of neutrons they contain
4. Compound – a substance formed by the chemical combination of two or more elements in definite proportions
5. Ionic bond – a chemical bond that forms when one or more electrons are transferred from one atom to another
6. Ion – positively and negatively charged atoms
7. Covalent bond – chemical bond that is formed when electrons are shared between elements
8. Molecule – the smallest unit of most compounds
9. Cohesion – the intermolecular attraction between molecules of the same substance. Surface tension results from the cohesive properties of water.
10. Adhesion – the intermolecular attraction between molecules of different substances. Capillary action results from the adhesive properties of water.
11. Mixture – a material that is composed of two or more elements or compounds that are physically mixed together but not chemically combined
12. Solution – a mixture in which all of the components are evenly distributed throughout
13. Solute – the substance in a solution that is dissolved
14. Solvent – the substance in a solution that dissolves the solute
15. Suspension – a mixture of water and undissolved material
16. pH scale – a scale that ranges from 0 to 14 and measures the acidity or alkalinity of a solution
17. Acid – any compound that forms hydrogen ions (H+) in solution
18. Base – any compound that forms hydroxide ions (OH-) in solution
19. Buffer – weak acids or bases that can react with strong acids or bases to prevent sharp, sudden changes in pH
20. Monomer – the smallest unit of molecules that make up polymers
21. Polymer – large molecules that are made from many smaller, repeating molecules called monomers
22. Carbohydrate – compounds made up of carbon, hydrogen, and oxygen atoms usually in a ration of 1:2:1
23. Monosaccharide – a simple sugar—the monomer of a carbohydrate
24. Polysaccharide – carbohydrate polymers made by making chains of monosaccharides
25. Lipid – biological polymers made mostly of carbon and hydrogen atoms
26. Nucleic acid – macromolecules made of hydrogen, oxygen, nitrogen, carbon, and

phosphorus
27. Nucleotide – the monomer of a nucleic acid consisting of a sugar molecule, a phosphate, and a base
28. Ribonucleic acid – one of the major types of nucleic acids that contains the sugar ribose
29. Deoxyribonucleic acid – one of the major types of nucleic acids that contains the sugar deoxyribose
30. Protein – macromolecules that are made of amino acids
31. Amino acid – monomers of proteins that are made up a an amino functional group (-NH2) and a carboxyl functional group (-COOH)
32. Biological Macromolecules - a group of biomacromolecules that interact with biological systems and their environments.
33. Cell - The basic unit of structure and function for all living organisms. Cells have three common components: genetic material, cytoplasm, and a cell membrane. Eukaryotic cells also contain specialized organelles.
34. Enzyme - A protein that increases the rate of a chemical reaction without being changed by the reaction; an organic catalyst.
35. Freezing Point - The temperature at which a liquid changes state to a solid.
36. Homeostasis - The regulatory process in which an organism regulates its internal environment.
37. Specific Heat - The measure of the heat energy required to increase the temperature of a unit quantity of a substance by a certain temperature interval. (1cal/g*Cº)
38. Temperature - A measure of the average kinetic energy (energy of motion) of particles in a sample of matter. This physical property can determine the rate and extent to which chemical reactions can occur within living systems. It is commonly measured in degrees Celsius (°C) or Fahrenheit (°F).
39. Catalyst - A substance that enables a chemical reaction to proceed at a usually faster rate or under different conditions (e.g., lower temperature) than otherwise possible without being changed by the reaction.
40. Hydrogen bond - A weak electrochemical bond which arises due to differences in electronegativity resulting in partial charges in species.

Unit/Module Student Learning Outcomes:

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1. Recognize that organisms produce waste in cells and must excrete these in ways which are safe to that organism.
2. Differentiate how organisms obtain and use energy through photosynthesis and cellular respiration to carry out their life processes.
3. Understand that DNA is the hereditary material for life and that organisms can reproduce their own kind using nucleic acids.
4. Understand that organisms must maintain homeostasis at all biological levels of organization.
5. Recognize that all life, excluding viruses, are made up of simpler membrane bound units called cells.
6. Realize that all life stems from preexisting life and organisms grow, develop, and eventually die.
7. Recognize that many biological molecules are polymers made from monomers that contain carbon chemically bound with other elements.
8. Understand that cells function as microscopic chemical factories synthesizing and degrading biological molecules necessary for life.
9. Know that all cells are composed mostly of the elements C, H, N, O, P, and S.
10. Understand that carbon rings and chains form the backbone of biological molecules because of its unique ability to form four stable covalent bonds.
11. Realize that biological molecules used by the cell can be used within the cell or transported outside for signaling or use by other cells.
12. Understand that molecular structure is related to function and that structure equates to function at all levels of organization.
13. Know that the macromolecules carbohydrates, lipids, proteins, and nucleic acids are the chemical foundations for life.
14. Recognize that liquid water forms hydrogen bonds, is a solvent, and forms hydronium ions allowing a wide range of biochemical reactions to occur.
15. Understand that a number of phenomenon necessary for life to exist could not occur if water did not have its unique properties due to the chemistry and geometry of the water molecule.

Competencies

1. Explain why life on earth is carbon based with reference to chemical bonding.
2. Categorize what forms of matter are characteristic of living things and provide examples of how each is useful for life.

3. Identify the chemical properties of water and cite evidence as to how these properties make water so important for life? (e.g. freezing point, high specific heat, cohesion).
4. Differentiate between an aqueous solution or mixture and how do aqueous solutions and mixtures affect living things.
5. Organize matter into atoms, molecules, macromolecules, tissues, organs, and organisms.
6. Explain what happens to energy during energy transformations, provide specific examples.
7. Describe and interpret relationships between structure and function at various levels of biochemical organization (i.e., atoms, molecules and macromolecules.)
8. Describe how biological macromolecules form from monomers with reference to the chemical bonds being formed.
9. Explain how enzymes regulate biochemical reactions within a cell.
10. Describe the role of an enzyme as a catalyst in regulating a specific biochemical reaction.
11. Explain how factors such as pH, temperature and concentration levels can affect enzyme function.
12. Compare the structure and function of carbohydrates, lipids, proteins and nucleic acids in organisms.
13. Explain how organisms obtain energy, transport matter, reproduce, develop, respond to their environment, excrete waste etc.
14. Identify and describe biologically important molecules and how they are utilized by living organisms.

STANDARDS

STATE: Pennsylvania SAS Keystone Anchors (2010)

BIO.A.1.1.1 (Advanced)	Describe the characteristics of life shared by all prokaryotic and eukaryotic organisms.
BIO.A.1.2.1 (Advanced)	Compare cellular structures and their functions in prokaryotic and eukaryotic cells.
BIO.A.1.2.2 (Advanced)	Describe and interpret relationships between structure and function at various levels of biological organization (i.e., organelles, cells, tissues, organs, organ systems, and multicellular organisms).
BIO.A.2.1.1 (Advanced)	Describe the unique properties of water and how these properties support life on Earth (e.g., freezing point, high specific heat, cohesion).
BIO.A.2.2.1 (Advanced)	Explain how carbon is uniquely suited to form biological macromolecules.
BIO.A.2.2.2 (Advanced)	Describe how biological macromolecules form from monomers.
BIO.A.2.2.3 (Advanced)	Compare the structure and function of carbohydrates, lipids, proteins, and nucleic acids in organisms.
BIO.A.2.3.1 (Advanced)	Describe the role of an enzyme as a catalyst in regulating a specific biochemical reaction.
BIO.A.2.3.2 (Advanced)	Explain how factors such as pH, temperature, and concentration levels can affect enzyme function.

Lesson Topic: Core Lesson 1: Characteristics of Life

Core Lesson/Topic Description:	The basis for understanding life rests in an understanding of the materials that make up living things. By understanding the basic chemistry of life, including the way molecules bond and the chemistry of water, students can gain an appreciation of the similarities and complexities of life even on the most fundamental levels.
Core Lesson/Topic Big Ideas:	1. Life is a product of the organization and interaction of matter. 2. Organisms share common characteristics of life. 3. Structure is related to function at all biological levels of organization. 4. Organisms obtain and use energy to carry out their life processes.
Core Lesson/Topic Essential Questions:	1. How do organisms take in energy and dispose of waste materials? 2. What macromolecule is responsible for the ability to pass on hereditary information? 3. Which life forms are composed of membrane bound cells? 4. Can life arise from abiotic factors or can life only stem from pre-existing life? 5. What six elements make up the majority of all organic matter within an organism? 6. How does the molecular structure is related to function and how that structure equates to function at all levels of organization? 7. What forms of matter are characteristic of living things and provide examples of how each is useful for life? 8. How is matter organized into atoms, molecules, macromolecules, tissues, organs, and organisms?

Core Lesson/Topic Key Terminology & Definitions:

1. Electron – a negatively charged subatomic particle with the mass of 1/1840th the mass of a proton
2. Element – a pure substance that consists of only one type of atom
3. Isotope – atoms of the same element that differ only in the number of neutrons they contain
4. Compound – a substance formed by the chemical combination of two or more elements in definite proportions
5. Ionic bond – a chemical bond that forms when one or more electrons are transferred from one atom to another
6. Ion – positively and negatively charged atoms
7. Covalent bond – chemical bond that is formed when electrons are shared between elements
8. Molecule – the smallest unit of most compounds
9. Cohesion – the intermolecular attraction between molecules of the same substance. Surface tension results from the cohesive properties of water.
10. Adhesion – the intermolecular attraction between molecules of different substances. Capillary action results from the adhesive properties of water.
11. Mixture – a material that is composed of two or more elements or compounds that are physically mixed together but not chemically combined
12. Solution – a mixture in which all of the components are evenly distributed throughout
13. Solute – the substance in a solution that is dissolved
14. Solvent – the substance in a solution that dissolves the solute
15. Suspension – a mixture of water and undissolved material
16. pH scale – a scale that ranges from 0 to 14 and measures the acidity or alkalinity of a solution
17. Acid – any compound that forms hydrogen ions (H+) in solution
18. Base – any compound that forms hydroxide ions (OH-) in solution
19. Buffer – weak acids or bases that can react with strong acids or bases to prevent sharp, sudden changes in pH
20. Monomer – the smallest unit of molecules that make up polymers
21. Polymer – large molecules that are made from many smaller, repeating molecules called monomers
22. Carbohydrate – compounds made up of carbon, hydrogen, and oxygen atoms usually in a ration of 1:2:1
23. Monosaccharide – a simple sugar—the monomer of a carbohydrate
24. Polysaccharide – carbohydrate polymers made by making chains of monosaccharides
25. Lipid – biological polymers made mostly of carbon and hydrogen atoms
26. Nucleic acid – macromolecules made of hydrogen, oxygen, nitrogen, carbon, and phosphorus
27. Nucleotide – the monomer of a nucleic acid consisting of a sugar molecule, a phosphate, and a base
28. Ribonucleic acid – one of the major types of nucleic acids that contains the sugar ribose
29. Deoxyribonucleic acid – one of the major types of nucleic acids that contains the sugar deoxyribose
30. Protein – macromolecules that are made of amino acids
31. Amino acid – monomers of proteins that are made up a an amino functional group (-NH2) and a carboxyl functional group (-COOH)
32. Biological Macromolecules - a group of biomacromolecules that interact with biological systems and their environments.
33. Cell - The basic unit of structure and function for all living organisms. Cells have three common components: genetic material, cytoplasm, and a cell membrane. Eukaryotic cells also contain specialized organelles.
34. Enzyme - A protein that increases the rate of a chemical reaction without being changed by the reaction; an organic catalyst.
35. Freezing Point - The temperature at which a liquid changes state to a solid.
36. Homeostasis - The regulatory process in which an organism regulates its internal environment.
37. Specific Heat - The measure of the heat energy required to increase the temperature of a unit quantity of a substance by a certain temperature interval. (1cal/g*Cº)
38. Temperature - A measure of the average kinetic energy (energy of motion) of particles in a sample of matter. This physical property can determine the rate and extent to which chemical reactions can occur within living systems. It is commonly measured in degrees Celsius (°C) or Fahrenheit (°F).
39. Catalyst - A substance that enables a chemical reaction to proceed at a usually faster rate or under different conditions (e.g., lower temperature) than otherwise possible without being changed by the reaction.
40. Hydrogen bond - A weak electrochemical bond which arises due to differences in electronegativity resulting in partial charges in species.

Core Lesson/Topic Student Learning Outcomes:	Concepts [endif]--> 1. Recognize that organisms produce waste in cells and must excrete these in ways which are safe to that organism. 2. Differentiate how organisms obtain and use energy through photosynthesis and cellular respiration to carry out their life processes. 3. Understand that DNA is the hereditary material for life and that organisms can reproduce their own kind using nucleic acids. 4. Understand that organisms must maintain homeostasis at all biological levels of organization. 5. Recognize that all life, excluding viruses, are made up of simpler membrane bound units called cells. 6. Realize that all life stems from preexisting life and organisms grow, develop, and eventually die. 7. Understand that cells function as microscopic chemical factories synthesizing and degrading biological molecules necessary for life. 8. Know that all cells are composed mostly of the elements C, H, N, O, P, and S. 9. Understand that molecular structure is related to function and that structure equates to function at all levels of organization. Competencies 1. Categorize what forms of matter are characteristic of living things and provide examples of how each is useful for life. 2. Organize matter into atoms, molecules, macromolecules, tissues, organs, and organisms. 3. Explain what happens to energy during energy transformations, provide specific examples. 4. Describe and interpret relationships between structure and function at various levels of biochemical organization (i.e., atoms, molecules and macromolecules.) 5. Explain how organisms obtain energy, transport matter, reproduce, develop, respond to their environment, excrete waste etc. 6. Explain and develop a list of characteristics that are shared by all living organisms.

Lesson Topic: Core Lesson 2: Basic Chemistry

Core Lesson/Topic Description:	The basis for understanding life rests in an understanding of the materials that make up living things. By understanding the basic chemistry of life, including the way molecules bond and the chemistry of water, students can gain an appreciation of the complexities of life even on the most fundamental levels.
Core Lesson/Topic Big Ideas:	1. Life is a product of the organization and interaction of matter. 2. Structure is related to function at all biological levels of organization. 3. Organisms obtain and use energy to carry out their life processes. 4. The chemistry of Carbon and Water provide unique chemical properties necessary for life on Earth.
Core Lesson/Topic Essential Questions:	1. Explain why life on earth is carbon based with reference to chemical bonding? 2. What forms of matter are characteristic of living things and provide examples of how each is useful for life? 3. What are the chemical properties of water how do those properties make water so important for life? (e.g. freezing point, high specific heat, cohesion). 4. What is an aqueous solution or mixture and how do aqueous solutions and mixtures affect living things? 5. How is matter organized into atoms, molecules, macromolecules, tissues, organs, and organisms? 6. How do hydrogen bonds form and dissociate and in what structures within the cell are hydrogen bonds essential? 7. How do you recognize a hydrophobic compound? Hydrophilic? 8. What are the differences between solute and solvent? 9. What are the differences between ionic, covalent, hydrogen bonds, and hydrophobic interactions?

Core Lesson/Topic Key Terminology & Definitions:

1. Electron – a negatively charged subatomic particle with the mass of 1/1840th the mass of a proton
2. Element – a pure substance that consists of only one type of atom
3. Isotope – atoms of the same element that differ only in the number of neutrons they contain
4. Compound – a substance formed by the chemical combination of two or more elements in definite proportions
5. Ionic bond – a chemical bond that forms when one or more electrons are transferred from one atom to another
6. Ion – positively and negatively charged atoms
7. Covalent bond – chemical bond that is formed when electrons are shared between elements
8. Molecule – the smallest unit of most compounds
9. Cohesion – the intermolecular attraction between molecules of the same substance. Surface tension results from the cohesive properties of water.
10. Adhesion – the intermolecular attraction between molecules of different substances. Capillary action results from the adhesive properties of water.
11. Mixture – a material that is composed of two or more elements or compounds that are physically mixed together but not chemically combined
12. Solution – a mixture in which all of the components are evenly distributed throughout
13. Solute – the substance in a solution that is dissolved
14. Solvent – the substance in a solution that dissolves the solute
15. Suspension – a mixture of water and undissolved material
16. pH scale – a scale that ranges from 0 to 14 and measures the acidity or alkalinity of a solution
17. Acid – any compound that forms hydrogen ions (H+) in solution
18. Base – any compound that forms hydroxide ions (OH-) in solution
19. Buffer – weak acids or bases that can react with strong acids or bases to prevent sharp, sudden changes in pH
20. Monomer – the smallest unit of molecules that make up polymers
21. Polymer – large molecules that are made from many smaller, repeating molecules called monomers
22. Carbohydrate – compounds made up of carbon, hydrogen, and oxygen atoms usually in a ration of 1:2:1
23. Monosaccharide – a simple sugar—the monomer of a carbohydrate
24. Polysaccharide – carbohydrate polymers made by making chains of monosaccharides
25. Lipid – biological polymers made mostly of carbon and hydrogen atoms
26. Nucleic acid – macromolecules made of hydrogen, oxygen, nitrogen, carbon, and phosphorus
27. Nucleotide – the monomer of a nucleic acid consisting of a sugar molecule, a phosphate, and a base
28. Ribonucleic acid – one of the major types of nucleic acids that contains the sugar ribose
29. Deoxyribonucleic acid – one of the major types of nucleic acids that contains the sugar deoxyribose
30. Protein – macromolecules that are made of amino acids
31. Amino acid – monomers of proteins that are made up a an amino functional group (-NH2) and a carboxyl functional group (-COOH)
32. Biological Macromolecules - a group of biomacromolecules that interact with biological systems and their environments.
33. Cell - The basic unit of structure and function for all living organisms. Cells have three common components: genetic material, cytoplasm, and a cell membrane. Eukaryotic cells also contain specialized organelles.
34. Enzyme - A protein that increases the rate of a chemical reaction without being changed by the reaction; an organic catalyst.
35. Freezing Point - The temperature at which a liquid changes state to a solid.
36. Homeostasis - The regulatory process in which an organism regulates its internal environment.
37. Specific Heat - The measure of the heat energy required to increase the temperature of a unit quantity of a substance by a certain temperature interval. (1cal/g*Cº)
38. Temperature - A measure of the average kinetic energy (energy of motion) of particles in a sample of matter. This physical property can determine the rate and extent to which chemical reactions can occur within living systems. It is commonly measured in degrees Celsius (°C) or Fahrenheit (°F).
39. Catalyst - A substance that enables a chemical reaction to proceed at a usually faster rate or under different conditions (e.g., lower temperature) than otherwise possible without being changed by the reaction.
40. Hydrogen bond - A weak electrochemical bond which arises due to differences in electronegativity resulting in partial charges in species.

Core Lesson/Topic	Concepts
Student Learning Outcomes:	[endif]--> 1. Understand that cells function as microscopic chemical factories synthesizing and degrading biological molecules necessary for life. 2. Know that all cells are composed mostly of the elements C, H, N, O, P, and S. 3. Understand that carbon rings and chains form the backbone of biological molecules because of its unique ability to form four stable covalent bonds. 4. Recognize that liquid water forms hydrogen bonds, is a solvent, and forms hydronium ions allowing a wide range of biochemical reactions to occur. 5. Understand that a number of phenomenon necessary for life to exist could not occur if water did not have its unique properties due to the chemistry and geometry of the water molecule. Competencies 1. Explain why life on earth is carbon based with reference to chemical bonding. 2. Categorize what forms of matter are characteristic of living things and provide examples of how each is useful for life. 3. Identify the chemical properties of water and cite evidence as to how these properties make water so important for life? (e.g. freezing point, high specific heat, cohesion). 4. Differentiate between an aqueous solution or mixture and how do aqueous solutions and mixtures affect living things. 5. Organize matter into atoms, molecules, macromolecules, tissues, organs, and organisms.

Lesson Topic: Core Lesson 3: Biochemistry

Core Lesson/Topic Description:	The basis for understanding life rests in an understanding of the materials that make up living things. By understanding the molecules that are used to build all living things, students can gain an appreciation of the complexities of life even on the most fundamental levels.
Core Lesson/Topic Big Ideas:	1. Life is a product of the organization and interaction of matter. 2. Organisms share common characteristics of life. 3. Structure is related to function at all biological levels of organization. 4. Organisms obtain and use energy to carry out their life processes. 5. The chemistry of Carbon and Water provide unique chemical properties necessary for life on Earth.
Core Lesson/Topic Essential Questions:	1. Explain why life on earth is carbon based with reference to chemical bonding? 2. What forms of matter are characteristic of living things and provide examples of how each is useful for life? 3. How is matter organized into atoms, molecules, macromolecules, tissues, organs, and organisms? 4. What happens to energy during energy transformations, provide specific examples (ATP)? 5. How does the relationships between structure and function at various levels of biochemical organization (i.e., atoms, molecules and macromolecules.) affect biological functions? 6. How do biological macromolecules (polymers) form from monomers? 7. What class of macromolecules are enzymes? 8. How do hydrogen bonds work? 9. In what structures within the cell are hydrogen bonds essential? 10. How do you recognize a hydrophobic compound? Hydrophilic? 11. What are the four types of macromolecules in the cell? 12. What are the differences between ionic, covalent, hydrogen bonds, and hydrophobic interactions?
Core Lesson/Topic Key Terminology & Definitions:	1. Electron – a negatively charged subatomic particle with the mass of 1/1840th the mass of a proton 2. Element – a pure substance that consists of only one type of atom 3. Isotope – atoms of the same element that differ only in the number of neutrons they contain

4. Compound – a substance formed by the chemical combination of two or more elements in definite proportions
5. Ionic bond – a chemical bond that forms when one or more electrons are transferred from one atom to another
6. Ion – positively and negatively charged atoms
7. Covalent bond – chemical bond that is formed when electrons are shared between elements
8. Molecule – the smallest unit of most compounds
9. Cohesion – the intermolecular attraction between molecules of the same substance. Surface tension results from the cohesive properties of water.
10. Adhesion – the intermolecular attraction between molecules of different substances. Capillary action results from the adhesive properties of water.
11. Mixture – a material that is composed of two or more elements or compounds that are physically mixed together but not chemically combined
12. Solution – a mixture in which all of the components are evenly distributed throughout
13. Solute – the substance in a solution that is dissolved
14. Solvent – the substance in a solution that dissolves the solute
15. Suspension – a mixture of water and undissolved material
16. pH scale – a scale that ranges from 0 to 14 and measures the acidity or alkalinity of a solution
17. Acid – any compound that forms hydrogen ions (H+) in solution
18. Base – any compound that forms hydroxide ions (OH-) in solution
19. Buffer – weak acids or bases that can react with strong acids or bases to prevent sharp, sudden changes in pH
20. Monomer – the smallest unit of molecules that make up polymers
21. Polymer – large molecules that are made from many smaller, repeating molecules called monomers
22. Carbohydrate – compounds made up of carbon, hydrogen, and oxygen atoms usually in a ration of 1:2:1
23. Monosaccharide – a simple sugar—the monomer of a carbohydrate
24. Polysaccharide – carbohydrate polymers made by making chains of monosaccharides
25. Lipid – biological polymers made mostly of carbon and hydrogen atoms
26. Nucleic acid – macromolecules made of hydrogen, oxygen, nitrogen, carbon, and phosphorus
27. Nucleotide – the monomer of a nucleic acid consisting of a sugar molecule, a phosphate, and a base
28. Ribonucleic acid – one of the major types of nucleic acids that contains the sugar ribose
29. Deoxyribonucleic acid – one of the major types of nucleic acids that contains the sugar deoxyribose
30. Protein – macromolecules that are made of amino acids
31. Amino acid – monomers of proteins that are made up a an amino functional group (-NH2) and a carboxyl functional group (-COOH)
32. Biological Macromolecules - a group of biomacromolecules that interact with biological systems and their environments.
33. Cell - The basic unit of structure and function for all living organisms. Cells have three common components: genetic material, cytoplasm, and a cell membrane. Eukaryotic cells also contain specialized organelles.
34. Enzyme - A protein that increases the rate of a chemical reaction without being changed by the reaction; an organic catalyst.
35. Freezing Point - The temperature at which a liquid changes state to a solid.
36. Homeostasis - The regulatory process in which an organism regulates its internal environment.
37. Specific Heat - The measure of the heat energy required to increase the temperature of a unit quantity of a substance by a certain temperature interval. (1cal/g*Cº)
38. Temperature - A measure of the average kinetic energy (energy of motion) of particles in a sample of matter. This physical property can determine the rate and extent to which chemical reactions can occur within living systems. It is commonly measured in degrees Celsius (°C) or Fahrenheit (°F).
39. Catalyst - A substance that enables a chemical reaction to proceed at a usually faster rate or under different conditions (e.g., lower temperature) than otherwise possible without being changed by the reaction.
40. Hydrogen bond - A weak electrochemical bond which arises due to differences in electronegativity resulting in partial charges in species.

Core Lesson/Topic Student Learning Concepts

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Outcomes:

1. Differentiate how organisms obtain and use energy through photosynthesis and cellular respiration to carry out their life processes.
2. Understand that DNA is the hereditary material for life and that organisms can reproduce their own kind using nucleic acids.
3. Recognize that all life, excluding viruses, are made up of simpler membrane bound units called cells.
4. Recognize that many biological molecules are polymers made from monomers that contain carbon chemically bound with other elements.
5. Understand that cells function as microscopic chemical factories synthesizing and degrading biological molecules necessary for life.
6. Know that all cells are composed mostly of the elements C, H, N, O, P, and S.
7. Understand that carbon rings and chains form the backbone of biological molecules because of its unique ability to form four stable covalent bonds.
8. Understand that molecular structure is related to function and that structure equates to function at all levels of organization.
9. Know that the macromolecules carbohydrates, lipids, proteins, and nucleic acids are the chemical foundations for life.

Competencies

1. Organize matter into atoms, molecules, macromolecules, tissues, organs, and organisms.
2. Explain what happens to energy during energy transformations, provide specific examples.
3. Describe and interpret relationships between structure and function at various levels of biochemical organization (i.e., atoms, molecules and macromolecules.)
4. Describe how biological macromolecules form from monomers with reference to the chemical bonds being formed.
5. Describe the role of an enzyme as a catalyst in regulating a specific biochemical reaction.
6. Compare the structure and function of carbohydrates, lipids, proteins and nucleic acids in organisms.
7. Explain how organisms obtain energy, transport matter, reproduce, develop, respond to their environment, excrete waste etc.
8. Identify and describe biologically important molecules and how they are utilized by living organisms.

Lesson Topic: Core Lesson 4: Enzymes

Core Lesson/Topic Description:

The basis for understanding life rests in an understanding of the materials that make up living things. By understanding the biochemical reactions that are essential for life and how they are regulated and facilitated, students gain an appreciation of the complexities of life even on the most fundamental levels.

Core Lesson/Topic Big Ideas:

1. Life is a product of the organization and interaction of matter.
2. Organisms share common characteristics of life.
3. Structure is related to function at all biological levels of organization.
4. Organisms obtain and use energy to carry out their life processes.
5. Chemical reactions within living systems require enzyme catalysis.

Core Lesson/Topic Essential Questions:

1. What happens to energy during energy transformations, provide specific examples (activation energy)?
2. How does the relationships between structure and function at various levels of biochemical organization (i.e., atoms, molecules and macromolecules.) affect biological functions?
3. How do biological macromolecules (polymers) form from monomers?
4. How do enzymes regulate biochemical reactions within a cell?
5. What is the role of an enzyme as a catalyst in regulating a specific biochemical reaction?
6. How do factors such as pH, temperature and concentration levels affect enzyme activity?
7. What class of macromolecules are enzymes?
8. Where on an enzyme does the substrate bind? Is this binding specific?
9. How do hydrogen bonds work?
10. In what structures within the cell are hydrogen bonds essential?

Core Lesson/Topic Key Terminology & Definitions:

1. Electron – a negatively charged subatomic particle with the mass of 1/1840th the mass of a proton
2. Element – a pure substance that consists of only one type of atom
3. Isotope – atoms of the same element that differ only in the number of neutrons they contain
4. Compound – a substance formed by the chemical combination of two or more elements in

definite proportions
5. Ionic bond – a chemical bond that forms when one or more electrons are transferred from one atom to another
6. Ion – positively and negatively charged atoms
7. Covalent bond – chemical bond that is formed when electrons are shared between elements
8. Molecule – the smallest unit of most compounds
9. Cohesion – the intermolecular attraction between molecules of the same substance. Surface tension results from the cohesive properties of water.
10. Adhesion – the intermolecular attraction between molecules of different substances. Capillary action results from the adhesive properties of water.
11. Mixture – a material that is composed of two or more elements or compounds that are physically mixed together but not chemically combined
12. Solution – a mixture in which all of the components are evenly distributed throughout
13. Solute – the substance in a solution that is dissolved
14. Solvent – the substance in a solution that dissolves the solute
15. Suspension – a mixture of water and undissolved material
16. pH scale – a scale that ranges from 0 to 14 and measures the acidity or alkalinity of a solution
17. Acid – any compound that forms hydrogen ions (H+) in solution
18. Base – any compound that forms hydroxide ions (OH-) in solution
19. Buffer – weak acids or bases that can react with strong acids or bases to prevent sharp, sudden changes in pH
20. Monomer – the smallest unit of molecules that make up polymers
21. Polymer – large molecules that are made from many smaller, repeating molecules called monomers
22. Carbohydrate – compounds made up of carbon, hydrogen, and oxygen atoms usually in a ration of 1:2:1
23. Monosaccharide – a simple sugar—the monomer of a carbohydrate
24. Polysaccharide – carbohydrate polymers made by making chains of monosaccharides
25. Lipid – biological polymers made mostly of carbon and hydrogen atoms
26. Nucleic acid – macromolecules made of hydrogen, oxygen, nitrogen, carbon, and phosphorus
27. Nucleotide – the monomer of a nucleic acid consisting of a sugar molecule, a phosphate, and a base
28. Ribonucleic acid – one of the major types of nucleic acids that contains the sugar ribose
29. Deoxyribonucleic acid – one of the major types of nucleic acids that contains the sugar deoxyribose
30. Protein – macromolecules that are made of amino acids
31. Amino acid – monomers of proteins that are made up a an amino functional group (-NH2) and a carboxyl functional group (-COOH)
32. Biological Macromolecules - a group of biomacromolecules that interact with biological systems and their environments.
33. Cell - The basic unit of structure and function for all living organisms. Cells have three common components: genetic material, cytoplasm, and a cell membrane. Eukaryotic cells also contain specialized organelles.
34. Enzyme - A protein that increases the rate of a chemical reaction without being changed by the reaction; an organic catalyst.
35. Freezing Point - The temperature at which a liquid changes state to a solid.
36. Homeostasis - The regulatory process in which an organism regulates its internal environment.
37. Specific Heat - The measure of the heat energy required to increase the temperature of a unit quantity of a substance by a certain temperature interval. (1cal/g*Cº)
38. Temperature - A measure of the average kinetic energy (energy of motion) of particles in a sample of matter. This physical property can determine the rate and extent to which chemical reactions can occur within living systems. It is commonly measured in degrees Celsius (°C) or Fahrenheit (°F).
39. Catalyst - A substance that enables a chemical reaction to proceed at a usually faster rate or under different conditions (e.g., lower temperature) than otherwise possible without being changed by the reaction.
40. Hydrogen bond - A weak electrochemical bond which arises due to differences in electronegativity resulting in partial charges in species.

Core Lesson/Topic Concepts

Student Learning Outcomes: [endif]-->

1. Understand that cells function as microscopic chemical factories synthesizing and degrading

biological molecules necessary for life.
2. Understand that molecular structure is related to function and that structure equates to function at all levels of organization.
3. Know that the macromolecules carbohydrates, lipids, proteins, and nucleic acids are the chemical foundations for life.
4. Understand that enzymes are protein catalysts which lower activation energies and increase rates of reactions.
5. Recognize that environmental factors can effect the activity of enzymes and other biological molecules.

Competencies

1. Explain what happens to energy during energy transformations, provide specific examples (activation energy).
2. Describe and interpret relationships between structure and function at various levels of biochemical organization (i.e., atoms, molecules and macromolecules.)
3. Explain how enzymes regulate biochemical reactions within a cell.
4. Describe the role of an enzyme as a catalyst in regulating a specific biochemical reaction.
5. Explain how factors such as pH, temperature and concentration levels can affect enzyme function.
6. Compare the structure and function of carbohydrates, lipids, proteins and nucleic acids in organisms.

Unit: Unit 3: Cells and Cell Processes - Cellular Structure and Function

Unit/Module Description: While subatomic particles are the building blocks of all matter, the cell is the most basic structural and functional unit similar to all living organisms and is the smallest unit of life which can be classified as living. Students will explore the relationships between structure and function of the cell and cellular components. An understanding of the structure and function of the various components of prokaryotic and eukaryotic cells will provide students with the basis for a comprehensive understanding of life.

Unit/Module Big Ideas:
1. New cells arise from the division of preexisting cells.
2. Organisms share common characteristics of life.
3. Cells have organized structures and systems necessary to support chemical reactions needed to maintain the living condition.
4. Structure is related to function at all biological levels of organization.
5. There are two fundamental types of cells, prokaryotic and eukaryotic cells.
6. Prokaryotic cells lack a membrance-enclosed nucleus, as well as other intracellular membranous organelles present in the eukaryotic cells.
7. A living cell is an extraordinary complex unit with an intricate internal structure: its activities are precisely integrated and controlled.
8. Eukaryotic cells can differentiate and organize making it possible for multicellularity.
9. There are two fundamental types of eukaryotic cells plant cell and animal cell.

Unit/Module Essential Questions:
1. How can area, volume, density, size, and shape affect cellular activity, cell lysis, and cell growth?
2. What is the relationship between structure and function when comparing a prokaryotic and eukaryotic cell?
3. Comparing models describe the function of each cellular organelle and how is each necessary for cellular activity? (nucleus, mitochondria, golgi complex, smooth/rough ER, plasma membrane, ribosome, lysozome, peroxizome, chloroplast, vacuole, cell wall, microfilaments, microtubules, vesicles)
4. What are the cellular characteristics of plant cells which allow plants to undergo photosynthesis, growth, development, and remain turgid?

Unit/Module Key Terminology & Definitions :
1. Cell - The basic unit of structure and function for all living organisms. Cells have three common components: genetic material, cytoplasm, and a cell membrane. 2. Chloroplast - An organelle found in plant cells and the cells of other eukaryotic photosynthetic organisms where photosynthesis occurs.
3. Endoplasmic Reticulum (ER) - An organelle, containing folded membranes and sacs, responsible for the production, processing, and transportation of materials for use inside and outside a eukaryotic cell. There are two forms of this organelle: rough ER that has surface ribosomes and participates in the synthesis of proteins mostly destined for export by the cell and smooth ER that has no ribosomes and participates in the synthesis of lipids and steroids as well as the transport of synthesized macromolecules.
4. Eukaryote - A type of organism composed of one or more cells containing a membrane bound nucleus, specialized organelles in the cytoplasm, and a mitotic nuclear division cycle.
5. Exocytosis - A process in which a cell releases substances to the extracellular environment by fusing a vesicular membrane with the plasma membrane, separating the membrane at the

point of fusion and allowing the substance to be released.
6. Extracellular - Located outside a cell.
7. Golgi Apparatus An organelle found in eukaryotic cells responsible for the final stages of processing proteins for release by the cell.
8. Intracellular - Located inside a cell.
9. Mitochondrion - A membrane bound organelle found in most eukaryotic cells; site of cellular respiration.
10. Multicellular - Made up of more than one cell.
11. Nucleus - A membrane bound organelle in eukaryotic cells functioning to maintain the integrity of the genetic material and, through the expression of that material, controlling and regulating cellular activities.
12. Plasma Membrane - A thin, phospholipid and protein molecule bilayer that encapsulates a cell and controls the movement of materials in and out of the cell through active or passive transport.
13. Plastids - A group of membrane bound organelles commonly found in photosynthetic organisms and mainly responsible for the synthesis and storage of food.
14. Prokaryote - A single celled organism that lacks a membrane bound nucleus and specialized organelles.
15. Ribosome - A cellular structure composed of RNA and proteins that is the site of protein synthesis in eukaryotic and prokaryotic cells.
16. System - A set of interacting or interdependent components, real or abstract, that form an integrated whole. An open system is able to interact with its environment. A closed system is isolated from its environment.
17. Tissue - An anatomical unit composed of cells organized to perform a similar function.
18. Unicellular - Made up of a single cell.
19. Adenosine triphosphate (ATP) – a nucleic acid that is one of the main chemical compounds that organisms use to store energy.
20. Diffusion – process by which molecule tend to move from an area where they are more concentrated to an area where they are less concentrated.
21. Selective permeability – property of biological membranes that allows only certain substances to pass through them.
22. Osmosis – diffusion of water through a selective permeable membrane.
23. Facilitated diffusion – movement of specific molecules across cell membranes through protein channels.
24. Active transport – energy-requiring process that moves material across a cell membrane against a concentration difference.
25. Endocytosis – process by which a cell membrane surrounds a particle and encloses the particle in a vesicle to bring it into the cell.
26. Phagocytosis – process by which a cell engulfs large particles or whole cells, either as a defense mechanism or as a means to obtain food.
27. Exocytosis – process by which a substance is released from the cell through a vesicle that transports the substance to the cell surface and then fuses with the membrane to let the substance out
28. Lipid bilayer – double-layered sheet that forms the core of nearly all cell membranes
29. Pinocytosis - method of active transport across the cell membrane in which the cell takes in extracellular fluid.
30. Organelle - individualized membrane bound unit within the cell which performs specific functions necessary for cellular operations.
31. Cilia - hairlike structures that project from the surface of some cells.
32. Flagella - hairlike structures that grow out of the cell and enables cell to move.
33. Conjugation- an exchange of genetic material that occurs between two temporarily joined cells.
34. Binary fission- a form of asexual reproduction in singe-celled organisms by which one cell divides into two cells of the same size.

Unit/Module Student Learning Outcomes: Concepts

1. Recognize that cells come only from the division of a pre-existing cells.
2. Recognize that a cell's interior is separated or compartmentalized from the environment by a phospholipid bilayer.
3. Compare and contrast the two basic forms of cells: Prokaryotes (Bacteria and Archaea) and Eukaryotes (all other cells).
4. Realize that the cytoplasm contains a collection of connected, internal membranous sacs that divide the cytoplasm into functional and structural compartments or organelles.
5. Realize that cells are the basic unit of structure and function for all living things.
6. Realize the simplest level of multicellular organization is a tissue.
7. Understand that organs work together as a system to perform common functions.
8. Differentiate that types of cells and tissues combine to form distinct structures known as organs which perform specific functions.
9. Understand that multicellular organization enables life functions such as movement, digestion, internal circulation of nutrients, excretion of waste and reproduction to be subdivided among specialized groups of cells.
10. Recognize that cells that have differentiated to perform specialized functions rely on the

collective function of other specialized cells within multicellular organisms to maintain their living condition.

Competencies

1. Explain why life only comes about from preexisting life.
2. Compare and contrast an open and closed system while describing the makeup of cell membranes.
3. Compare and contrast the two basic forms of cells: Prokaryotes (Bacteria and Archaea) and Eukaryotes (all other cells).
4. Explain how individualized units or organelles within the cell are isolated from the other components of the cell while still functioning as a single unit.
5. Describe the levels of cellular organization from a single cell to multicellular environments to tissues to organs to organ systems to organisms and explain how structure is related to function at each level.
6. Describe the structure of mitochondria and chloroplasts in eukaryotic cells.
7. Describe the fundamental roles of plastids (e.g., chloroplasts) and mitochondria in energy transformations.
8. Describe how the structure of the plasma membrane allows it to function as a regulatory structure and/or protective barrier for a cell.
9. Describe the fundamental roles of smooth and rough endoplasmic reticulum and ribosomes in protein and lipid synthesis and transport.
10. Describe the fundamental roles of lysozomes, peroxizomes, and vesicles.

STANDARDS

STATE: Pennsylvania SAS Keystone Anchors (2010)

BIO.A.1.1.1 (Advanced)	Describe the characteristics of life shared by all prokaryotic and eukaryotic organisms.
BIO.A.1.2.1 (Advanced)	Compare cellular structures and their functions in prokaryotic and eukaryotic cells.
BIO.A.1.2.2 (Advanced)	Describe and interpret relationships between structure and function at various levels of biological organization (i.e., organelles, cells, tissues, organs, organ systems, and multicellular organisms).
BIO.A.3.1.1 (Advanced)	Describe the fundamental roles of plastids (e.g., chloroplasts) and mitochondria in energy transformations.
BIO.A.4.1.1 (Advanced)	Describe how the structure of the plasma membrane allows it to function as a regulatory structure and/or protective barrier for a cell.
BIO.A.4.1.3 (Advanced)	Describe how membrane-bound cellular organelles (e.g., endoplasmic reticulum, Golgi apparatus) facilitate the transport of materials within a cell.
BIO.B.2.2.2 (Advanced)	Describe the role of ribosomes, endoplasmic reticulum, Golgi apparatus, and the nucleus in the production of specific types of proteins.

Lesson Topic: Core Lesson 1: Cell Diversity

Core Lesson/Topic Description:	While subatomic particles are the building blocks of all matter, the cell is the most basic structural and functional unit similar to all living organisms and is the smallest unit of life which can be classified as living. Students will explore the relationships between structure and function of the cell and cellular components. An understanding of the history of cell biology and the dimensions of cells provide a basis for understanding the relationships between structure and function at all levels of organization. The cell theory is one of the cornerstone theories of biology that is used to explain the most basic level of material organization that is considered alive. Understanding the cell theory and the basic types and parts of cells is essential for any fundamental understanding of biology.
Core Lesson/Topic Big Ideas:	1. New cells arise from the division of preexisting cells. (Cell Theory) 2. Organisms share common characteristics of life. 3. Cells have organized structures and systems necessary to support chemical reactions needed to maintain the living condition. 4. Structure is related to function at all biological levels of organization.
Core Lesson/Topic Essential Questions:	1. How can area, volume, density, size, and shape affect cellular activity, cell lysis, and cell growth? 2. How has our contemporary view of the cell changed overtime compared to the beginnings of cell theory?
Core	

Lesson/Topic Key Terminology & Definitions:	1. Cell - The basic unit of structure and function for all living organisms. Cells have three common components: genetic material, cytoplasm, and a cell membrane. 2. Chloroplast - An organelle found in plant cells and the cells of other eukaryotic photosynthetic organisms where photosynthesis occurs. 3. Endoplasmic Reticulum (ER) - An organelle, containing folded membranes and sacs, responsible for the production, processing, and transportation of materials for use inside and outside a eukaryotic cell. There are two forms of this organelle: rough ER that has surface ribosomes and participates in the synthesis of proteins mostly destined for export by the cell and smooth ER that has no ribosomes and participates in the synthesis of lipids and steroids as well as the transport of synthesized macromolecules. 4. Eukaryote - A type of organism composed of one or more cells containing a membrane-bound nucleus, specialized organelles in the cytoplasm, and a mitotic nuclear division cycle. 5. Exocytosis - A process in which a cell releases substances to the extracellular environment by fusing a vesicular membrane with the plasma membrane, separating the membrane at the point of fusion and allowing the substance to be released. 6. Extracellular - Located outside a cell. 7. Golgi Apparatus An organelle found in eukaryotic cells responsible for the final stages of processing proteins for release by the cell. 8. Intracellular - Located inside a cell. 9. Mitochondrion - A membrane-bound organelle found in most eukaryotic cells; site of cellular respiration. 10. Multicellular - Made up of more than one cell. 11. Nucleus - A membrane-bound organelle in eukaryotic cells functioning to maintain the integrity of the genetic material and, through the expression of that material, controlling and regulating cellular activities. 12. Plasma Membrane - A thin, phospholipid and protein molecule bilayer that encapsulates a cell and controls the movement of materials in and out of the cell through active or passive transport. 13. Plastids - A group of membrane-bound organelles commonly found in photosynthetic organisms and mainly responsible for the synthesis and storage of food. 14. Prokaryote - A single-celled organism that lacks a membrane-bound nucleus and specialized organelles. 15. Ribosome - A cellular structure composed of RNA and proteins that is the site of protein synthesis in eukaryotic and prokaryotic cells. 16. System - A set of interacting or interdependent components, real or abstract, that form an integrated whole. An open system is able to interact with its environment. A closed system is isolated from its environment. 17. Tissue - An anatomical unit composed of cells organized to perform a similar function. 18. Unicellular - Made up of a single cell. 19. Adenosine triphosphate (ATP) – a nucleic acid that is one of the main chemical compounds that organisms use to store energy. 20. Diffusion – process by which molecule tend to move from an area where they are more concentrated to an area where they are less concentrated. 21. Selective permeability – property of biological membranes that allows only certain substances to pass through them. 22. Osmosis – diffusion of water through a selective permeable membrane. 23. Facilitated diffusion – movement of specific molecules across cell membranes through protein channels. 24. Active transport – energy-requiring process that moves material across a cell membrane against a concentration difference. 25. Endocytosis – process by which a cell membrane surrounds a particle and encloses the particle in a vesicle to bring it into the cell. 26. Phagocytosis – process by which a cell engulfs large particles or whole cells, either as a defense mechanism or as a means to obtain food. 27. Exocytosis – process by which a substance is released from the cell through a vesicle that transports the substance to the cell surface and then fuses with the membrane to let the substance out 28. Lipid bilayer – double-layered sheet that forms the core of nearly all cell membranes 29. Pinocytosis - method of active transport across the cell membrane in which the cell takes in extracellular fluid. 30. Organelle - individualized membrane bound unit within the cell which performs specific functions necessary for cellular operations. 31. Cilia - hairlike structures that project from the surface of some cells. 32. Flagella - hairlike structures that grow out of the cell and enables cell to move. 33. Conjugation- an exchange of genetic material that occurs between two temporarily joined cells. 34. Binary fission- a form of asexual reproduction in singe-celled organisms by which one cell divides into two cells of the same size.
Core Lesson/Topic Student Learning	Concepts 1. Recognize that cells come only from the division of a pre-existing cells. 2. Recognize that a cell's interior is separated or compartmentalized from the environment by

Outcomes:

a phospholipid bilayer.
3. Realize that cells are the basic unit of structure and function for all living things.
4. Realize the simplest level of multicellular organization is a tissue.
5. Understand that organs work together as a system to perform common functions.
6. Differentiate that types of cells and tissues combine to form distinct structures known as organs which perform specific functions.

Competencies

1. Explain why life only comes about from preexisting life.
2. Compare and contrast an open and closed system while describing the makeup of cell membranes.
3. Explain how individualized units or organelles within the cell are isolated from the other components of the cell while still functioning as a single unit.
4. Describe the levels of cellular organization from a single cell to multicellular environments to tissues to organs to organ systems to organisms and explain how structure is related to function at each level.
5. Describe how the structure of the plasma membrane allows it to function as a regulatory structure and/or protective barrier for a cell.

Lesson Topic: Core Lesson 2: Prokaryotic v Eukaryotic Cells

Core Lesson/Topic Description:

While subatomic particles are the building blocks of all matter, the cell is the most basic structural and functional unit similar to all living organisms and is the smallest unit of life which can be classified as living. Students explore the relationships between structure and function of the cell and cellular components. An understanding of the structure and function of the various components of prokaryotic and eukaryotic cells will provide students with the basis for a comprehensive understanding of life.

Core Lesson/Topic Big Ideas:

1. New cells arise from the division of preexisting cells.
2. Organisms share common characteristics of life.
3. Cells have organized structures and systems necessary to support chemical reactions needed to maintain the living condition.
4. Structure is related to function at all biological levels of organization.
5. There are two fundamental types of cells, prokaryotic and eukaryotic cells.
6. Prokaryotic cells lack a membrance-enclosed nucleus, as well as other intracellular membranous organelles present in the eukaryotic cells.
7. A living cell is an extraordinary complex unit with an intricate internal structure: its activities are precisely integrated and controlled.
8. Eukaryotic cells can differentiate and organize making it possible for multicellularity.
9. There are two fundamental types of eukaryotic cells plant cell and animal cell.

Core Lesson/Topic Essential Questions:

1. How can area, volume, density, size, and shape affect cellular activity, cell lysis, and cell growth?
2. What is the relationship between structure and function when comparing a prokaryotic and eukaryotic cell?
3. Comparing models describe the function of each cellular organelle and how is each necessary for cellular activity? (nucleus, mitochondria, golgi complex, smooth/rough ER, plasma membrane, ribosome, lysozome, peroxizome, chloroplast, vacuole, cell wall, microfilaments, microtubules, vesicles)

Core Lesson/Topic Key Terminology & Definitions:

1. Cell - The basic unit of structure and function for all living organisms. Cells have three common components: genetic material, cytoplasm, and a cell membrane. 2. Chloroplast - An organelle found in plant cells and the cells of other eukaryotic photosynthetic organisms where photosynthesis occurs.
3. Endoplasmic Reticulum (ER) - An organelle, containing folded membranes and sacs, responsible for the production, processing, and transportation of materials for use inside and outside a eukaryotic cell. There are two forms of this organelle: rough ER that has surface ribosomes and participates in the synthesis of proteins mostly destined for export by the cell and smooth ER that has no ribosomes and participates in the synthesis of lipids and steroids as well as the transport of synthesized macromolecules.
4. Eukaryote - A type of organism composed of one or more cells containing a membrane-bound nucleus, specialized organelles in the cytoplasm, and a mitotic nuclear division cycle.
5. Exocytosis - A process in which a cell releases substances to the extracellular environment by fusing a vesicular membrane with the plasma membrane, separating the membrane at the point of fusion and allowing the substance to be released.
6. Extracellular - Located outside a cell.
7. Golgi Apparatus An organelle found in eukaryotic cells responsible for the final stages of processing proteins for release by the cell.
8. Intracellular - Located inside a cell.
9. Mitochondrion - A membrane-bound organelle found in most eukaryotic cells; site of cellular

respiration.
10. Multicellular - Made up of more than one cell.
11. Nucleus - A membrane-bound organelle in eukaryotic cells functioning to maintain the integrity of the genetic material and, through the expression of that material, controlling and regulating cellular activities.
12. Plasma Membrane - A thin, phospholipid and protein molecule bilayer that encapsulates a cell and controls the movement of materials in and out of the cell through active or passive transport.
13. Plastids - A group of membrane-bound organelles commonly found in photosynthetic organisms and mainly responsible for the synthesis and storage of food.
14. Prokaryote - A single-celled organism that lacks a membrane-bound nucleus and specialized organelles.
15. Ribosome - A cellular structure composed of RNA and proteins that is the site of protein synthesis in eukaryotic and prokaryotic cells.
16. System - A set of interacting or interdependent components, real or abstract, that form an integrated whole. An open system is able to interact with its environment. A closed system is isolated from its environment.
17. Tissue - An anatomical unit composed of cells organized to perform a similar function.
18. Unicellular - Made up of a single cell.
19. Adenosine triphosphate (ATP) – a nucleic acid that is one of the main chemical compounds that organisms use to store energy.
20. Diffusion – process by which molecule tend to move from an area where they are more concentrated to an area where they are less concentrated.
21. Selective permeability – property of biological membranes that allows only certain substances to pass through them.
22. Osmosis – diffusion of water through a selective permeable membrane.
23. Facilitated diffusion – movement of specific molecules across cell membranes through protein channels.
24. Active transport – energy-requiring process that moves material across a cell membrane against a concentration difference.
25. Endocytosis – process by which a cell membrane surrounds a particle and encloses the particle in a vesicle to bring it into the cell.
26. Phagocytosis – process by which a cell engulfs large particles or whole cells, either as a defense mechanism or as a means to obtain food.
27. Exocytosis – process by which a substance is released from the cell through a vesicle that transports the substance to the cell surface and then fuses with the membrane to let the substance out
28. Lipid bilayer – double-layered sheet that forms the core of nearly all cell membranes
29. Pinocytosis - method of active transport across the cell membrane in which the cell takes in extracellular fluid.
30. Organelle - individualized membrane bound unit within the cell which performs specific functions necessary for cellular operations.
31. Cilia - hairlike structures that project from the surface of some cells.
32. Flagella - hairlike structures that grow out of the cell and enables cell to move.
33. Conjugation- an exchange of genetic material that occurs between two temporarily joined cells.
34. Binary fission- a form of asexual reproduction in singe-celled organisms by which one cell divides into two cells of the same size.

Core Lesson/Topic Student Learning Outcomes:

Concepts

1. Recognize that cells come only from the division of a pre-existing cells.
2. Recognize that a cell's interior is separated or compartmentalized from the environment by a phospholipid bilayer.
3. Compare and contrast the two basic forms of cells: Prokaryotes (Bacteria and Archaea) and Eukaryotes (all other cells).
4. Realize that the cytoplasm contains a collection of connected, internal membranous sacs that divide the cytoplasm into functional and structural compartments or organelles.
5. Realize that cells are the basic unit of structure and function for all living things.
6. Realize the simplest level of multicellular organization is a tissue.
7. Understand that organs work together as a system to perform common functions.
8. Differentiate that types of cells and tissues combine to form distinct structures known as organs which perform specific functions.
9. Understand that multicellular organization enables life functions such as movement, digestion, internal circulation of nutrients, excretion of waste and reproduction to be subdivided among specialized groups of cells.
10. Recognize that cells that have differentiated to perform specialized functions rely on the collective function of other specialized cells within multicellular organisms to maintain their living condition.

Competencies

1. Explain why life only comes about from preexisting life.

2. Compare and contrast an open and closed system while describing the makeup of cell membranes.
3. Compare and contrast the two basic forms of cells: Prokaryotes (Bacteria and Archaea) and Eukaryotes (all other cells).
4. Explain how individualized units or organelles within the cell are isolated from the other components of the cell while still functioning as a single unit.
5. Describe the levels of cellular organization from a single cell to multicellular environments to tissues to organs to organ systems to organisms and explain how structure is related to function at each level.

Lesson Topic: Core Lesson 3: Plant v Animal Cells and Organelles

Core Lesson/Topic Description:	While subatomic particles are the building blocks of all matter, the cell is the most basic structural and functional unit similar to all living organisms and is the smallest unit of life which can be classified as living. Students explore the relationships between structure and function of the cell and cellular organelles. An understanding of the structure and function of the various components of prokaryotic and eukaryotic cells will provide students with the basis for a comprehensive understanding of life.
Core Lesson/Topic Big Ideas:	1. New cells arise from the division of preexisting cells. 2. Organisms share common characteristics of life. 3. Cells have organized structures and systems necessary to support chemical reactions needed to maintain the living condition. 4. Structure is related to function at all biological levels of organization. 5. There are two fundamental types of cells, prokaryotic and eukaryotic cells. 6. Prokaryotic cells lack a membrance-enclosed nucleus, as well as other intracellular membranous organelles present in the eukaryotic cells. 7. A living cell is an extraordinary complex unit with an intricate internal structure: its activities are precisely integrated and controlled. 8. Eukaryotic cells can differentiate and organize making it possible for multicellularity. 9. There are two fundamental types of eukaryotic cells plant cell and animal cell.
Core Lesson/Topic Essential Questions:	1. What is the relationship between structure and function when comparing a prokaryotic and eukaryotic cell? 2. Comparing models describe the function of each cellular organelle and how is each necessary for cellular activity? (nucleus, mitochondria, golgi complex, smooth/rough ER, plasma membrane, ribosome, lysozome, peroxizome, chloroplast, vacuole, cell wall, microfilaments, microtubules, vesicles) 3. What are the cellular characteristics of plant cells which allow plants to undergo photosynthesis, growth, development, and remain turgid?
Core Lesson/Topic Key Terminology & Definitions:	1. Cell - The basic unit of structure and function for all living organisms. Cells have three common components: genetic material, cytoplasm, and a cell membrane. 2. Chloroplast - An organelle found in plant cells and the cells of other eukaryotic photosynthetic organisms where photosynthesis occurs. 3. Endoplasmic Reticulum (ER) - An organelle, containing folded membranes and sacs, responsible for the production, processing, and transportation of materials for use inside and outside a eukaryotic cell. There are two forms of this organelle: rough ER that has surface ribosomes and participates in the synthesis of proteins mostly destined for export by the cell and smooth ER that has no ribosomes and participates in the synthesis of lipids and steroids as well as the transport of synthesized macromolecules. 4. Eukaryote - A type of organism composed of one or more cells containing a membrane-bound nucleus, specialized organelles in the cytoplasm, and a mitotic nuclear division cycle. 5. Exocytosis - A process in which a cell releases substances to the extracellular environment by fusing a vesicular membrane with the plasma membrane, separating the membrane at the point of fusion and allowing the substance to be released. 6. Extracellular - Located outside a cell. 7. Golgi Apparatus An organelle found in eukaryotic cells responsible for the final stages of processing proteins for release by the cell. 8. Intracellular - Located inside a cell. 9. Mitochondrion - A membrane-bound organelle found in most eukaryotic cells; site of cellular respiration. 10. Multicellular - Made up of more than one cell. 11. Nucleus - A membrane-bound organelle in eukaryotic cells functioning to maintain the integrity of the genetic material and, through the expression of that material, controlling and regulating cellular activities. 12. Plasma Membrane - A thin, phospholipid and protein molecule bilayer that encapsulates a cell and controls the movement of materials in and out of the cell through active or passive transport. 13. Plastids - A group of membrane-bound organelles commonly found in photosynthetic organisms and mainly responsible for the synthesis and storage of food.

14. Prokaryote - A single-celled organism that lacks a membrane-bound nucleus and specialized organelles.
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17. Tissue - An anatomical unit composed of cells organized to perform a similar function.
18. Unicellular - Made up of a single cell.
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20. Diffusion – process by which molecule tend to move from an area where they are more concentrated to an area where they are less concentrated.
21. Selective permeability – property of biological membranes that allows only certain substances to pass through them.
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Core Lesson/Topic Student Learning Outcomes:

Concepts

1. Recognize that cells come only from the division of a pre-existing cells.
2. Recognize that a cell's interior is separated or compartmentalized from the environment by a phospholipid bilayer.
3. Realize that the cytoplasm contains a collection of connected, internal membranous sacs that divide the cytoplasm into functional and structural compartments or organelles.
4. Realize that cells are the basic unit of structure and function for all living things.
5. Understand that multicellular organization enables life functions such as movement, digestion, internal circulation of nutrients, excretion of waste and reproduction to be subdivided among specialized groups of cells.
6. Recognize that cells that have differentiated to perform specialized functions rely on the collective function of other specialized cells within multicellular organisms to maintain their living condition.

Competencies

1. Explain why life only comes about from preexisting life.
2. Compare and contrast an open and closed system while describing the makeup of cell membranes.
3. Explain how individualized units or organelles within the cell are isolated from the other components of the cell while still functioning as a single unit.
4. Describe the levels of cellular organization from a single cell to multicellular environments to tissues to organs to organ systems to organisms and explain how structure is related to function at each level.
5. Describe the structure of mitochondria and chloroplasts in eukaryotic cells.
6. Describe the fundamental roles of plastids (e.g., chloroplasts) and mitochondria in energy transformations.
7. Describe how the structure of the plasma membrane allows it to function as a regulatory structure and/or protective barrier for a cell.
8. Describe the fundamental roles of smooth and rough endoplasmic reticulum and ribosomes in protein and lipid synthesis and transport.
9. Describe the fundamental roles of lysozomes, peroxizomes, and vesicles.

Unit: Unit 4: Cells and Cell Processes - Homeostasis, Transport, and Bioenergetics

Unit/Module Description:

Living things must be able to acquire energy, transport molecules, and recycle and maintain concentration gradients to carry out all of the processes necessary for life. Some organisms are capable of utilizing light or chemical energy directly, while others must look to other organisms for energy. Students explore the energy transfers that are essential for life, how organisms maintain homeostasis, transport of biological molecules, and also addresses how cycles are an integral part of these processes.

Unit/Module Big Ideas:

1. Organisms obtain and use energy to carry out their life processes.
2. Through a variety of mechanisms organisms maintain homeostasis.
3. Biological systems have evolved to meet the energy needs of biological reactions by using the energy of the sun or inorganic molecules to produce their own food. These producers then act as food that supplies organisms through the food chain with energy.
4. Organisms that are able to make their own food molecule are referred to as autotrophs.
5. A cell stores energy that it obtained from the sun or inorganic sources in the chemical bonds of a sugar or ATP molecule. $6CO_2 + 6H_2O$ ----------> $C_6 H_{12} O_6$
6. Light is the energy source in photosynthesis. Chlorophyll is a pigment molecule that is able to use the light energy of sunlight to make food.
7. Overall photosynthesis is part of the carbon cycle because it takes CO_2 and locks it in biological molecules.
8. The three main factors that affect the rate of photosynthesis are availability of water, temperature, and intensity of light.
9. Aerobic respiration is an efficient process of accessing the stored chemical potential energy found in food molecules and using that energy to make ATP.
10. The two main types of anaerobic respiration are lactic acid fermentation, and alcoholic fermentation. These two processes are less efficient than aerobic respiration but they can occur in environments that are oxygen-free.
11. Respiration is part of the carbon cycle because it takes carbon-rich molecules that are locked in living tissues and breaks them down into CO_2 that returns to the atmosphere or dissolves in aqueous solutions.
12. Many groups of microbes are capable of making their own food molecules. These microbes are called photoautotrophs if they are capable of photosynthesis and chemoautotrophs if they are capable of chemosynthesis. There are even microbes called photoheterotrophs that are capable of photosynthesis, but must also get food molecules from other microbes.
13. Any chemical reaction requires activation energy, or an outside push to get a reaction going. Enzymes are used by living things to lower the activation energy needed to get a reaction started. Some reactions (endergonic) require constant energy input to yield a product while others (exergonic) will release energy once they get the initial push. Living things have evolved systems such as photosynthesis and chemosynthesis to produce high energy food molecules using endergonic reactions. In addition, living things have evolved ways to harness exergonic reactions to use that food energy to power cellular work.
14. A cell stores energy that it obtained from the sun or inorganic sources in the chemical bonds of a sugar or ATP molecule. Light is the energy source in photosynthesis. Chlorophyll is a pigment molecule that is able to use the light energy of sunlight break up water molecules can energize electrons.
15. The light-dependent reactions take sunlight and use its energy to break water molecules. The electrons of these broken molecules are used to generate ATP and electron carriers.
16. The Calvin cycle uses the ATP and electron carriers from the light-dependent reactions to assemble high-energy sugars that will be used to store the energy obtained until it is needed.
17. Aerobic respiration is an efficient process of accessing the stored chemical potential energy found in food molecules and using that energy to make ATP.
18. The three main stages of aerobic respiration are: glycolysis, the Krebs cyce, and the electron transport chain. Overall aerobic respiration produces 36-38 ATP molecules per molecule of glucose.
19. Various cell structures are involved in transport of materials into, out of, and throughout the cell.
20. Molecules are transported into and out of cells via various types of active and passive transport. These mechanisms are dependent on factors such as size, shape, and chemical makeup.
21. Organisms maintain balance between their internal and external environments in areas such as temperature and concentration via homeostatic mechanisms.

Unit/Module Essential Questions:

1. How do changes in energy affect biological reactions and how have biological systems evolved to respond to the energy needs of biological reactions?
2. What organisms are able to make their own food molecules?
3. How does a cell store and use the energy it obtains from photosynthesis?
4. What is the overall equation for photosynthesis and what is the role of light and chlorophyll in photosynthesis?
5. What is the basic operation of the light-dependent reactions and the Calvin cycle?
6. How is photosynthesis part of the carbon cycle?
7. What are some of the factors that will affect the rate of photosynthesis?
8. What is aerobic respiration and what are the three main stages of aerobic respiration?
9. What are the two main types of anaerobic respiration?

10. How is respiration part of the carbon cycle?
11. How do microbes play a role in production, respiration, and the global carbon cycle?
12. How does a cell store and use the energy it obtains from photosynthesis?
13. How are the various methods of active and passive transport used to transport biologically important molecules?
14. How do organisms utilize homeostatic mechanisms to maintain balance between internal and external environments?

Unit/Module Key Terminology & Definitions :

1. Active Transport - The movement of particles from an area of low concentration to an area of high concentration that uses energy provided by ATP or a difference in electrical charges across a cell membrane.
2. Adenosine Triphosphate (ATP) A molecule that provides energy for cellular reactions and processes. ATP releases energy when one of its high energy bonds is broken to release a phosphate group.
3. Biochemical Conversion The changing of organic matter into other chemical forms such as fuels.
4. Bioenergetics The study of energy flow (energy transformations) into and within living systems.
5. Biogeochemical Cycles - The movement of abiotic factors between the living and nonliving components within ecosystems; also known as nutrient cycles (i.e., water cycle, carbon cycle, oxygen cycle, and nitrogen cycle).
6. Biotechnology - Any procedure or methodology that uses biological systems or living organisms to develop or modify either products or processes for specific use. This term is commonly associated with genetic engineering, which is one of many applications.
7. Carrier (Transport) Proteins - Proteins embedded in the plasma membrane involved in the movement of ions, small molecules, and macromolecules into and out of cells; also known as transport proteins.
8. Cellular Respiration - A complex set of chemical reactions involving an energy transformation where potential chemical energy in the bonds of "food" molecules is released and partially captured in the bonds of adenosine triphosphate (ATP) molecules.
9. Chloroplast - An organelle found in plant cells and the cells of other eukaryotic photosynthetic organisms where photosynthesis occurs.
10. Concentration - The measure of the amount or proportion of a given substance when combined with another substance.
11. Concentration Gradient - The graduated difference in concentration of a solute per unit distance through a solution.
12. Energy Transformation - A process in which energy changes from one form to another form while some of the energy is lost to the environment.
13. Environment - The total surroundings of an organism or a group of organisms.
14. Facilitated Diffusion - A process in which substances are transported across a plasma membrane with the concentration gradient with the aid of carrier (transport) proteins; does not require the use of energy.
15. Homeostasis - The regulatory process in which an organism regulates its internal environment.
16. Homeostatic Mechanism - A regulatory mechanism that contributes to maintaining a state of equilibrium (e.g., thermoregulation, water regulation, and oxygen regulation).
17. Impermeable - Not permitting passage of a substance or substances.
18. Mitochondrion - A membrane bound organelle found in most eukaryotic cells; site of cellular respiration.
19. Passive Transport - The transportation of materials across a plasma membrane without using energy.
20. Plasma Membrane - A thin, phospholipid and protein molecule bilayer that encapsulates a cell and controls the movement of materials in and out of the cell through active or passive transport.
21. Pumps (Ion or Molecular) - Any of several molecular mechanisms in which ions or molecules are transported across a cellular membrane requiring the use of an energy source (e.g., glucose, sodium [Na+], calcium [Ca+], and potassium [K+]).
22. Calorie – the amount of energy needed to raise the temperature of 1 gram of water 1º C.
23. Glycolysis – stage of aerobic and anaerobic respiration where glucose is broken down to produce ATP and electron carriers.
24. Aerobic respiration – chemical breakdown of food molecules that occurs in the presence of oxygen.
25. NAD+ - electron carrier molecule used in respiration.
26. Fermentation – chemical breakdown of food molecules that occurs in environments where oxygen is not available.
27. Anaerobic respiration – chemical breakdown of food molecules that occurs in environments where oxygen is not available.
28. Krebs cycle – the second stage of food breakdown in aerobic respiration where ATP and electron carriers are generated.
29. Electron transport chain – the third and final stage of aerobic cellular respiration where electron carriers are used to generate ATP.
30. ATP synthase – intermembrane protein that uses the energy of flowing H+ to produce ATP.
31. Chemical reaction – a process that changes one set of chemicals into another set of chemicals.

32. Reactant – the elements or compounds that enter into a chemical reaction.
33. Product – the elements or compounds that are produced by a chemical reaction.
34. Activation energy – the energy needed to get a chemical reaction started. An enzyme reduces the required activation energy.
35. Catalyst – a substance that speeds up the rate of a chemical reaction.
36. Enzyme – a protein that acts as a biological catalyst.
37. Substrate – the reactant of an enzyme-catalyzed reaction.
38. Chlorophyll – chief pigment of photosynthesis.
39. Thylakoid – saclike photosynthetic membranes found inside chloroplasts.
40. Stroma – the space inside chloroplasts that lies between the outer membrane and the thylakiods.
41. NADP+ - electron carrier molecule used in photosynthesis.
42. Light-dependent reactions – a set of reactions in photosynthesis that use light energy to produce ATP and NADPH and oxygen.
43. Calvin cycle – a set of reactions in photosynthesis that produces high-energy sugars.
44. Photosynthesis – process in which organisms use the energy of the sun to convert water and carbon dioxide into oxygen and high energy carbohydrates.
45. Pigment – light absorbing molecules.
46. Photoheterotroph – prokaryotes that are photosynthetic, but also obtain energy from organic compounds.
47. Autotroph – organisms that make their own food.
48. Heterotroph – organisms that cannot make their own food molecules and must rely on other organisms for food.

Unit/Module Student Learning Outcomes:

Concepts:

1. Understand how the structure of the plasma membrane allows it to function as a regulatory structure and/or protective barrier for the cell.
2. Compare the mechanisms that transport materials across the plasma membrane.
3. Differentiate between the various mechanisms of passive transport: osmosis, diffusion, facilitated diffusion, ion channels.
4. Differentiate between the various mechanism of active transport: sodium potassium pumps, endocytosis (pinocyctosis, phagocytosis), exocytosis.
5. Understand between Hypo, hyper and isotonic and explain how they relate to biological membranes (cytolysis, plasmolysis, turgor pressure).
6. Differentiate between the types of energy and energy transformations.
7. Differentiate and explain the Laws of Thermodynamics.
8. Describe how the breaking down of ATP supplies energy to drive chemical reactions.
9. Explain how all matter and energy is conserved during energy transformations.
10. Explain why almost all organisms depend on photosynthesis.
11. Differentiate between light and dark reactions.
12. Understand how plant cells' structure and function allow for the utilization of light energy in the formation of sugars and ATP.
13. Differentiate between the chloroplasts pigments and their light absorption capabilities.
14. Describe and understand the major types of cellular respiration.
15. Differentiate between aerobic and anaerobic respiration.
16. Describe the fermentation process.

Competencies:

1. Describe how membrane-bound cellular organelles facilitate the transport of materials with a cell (golgi apparatus, endoplasmic reticulum).
2. Explain the mechanisms that permit organisms to maintain biological balance between their internal and external environments.
3. Explain how organisms maintain homeostasis (e.g. thermoregulation, water regulation, oxygen regulation).
4. Describe how the structure of the plasma membrane allows it to function as a regulatory structure and/or protective barrier for the cell.
5. Compare and contrast between the various mechanisms of passive transport: osmosis, diffusion, facilitated diffusion, ion channels.
6. Compare and contrast between the various mechanism of active transport: sodium potassium pumps, endocytosis (pinocyctosis, phagocytosis), exocytosis.
7. Illustrate between Hypo, hyper and isotonic and explain how they relate to biological membranes (cytolysis, plasmolysis, turgor pressure).
8. Compare and contrast between the types of energy and energy transformations.
7. Compare and contrast between the Laws of Thermodynamics.
8. Describe how the breaking down of ATP supplies energy to drive chemical reactions.
9. Explain how all matter and energy is conserved during energy transformations.
10. Explain why almost all organisms depend on photosynthesis.
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12. Describe how plant cells' structure and function allow for the utilization of light energy in the formation of sugars and ATP.
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14. Describe the major types of cellular respiration.
15. Differentiate between aerobic and anaerobic respiration.
16. Describe the fermentation process.

STANDARDS

STATE: Pennsylvania SAS Keystone Anchors (2010)

BIO.A.3.1.1 (Advanced)	Describe the fundamental roles of plastids (e.g., chloroplasts) and mitochondria in energy transformations.
BIO.A.3.2.1 (Advanced)	Compare the basic transformation of energy during photosynthesis and cellular respiration.
BIO.A.3.2.2 (Advanced)	Describe the role of ATP in biochemical reactionssms.
BIO.A.4.1.1 (Advanced)	Describe how the structure of the plasma membrane allows it to function as a regulatory structure and/or protective barrier for a cell.
BIO.A.4.1.2 (Advanced)	Compare the mechanisms that transport materials across the plasma membrane (i.e., passive transport—diffusion, osmosis, facilitated diffusion; and active transport—pumps, endocytosis, exocytosis).
BIO.A.4.1.3 (Advanced)	Describe how membrane-bound cellular organelles (e.g., endoplasmic reticulum, Golgi apparatus) facilitate the transport of materials within a cell.
BIO.A.4.2.1 (Advanced)	Explain how organisms maintain homeostasis (e.g., thermoregulation, water regulation, oxygen regulation).

Lesson Topic: Core Lesson 1: Homeostasis and Transport

Core Lesson/Topic Description:	Living things must be able to acquire energy, transport molecules, and recycle and maintain concentration gradients to carry out all of the processes necessary for life. Students explore the energy transfers that are essential for life, how organisms maintain homeostasis, transport of biological molecules, and also addresses how cycles are an integral part of these processes.
Core Lesson/Topic Big Ideas:	1. Organisms obtain and use energy to carry out their life processes. 2. Through a variety of mechanisms organisms maintain homeostasis. 3. Any chemical reaction requires activation energy, or an outside push to get a reaction going. Enzymes are used by living things to lower the activation energy needed to get a reaction started. Some reactions (endergonic) require constant energy input to yield a product while others (exergonic) will release energy once they get the initial push. Living things have evolved systems such as photosynthesis and chemosynthesis to produce high energy food molecules using endergonic reactions. In addition, living things have evolved ways to harness exergonic reactions to use that food energy to power cellular work. 4. Various cell structures are involved in transport of materials into, out of, and throughout the cell. 5. Molecules are transported into and out of cells via various types of active and passive transport. These mechanisms are dependent on factors such as size, shape, and chemical makeup. 6. Organisms maintain balance between their internal and external environments in areas such as temperature and concentration via homeostatic mechanisms.
Core Lesson/Topic Essential Questions:	1. How do changes in energy affect biological reactions and how have biological systems evolved to respond to the energy needs of biological reactions? 2. How are the various methods of active and passive transport used to transport biologically important molecules? 3. How do organisms utilize homeostatic mechanisms to maintain balance between internal and external environments?
Core Lesson/Topic Key Terminology & Definitions:	1. Active Transport - The movement of particles from an area of low concentration to an area of high concentration that uses energy provided by ATP or a difference in electrical charges across a cell membrane. 2. Adenosine Triphosphate (ATP) A molecule that provides energy for cellular reactions and processes. ATP releases energy when one of its high-energy bonds is broken to release a

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45. Pigment – light absorbing molecules.
46. Photoheterotroph – prokaryotes that are photosynthetic, but also obtain energy from organic compounds.
47. Autotroph – organisms that make their own food.
48. Heterotroph – organisms that cannot make their own food molecules and must rely on other organisms for food.

Core Lesson/Topic Student Learning Outcomes:

Concepts:

1. Understand how the structure of the plasma membrane allows it to function as a regulatory structure and/or protective barrier for the cell.
2. Compare the mechanisms that transport materials across the plasma membrane.
3. Differentiate between the various mechanisms of passive transport: osmosis, diffusion, facilitated diffusion, ion channels.
4. Differentiate between the various mechanism of active transport: sodium potassium pumps, endocytosis (pinocytosis, phagocytosis), exocytosis.
5. Understand between Hypo, hyper and isotonic and explain how they relate to biological membranes (cytolysis, plasmolysis, turgor pressure).
6. Differentiate between the types of energy and energy transformations.
7. Differentiate and explain the Laws of Thermodynamics.

Competencies:

1. Describe how membrane-bound cellular organelles facilitate the transport of materials with a cell (golgi apparatus, endoplasmic reticulum).
2. Explain the mechanisms that permit organisms to maintain biological balance between their internal and external environments.
3. Explain how organisms maintain homeostasis (e.g. thermoregulation, water regulation, oxygen regulation).
4. Describe how the structure of the plasma membrane allows it to function as a regulatory structure and/or protective barrier for the cell.
5. Compare and contrast between the various mechanisms of passive transport: osmosis, diffusion, facilitated diffusion, ion channels.
6. Compare and contrast between the various mechanism of active transport: sodium potassium pumps, endocytosis (pinocytosis, phagocytosis), exocytosis.
7. Illustrate between Hypo, hyper and isotonic and explain how they relate to biological membranes (cytolysis, plasmolysis, turgor pressure).
8. Compare and contrast between the types of energy and energy transformations.
7. Compare and contrast between the Laws of Thermodynamics.

Lesson Topic: Core Lesson 2: Bioenergetics - Photosynthesis

Core Lesson/Topic Description:

Living things must be able to acquire energy, transport molecules, and recycle and maintain concentration gradients to carry out all of the processes necessary for life. Some organisms are capable of utilizing light or chemical energy directly, while others must look to other organisms for energy. Students explore the energy transfers that are essential for life, how organisms maintain homeostasis, transport of biological molecules, and also addresses how cycles are an integral part of these processes.

Core Lesson/Topic Big Ideas:

1. Organisms obtain and use energy to carry out their life processes.
2. Biological systems have evolved to meet the energy needs of biological reactions by using the energy of the sun or inorganic molecules to produce their own food. These producers then act as food that supplies organisms through the food chain with energy.
3. Organisms that are able to make their own food molecule are referred to as autotrophs.
4. A cell stores energy that it obtained from the sun or inorganic sources in the chemical bonds of a sugar or ATP molecule. $6CO_2 + 6H_2O$ ----------> $C_6H_{12}O_6$

5. Light is the energy source in photosynthesis. Chlorophyll is a pigment molecule that is able to use the light energy of sunlight to make food.
6. Overall photosynthesis is part of the carbon cycle because it takes CO2 and locks it in biological molecules.
7. The three main factors that affect the rate of photosynthesis are availability of water, temperature, and intensity of light.
8. Many groups of microbes are capable of making their own food molecules. These microbes are called photoautotrophs if they are capable of photosynthesis and chemoautotrophs if they are capable of chemosynthesis. There are even microbes called photoheterotrophs that are capable of photosynthesis, but must also get food molecules from other microbes.
9. Any chemical reaction requires activation energy, or an outside push to get a reaction going. Enzymes are used by living things to lower the activation energy needed to get a reaction started. Some reactions (endergonic) require constant energy input to yield a product while others (exergonic) will release energy once they get the initial push. Living things have evolved systems such as photosynthesis and chemosynthesis to produce high energy food molecules using endergonic reactions. In addition, living things have evolved ways to harness exergonic reactions to use that food energy to power cellular work.
10. A cell stores energy that it obtained from the sun or inorganic sources in the chemical bonds of a sugar or ATP molecule. Light is the energy source in photosynthesis. Chlorophyll is a pigment molecule that is able to use the light energy of sunlight break up water molecules can energize electrons.
11. The light-dependent reactions take sunlight and use its energy to break water molecules. The electrons of these broken molecules are used to generate ATP and electron carriers.
12. The Calvin cycle uses the ATP and electron carriers from the light-dependent reactions to assemble high-energy sugars that will be used to store the energy obtained until it is needed.

Core Lesson/Topic Essential Questions:

1. How do changes in energy affect biological reactions and how have biological systems evolved to respond to the energy needs of biological reactions?
2. What organisms are able to make their own food molecules?
3. How does a cell store and use the energy it obtains from photosynthesis?
4. What is the overall equation for photosynthesis and what is the role of light and chlorophyll in photosynthesis?
5. What is the basic operation of the light-dependent reactions and the Calvin cycle?
6. How is photosynthesis part of the carbon cycle?
7. What are some of the factors that will affect the rate of photosynthesis?
8. What is aerobic respiration and what are the three main stages of aerobic respiration?
9. What are the two main types of anaerobic respiration?
10. How is respiration part of the carbon cycle?
11. How do microbes play a role in production, respiration, and the global carbon cycle?
12. How does a cell store and use the energy it obtains from photosynthesis?
13. How are the various methods of active and passive transport used to transport biologically important molecules?
14. How do organisms utilize homeostatic mechanisms to maintain balance between internal and external environments?

Core Lesson/Topic Key Terminology & Definitions:

1. Active Transport - The movement of particles from an area of low concentration to an area of high concentration that uses energy provided by ATP or a difference in electrical charges across a cell membrane.
2. Adenosine Triphosphate (ATP) A molecule that provides energy for cellular reactions and processes. ATP releases energy when one of its high-energy bonds is broken to release a phosphate group.
3. Biochemical Conversion The changing of organic matter into other chemical forms such as fuels.
4. Bioenergetics The study of energy flow (energy transformations) into and within living systems.
5. Biogeochemical Cycles - The movement of abiotic factors between the living and nonliving components within ecosystems; also known as nutrient cycles (i.e., water cycle, carbon cycle, oxygen cycle, and nitrogen cycle).
6. Biotechnology - Any procedure or methodology that uses biological systems or living organisms to develop or modify either products or processes for specific use. This term is commonly associated with genetic engineering, which is one of many applications.
7. Carrier (Transport) Proteins - Proteins embedded in the plasma membrane involved in the movement of ions, small molecules, and macromolecules into and out of cells; also known as transport proteins.
8. Cellular Respiration - A complex set of chemical reactions involving an energy transformation where potential chemical energy in the bonds of "food" molecules is released and partially captured in the bonds of adenosine triphosphate (ATP) molecules.
9. Chloroplast - An organelle found in plant cells and the cells of other eukaryotic photosynthetic organisms where photosynthesis occurs.
10. Concentration - The measure of the amount or proportion of a given substance when

combined with another substance.
11. Concentration Gradient - The graduated difference in concentration of a solute per unit distance through a solution.
12. Energy Transformation - A process in which energy changes from one form to another form while some of the energy is lost to the environment.
13. Environment - The total surroundings of an organism or a group of organisms.
14. Facilitated Diffusion - A process in which substances are transported across a plasma membrane with the concentration gradient with the aid of carrier (transport) proteins; does not require the use of energy.
15. Homeostasis - The regulatory process in which an organism regulates its internal environment.
16. Homeostatic Mechanism - A regulatory mechanism that contributes to maintaining a state of equilibrium (e.g., thermoregulation, water regulation, and oxygen regulation).
17. Impermeable - Not permitting passage of a substance or substances.
18. Mitochondrion - A membrane-bound organelle found in most eukaryotic cells; site of cellular respiration.
19. Passive Transport - The transportation of materials across a plasma membrane without using energy.
20. Plasma Membrane - A thin, phospholipid and protein molecule bilayer that encapsulates a cell and controls the movement of materials in and out of the cell through active or passive transport.
21. Pumps (Ion or Molecular) - Any of several molecular mechanisms in which ions or molecules are transported across a cellular membrane requiring the use of an energy source (e.g., glucose, sodium [Na+], calcium [Ca+], and potassium [K+]).
22. Calorie – the amount of energy needed to raise the temperature of 1 gram of water 1º C.
23. Glycolysis – stage of aerobic and anaerobic respiration where glucose is broken down to produce ATP and electron carriers.
24. Aerobic respiration – chemical breakdown of food molecules that occurs in the presence of oxygen.
25. NAD+ - electron carrier molecule used in respiration.
26. Fermentation – chemical breakdown of food molecules that occurs in environments where oxygen is not available.
27. Anaerobic respiration – chemical breakdown of food molecules that occurs in environments where oxygen is not available.
28. Krebs cycle – the second stage of food breakdown in aerobic respiration where ATP and electron carriers are generated.
29. Electron transport chain – the third and final stage of aerobic cellular respiration where electron carriers are used to generate ATP.
30. ATP synthase – intermembrane protein that uses the energy of flowing H+ to produce ATP.
31. Chemical reaction – a process that changes one set of chemicals into another set of chemicals.
32. Reactant – the elements or compounds that enter into a chemical reaction.
33. Product – the elements or compounds that are produced by a chemical reaction.
34. Activation energy – the energy needed to get a chemical reaction started. An enzyme reduces the required activation energy.
35. Catalyst – a substance that speeds up the rate of a chemical reaction.
36. Enzyme – a protein that acts as a biological catalyst.
37. Substrate – the reactant of an enzyme-catalyzed reaction.
38. Chlorophyll – chief pigment of photosynthesis.
39. Thylakoid – saclike photosynthetic membranes found inside chloroplasts.
40. Stroma – the space inside chloroplasts that lies between the outer membrane and the thylakiods.
41. NADP+ - electron carrier molecule used in photosynthesis.
42. Light-dependent reactions – a set of reactions in photosynthesis that use light energy to produce ATP and NADPH and oxygen.
43. Calvin cycle – a set of reactions in photosynthesis that produces high-energy sugars.
44. Photosynthesis – process in which organisms use the energy of the sun to convert water and carbon dioxide into oxygen and high energy carbohydrates.
45. Pigment – light absorbing molecules.
46. Photoheterotroph – prokaryotes that are photosynthetic, but also obtain energy from organic compounds.
47. Autotroph – organisms that make their own food.
48. Heterotroph – organisms that cannot make their own food molecules and must rely on other organisms for food.

Core Lesson/Topic Student Learning Outcomes:

Concepts:

1. Understand how the structure of the plasma membrane allows it to function as a regulatory structure and/or protective barrier for the cell.
2. Compare the mechanisms that transport materials across the plasma membrane.

3. Differentiate between the various mechanisms of passive transport: osmosis, diffusion, facilitated diffusion, ion channels.
4. Differentiate between the various mechanism of active transport: sodium potassium pumps, endocytosis (pinocyctosis, phagocytosis), exocytosis.
5. Understand between Hypo, hyper and isotonic and explain how they relate to biological membranes (cytolysis, plasmolysis, turgor pressure).
6. Differentiate between the types of energy and energy transformations.
7. Differentiate and explain the Laws of Thermodynamics.
8. Describe how the breaking down of ATP supplies energy to drive chemical reactions.
9. Explain how all matter and energy is conserved during energy transformations.
10. Explain why almost all organisms depend on photosynthesis.
11. Differentiate between light and dark reactions.
12. Understand how plant cells' structure and function allow for the utilization of light energy in the formation of sugars and ATP.
13. Differentiate between the chloroplasts pigments and their light absorption capabilities.
14. Describe and understand the major types of cellular respiration.
15. Differentiate between aerobic and anaerobic respiration.
16. Describe the fermentation process.

Competencies:

1. Describe how membrane-bound cellular organelles facilitate the transport of materials with a cell (golgi apparatus, endoplasmic reticulum).
2. Explain the mechanisms that permit organisms to maintain biological balance between their internal and external environments.
3. Explain how organisms maintain homeostasis (e.g. thermoregulation, water regulation, oxygen regulation).
4. Describe how the structure of the plasma membrane allows it to function as a regulatory structure and/or protective barrier for the cell.
5. Compare and contrast between the various mechanisms of passive transport: osmosis, diffusion, facilitated diffusion, ion channels.
6. Compare and contrast between the various mechanism of active transport: sodium potassium pumps, endocytosis (pinocyctosis, phagocytosis), exocytosis.
7. Illustrate between Hypo, hyper and isotonic and explain how they relate to biological membranes (cytolysis, plasmolysis, turgor pressure).
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7. Compare and contrast between the Laws of Thermodynamics.
8. Describe how the breaking down of ATP supplies energy to drive chemical reactions.
9. Explain how all matter and energy is conserved during energy transformations.
10. Explain why almost all organisms depend on photosynthesis.
11. Differentiate between light and dark reactions.
12. Describe how plant cells' structure and function allow for the utilization of light energy in the formation of sugars and ATP.
13. Differentiate between the chloroplasts pigments and their light absorption capabilities.
14. Describe the major types of cellular respiration.
15. Differentiate between aerobic and anaerobic respiration.
16. Describe the fermentation process.

Lesson Topic: Core Lesson 3: Bioenergetics - Cellular Respiration

Core Lesson/Topic Description:

Living things must be able to acquire energy, transport molecules, and recycle and maintain concentration gradients to carry out all of the processes necessary for life. Some organisms are capable of utilizing light or chemical energy directly, while others must look to other organisms for energy. Students explore the energy transfers that are essential for life, how organisms maintain homeostasis, transport of biological molecules, and also addresses how cycles are an integral part of these processes.

Core Lesson/Topic Big Ideas:

1. Organisms obtain and use energy to carry out their life processes.
2. Biological systems have evolved to meet the energy needs of biological reactions by using the energy of the sun or inorganic molecules to produce their own food. These producers then act as food that supplies organisms through the food chain with energy.
3. Organisms that are able to make their own food molecule are referred to as autotrophs and organisms who acquire food by consuming other life are called heterotrophs.
4. Aerobic respiration is an efficient process of accessing the stored chemical potential energy found in food molecules and using that energy to make ATP.
5. The two main types of anaerobic respiration are lactic acid fermentation, and alcoholic

fermentation. These two processes are less efficient than aerobic respiration but they can occur in environments that are oxygen-free.
6. Respiration is part of the carbon cycle because it takes carbon-rich molecules that are locked in living tissues and breaks them down into CO2 that returns to the atmosphere or dissolves in aqueous solutions.
7. Aerobic respiration is an efficient process of accessing the stored chemical potential energy found in food molecules and using that energy to make ATP.
8. The three main stages of aerobic respiration are: glycolysis, the Krebs cyce, and the electron transport chain. Overall aerobic respiration produces 36-38 ATP molecules per molecule of glucose.

Core Lesson/Topic Essential Questions:

1. How do changes in energy affect biological reactions and how have biological systems evolved to respond to the energy needs of biological reactions?
2. What is aerobic respiration and what are the three main stages of aerobic respiration?
3. What are the two main types of anaerobic respiration?
4. How is respiration part of the carbon cycle?
5. How do microbes play a role in production, respiration, and the global carbon cycle?
6. How does a cell store and use the energy it obtains from photosynthesis?

Core Lesson/Topic Key Terminology & Definitions:

1. Active Transport - The movement of particles from an area of low concentration to an area of high concentration that uses energy provided by ATP or a difference in electrical charges across a cell membrane.
2. Adenosine Triphosphate (ATP) A molecule that provides energy for cellular reactions and processes. ATP releases energy when one of its high-energy bonds is broken to release a phosphate group.
3. Biochemical Conversion The changing of organic matter into other chemical forms such as fuels.
4. Bioenergetics The study of energy flow (energy transformations) into and within living systems.
5. Biogeochemical Cycles - The movement of abiotic factors between the living and nonliving components within ecosystems; also known as nutrient cycles (i.e., water cycle, carbon cycle, oxygen cycle, and nitrogen cycle).
6. Biotechnology - Any procedure or methodology that uses biological systems or living organisms to develop or modify either products or processes for specific use. This term is commonly associated with genetic engineering, which is one of many applications.
7. Carrier (Transport) Proteins - Proteins embedded in the plasma membrane involved in the movement of ions, small molecules, and macromolecules into and out of cells; also known as transport proteins.
8. Cellular Respiration - A complex set of chemical reactions involving an energy transformation where potential chemical energy in the bonds of "food" molecules is released and partially captured in the bonds of adenosine triphosphate (ATP) molecules.
9. Chloroplast - An organelle found in plant cells and the cells of other eukaryotic photosynthetic organisms where photosynthesis occurs.
10. Concentration - The measure of the amount or proportion of a given substance when combined with another substance.
11. Concentration Gradient - The graduated difference in concentration of a solute per unit distance through a solution.
12. Energy Transformation - A process in which energy changes from one form to another form while some of the energy is lost to the environment.
13. Environment - The total surroundings of an organism or a group of organisms.
14. Facilitated Diffusion - A process in which substances are transported across a plasma membrane with the concentration gradient with the aid of carrier (transport) proteins; does not require the use of energy.
15. Homeostasis - The regulatory process in which an organism regulates its internal environment.
16. Homeostatic Mechanism - A regulatory mechanism that contributes to maintaining a state of equilibrium (e.g., thermoregulation, water regulation, and oxygen regulation).
17. Impermeable - Not permitting passage of a substance or substances.
18. Mitochondrion - A membrane-bound organelle found in most eukaryotic cells; site of cellular respiration.
19. Passive Transport - The transportation of materials across a plasma membrane without using energy.
20. Plasma Membrane - A thin, phospholipid and protein molecule bilayer that encapsulates a cell and controls the movement of materials in and out of the cell through active or passive transport.
21. Pumps (Ion or Molecular) - Any of several molecular mechanisms in which ions or molecules are transported across a cellular membrane requiring the use of an energy source (e.g., glucose, sodium [Na+], calcium [Ca+], and potassium [K+]).
22. Calorie – the amount of energy needed to raise the temperature of 1 gram of water 1º C.
23. Glycolysis – stage of aerobic and anaerobic respiration where glucose is broken down to produce ATP and electron carriers.

24. Aerobic respiration – chemical breakdown of food molecules that occurs in the presence of oxygen.
25. NAD+ - electron carrier molecule used in respiration.
26. Fermentation – chemical breakdown of food molecules that occurs in environments where oxygen is not available.
27. Anaerobic respiration – chemical breakdown of food molecules that occurs in environments where oxygen is not available.
28. Krebs cycle – the second stage of food breakdown in aerobic respiration where ATP and electron carriers are generated.
29. Electron transport chain – the third and final stage of aerobic cellular respiration where electron carriers are used to generate ATP.
30. ATP synthase – intermembrane protein that uses the energy of flowing H+ to produce ATP.
31. Chemical reaction – a process that changes one set of chemicals into another set of chemicals.
32. Reactant – the elements or compounds that enter into a chemical reaction.
33. Product – the elements or compounds that are produced by a chemical reaction.
34. Activation energy – the energy needed to get a chemical reaction started. An enzyme reduces the required activation energy.
35. Catalyst – a substance that speeds up the rate of a chemical reaction.
36. Enzyme – a protein that acts as a biological catalyst.
37. Substrate – the reactant of an enzyme-catalyzed reaction.
38. Chlorophyll – chief pigment of photosynthesis.
39. Thylakoid – saclike photosynthetic membranes found inside chloroplasts.
40. Stroma – the space inside chloroplasts that lies between the outer membrane and the thylakiods.
41. NADP+ - electron carrier molecule used in photosynthesis.
42. Light-dependent reactions – a set of reactions in photosynthesis that use light energy to produce ATP and NADPH and oxygen.
43. Calvin cycle – a set of reactions in photosynthesis that produces high-energy sugars.
44. Photosynthesis – process in which organisms use the energy of the sun to convert water and carbon dioxide into oxygen and high energy carbohydrates.
45. Pigment – light absorbing molecules.
46. Photoheterotroph – prokaryotes that are photosynthetic, but also obtain energy from organic compounds.
47. Autotroph – organisms that make their own food.
48. Heterotroph – organisms that cannot make their own food molecules and must rely on other organisms for food.

Core Lesson/Topic Student Learning Outcomes:

Concepts:

1. Differentiate between the types of energy and energy transformations.
2. Differentiate and explain the Laws of Thermodynamics.
3. Describe how the breaking down of ATP supplies energy to drive chemical reactions.
4. Explain how all matter and energy is conserved during energy transformations.
5. Understand how plant cells' structure and function allow for the utilization of light energy in the formation of sugars and ATP.
6. Describe and understand the major types of cellular respiration.
7. Differentiate between aerobic and anaerobic respiration.
8. Describe the fermentation process.

Competencies:

1. Compare and contrast between the types of energy and energy transformations.
2. Compare and contrast between the Laws of Thermodynamics.
3. Describe how the breaking down of ATP supplies energy to drive chemical reactions.
4. Explain how all matter and energy is conserved during energy transformations.
5. Describe how plant cells' structure and function allow for the utilization of light energy in the formation of sugars and ATP.
6. Describe the major types of cellular respiration.
7. Differentiate between aerobic and anaerobic respiration.
8. Describe the fermentation process.

Unit: Unit 5: Continuity and Unity of Life - Cell Growth and Reproduction

Unit/Module Description: Students will define, compare and contrast the differences between sexual and asexual reproduction. Students will describe the major events of cell division in prokaryotes and eukaryotes. Students will describe the structure and explain the differences between chromosomes. Students will identify and compare the phases of mitosis and meiosis.

Unit/Module Big Ideas:

[if !supportLists]-->1. 1. Define, compare and contrast between sexual and asexual reproduction.

[if !supportLists]-->2. 2. Describe the structure of a chromosome.

[if !supportLists]-->3. 3. <!--[endif]-->Identify the differences in chromosome structure between prokaryotic and eukaryotic .

[if !supportLists]-->4. 4. <!--[endif]-->Identify that organisms are characterized by the number of chromosomes.

[if !supportLists]-->5. 5. Explain the differences between the types of chromosomes.

[if !supportLists]-->6. 6. <!--[endif]-->Distinguish between haploid and diploid.

[if !supportLists]-->7. 7. <!--[endif]-->Describe the major events of cell division in prokaryotes and eukaryotes.

[if !supportLists]-->8. 8. <!--[endif]-->Compare the end products of mitosis with those of meiosis.

[if !supportLists]-->9. 9. <!--[endif]-->Explain crossing over and how it contributes to the production of unique individuals.

Unit/Module Essential Questions:

What is the difference between the prokaryote and eukaryote genome?

What cells typically undergo mitosis?

When does mitosis occur?

How does a normal cell become cancerous or malignant?

Unit/Module Student Learning Outcomes:

CONCEPTS:

[if !supportLists]-->1. <!--[endif]--> Define Sexual and asexual reproduction.

[if !supportLists]-->2. <!--[endif]-->Describe and define a chromosome.

[if !supportLists]-->3. <!--[endif]-->Recognize the differences between the two types of chromosomes.

[if !supportLists]-->4. <!--[endif]-->Describe and recognize the major events of cell division in prokaryotes and eukaryotes.

COMPENTENCIES:

[if !supportLists]-->1. <!--[endif]--> Compare and contrast between sexual and asexual reproduction.

[if !supportLists]-->2. <!--[endif]-->Identify the differences in chromosomes between prokaryotic and eukaryotic.

[if !supportLists]-->3. <!--[endif]-->Students will compare the number of chromosomes in different species.

1. Describe the three stages
of the cell cycle
a. Interphase
b. Nuclear
Division
c. Cytokinesis
☐ Describe the events
that occur during the
cell cycle
☐ Compare the
processes and
outcomes of mitotic
and meiotic
divisions.
2. Explain how genetic
information is inherited.
☐ Describe how the
process of DNA
replication results in
the transmission
and/or conservation
of genetic
information.
☐ Explain the function
relationships
between DNA,
genes, alleles, and
chromosomes and
their roles in
inheritance
Phases of Mitosis
☐ Phases of Meiosis
☐ Importance of Mitosis and Meiosis
☐ Outcomes of Mitosis and Meiosis
☐ Process of DNA Replication (preview)
☐ Importance of chromosome composition
and number controlling phenotype
☐ Chromosomal Mutations during Mitosis
and Meiosis
Describe the events that
occur during the cell cycle.
☐ Compare and contrast the
processes and outcomes of
mitotic and meiotic nuclear
divisions.
☐ Describe processes that can
alter composition or
number of chromosomes
(chromosomal mutations).

Lesson Topic: Core Lesson 1: Cell Growth and Reproduction

Lesson Topic: Core Lesson 2: Cell Division

Lesson Topic: Core Lesson 3: Meiosis

Unit: Unit 6: Continuity and Unity of Life - Genetics

Unit/Module Description: Students will discover how heredity follows certain patterns based on the laws of probability. Students will learn how Mendel's experiments and his laws to apply them when solving genetics problems. They will also learn to solve genetics problems using Punnett squares and determine phenotypic and genotypic ratios. Students will differentiate between alleles, genes and chromosomes and predict the offspring of genetic crosses using a Punnett square. Students will differentiate between incomplete dominance and codominant alleles. Explain how multiple alleles and polygenic traits increase variation in the population.

Unit/Module Big Ideas:
1. Hereditary information in genes is inherited and expressed.
2. Distinguish between dominant and recessive traits.

3. Describe how Mendel's results can be explained by scientific knowledge of genes and chromsomes.
4. Differentiate between the genotype and the phenotype of an organism.
5. Explain how probability is used to predict the results of genetic crosses.
6. Use a Punnett square to predict the results of monohybrid and dihybrid genetic crosses.
7. Explain how a testcross is used to show the genotype of an individual whose phenotype expresses the dominant trait.
8. Differentiate between an monohybrid and dihybrid cross.

Unit/Module Essential Questions:

1. How is the hereditary information in genes inherited and expressed?

2. Distinguish among observed inheritance patterns caused by several types of genetic traits (dominant, recessive, codominant, sex-linked, polygenic, incomplete dominance, multiple alleles).

Unit/Module Key Terminology & Definitions :

Alleles - Forms of genes responsible for controlling the same trait; different versions of the same gene.

Autosome - A chromosome that is not a sex (X or Y) chromosome.

Codominant - Alleles that are fully expressed in the heterozygous condition.

Dominant Allele - An allele that is always expressed when it is present in an individual.

Gene - The fundamental, physical, and functional unit of heredity.

Hybrid - Offspring produced from a cross between two purebred organisms.

Incomplete Dominance - Traits in which the heterozygote shows a different phenotype from the homozygous dominant phenotype.

Phenotype - The physical characteristics of an organism.

Polygenic - Traits in which several genes contribute to the overall phenotype.

Recessive - An allele that is only expressed when the dominant allele for a trait is not present.

Sex-linked Traits - Phenotype of an allele located on a sex chromosome.

Trait - A specific characteristic that varies from one individual to another.

Genotype - The genetic makeup of an organism.

Heredity - The passing of genetic factors from parent to offspring.

Heterozygous - Having dissimilar alleles that code for the same gene or trait.

Homozygous - Having two identical alleles that code for the same trait.

Sex‐linked Trait - A trait, associated with a gene that is carried by either the male or female parent (e.g., color blindness and
sickle‐cell anemia).

Polygenic Trait - A trait in which the phenotype is controlled by two or more genes at different loci on different chromosomes.

Multiple Alleles - More than two forms of a gene controlling the expression of a trait.

Incomplete Dominance - A pattern of inheritance in which two alleles, inherited from the parents, are neither dominant nor recessive. The resulting offspring have a phenotype that is a blending of the parental traits.

Inheritance - The process in which genetic material is passed from parents to their offspring.

Gamete - A specialized cell (egg or sperm) used in sexual reproduction containing half the normal number of chromosomes of a somatic cell.

Gene - A sequence of nucleotides composing a segment of DNA that provides a blueprint for a specific hereditary trait.

Gene Expression - The process in which a nucleotide sequence of a gene is used to make a functional product such as protein or RNA.

Gene Recombination - A natural process in which a nucleic acid molecule (usually DNA but can be RNA) is broken and then joined to a different molecule; a result of crossing‐over.

Gene Splicing - A type of gene recombination in which the DNA is intentionally broken and recombined using laboratory techniques.

Gene Therapy - The intentional insertion, alteration, or deletion of genes within an individual's cells and tissues for the purpose of treating a disease.

Genetic Drift - A change in the allele frequency of a population as a result of chance events rather than natural selection.

Genetic Engineering - A technology that includes the process of manipulating or altering the genetic material of a cell resulting in desirable functions or outcomes that would not occur naturally.

Genetically Modified Organism - An organism whose genetic material has been altered through some genetic engineering technology or technique.

Genetics - The scientific study of inheritance.

Dominant Inheritance- A pattern of inheritance in which the phenotypic effect of one allele is completely expressed within a homozygous and heterozygous genotype.

Crossing‐over - An exchange of genetic material between homologous chromosomes during anaphase I of meiosis; contributes to the genetic variability in gametes and ultimately in offspring.

Chromosomal Mutation - A change in the structure of a chromosome (e.g., deletion, the loss of a segment of a chromosome and thus the loss of segment containing genes; duplication, when a segment of a chromosome is duplicated and thus displayed more than once on the chromosome; inversion, when a segment of a chromosome breaks off and reattaches in reverse order; and translocation, when a segment of one chromosome breaks off and attaches to a nonhomologous chromosome).

Chromosomes - A single piece of coiled DNA and associated proteins found in linear forms in the nucleus of eukaryotic cells and circular forms in the cytoplasm of prokaryotic cells; contains genes that encode traits. Each species has a characteristic
number of chromosomes.

Cloning - A process in which a cell, cell product, or organism is copied from an original source (e.g., DNA cloning, the transfer of a DNA fragment from one organism to a self‐replicating genetic element such as a bacterial plasmid; reproductive cloning,
the transfer of genetic material from the nucleus of a donor adult cell to an egg cell that has had its nucleus removed for the purpose of creating an embryo that can produce an exact genetic copy of the donor organism; or therapeutic cloning, the process of taking undifferentiated embryonic cells [STEM cells] for use in medical research).

Co‐dominance - A pattern of inheritance in which the phenotypic effect of two alleles in a heterozygous genotype express each phenotype of each allele fully and equally; a phenotype which would not be expressed in any other genotypic combination.

Allele Frequency - The measure of the relative frequency of an allele at a genetic locus in a population; expressed as a proportion or percentage.

Unit/Module Student Learning Outcomes:

Concepts:

1. Sexually reproducing organisms produce gametes which transport hereditary information from one generation of organisms into another generation.
2. Patterns of inheritance reflecting how genes interact and express themselves (dominant, recessive, codominance, incomplete dominance, sex linked, sex influenced, multiple alleles) can be predicted, observed and described.
3. The Punnett square is a tool that can be used to predict the probability of an offspring's geneotype and phenotype.
4. One of more pairs of genes on one or more chromosomes code for the expression on inherited traits.
5. Meiosis involves a two-step nuclear division reducing the number of chromosomes in half producing gametes.
6. During the process of meiosis genetic recombinations may occur contributing to genetic

variability within a population.
7. Patterns of inheritance reflecting how genes interact and express themselves Patterns of inheritance reflecting how genes interact and express themselves (including dominant, recessive, codominance, incomplete dominance, sex-linked, sex-influenced, multiple alleles) can be predicted, observed and described.
8. Two or more versions of a gene (alleles) contribute to the expression on inherited traits.
Competencies:

1. Select and use appropriate tools and techniques when designing and conducting experiments related to the biological sciences and then communicate and analysis of the findings using various types of media.

2. Develop Punnett squares to explain and predict the probablility of orgainisms genotype and phentype.

This Curriculum Map Unit has no Topics to display

Unit: Unit 7: Continuity and Unity of Life - Theory of Evolution

This Curriculum Map Unit has no Topics to display

Unit: Unit 8: Continuity and Unity of Life - Ecology

This Curriculum Map Unit has no Topics to display

Unit: Integrated Unit 9: Literacy in Science

Timeline: Week 1 to 36

This Curriculum Map Unit has no Topics to display