Clare Gilroy **Chemistry Unit Plan: Biochemistry Unit**

What big ideas or major concepts do you hope to address through this unit?
With this unit, I am hoping to address the major concept that molecules in our food play significant roles in our body. These molecules can be arranged/rearranged to create new molecules. I am hoping that this unit will serve as a "hands on, minds on" series of lessons. Not only will students be doing inquiry-based labs, they will also be working with real-world scenarios. These activities will better align with the Next Generation Science Standards HS-LS1-6: Formation of Carbon-Based Molecules ***"****Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules. (Energy and Matter)".* I am also trying to give students an opportunity to use their own voices and creative minds as they navigate these concepts, rather than regurgitating information from a slideshow.

What resources from this course do you plan to integrate with your unit plan?
This course provided numerous resources relevant to building this unit. I was able to use a great deal of information from our guest speaker, NASA Food Scientists Xulei Wu. This inspired me to change the standard from creating a typical diet, to one of a NASA Astronaut. Additionally, the Biochemistry lesson was a fantastic resource (The University of Nebraska Lincoln Food Science: "Chemistry/Biochemistry Labs" retrieved from http://www.math.unl.edu/~jump/Center1/BioChemLabs.html) was extremely helpful. There were a plethora of labs that could apply to this unit, however the activity "An Introduction to 4 Groups of Biologically Important Compounds" applied best to my unit. (Hadley, Genee. Lincoln High School. "Biochemistry Lesson Plans for use in a Biology classroom" http://www.math.unl.edu/~jump/Center1/Labs/GeneeHandley.pdf). This activity utilized demonstrations of indicators to test for the presence of molecules in foods. I utilized a lab similar to this from a mentor teacher, Nick Malgieri (Wallkill High School) in my unit, but changed some wording after reading through the University of Nebraska website.

How will using these resources help your students better achieve your goals for the unit?
These resources are integral aspects of creating a unit that revolves around hands on, minds on learning. The activities in this unit are more than just regurgitating information, taking mundane notes, or doing a cookie-cutter lab. In this unit, students discover the information themselves and can use

student voice to convey their understanding. By first completing the Nutrient Lab, students are working hands-on with lab materials, understanding the role of indicators, and discovering what nutrients are in specific food types. Students will also try to devise a diet for an astronaut based on their prior knowledge. Next, students will learn about what these organic molecules are and how they are utilized in bodies. Finally, students will research different diets from all over the world. Then, students will revise their original diet for an astronaut, incorporating their learning from the unit. As discussed in live sessions and on discussion boards with our class, this learning is much more meaningful to students.   This unit also revolves around authentic problems that are not only interesting to students, but relevant to their own personal lives. By framing learning under this context, I am hoping to get more buy-in from students.

Day 1: Lab

Class: 9th Grade Living Environment (Biology) Class	
NYS Standards: HS-LS1-6: Formation of Carbon-Based Molecules *"Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules. (Energy and Matter)".*	
Content: • Students will work with chemical indicators to test nutrients present in different food types	
Time	
4 mins	Pre-assessment Do Now- Write down components of a balanced diet. Afterwards, teacher leads a brief discussion about nutrients in our food, hitting on proteins, carbohydrates (sugar and starch), and fats.
2 mins	Teacher will hand out labs and draw student's attention to specific lab safety precautions, such as goggles and hot plate safety.
23 mins	Students will gather in semester lab groups. They will read about how to test for each type of nutrient, then will follow the procedure to test for it *(see lab procedure below for specifics).* Afterwards,

	students will record their data and complete the conclusion questions.
3 mins	Students will clean up their lab materials and return to their desk. *To cue students on this transition, I will turn the lights off.*
2 mins	Teacher will review some major concepts of the lab- did any 1 food have all the nutrients? Why is this significant?
6 mins	Exit Ticket: Students will design a nutrition plan for an astronaut going into space. The diet plan can be brief and bulleted, but should include meals for 3 days. *To modify for students with special needs, I will provide a graphic organizer with breakfast/lunch/dinner sections for each day. If necessary, I will include prompts to remind students about categories of organic molecules.*
Informal and/or Formal Diagnostic and/or Formative Assessment: Lab reports, do-now	
Instructional Resources Needed: Goggles, paper towels, test tubes, Benedict's solution, Biuret solution, Iodine solution, brown paper (paper bag), garbage, plastic knife to cut foods	
Homework Assignment: Finish any conclusion questions not done in class	

Student Lab Copy, adapted from mentor teacher Nick Malgieri, Wallkill NY:

Name: ___________________________________ **Nutrient Lab**

Task: You will conduct multiple experiments to determine which of 4 foods contains sugar, protein, starch, or fat.

Background: In order to determine which food sugar, protein, starch, or fat you will perform 4 tests. 3 of these tests will involve indicators, which change color if a specific chemical or molecule is present.

Nutrient	Test	Positive Result	Materials
Glucose	Benedict's	White/Yellow/ Orange	Test tube Hot plate Hot water bath

Protein	Biuret	Lavender/Purple	Petri dish
Starch	Iodine	Blue/black	Test tubes or petri dish
Fat	Brown paper	Grease stain	Paper square

Since this is my student's first-time using indicators, I modified the lab to have this "cheat sheet" to support student learning.

A) Glucose test

1. Place a piece of teach food into its own test tube. (4 test tubes, each with 1 type of food in it).
2. Add a small amount of water (about 5 drops) and 1 full dropper of Benedict's solution.
3. Carefully place all 4 test tubes in the hot water bath.
4. Wait several minutes, do not touch the hot plate or test tubes.
5. Carefully remove each test tube and place it in the test tube rack. Observe any color changes and record your findings in the chart.
6. To clean up, pour any liquids into the trash. Rinse the test tubes. Place UPSIDE DOWN in the test tube rack to dry.

B) Protein test

1. Place a crushed piece of food into separate sections of a petri dish. You will have 1 petri dish with 4 pieces (1 of each type of food) in it.
2. Add 1 full dropper of Biuret solution to each piece of food.
3. Observe the color and record your findings in the chart.
4. Throw your petri dish and food particles into the trash.

C) Starch test

1. Place a crushed piece of food into separate sections of a petri dish. You will have 1 petri dish with 4 pieces (1 of each type of food) in it.
2. Add 2 drops of iodine solution to each food.
3. Observe the color and record your findings in the chart.
4. Throw your petri dish and food particles into the trash.

D) Starch test

1. Label the brown paper with the name of each type of food.
2. Under each label, rub each food on the paper in a streak. Allow to dry.
3. Observe the brown paper for a lingering wet spot and record your findings in the chart.
4. Throw your paper towel and food particles into the trash.

*Before moving on, ensure your lab table is clean. All materials should be discarded or returned. Wipe down your table if needed.

Results: Record color changes in each section

Indicator	Food: ______________	Food: ______________	Food: ______________	Food: ______________
Benedict's solution				
Biuret solution				
Iodine solution				
Brown paper				

Conclusion Questions *<u>to be answered as an individual:</u>*

1. Use your results from the table to list the foods that contain-
    a. Glucose:

    b. Protein:

    c. Starch:

    d. Fat:

2. Using your results, explain why it is necessary to have a balanced diet featuring different nutrition types?

3. Did any results from this experiment surprise you? Explain why or why not.

4. Ms. Gilroy obtains a piece of food that did not create a wet spot on brown paper, stayed brown with iodine solution, turned lavender with Biuret solution, and remained blue with Benedict's solution. What type of food could this be?

EXIT TICKET:

Based on what you learned in today's lab, create a nutrition plan for an astronaut going into space for an extended period of time. Your nutrition plan can be bulleted, and should include 3 days' worth of meals.

If needed, the following graphic organizer will be provided:

Day 1:	Breakfast: a) b) c)	Lunch: a) b) c)	Dinner: a) b) c)
Day 2:	Breakfast: a) b) c)	Lunch: a) b) c)	Dinner: a) b) c)
Day 3:	Breakfast: a) b) c)	Lunch: a) b) c)	Dinner: a) b) c)

Day 2: Notes

Class: 9th Grade Living Environment (Biology) Class
NYS Standards: HS-LS1-6: Formation of Carbon-Based Molecules ***"****Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules. (Energy and Matter)".*
Content:

• Students will understand the 4 organic molecules' structure and function	
Time	
4 mins	Do Now: What surprised you from the lab yesterday? What made sense to you? Teacher will lead a discussion with students to go through the lab findings from yesterday. If needed, teacher will go through any conclusion questions from yesterday's lab.
4 mins	Teacher will present students with short article "Eating In Space" to engage students. (2010, June 27. Eating In Space. NASA. https://www.nasa.gov/audience/foreducators/stem-on-station/ditl_eating)
5 mins	Students will each read about the monomers, functions, and examples of each. Each student in a group of 4 will focus on one organic molecule.
15 mins	Students jigsaw and share their key takeaways from the reading with each other. Students will fill their notes in.
6 mins	Teacher will debrief the major takeaways regarding organic molecules. Students can ask questions for clarification.
6 mins	Students will take time to revise their diet plan (from yesterday's exit ticket) based on their learning from today.
Informal and/or Formal Diagnostic and/or Formative Assessment: Questioning, exit ticket	
Instructional Resources Needed: Reading materials, SMART board	
Homework Assignment: Continue to revise diet plan if not finished in class	

Student Note Worksheet:

Name	Elements/	Monomers (Building	Functions	Example

	Structure	Block)		s
Carbohydrate s				
Lipids				
Proteins				
Nucleic Acids				

Jigsaw reading material: Source- Cliffs Notes. Houghton Mifflin Harcourt. "Organic Molecules." https://www.cliffsnotes.com/study-guides/anatomy-and-physiology/anatomy-and-chemistry-basics/organic-molecules. I added in some details that I wanted students to focus on/removed details that weren't pertinent. The edits are in purple.

Carbohydrates are classified into three groups according to the number of sugar (or saccharide) molecules present:

- A *monosaccharide* is the simplest kind of carbohydrate. It is a single sugar molecule, such as a fructose or glucose (Figure 1). Sugar molecules have the formula $(CH_2O)_n$, where *n* is any number from 3 to 8. For glucose, *n* is 6, and its formula is $C_6H_{12}O_6$. The formula for fructose is also $C_6H_{12}O_6$, but as you can see in Figure 1, the placement of the carbon atoms is different. Very small changes in the position of certain atoms, such as those that distinguish glucose and fructose, can dramatically change the chemistry of a molecule. Monosaccharides can link together to form a larger molecule, a disaccharide or polysaccharide.
- A *disaccharide* consists of two linked sugar molecules. Glucose and fructose, for example, link to form sucrose (see Figure 1).
- A *polysaccharide* consists of a series of connected monosaccharides. Thus, a polysaccharide is a polymer because it consists of repeating units of monosaccharide. Starch is a polysaccharide made up of a thousand or more glucose molecules and is used in plants for energy storage. We call this energy "quick energy" since it can more easily be accessed and used by the body. A similar polysaccharide, glycogen, is used in animals for the same purpose. Other polysaccharides, like cellulose, are important to the structure of plant cell walls. Carbohydrates are very diverse, yet significant, organic molecules.

Lipids are a class of substances that are insoluble in water (and other polar solvents), but are soluble in nonpolar substances (such as ether or chloroform). They are utilized as long-term energy storage because they can store energy for long periods of time. They also are used for insolation, cushioning major organs, and the structure of the cell membrane. There are three major groups of lipids:

- *Triglycerides* include fats, oils, and waxes. They consist of three fatty acids bonded to a glycerol molecule (Figure 2). Fatty acids are hydrocarbons (chains of covalently bonded carbons and hydrogens) with a carboxyl group (–COOH) at one end of the chain. A saturated fatty acid has a single covalent bond between each pair of carbon atoms, and each carbon has two hydrogens bonded to it. You can remember this fact by thinking that each carbon is “saturated” with hydrogen. An unsaturated fatty acid occurs when a double covalent bond replaces a single covalent bond and two hydrogen atoms (Figure 2). Polyunsaturated fatty acids have many of these double bonds.

- *Phospholipids* look just like lipids except that one of the fatty acid chains is replaced by a phosphate ($–P0_4{}^{3-}$) group (Figure 3). Additional chemical groups (indicated by R in Figure 3) are usually attached to the phosphate group. Since the fatty acid “tails” of phospholipids are nonpolar and hydrophobic and the glycerol and phosphate “heads” are polar and hydrophilic, phospholipids are often found oriented in sandwichlike formations with the hydrophobic heads oriented toward the outside. Such formations of phospholipids provide the structural foundation of cell membranes.

- ***Steroids*** are characterized by a backbone of four linked carbon rings (Figure 4). Examples of steroids include cholesterol (a component of cell membranes) and certain hormones, including testosterone and estrogen.

Proteins

Proteins represent a class of molecules that have varied functions. Eggs, muscles, antibodies, silk, fingernails, and many hormones are partially or entirely proteins. Although the functions of proteins are diverse, their structures are similar. All proteins are polymers of amino acids; that is, they consist of a chain of amino acids covalently bonded. The bonds between the amino acids are called peptide bonds, and the chain is a polypeptide, or peptide. One protein differs from another by the number and arrangement of the 20 different amino acids. Each amino acid consists of a central carbon bonded to an amine group ($–NH_2$), a carboxyl group (–COOH), and a hydrogen atom (Figure 5). The fourth bond of the central carbon is shown with the letter R, which indicates an atom or group of atoms that varies from one kind of amino acid to another. For the simplest amino acid, glycine, the R is a hydrogen atom. For serine, R is CH_2OH. For other amino acids, R may contain sulfur (as in cysteine) or a carbon ring (as in phenylalanine).

Proteins have a plethora of uses in the body. Some proteins, like enzymes, help speed up reactions. Others transport molecules. Molecules can be moved across the body, as is the case for hemoglobin, which helps transports oxygen around the body. Other protein “carriers” help things move in and out of the cell membrane. Antibodies, an important aspect of your immune system that helps you fight diseases, are made of proteins. Most people associate proteins with muscles, because proteins help build structures like muscles in your body. Collagen and keratin are two common examples of proteins. There are ample other uses for proteins, and as we learn more about DNA, we will learn how our body creates these complex structures!

The genetic information of a cell is stored in molecules of **deoxyribonucleic acid (DNA).** The DNA, in turn, passes its genetic instructions to **ribonucleic acid (RNA)** for directing various metabolic activities of the cell.

DNA is a polymer of nucleotides that consists of three parts—a nitrogenous base, a five-carbon sugar called deoxyribose, and a phosphate group. There are four DNA nucleotides, each with one of the four nitrogenous bases (adenine, thymine, cytosine, and guanine). The first letter of each of these four bases is often used to symbolize the respective nucleotide (A for adenine nucleotide, for example). RNA differs from DNA in the following ways:

- The sugar in the nucleotides that make an RNA molecule is ribose, not deoxyribose as it is in DNA.
- The thymine nucleotide does not occur in RNA. It is replaced by uracil. When pairing of bases occurs in RNA, uracil (instead of thymine) pairs with adenine.
- RNA is usually single-stranded and does not form a double helix as does DNA.

DNA and RNA are both integral aspects of transporting genetic information and giving instructions to build proteins.

Day 3: Research and Final Project

Class: 9th Grade Living Environment (Biology) Class
NYS Standards: HS-LS1-6: Formation of Carbon-Based Molecules *"Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules. (Energy and Matter)".*
Content: • Students will understand how to apply organic molecules and biochemistry to nutrition plans

Time	
4 mins	Do Now: What are the 4 organic molecules? What are examples of each?
12 mins	Teacher will present students with 3 different diets from around the world. When analyzing the diets, students will look for patterns, as well as analyze energy. Source- Anderson, Paul. The Wonder of Science (Adapted from SNAP Assessment): Short Performance Assessment: **HS-LS1-6.** https://docs.google.com/document/d/17d53W_xzqm5S1CP5p317cVuARuU3vTNTdapao66qCsA/edit Worksheets: **Energy and Matter:** Anderson, Paul. The Wonder of Science. Instructional Resources: Energy and Matter. https://static1.squarespace.com/static/59c3bad759cc68f757a465a3/t/5b50e038562fa7ad87d257fe/1532026936920/Energy+Matter.pdf **Patterns**: Anderson, Paul. The Wonder of Science. Instructional Resources: Patterns. https://static1.squarespace.com/static/59c3bad759cc68f757a465a3/t/5b50dff7575d1ff383c07934/1532026871790/Patterns.pdf Students will return chromebooks to the cart. Students at the desks will first return their chromebooks, then students at the lab tables will return theirs. Chromebooks should be plugged in and placed in the correctly numbered slot that matches their chromebook number.
12 mins	Students will watch the video about NASA Astronaut diets. NASA Johnson (Producer.) (2018, June 20). Eat Like an Astronaut. Retreived from https://www.youtube.com/watch?v=AGR3FiEkBwA
12 mins	Students will make their final revisions for their dietary plans and complete the reflection questions. Students will also answer the question “how can oxygen, carbon, hydrogen be rearranged to form new molecules?” *If needed, the scaffold “think about the monomer and polymers” will be given.* If done in class, students can hand in their diet plan. If needed, students can finish for homework and hand in the following day.

Informal and/or Formal Diagnostic and/or Formative Assessment: Questioning, dietary plan
Instructional Resources Needed: Reading materials/chromebooks, SMART board
Homework Assignment: Continue to revise diet plan if not finished in class

Diet Plan Graphic Organizer if needed:

Day 1:	Breakfast: a) b) c)	Lunch: a) b) c)	Dinner: a) b) c)
Day 2:	Breakfast: a) b) c)	Lunch: a) b) c)	Dinner: a) b) c)
Day 3:	Breakfast: a) b) c)	Lunch: a) b) c)	Dinner: a) b) c)

Reflection Questions:

- Why did you pick these specific foods?
    - How do they connect to a balanced diet?
- What are specific considerations necessary for this diet plan considering this astronaut will be going to space?
- *This question was one I added after watching Xueli's presentation. It was interesting to see the types of food astronauts can eat considering the gravity situation, as well as the chemistry (dehydrating foods, not having freezer space, etc.). I wanted to give students a chance to be creative as well. Students might also take this question to think about the "health" perspective since astronauts need to be extremely fit, which is appropriate and relevant also.*
- How can oxygen, carbon, hydrogen be rearranged to form new molecules? Give relevant examples.

  "Think about the monomer and polymers… What molecules are necessary?"