Theme

How can citizens innovate, manage, and use technology in ways that are socially responsible?

STEM Innovation Academy Unit 2 Plan

Subject: Principals of Biomedical Science Unit Title: Diabetes Grade: 9th	Teacher: Andrea Henry Duration: 9 Weeks

Summary of Unit

In Unit 2 students investigate the biology of diabetes as well as the impact this disease can have on the individual, as well as on family and friends. In this first lesson, students investigate what it means to have diabetes. Students will explore how doctors make an initial diagnosis of diabetes and characterize the disease as well as what is happening inside the body of a person who is affected. Students explore the relationship between blood glucose and diabetes. Glucose levels are related to the food we consume. Students will investigate the science of food, the composition of our food, and look in detail at the biochemistry of macromolecules. Students will use chemical indicators to test for the presence of sugar, starch, protein, and lipids in three common food items as well as in the stomach contents of the ill-fated Anna Garcia. Analysis of her stomach contents at the time of her death reveal information about Anna's last meal and provide additional evidence regarding the conditions surrounding her mysterious death. By the end of the unit, students will explore the personal side of life with diabetes. They will design a guide to help patients cope with a new diagnosis as well as explain possible complications of the disease. They will also examine what happens inside the body of a diabetic as they simulate how the body reacts to varying blood glucose concentrations. Finally students will design an innovation that helps diabetics treat, manage, or even cure their disease and present their idea in a format tailored to a panel audience offering a research grant or market their innovative product in the form of an infomercial.

Standards/Outcomes/ PARCC Related items:

NGSS and CCSS standards covered in each lesson
included in this link

DCI - LS1.A - From Molecules to Organisms: Structures and Processes - Structure and Function
Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1)

DCI - LS1.A - From Molecules to Organisms: Structures and Processes - Structure and Function
Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. (HS-LS1-2)

DCI - LS1.A - From Molecules to Organisms: Structures and Processes - Structure and Function Feedback
mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. (HS-LS1-3)

DCI - LS1.C - From Molecules to Organisms: Structures and Processes - Organization for Matter and Energy Flow in Organisms

The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to form new cells. (HS-LS1-6)

DCI - LS1.C - From Molecules to Organisms: Structures and Processes - Organization for Matter and Energy Flow in Organisms
As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. (HS-LS1-6), (HS-LS1-7)

DCI - LS1.C - From Molecules to Organisms: Structures and Processes - Organization for Matter and Energy Flow in Organisms
As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment. (HS-LS1-7)

DCI - LS2.B - Ecosystems: Interactions, Energy, and Dynamics - Cycles of Matter and Energy Transfer in Ecosystems
Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. (HS-LS2-3)

HS.LS1.2 - From Molecules to Organisms: Structures and Processes
Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

HS.LS1.3 - From Molecules to Organisms: Structures and Processes
Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

HS.LS1.6 - From Molecules to Organisms: Structures and Processes
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.

HS.LS2.5 - Ecosystems: Interactions, Energy, and Dynamics
Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.

DCI - PS1.A - Matter and Its Interactions - Structure and Properties of Matter
Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (HS-PS1-1)

DCI - PS1.A - Matter and Its Interactions - Structure and Properties of Matter
The periodic table orders elements horizontally by the number of protons in the atom’s nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. (HS-PS1-1)

DCI - PS1.A - Matter and Its Interactions - Structure and Properties of Matter
A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart. (HS-PS1-4)

DCI - PS3.A - Energy - Definitions of Energy
Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation

within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. (HSPS3-1), (HS-PS3-2)

DCI - PS3.A - Energy - Definitions of Energy
At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy . (HSPS3-2), (HS-PS3-3)

DCI - PS3.B - Energy - Conservation of Energy and Energy Transfer
Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1), (HS-PS3-4)

DCI - PS3.B - Energy - Conservation of Energy and Energy Transfer
The availability of energy limits that can occur in any system. (HS-PS3-1)

DCI - PS3.B - Energy - Conservation of Energy and Energy Transfer
Uncontrolled systems always evolve toward more stable states— that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down). (HS-PS3-4)

HS.ETS1.1 - Engineering Design
Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

HS.ETS1.3 - Engineering Design
Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

DCI - ETS1.B - Engineering Design - Developing Possible Solutions
When evaluating solutions, it is important to take into account a range of constraints, including cost, safety , reliability , and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3)

DCI - ETS1.C - Engineering Design - Optimizing the Design Solution
Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (secondary to HS-PS1-6)

Stage 1 – Desired Results

Essential Questions:

<u>Unit 2 lesson 1</u>

1. What are several ways the life of someone with diabetes is impacted by the condition?
2. How do the terms hyperglycemia and hypoglycemia relate to diabetes?
3. What might happen to cells that are exposed to high concentrations of sugar?
4. How do type 1 and type 2 diabetes differ?
5. What are the current treatments for type 1 and type 2 diabetes?
6. What is the importance of checking blood sugar levels for a diabetic?
7. How can an insulin pump help a diabetic?
8. What are potential short and long term complications of diabetes?
9. What innovations are available to help diabetics manage and treat their disease?

Unit 2 lesson 2

10. What are the main nutrients found in food?
11. How can carbohydrates, lipids, and proteins be detected in foods?
12. What types of foods supply sugar, starch, proteins and lipids?
13. How can food labels be used to evaluate dietary choices?
14. What role do basic nutrients play in the function of the human body?
15. What are basic recommendations for a diabetic diet?
16. What are the main structural components of carbohydrates, proteins and lipids?
17. What is dehydration synthesis and hydrolysis?
18. How do dehydration synthesis and hydrolysis relate to harnessing energy from food?
19. How is the amount of energy in a food determined?

Unit 2 Lesson 3

20. What are the differences between Type 1 and Type 2 diabetes?
21. How does blood glucose concentration affect the movement of water in and out of body cells?
22. How is a Type 1 or Type 2 diabetic's life affected by the disease?

Enduring Understandings

1. The human body is made up of many systems that work in conjunction with one another to perform specialized tasks
2. Diabetes is a disorder that results from improper hormonal regulation of blood sugar, which causes disruptions to water balance, metabolic functions, and homeostatic control.
3. Familiarity with nutritional information allows consumers to make informed decisions about how the chemical composition of food affects health, energy, and metabolism.

Stage 2 – Assessment Evidence

Unit Pre-Assessment:

Sugar babies documentary: Students watch a 45 min documentary chronicling the lives of children with type 1 and type 2 diabetes and complete accompanying analysis questions to assess prior knowledge on the disease.

Performance Task(s):

PLTW 2.1 What is Diabetes?

Blood glucose homeostasis feedback loop: Students create a concept map including the required key terms to explain how the human body maintains blood sugar homeostasis and explain how type 1 and type 2 diabetes interfere with this process

Glucose insulin model: Students create and present a teaching model for physicians so that they can explain the glucose/ insulin interaction to a patient diagnosed with diabetes in language a 6th grader could understand

Diagnosing diabetes lab: Students complete lab which simulates the testing of insulin and blood glucose levels for three patients who have reported symptoms characteristic of diabetes to their doctor. They create line graphs and analyze the blood serum concentration to diagnose the patients (taught as flipped classroom).

PLTW 2.2 The Science of Food

Food label analysis/ dietitian recommendations: Students review Anna Garcia's food diary and determine the nutritional content of the items consumed the three days prior to her death. They research the dietary

recommendations for diabetics and create their own diet plan that they would recommend Anna follow considering her diagnosis as a type 1 diabetic.

Constructing macromolecules puzzle: Students explore the processes of dehydration synthesis, hydrolysis, and their role in constructing macromolecules from their monomers. This lesson includes a ~70 slide review of all chemistry topics which should have been covered in previous years. Students are required to take notes as they work through the puzzle, and were permitted to use these notes on the short answer quiz.

Stomach content analysis lab and report: Students establish negative and positive controls from four macromolecule indicators using water and positive solutions (protein, starch, sugar, and lipids). The following day, students test Anna Garcia's stomach contents with the procedures they have written. They write a lab report based on their results.
Calorimetry lab: Students explore the calorie unit and its measure of energy by conducting a calorimetric analysis of various food samples.

PLTW 2.3 A Day in the Life of a Diabetic
Osmosis lab and analysis: Students simulate body cells by filling dialysis tubing with saline solution. They place the tubing in three different solutions of varying concentrations. By comparing the weight before and after submersion, students can determine which solutions were hypertonic, hypotonic and isotonic. Conclusion questions and data analysis makes connections between this lab and hyperglycemia/ hypoglycemia symptoms. (Extension assessment)
Diabetic complications: Students complete jigsaw style presentations of various complications that can occur as a result of diabetes. They use this information to identify needs for the culminating project.
Diabetic innovation: Students develop an innovation marketed toward physicians, patients, etc. in order to make the lives of diabetics easier. They develop a prototype, a computer graphic or a poster explaining how their idea fills a need and provides an advantage over available technologies. They film a commercial pitching their idea to their target audience.
Unit exam

Authentic Experiences:
Labs/ R&D Commercial or "shark tank" presentation
Panel presentations

Extensions (Tier I):	Differentiation (Tiers 2 and 3)
• Stoichiometry/ Lewis structures • Lab set up questions/ error analysis/ flipped classroom presentations	• Group work • Study skills (Self-assessment quizzes embedded in curriculum, regular quizzes, digital notecards, study resource folder updated by instructor) • Options for potential research websites/ videos/ animations provided • Hands on models • Choice in process/ product/ ways to access content (Diabetic Innovation)

Stage 3 – Learning Plan

Principles of Biomedical Science Unit 2 Digital Access (Password Required):
https://pltw.read.inkling.com/a/b/8e22fd7ebe0d495a9597588bba11b214/p/5669cf431a4e47bdb47197be8824bbf1
The PBS curriculum linked above includes laboratory procedures, project requirements, presentations, and research articles used in the design of the learning tasks described in the stage 2 section of this unit plan.

Vocabulary

- Glucagon
- Glucose Tolerance Test
- Homeostasis
- Hormone
- Insulin
- Negative Feedback
- Positive Feedback
- Type 1
- Type 2
- ATP
- Amino Acid
- Calorie
- Carbohydrate
- Chemical Bond
- Chemical Indicator
- Compound
- Covalent Bond
- Dehydration Synthesis
- Disaccharide
- Element
- Glucose
- Hydrolysis
- Ionic Bond
- Lipid
- Macromolecule
- Molecule
- Monomer
- Monosaccharice
- Nutrient
- Polymer
- Polysaccharide
- Protein
- Hemoglobin A1c
- Hyperglycemia
- Hypertonic
- Hypotonic
- Osmosis
- Solute
- Solution
- Solvent

Expert/Field Experience(s)
*Potential guest speakers: Food scientist, diabetic patient interviews, panel presentations of innovation
*Potential field trips: Hospitals, Liberty Science Center

Literacy Connections/Research

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