Principles of Biomedical Science
Course Units
PBS Course Units

• Unit 1 – The Mystery
• Unit 2 – Diabetes
• Unit 3 – Sickle Cell Disease
• Unit 4 – Heart Disease
• Unit 5 – Infectious Disease
• Unit 6 – Post Mortem
Lesson 1.1 – The Crime

• **Activity 1.1.1 A Mysterious Death**
  • Students will be introduced to the mysterious death of Anna Garcia, set-up their organization scheme for the course, learn how to use Inspiration® software, and learn about the steps used to process a crime scene.

• **Activity 1.1.2 Examining the Scene**
  – Students will play the role of crime scene investigators to examine the scene of Anna Garcia’s death for clues.

• **Activity 1.1.3 Careers in Biomedical Science**
  – Students will examine key information gathered from persons of interest and explore biomedical science professionals involved thus far in Anna Garcia’s case.
Lesson 1.1 – The Crime

• **Activity 1.1.4 The Evidence**
  - Students will play the role of forensic scientists to analyze the evidence collected from the crime scene.

• **Activity 1.1.5 Time of Death**
  - Students will learn the fundamentals of experiment design and perform an experiment to determine how ambient temperature affects body cooling. Students will also estimate Anna’s time of death.

• **Project 1.1.6 Blood Spatter Analysis**
  - Students will design and perform their own experiment to investigate how height or surface materials affect bloodstain patterns.
Lesson 1.2 – DNA Analysis

• **Activity 1.2.1 What is DNA?**
  – Students will investigate the structural composition of DNA by building a three-dimensional model of the molecule.

• **Activity 1.2.2 DNA Extraction**
  – Students will extract DNA from both plant and animal cells.

• **Activity 1.2.3 DNA Analysis**
  – Students will investigate the methods used to analyze DNA and then work as a forensic DNA analyst to compare the DNA found at the Anna Garcia crime scene with the DNA obtained from each of the suspects.
Lesson 1.3 – The Findings

- **Activity 1.3.1 The Autopsy**
  - Students will explore the science of autopsies and then will be given the first piece of Anna Garcia’s autopsy report and brainstorm what the findings suggest.

- **Activity 1.3.2 Confidentiality**
  - Students will investigate the laws that relate to patient confidentiality and analyze real world scenarios to identify potential HIPAA violations.

- **Activity 1.3.3 Was it a Crime?**
  - Students will put all of the evidence they have collected and analyzed regarding Anna’s mysterious death together and draw conclusions about the manner of death (accident, homicide, or suicide). Students also explore additional careers encountered in Anna’s case.
Lesson 2.1 – What is Diabetes?

• **Activity 2.1.1 Diagnosing Diabetes**
  – Students will read portion of autopsy report that relates to changes related to Anna’s status as a diabetic as well as read pieces of Anna’s medical history chronicling Anna’s initial symptoms. Students will then complete laboratory tests to diagnose Anna and other fictional patients. They will perform simulated glucose and insulin level testing and discuss the biology of diabetes.

• **Activity 2.1.2 The Insulin Glucose Connection**
  – Students will design a 3-D working model to show how insulin is needed to move glucose into cells. Students also explore how to locate credible sources for scientific research.

• **Activity 2.1.3 Feedback**
  – Students will investigate negative feedback loops and explore the feedback relationship of glucose and insulin.
Lesson 2.2 – The Science of Food

• **Activity 2.2.1 Food Testing**
  – Students will test standard food items as well as “stomach contents” of Anna Garcia to identify the components of food and become familiar with the terms carbohydrates, fats, and proteins.

• **Activity 2.2.2 Food Labels**
  – Students will analyze food labels, complete a modified version of the existing nutritional terms chart, and discuss the role of specific macromolecules in the body. Students also explore the connection between a food log maintained by Anna Garcia and the regulation of her disease.
Lesson 2.2 – The Science of Food

• **Activity 2.2.3 The Biochemistry of Food**
  – Students will relate what they have learned about carbohydrates, fats and proteins to the basic chemical structure of the macromolecules. They will explore hydrolysis and dehydration synthesis reactions using 2-dimensional models. Students relate what they see to energy in the body.

• **Activity 2.2.4 Energy in Food**
  – Students will complete a calorimetry experiment using the same foods they have tested and explored in the preceding lessons.
Lesson 2.3 – Life with Diabetes

• **Activity 2.3.1 A Day in the Life of a Diabetic**
  – Students will write a “What to Expect” guide for a new diagnosis of diabetes – including diet, lifestyle modifications, and medical professionals involved in the treatment and regulation of a patient with Type I or Type II diabetes.

• **Project 2.3.2 Diabetic Emergency!**
  – Students will explore how high amounts of sugar in the bloodstream extract water from the body tissues, leading to increased thirst and urination. Students will complete a dialysis tubing experiment to explore what happens to cells when there is too much glucose in the blood. Students are then introduced to diabetic emergencies and complete a more extensive dialysis experiment to match patient serum with the correct blood sugar levels. They will relate the terms *hypoglycemic* and *hyperglycemic* to patient symptoms.
Lesson 2.3 – Life with Diabetes

• **Activity 2.3.3 Complications of Diabetes**
  – Students will explore and compare the short/long term complications of Type I and Type II diabetes and investigate how the disease impacts body systems.

• **Problem 2.3.4 The Future of Diabetes Management and Treatment**
  – Students will explore medical interventions and devise an innovation involved in the diagnosis, treatment, and monitoring of diabetes. The most creative idea/design will win a medical grant sponsored by Anna’s family.
  – Students will investigate how to give a proper presentation and will use the skills learned to complete a formal presentation of their idea.
Lesson 3.1 – The Disease

• **Activity 3.1.1 Blood Detectives**
  – Students will examine Anna’s blood with a microscope in order to investigate the effect sickle cell disease has on the blood. Students will also complete a blood test called a hematocrit in order to determine whether Anna was anemic at the time of her death.

• **Activity 3.1.2 Sickle Cell Diaries**
  – Students will review Anna Garcia’s medical records to learn more about her diagnosis as well as read her diary entries detailing what life was like for her living with sickle cell anemia. Students will then be assigned a fictitious patient who is undergoing a treatment for sickle cell disease. They will write diary entries for their assigned patient detailing how they are feeling and a description of the treatment they are receiving, including the risks and benefits. Students will also include a narrative of all of the biomedical professions the patient encounters during their treatment journey.
Lesson 3.2 – It’s in the Genes

• Activity 3.2.1 Protein Synthesis
  – Students will explore the process of protein synthesis through various interactive tutorials and will then fill-in a concept map outlining the process.

• Activity 3.2.2 The Genetic Code
  – Students will apply their knowledge of transcription and translation to decode a secret message as well as investigate the effect various mutations have on protein production. Students will then look specifically at the genetic mutation that causes sickle cell disease.

• Activity 3.2.3 Does Changing One Nucleotide Make a Difference?
  – Students will use computer simulations to visualize the interactions between amino acids and how these relate to protein structure as well as visual how changes in the β-globin protein is due to the mutation associated with sickle cell disease.
Lesson 3.3 – Chromosomes

• **Activity 3.3.1 How is DNA Passed Through the Generations?**
  – Students will explore the role chromosomes play in transferring genetic material from cell to cell as well as from generation to generation, through mitosis and meiosis. Students will also be introduced to the basics of Mendelian genetics.

• **Activity 3.3.2 Chromosomes – A Closer Look (Optional)**
  – Students will observe human chromosomes by using the HeLa tumor cell line to prepare a chromosome spread.
Lesson 3.3 – Chromosomes

• Activity 3.3.3 The Immortal Cells (Optional)
  – Students will explore the history behind the HeLa cell line grown in the laboratory. They will listen to a podcast as well as read articles from the perspective of the family of Henrietta Lacks as well as Dr. Gey. Students will then discuss the ethics surrounding Henrietta’s case and debate the commodification of human body parts.
Lesson 3.4 - Inheritance

• Activity 3.4.1 Family Inheritance
  – Students will look at and analyze gel pictures to determine sickle cell genotype of Anna’s family members and then create a pedigree using this information.

• Activity 3.4.2 What is the Probability?
  – Students will use two coins to represent the father and mother to determine the probability of children with sickle cell disease. Students will then use Punnett Squares to predict the chance and compare their results to their experimental findings. Finally, students will calculate the probabilities for three pedigrees.

• Activity 3.4.3 World Distribution of Sickle Cell Disease (Optional)
  – Students will investigate the relationship between sickle cell carriers and malaria resistance.
Lesson 4.1 – Heart Structure

• Activity 4.1.1 Path of Blood in the Heart
  – Students will read a portion of Anna’s autopsy report that relates to gross anatomy changes of the heart. They will research terms from the report and create a simple drawing or set of drawings to be used during the heart dissection in the next activity.

• Activity 4.1.2 Anatomy of the Heart
  – Students will dissect a sheep heart and explore basic anatomy and the path of blood flow.
Lesson 4.2 – The Heart at Work

• **Project 4.2.1 Heart Rate**
  – Students will review Anna’s medical history documents related to cardiac function – heart rate, blood pressure, and electrical activity/conduction.
  – Students will complete the Vernier Heart Rate lab and design an experiment using the heart rate sensors. Students will have the option to either complete a formal laboratory report for this experiment or for the experiment in the next activity.

• **Project 4.2.2 Blood Pressure**
  – Students will explore elements of blood pressure and run baseline blood pressure readings with Vernier and compare measurements retrieved manually versus those retrieved via the sensor. Students will design an experiment using the Vernier probes to determine the effect of a specific variable has on blood pressure.
Lesson 4.2 – The Heart at Work

• **Activity 4.2.3 EKG**
  
  Students will compare an abnormal EKG reading for Anna with a normal EKG. Students will research the conduction system of the heart and add key structures to their heart diagrams. Finally, students will record an example EKG and measure key intervals using Vernier.
Lesson 4.3 – Heart Dysfunction

• **Project 4.3.1 What is Cholesterol?**
  – Students will investigate Anna’s last cholesterol numbers and will research the relationship between cholesterol and blood flow. They will describe the role of LDL and HDL in body as well as interventions to keep healthy levels.

• **Activity 4.3.2 Hypercholesterolemia**
  – Students will complete a DNA electrophoresis lab to determine if Anna and members of her family have familial hypercholesterolemia.

• **Problem 4.3.3 The Heart as a Pump**
  – Students will design and build a simple pump to simulate the action of the heart. Students will then design an experiment to simulate the effects of cholesterol plaques on blood flow rate.
Lesson 4.4 – Heart Interventions

• Project 4.4.1 Unblocking the Vessels
  – Students will investigate lifestyle/health and identify behaviors that increase or decrease the risk of heart disease. Students will then create models to demonstrate various blockages and use their models to demonstrate different treatment technique to unblock vessels.

• Project 4.4.2 Heart Disease Intervention
  – Students will learn to assess risk of heart disease using an online risk calculator. They will explore factors that increase or decrease a risk for a heart attack and design a heart disease intervention plan for an assigned patient.
Lesson 5.1 – Infection

• **Activity 5.1.1 Contagious**
  – Students will demonstrate the transmission of an unknown infectious agent from person to person and use deductive reasoning to determine “patient zero.”

• **Activity 5.1.2 Infectious Disease Agents**
  – Students will explore different pathogens in order to identify the type of agent that caused Anna’s infection.

• **Activity 5.1.3 Isolating Bacteria**
  – Students will use aseptic technique to isolate bacterial colonies and complete a gross colony examination from a swab taken from Anna during her autopsy.
Lesson 5.1 – Infection

• **Activity 5.1.4 Gram Staining**
  – Students will look at prepared slides of Gram positive and Gram negative bacteria and then perform a Gram stain from a swab taken from Anna during her autopsy.

• **Activity 5.1.5 Bacterial Identification**
  – Students will analyze the results of various biochemical tests in order to identify the unknown bacterial species infecting Anna.

• **Project 5.1.6 Lines of Defense**
  – Students will design a board game or children’s book that showcases how the immune system works to fight infection.
Lesson 6.1 – Analyzing Anna

• **Project 6.1.1 How Do the Parts Make a Whole?**
  – Students will be assigned a body system and determine/showcase all of the ways each of the diseases encountered in the course could possibly effect the assigned body system. Students will have to include examples taken from Anna’s medical records and autopsy report.

• **Activity 6.1.2 How Did She Die?**
  – Students will be presented with the final pieces of Anna’s autopsy report and will put everything they’ve learned about Anna together to determine her cause of death. Students will then investigate interventions/treatments that could have possibly saved Anna’s life.