Theme

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

STEM Innovation Academy Unit 3 Plan

Subject: Human Body Systems Unit Title: Power Grade: 10	Teacher: Andrea Henry Duration: 8 Weeks; December 21-February 22

Summary of Unit

Lesson 3.1 Introduction to Power: The goal of this lesson is to introduce students to the concept of power in the human body through examination of the body's ability to survive in extreme environments. They will explore the resources that fuel life as well as debate how long the body can last when these resources become scarce. Students will discuss how environmental conditions and personal factors impact the body's ability to deal with a fuel shortage. As the unit progresses, students will study the body systems that help create, process, or distribute each of the body's three main resources – food, oxygen, and water.

Lesson 3.2 Food: The goal of this lesson is for students to relate the macromolecules that are processed from food to energy potential. Student teams will design and build models of the human digestive system and model chemical digestion of a specific bite of food as it moves through this model. Students will investigate enzyme-substrate interactions and design experiments to test the optimal conditions for the action of the catalase enzyme. Acting as nutritionists or dieticians, students will analyze diet and explore the concept of metabolism. They will assess a fictional client, analyze diet, and write a client report that compares energy inputs and outputs and analyzes overall health and fitness. Finally, students will directly relate food, particularly glucose, to the production of adenosine triphosphate (ATP). They will explore the structure of ATP and examine how this energy source is used to fuel all of the cellular processes in the body.

Lesson 3.3 Oxygen: The goal of this lesson is for students to investigate respiratory system anatomy and analyze how disease impacts function in this system as well as in other systems of the body. In the first activity, students are introduced to a young woman who is experiencing shortness of breath and wheezing during her normal activities. As they progress through her case and make a diagnosis, students explore the structure of the respiratory system and its connection to the cardiovascular system. Students explore the changes in the respiratory system that lead to a condition such as asthma. The second activity introduces students to the mechanics of breathing and to the use of a spirometer to measure lung capacity. Students will then analyze prescription medications and begin to think about how drugs work in the human body. Students will analyze how each medication prescribed to their patient relates to anatomy and physiology. Students will then play the role of a respiratory therapist to design a plan to help their patient manage her illness.

Lesson 3.4 Water: The goal of this lesson is for students to review the many functions of water in the human body and explore the main human body system that not only conserves water and important ions, but also rids the body of harmful wastes – the urinary system. Students will explore the structure of the kidney by completing a dissection and mapping out the general path of urine formation and excretion. Students will then zoom in on the kidney and explore exactly what takes place in the nephron, the functional unit of the organ. By creating a drawing of nephron action, students will explore the connection between blood and urine and then visualize which substances are reabsorbed by the body and which

substances are filtered out of the blood and excreted as urine. Students will then investigate how the body uses hormones to regulate and control the amount of water in the body. Finally, students will unlock the medical clues hidden in urine as they complete urinalysis testing for fictional patients. They will see that changes in urine often signal illness or dysfunction that originates in body systems other than the urinary system.

Standards/Outcomes/ PARCC Related items:

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

HS.LS1.7 - From Molecules to Organisms: Structures and Processes
Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.

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.B - Energy - Conservation of Energy and Energy Transfer
Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. (HS-PS3-1)

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)

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.

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)

Stage 1 – Desired Results

Essential Questions:

Unit 3 lesson 1
3.2- 1 How does the digestive, respiratory, and urinary systems work together to power the body?

Unit 3 lesson 2
3.2 - 1 How does the body obtain and use energy from food?
3.2 - 2 Why does an enzyme only catalyze a specific chemical reaction under specific conditions?
3.2 - 3 How is the air you breathe and the food you eat used in the production of ATP?

Unit 3 lesson 3
3.3 - 1 How do the systems of the human body work together to facilitate gas exchange?
3.3 - 2 How can analysis of lung capacity be used to diagnose or treat a patient?
3.3 - 3 How can an individual improve or damage their lung function?

Unit 3 lesson 4
3.4 - 1 How does the nephron function to maintain fluid and electrolyte balance in the human body?
3.4 - 2 How can the composition of urine provide clues about problems in human body systems?
3.4 - 3 How do hormones help maintain water balance in the human body?

Enduring Understandings
The digestive, respiratory, and urinary systems all contribute to the production and use of energy containing molecules
Patient records and other pieces of medical evidence can be used to assess a person's health and identify disease
Diagnostic tests can evaluate health and determine whether structures in the body are not properly functioning. Test results aid biomedical professionals in making a diagnosis and recommending a treatment.

Stage 2 – Assessment Evidence

Unit Pre-Assessment:

Relevant prior knowledge from PBS to be assessed:
-Dehydration synthesis/ hydrolysis
-Protein synthesis
-Diffusion and osmosis

Performance Task(s):

3.1: Introduction to Power

3.1.1 Introduction to power: Students watch a video clip about Mauro Prosperi's struggle to survive in the Sahara desert. They will list the requirements for survival on the board and debate the length of time a human can survive without them as a class. They will be introduced to the rule of threes.

3.2: Food

3.2.1 Students will create a concept map and a model that explains how an enzyme assigned to their group operates to catalyze reactions. They will record and share videos explaining how the enzyme operates, the reactants/ products, coenzyme requirements and optimal conditions. Videos will be uploaded to Flipgrid and shared with the class.

3.2.2 Students will explore how the structures of the digestive system support their function by working in teams to build anatomical structures on their manikens while completing the research questions provided by the curriculum

3.2.4 Students will be provided with catalase enzymes and hydrogen peroxide. They will be instructed to measure the rate of the decomposition reaction and provided with a procedure to do so. Then, students will design an investigation to test the effects of various independent variables on the efficiency of the enzymatic reaction and write a lab report summarizing their findings.

3.2.5 Students will offer nutritional counseling tailored to a client profile. They will calculate BMI, BMR, and TDEE. They will create recommendations based on their calculations and design a diet for their client.

3.2.6 Students should use the cell zone molecular models to demonstrate how ATP is assembled and broken down to release energy. They should also demonstrate the role of water in these processes and be able to explain hydrolysis and dehydration. They will conduct research on the structure and function of ATP.

3.3: Oxygen

3.3.1 Pig lung inflation demo used as engagement activity. Students discuss the function of respiratory structures and respiratory disorders. Respiratory Project: Students will be introduced to a young girl, Melissa Martin, who is having trouble breathing. They will analyze her medical history to determine a possible diagnosis. Melissa's symptoms indicate a high probability of asthma. They will analyze peak flow data and create recommendations based on the results (instructions linked here).

3.3.2 Students will conduct a spirometry test on themselves and analyze the features of the graph. They will research how obstructive abnormalities are detected using this test and analyze Melissa's results and FEV1 levels (instructions linked here). Students will explore pharmacology abbreviations and use this research to translate Melissa's prescriptions. They will conduct research on how the medications prescribed to minimize her symptoms. Finally, they will develop an asthma action plan for Melissa, template linked here. Melissa case rubric linked here.

3.3.4 Students will create a mock resume for a respiratory therapist

3.4 Water

3.4.1 Students will build urinary anatomical structures on their manikens while completing research questions with their partners

3.4.2 Students will dissect a kidney and identify key anatomical structures. They will photograph and label the structures using Skitch.

3.4.3 Students will select roles and work in teams to calculate glomerular filtration rate in the activity linked here. students will create a 3D diagram of the nephron that depicts the location of water/ solute secretion, resorption, and filtration

3.4.4 Students will create a feedback loop that explains how blood volume is regulated by antidiuretic hormone

3.4.5 Students will conduct urinalysis and diagnose patients based on their profile and test results
Unit 3 Exam

Extensions (Tier I):	Differentiation (Tiers 2 and 3)
-Stop motion video version of nephron project -Additional teacher created client reports/ diagnostic challenges (e.g. respiratory client with COPD symptoms associated with vaping)	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 Student choice in design of independent investigation Slides and note organizers provided after every lesson Teacher youtube channel for asynchronous learning

Stage 3 – Learning Plan

Principles of Biomedical Science Unit 2 Digital Access (Password Required):
https://pltw.read.inkling.com/a/b/8e22fd7ebe0d495a9597588bba11b214/p/5669cf431a4e47bdb47197be8824bbf1

Vocabulary

- Abdominal cavity
- Adenosine triphosphate
- Adrenal gland
- Aldosterone
- Aveoli
- Antidiuretic hormone
- Basal metabolic rate
- Body mass index
- Kidney
- Large and small intestines
- Liver
- Macromolecule
- Minute volume
- Monomer
- Nephron
- Oral cavity

• Bolus • Bronchi • Calorie • Catabolism • Catalyst • Diaphragm • Digestion • Enzyme • Esophagus • Excretion • Filtration • Gallbladder • Gastrointestinal tract • Glomerulus • Homeostasis • Intercostal muscle	• Pancreas • Peristalsis • Pharynx • Polymer • Residual Volume • Resource • Salivary amylase • Spirometer • Substrate • Thoracic cavity • Tidal volume • Ureter • Urethra • Urinalysis • Vital capacity
Expert/Field Experience(s)	
*Potential guest speakers: Food scientist, GI Doctor, Endocrinologist, Internist, Urologist (if available) *Potential field trips: Liberty Science Center 'Live from Surgery' provides a feed into an OR at St. Barnabas where a patient is undergoing kidney transplant. Students engage with surgeons in a Q&A session after viewing the procedure.	
Literacy Connections/Research	
Students will design an investigation to test the effects of various independent variables on the efficiency of the enzymatic reaction and write a lab report summarizing their findings. Students will create a concept map and a model that explains how an enzyme assigned to their group operates to catalyze reactions. They will record and share videos explaining how the enzyme operates, the reactants/ products, coenzyme requirements and optimal conditions. Videos will be uploaded to Flipgrid and shared with the class.	

Modifications

Special Education/ 504:	**English Language Learners:**
-Adhere to all modifications and health concerns stated in each IEP. -Accommodate Instructional Strategies: reading aloud text, graphic organizers, one-on-one instruction, class website (Google Classroom), handouts, definition list with visuals, extended time -Provide breaks between tasks, use positive reinforcement, use proximity -Assure students have experiences that are on the Concrete- Pictorial- Abstract spectrum by using manipulatives	- Use manipulatives to promote conceptual understanding and enhance vocabulary usage - Provide graphic representations, gestures, drawings, equations, realia, and pictures during all segments of instruction - Utilize graphic organizers which are concrete, pictorial ways of constructing knowledge and organizing information - Utilize program translations (if available) for L1/ L2 students - Reword questions in simpler language

-Implement supports for students with disabilities (click here) - Make use of strategies imbedded within lessons -Common Core Approach to Differentiate Instruction: Students with Disabilities (pg 17-18)	-Scaffolding instruction for ELL Learners -Common Core Approach to Differentiate Instruction: Students with Disabilities (pg 16-17)
Gifted and Talented:	**Students at Risk for Failure:**
- Elevated contextual complexity - Inquiry based or open ended assignments and projects - More time to study concepts with greater depth - Promote the synthesis of concepts and making real world connections - Provide students with enrichment practice that are imbedded in the curriculum such as: ● Application / Conceptual Development ● Are you ready for more? - Provide opportunities for science competitions - Alternative instruction pathways available	- Assure students have experiences that are on the Concrete- Pictorial- Abstract spectrum - Modify Instructional Strategies, reading aloud text, graphic organizers, one-on-one instruction, class website (Google Classroom), inclusion of more visuals and manipulatives, Peer Support - Parental/ guardian contact - Provide academic contracts to students & guardians - Create an interactive notebook with samples, key vocabulary words, student goals/ objectives. - Plan to address students at risk in your learning tasks, instructions, and directions. Anticipate where the needs will be, then address them prior to lessons. -Common Core Approach to Differentiate Instruction: Students with Disabilities (pg 19)

21st Century Life and Career Skills:

Career Ready Practices describe the career-ready skills that all educators in all content areas should seek to develop in their students. They are practices that have been linked to increase college, career, and life success. Career Ready Practices should be taught and reinforced in all career exploration and preparation programs with increasingly higher levels of complexity and expectation as a student advances through a program of study.
https://www.state.nj.us/education/cccs/2014/career/9.pdf

● **CRP1**. Act as a responsible and contributing citizen and employee. ● **CRP2**. Apply appropriate academic and technical skills. ● **CRP3**. Attend to personal health and financial well-being. ● **CRP4**. Communicate clearly and effectively and with reason. ● **CRP5**. Consider the environmental, social and economic impacts of decisions. ● **CRP6**. Demonstrate creativity and innovation.	● **CRP7**. Employ valid and reliable research strategies. ● **CRP8**. Utilize critical thinking to make sense of problems and persevere in solving them. ● **CRP9**. Model integrity, ethical leadership and effective management. ● **CRP10**. Plan education and career paths aligned to personal goals. ● **CRP11**. Use technology to enhance productivity. ● **CRP12**. Work productively in teams while using cultural global competence.

Students are given an opportunity to communicate with peers effectively, clearly, and with the use of technical language. They are encouraged to reason through experiences that promote critical thinking and emphasize the importance of perseverance. Students are exposed to various mediums of technology, such as digital learning, calculators, and educational websites.