Unit Title: Chemistry of Life	**Content Area:** Biology	**Grade Level:** 9-12

Unit Summary: This unit explores the basic concepts in chemistry and applies them to more advanced biochemical concepts. There are two lab investigations where students will create, design and implement their investigations to further their scientific practice skills and apply them to pH and enzyme function. The properties or water and the macromolecules and their importance to life on earth are addressed and students will investigate and conclude what factors affect an enzyme's ability to function.

Scientific Practices Addressed: Asking questions Asking questions (for science) and defining problems (for engineering), Planning and carrying out investigations, Analyzing and interpreting data, Constructing explanations (for science) and designing solutions (for engineering), Engaging in argument from evidence, and Obtaining, evaluating, and communicating information

Cross-Cutting Concepts Addressed: Patterns, Cause and Effect, Systems and System Models, and Structure and Function

Unit Essential Questions:	**Unit Enduring Understandings:**
• How does the structure relate to function in living systems from organismal to the cellular level? • What are the properties of water that make it essential to most life on earth? • How can we determine the pH of household chemicals (lab)? • What are the four macromolecules and why are they important for life? • What factors affect an enzyme's function?	• Water is essential to life on earth because of its specific properties (Specifically: polarity, adhesion, cohesion, pH). • Cells are made up of complex molecules that consist mostly of a few elements. Each class of molecules has its own building blocks and specific functions (Specifically: Carbohydrates, Proteins, Lipids, and Nucleic Acids). • Enzymes' ability to carry out cellular processes is affected by temperature and pH.

Possible Student Misconceptions: Students may conclude that all water has a pH of 7. Students may believe that extreme pH and temperatures will always affect an enzyme. It is important to address that depending on the enzyme and its normal functioning pH or temperature. For example, enzymes in the bacteria found in hot springs function at higher temperatures.

NJCCCS: 5.3.12.A.1, 5.3.12.A.2, 5.3.12.A.3, 5.3.6.A.1,5.3.4.A.1

NGSS *Performance Expectations: Students who demonstrate understanding can…*
HS-LS1-2. Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
HS-LS1-3. Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

Primary CCSS ELA/Literacy Connections: CCSS.ELA-Literacy.RI.11-12.2, CCSS.ELA-Literacy.RI.11-12.4, CCSS.ELA-Literacy.W.11-12.1, CCSS.ELA-Literacy.W.11-12.4, CCSS.ELA-Literacy.W.11-12.7, CCSS.ELA-Literacy.SL.11-12.1, CCSS.ELA-Literacy.SL.11-12.4	**Primary CCSS Mathematics Connections:** CCSS.Math.Content.HSS.ID.A.1, CCSS.Math.Content.HSS.ID.B.5, CCSS.Math.Content.HSS.ID.C.7

Lesson Pace & Sequence

Lesson Title/Number: Intro to Chemistry, Lesson 1	**Learning Objective(s):** Apply their knowledge of chemistry to create a model of an atom.	**Lesson Duration:** 80 minutes

Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***
Elicit: How will you access students' prior knowledge?	Do Now: List the following words from smallest to largest: molecule, electron, bond, atom.			LS1.C: Organization for Matter and Energy Flow in Organisms	
Engage: How will you capture students' interest and get students' minds focused on	Inquiry Activity: Do large and small molecules act exactly a like?	• Ch. 2, page #34.	Analyzing and interpreting data Constructing		Patterns. Observed patterns of forms and events guide organization and

the concept/topic?			explanations (for science) and designing solutions (for engineering) Obtaining, evaluating, and communicating information		classification, and they prompt questions about relationships and the factors
Explain: How will you help students connect their exploration to the concept/topic under investigation?	Class Discussion on the Nature of Matter (Ch. 2.1). Students can read experts from the text and generate discussion questions.	• Chapter 2.1	Asking questions (for science) and defining problems (for engineering)		Patterns. Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors
Elaborate: How will students apply their learning and develop a more sophisticated understanding of the concept/topic?	Have students build their own model of atoms using toothpicks and gumdrops. Assign each student on or more of the elements mentioned in section 2.1- helium, hydrogen, oxygen, carbon, sodium and chlorine.		Developing and using models		Systems and system models. Defining the system under study —specifying its boundaries and making explicit a model of that system —provides tools for understanding and testing ideas that are applicable throughout science and engineering
Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Exit Ticket: Using the terms from the do now, explain how they are all related, then place them in order from smallest to largest.		Constructing explanations (for science) and designing solutions (for engineering)		Patterns. Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors
Lesson Title/Number: Properties of Water		**Learning Objective(s):** Describe and model the properties of water by completing minilab and extend their understandings in defining capillary action.			**Lesson Duration:** 80 minutes
Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***
Elicit: How will you access students' prior knowledge?	Do Now: Why is water important to life on earth?			ESS2.C: The Roles of Water in Earth's Surface Processes	Cause and effect: Mechanism and explanation. Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is
Engage: How will you capture students' interest and get students' minds focused on	YouTube video on water and generate questions in pairs.	• Water Movie: https://www.youtube.com/watch?v=iOOvX0jmhJ4	Asking questions (for science) and defining problems (for engineering).		

the concept/topic?					investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.
Explore: What hands-on/minds-on common experience(s) will you provide for students?	Penny Mini Lab: Using a pipet with water and a penny, students will predict what they expect to happen with water as they drop the water on the penny. After taking observations, students will create an explanation describing what they think happened.		Constructing explanations (for science) and designing solutions (for engineering)		
Explain: How will you help students connect their exploration to the concept/topic under investigation?	Use student ideas from minilab to help frame the formal presentation of the properties of water. Formal presentation will be related to the content Chapter 2.2. Then have students pair share their summary of the content.	• Ch. 2.2- Properties of Water			Patterns. Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.
Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Students will revise their statements describing what happened on the penny using key vocabulary (cohesion, adhesion, polar molecule)		Constructing explanations (for science) and designing solutions (for engineering)		Structure and function. The way in which an object or living thing is Shaped and its substructure determine many of its properties and functions
Extend: How will students deepen their conceptual understanding through use in new context?	Capillary Action: Have students read an expert about capillary action. Students will then write a response to the following question: How do the properties of water influence how water is transported up a tree?	• Capillary Action Video: http://water.usgs.gov/edu/capillaryaction.htm			
Lesson Title/Number: Introduction to pH, Lesson 2		**Learning Objective(s):** Apply understanding of the pH value while designing a lab that investigates the pH value of various home materials.			**Lesson Duration:** 80 minutes
Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***

Elicit: How will you access students' prior knowledge?	Do Now: One of the properties of water is that it has a neutral pH, what do you think is meant by that?			PS1.A: Structure and Properties of Matter	Systems and system models. Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering.
Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	Include different types of materials that vary on the pH scale. Ask students to predict if the substances are acids or bases. Then ask students to predict what characteristics make something an acid or base.		Constructing explanations (for science) and designing solutions (for engineering)		
Explain: How will you help students connect their exploration to the concept/topic under investigation?	Class Discussion: pH Scale (Ch. 2.2). Ask students to read and summarize different sections prior to discussing that particular subsection.	• Ch. 2.2- Properties of Water	Obtaining, evaluating, and communicating information		
Elaborate: How will students apply their learning and develop a more sophisticated understanding of the concept/topic?	Design and predict the results for a lab that aims to answer the following question, "How can we predict and determine the pH of various household products?"	• Teaching Students How to Design their Own Experiments: http://sciencestuffbyamy.blogspot.com/2013/08/how-to-teach-your-students-to-design.html	Planning and carrying out investigations		
Evaluate: How will students demonstrate their mastery of the learning objective(s)?	By accurately creating a hypothesis for each product they chose to test. Also, by creating valid procedures, and method of data collection.				
Extend: How will students deepen their conceptual understanding through use in new context?	Apply their knowledge of the pH scale and characteristics of acids and bases to help design and predict the outcomes of the products they chose to test.				
Lesson Title: pH Lab Investigation , Lesson 3		**Learning Objective(s):** Continue to design and implement the procedures that aim to investigate the pH of common household materials.			**Lesson Duration:** 160 minutes

Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***
Elicit: How will you access students' prior knowledge?	Do Now: Describe what you know about the pH Scale.	• Ch. 2.2	Analyzing and interpreting data Obtaining, evaluating, and communicating information	PS1.A: Structure and Properties of Matter	Systems and system models. Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering.
Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	Recap: Students should get into their lab groups and review their hypotheses.				
Explore: What hands-on/minds-on common experience(s) will you provide for students?	In their lab groups, students will revise procedures and conduct experiment using pH testing paper to determine the pH's of their materials and collect their data in their lab journals.		Planning and carrying out investigations.		
Elaborate: How will students apply their learning and develop a more sophisticated understanding of the concept/topic?	Post lab questions (independently): Were your predictions accurate? Which substance had a high OH- concentration? Which had a high H+ concentration?		Analyzing and interpreting data		
Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Completing the lab investigation, accurately collecting and analyzing data, completing a comprehensive conclusion.		Planning and carrying out investigations. Analyzing and interpreting data		

Extend: How will students deepen their conceptual understanding through use in new context?	Ask students to answer the following question, "What could you do to decrease your highest pH item or increase your lowest pH item?" Have students defend their answer to their neighbor.		Engaging in argument from evidence		
Lesson Title/Number: Intro to Macromolecules, Lesson 4		**Learning Objective(s):** Compare and contrast the characteristics of the four macromolecules by completing a graphic organizer. Create a dinner menu that correctly identifies each meal component as one of the macromolecules.			**Lesson Duration:** 160 minutes
Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***
Elicit: How will you access students' prior knowledge?	Do Now: What do you think the work "macromolecule" means?	• Chapter 2.3: Carbon Compounds		PS1.A: Structure and Properties of Matter	
Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	Introduce the four macromolecules by referring to their common daily uses. Focus discussion on why these macromolecules are important for daily processes. Example: Why do people that use the gym have protein shakes after their workout? Why do athletic teams have "pasta parties" the night before a game? Have students write one discussion question for every PPT slide.		Asking questions (for science) and defining problems (for engineering)		Patterns. Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.
Explore: What hands-on/minds-on common experience(s) will you provide for students?	Create a chart with column heads: Macromolecule, Chemical Composition, Examples, Function in Living Things. In small groups they will complete one of the columns and become "experts."		Obtaining, evaluating, and communicating information		

Explain: How will you help students connect their exploration to the concept/topic under investigation?	Jigsaw Activity: Ask groups of students to complete one of the four macromolecule rows on their charts. Have student groups present on their macromolecule to the rest of the class.				
Elaborate: How will students apply their learning and develop a more sophisticated understanding of the concept/topic?	Food Menu: Have students create a menu with three entree options for a themed party they are throwing. Students must accurately label each component of their menu to include protein, carbohydrate and lipids.				
Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Section 2-3 Assessment, pg. 48				
Extend: How will students deepen their conceptual understanding through use in new context?	Write and explanation of how polysaccharides, nucleic acids and proteins are formed. Use the terms monosaccharides, nucleotides and amino acids to explain polymerization.		Constructing explanations (for science) and designing solutions (for engineering)		
Lesson Title/Number: Enzymes, Lesson 5		**Learning Objective(s):** Design an investigation that will aim to address the lab question: "What factors affect an enzyme's function?"			**Lesson Duration:** 80 minutes
Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***
Elicit: How will you access students' prior knowledge?	Do Now: What type of macromolecule is an enzyme?			PS1.A: Structure and Properties of Matter	

Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	Chemical Reaction Demonstration: Baking soda and vinegar. Ask: What do these substances look like before we mix them? Predict what you expect to happen. After the demo: Describe what happened. What did you hear? What did you see? How do we know a chemical reaction took place?		Constructing explanations (for science) and designing solutions (for engineering) Analyzing and interpreting data		Cause and effect: Mechanism and explanation. Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.
Explain: How will you help students connect their exploration to the concept/topic under investigation?	Ask students: Write down three questions you want to know about enzymes and chemical reactions. Class Discussion: Chemical Reactions and enzymes.	• Ch. 2-4	Asking questions (for science) and defining problems (for engineering)		Cause and effect: Mechanism and explanation. Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.
Elaborate: How will students apply their learning and develop a more sophisticated understanding of the concept/topic?	Analyzing Data: How does pH affect an enzyme? Students will study a graph on the effect of pH on catalase activity. They will then answer questions that will ask them to apply concepts, interpret graphics, infer and draw conclusions.	• Ch. 2-4, pg. 51	Analyzing and interpreting data		

Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Lab Design: What factors affect an enzyme's function?	• Apples and Enzymes: http://school.discoveryeducation.com/foodscience/pdfs/EnzymesSG.pdf	Asking questions (for science) and defining problems (for engineering) Planning and carrying out investigations		Patterns. Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them. Cause and effect: Mechanism and explanation. Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.
Extend: How will students deepen their conceptual understanding through use in new context?	Pre lab questions: What does your group predict will affect how an enzyme functions? What is your expected outcome for each variable? How will you know if the enzyme in apples is being affected? How will you collect this data?		Constructing explanations (for science) and designing solutions (for engineering)		Cause and effect: Mechanism and explanation. Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.
Lesson Title/Number: Enzyme Lab Investigation, Lesson 6		**Learning Objective(s):** Design and implement lab investigation that identifies the factors that affect enzyme function.			**Lesson Duration:** 160 minutes

Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***
Elicit: How will you access students' prior knowledge?	Do Now: What did your group hypothesize for today's investigation?		Asking questions (for science) and defining problems (for engineering	PS1.A: Structure and Properties of Matter	Cause and effect: Mechanism and explanation. Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.
Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	Recap: In their groups, students continue to design their lab investigation. Determine procedures, variables, control, and data collection methods.				
Explore: What hands-on/minds-on common experience(s) will you provide for students?	Complete enzyme lab investigation.	• Provide students with apples sitting in various solutions; water, milk of magnesia, boiled water, frozen apples, and lime juice.	Planning and carrying out investigations		
Explain: How will you help students connect their exploration to the concept/topic under investigation?	Accurately creating procedures and methods of data collection that aims to address the lab question, "what factors affect an enzyme's function?"	• Apples and Enzymes: http://school.discoveryeducation.com/foodscience/pdfs/EnzymesSG.pdf			

Elaborate: How will students apply their learning and develop a more sophisticated understanding of the concept/topic?	Analyze their outcomes as groups then as a large class. Determine final lab conclusions as a class.		Analyzing and interpreting data		
Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Post Lab questions: How did you know the enzyme did not work? What factors affected the enzyme's function and how did you know?		Analyzing and interpreting data Obtaining, evaluating, and communicating information		
Extend: How will students deepen their conceptual understanding through use in new context?	Provide students with the definition of "denature." In the conclusion portion of their lab, ask them to properly use the term denature in their overall summary of what occurred in their investigation.		Obtaining, evaluating, and communicating information		Structure and function. The way in which an object or living thing is Shaped and its substructure determine many of its properties and functions.