Principles of the Biomedical Sciences Field Test Detailed Outline

Unit One: The Mystery (31 days)

Lesson 1.1: Investigating the Scene (15 days)

Understandings Addressed in Lesson:

1. Principles of biomedical science can be used to investigate the circumstances surrounding a mysterious death.
2. Experiments are designed to find answers to testable questions.

Knowledge and Skills Addressed in Lesson:

It is expected that students will:

- Recognize that processing a crime scene involves purposeful documentation of the conditions at the scene and the collection of any physical evidence.
- Describe how evidence at a crime scene, such as blood, hair, fingerprints, and shoeprints can help forensic investigators determine what might have occurred and help identify or exonerate potential suspects.
- Recognize that bloodstain patterns left at a crime scene can help investigators establish the events that took place during the crime.
- Recognize that all external variables in an experiment need to be controlled.
- Analyze key information gathered at a simulated crime scene.
- Design a controlled experiment.
- Graph and analyze experimental data to determine the height associated with bloodstain patterns.

Lesson 1.2: DNA Analysis (9 days)

Understandings Addressed in Lesson:

1. Human DNA is a unique code of over three billion base pairs that provides a genetic blueprint of an individual.
2. DNA is packaged as chromosomes, which each contain numerous genes or segments of DNA sequence that code for traits.
3. DNA from all living organisms has the same basic structure – the differences are in the sequences of the nucleotides.
4. Restriction enzymes recognize and cut specific sequences in DNA.
5. Gel electrophoresis separates DNA fragments based on size and is used in Restriction Fragment Length Polymorphism (RFLP) analysis.

Knowledge and Skills Addressed in Lesson:

It is expected that students will:
- Describe the relationship between DNA, genes, and chromosomes.
- Describe the structure of DNA.
- Describe the structure of a nucleotide.
- Explain how restriction enzymes cut DNA.
- Describe how gel electrophoresis separates DNA fragments.
- Recognize that gel electrophoresis can be used to examine DNA differences between individuals.
- Demonstrate how restriction enzymes work.
- Demonstrate the steps of gel electrophoresis and analyze the resulting restriction fragment length polymorphisms (RFLPs).

Lesson 1.3: The Findings (7 days)

Understandings Addressed in Lesson:
1. The purpose of an autopsy is to answer any questions about the illness, cause of death, and/or any co-existing conditions.
2. Determining the manner of death involves the investigation of many aspects, including the medical condition of the victim, the internal and external examination of the body, the chemical and microscopic analysis of tissues and body fluids, and the analysis of all evidence found at the scene.
3. A comprehensive set of standards and practices is necessary in order to give patients specific rights regarding their personal health information.

Knowledge and Skills Addressed in Lesson:
It is expected that students will:

- Describe how an autopsy is performed and the types of information it provides to officials regarding the manner and cause of death.
- Recognize that a variety of biomedical science professionals are involved in crime scene analysis and determination of manner of death in mysterious death cases.
- Interpret information from an autopsy report to predict the manner of death.
- Explain the importance of confidentiality when dealing with patients, and describe the major patient protections written into the Health Insurance Portability and Accountability Act (HIPAA).
- Analyze patient confidentiality scenarios.

Unit Two: Diabetes (38 days)

Lesson 2.1: What Is Diabetes? (10 days)

Understandings Addressed in Lesson:

1. Diabetes is a disorder characterized by high blood glucose levels and caused by insufficient insulin or the inability of the insulin to function properly.
2. Diabetes can be diagnosed and further characterized as Type 1 or Type 2 by measuring glucose and insulin levels in the blood or urine.
3. The human body uses feedback mechanisms to maintain homeostasis.
4. It is important to evaluate a source of information to ensure the information is accurate and unbiased.

Knowledge and Skills Addressed in Lesson:
*It is expected that students will:*

- Recognize that insulin is the protein that regulates the transfer of glucose into body cells.
- Recognize that blood glucose levels are regulated by the feedback action of the hormones insulin and glucagon.
- Graph laboratory blood glucose and insulin level data and interpret results.
- Compare Type 1 and Type 2 diabetes.
- Demonstrate the role of insulin in transferring glucose from blood into cells.
- Diagram the feedback relationship of blood glucose and the hormones insulin and glucagon.
- Evaluate web resources to determine their level of credibility.

Lesson 2.2: The Science of Food (13 days)

Understandings Addressed in Lesson:

1. Foods contain macromolecules, particularly carbohydrates, lipids, and proteins, which are broken down and reassembled for use in the human body.
2. The human body utilizes nutrients, vitamins, and minerals consumed in food to maintain overall health and homeostasis.
3. Energy is stored in the chemical bonds of the macromolecules found in food.

Knowledge and Skills Addressed in Lesson:
*It is expected that students will:*

- Describe which foods are high in carbohydrates, lipids, and proteins.
- Recognize that the nutritional content of food helps individuals make decisions about diet and maintain good health.
- Describe basic nutritional terms as well as identify the role of each nutrient in the body.
- Recognize that the structure of macromolecules is related to their function in the human body.
- Explain the process of calorimetry and how it is used to measure the amount of energy in a food.
- Analyze food labels and food choices for nutritional content.
- Demonstrate the processes of dehydration synthesis and hydrolysis.
- Perform calorimetric measurements on food items and interpret the results.

Lesson 2.3: Life With Diabetes (15 days)

Understandings Addressed in Lesson:

1. Diabetes affects the overall health of the individual as well as aspects of daily life.
2. Blood glucose concentration affects osmosis, the movement of water in and out of body cells.
3. Type 1 and Type 2 diabetes can cause significant complications in many human body systems.
4. Scientists need to make sure that what they present is accurate and is communicated in a way that keeps interest and focus.

Knowledge and Skills Addressed in Lesson:
*It is expected that students will:*

- Recognize that a wide variety of treatment and management medical interventions are available to diabetics.
- Recognize that regulation of blood sugar is necessary to avoid severe and life-threatening diabetic emergencies.
- Be able to advise a patient newly diagnosed with diabetes on treating and living with the disease.
- Compare Type 1 and Type 2 diabetes.
- Demonstrate how water moves across a cell membrane to balance the level of dissolved solutes on either side.
- Diagram complications of diabetes on a human body graphic organizer.
- Assess the qualities of a successful oral and visual presentation.

Unit Three: Sickle Cell Disease (25 days)

Lesson 3.1: The Disease (6 days)

Understandings Addressed in Lesson:

1. Sickle cell disease is caused by an abnormal type of hemoglobin which causes red blood cells to become shaped like crescents or sickles.
2. Sickle cell disease and anemia cause many health problems and affect daily life for someone with the disease.

Knowledge and Skills Addressed in Lesson:
*It is expected that students will:*

- Explain the function of each of the major components of blood.
- Recognize that anemia is a deficiency in red blood cells or hemoglobin.
- Recognize that a hematocrit, a test performed to determine if someone is anemic, is the percent of the volume of whole blood that is composed of red blood cells.
- Compare normal vs. sickle-shaped red blood cells.
- Demonstrate how sickle-shaped red blood cells lead to decreased oxygen flow to body tissues.
- Create diary entries for a sickle cell patient and reflect on what living with sickle cell anemia is like.

Lesson 3.2: It’s In the Genes (9 days)
Understandings Addressed in Lesson:

1. Proteins are produced through the processes of transcription and translation.
2. Changes in the genetic material may cause changes in the structure and function of a protein and consequently the traits of an organism.

Knowledge and Skills Addressed in Lesson:

It is expected that students will:

- Recognize that the sequence of nucleotides in DNA determines the sequence of amino acids in a protein.
- Explain the process of protein synthesis.
- Explain how changes in the b-globin protein are due to the mutation associated with sickle cell disease.
- Demonstrate transcription and translation to create a simulated protein.
- Analyze the effect that base pair mutations have on a simulated protein.
- Manipulate computer simulated proteins to visualize the interactions between amino acids and analyze protein structural changes.

Lesson 3.3: Chromosomes (4 days)

Understandings Addressed in Lesson:

1. Chromosomes transfer genetic material from cell to cell as well as from generation to generation, in processes called mitosis and meiosis.
2. There are often several forms of each gene, some being dominant over the others.
3. There are many moral, ethical, and legal considerations surrounding the right to a person’s tissues and organs.

Knowledge and Skills Addressed in Lesson:

It is expected that students will:

- Recognize that in order for cellular division to occur, exact copies of the DNA must be transferred to the resulting daughter cells.
- Recognize that chromosomes in reproductive cells contain numerous genes that carry traits through the generations.
- Demonstrate the processes of mitosis and meiosis.
- Model the inheritance of genetic diseases.
- Analyze genotype to determine phenotype.
- Use proper techniques to examine, count, and measure chromosomes.
- Appraise the rights a person has to the use of his or her tissues and/or organs.

Lesson 3.4: Inheritance (6 days)

Understandings Addressed in Lesson:

1. The expression of a trait through the generations of a family can be visualized using a pedigree.
2. A Punnett square is a simple graphical way of discovering all of the potential combinations of genotypes of an offspring and can be used to determine the percent chance of each genotype occurring.

Knowledge and Skills Addressed in Lesson:
It is expected that students will:

- Explain how pedigrees can be used to determine the mode of inheritance of genetic diseases.
- Draw and analyze pedigree charts to illustrate passage of a trait through generations.
- Determine and compare the experimental probability and the theoretical probability of inheriting a trait.
- Analyze pedigrees to calculate the probability of inheriting a trait or disease.

Unit 4: Heart Disease (39 days)
Lesson 4.1: Heart Structure (7 days)

Understandings Addressed in Lesson:

1. The human heart is a four-chambered muscular pump designed to provide the force needed to transport blood through all the tissues of the body.
2. The heart’s pulmonary circuit pumps blood to the lungs to pick up oxygen, while the systemic circuit pumps oxygenated blood out to the tissues of the body.
3. The structure of blood vessels relates to their overall function.

Knowledge and Skills Addressed in Lesson:
It is expected that students will:

- Identify the main structures of the heart and describe their functions.
- Outline the path of the major blood vessels to and from the heart.
- Recognize that heart valves function to keep blood moving in the proper direction.
- Recognize that arteries move blood away from the heart and veins carry blood back to the heart.
- Compare the structure and function of arteries and veins.

Lesson 4.2: The Heart at Work (11 days)

Understandings Addressed in Lesson:

1. Heart rate, EKG, and blood pressure measurements are indicators of a person’s overall cardiac health.
2. Experiments are designed to find answers to testable questions.

Knowledge and Skills Addressed in Lesson:
It is expected that students will:
• Recognize that the heartbeat is caused by the contraction of muscle cells and results in the movement of blood from the heart to the arteries and the rest of the body.
• Recognize that heart rate is the number of heart contractions per unit of time, usually per minute.
• Recognize that blood pressure is a measure of the force put on the vascular walls by the blood as it is pushed by the cardiac muscles through the blood vessels.
• Recognize that the electrical activity of the heart can be measured and recorded by an electrocardiogram (EKG or ECG).
• Describe how internal and external factors can affect heart function and can contribute to the development of heart disease.
• Recognize that all external variables in an experiment need to be controlled.
• Measure heart rate and blood pressure manually and with scientific software and probes.
• Design controlled experiments to test the effect of factors such as exercise or body position on heart rate and blood pressure.
• Analyze EKG readings and relate resultant data to heart function.

Lesson 4.3: Heart Dysfunction (12 days)

Understandings Addressed in Lesson:

1. Cholesterol is a lipid that is necessary for the proper functioning of cells and for maintaining a healthy body.
2. The measurement of the HDL and LDL complexes may indicate a person’s risk for heart disease.
3. Restriction Fragment Length Polymorphism (RFLP) analysis can be used to diagnose genetic disease and disorders.
4. The human heart pumps blood around the body, and the efficiency of this pump is affected by the rate at which blood can move through the vessels.
5. Experiments are designed to find answers to testable questions.

Knowledge and Skills Addressed in Lesson:

It is expected that students will:

• Recognize that cholesterol is transported in the blood by protein complexes called high density lipoprotein (HDL) and low density lipoprotein (LDL).
• Describe how restriction enzymes and gel electrophoresis can be used to analyze genetic information.
• Describe how cholesterol buildup can impact blood flow through arteries.
• Compare and contrast the role of HDL and LDL in the body and how each relates to health.
• Use proper laboratory techniques to separate DNA fragments by gel electrophoresis.
• Analyze the results of the gel electrophoresis to correctly diagnose the presence of the familial hypercholesterolemia mutation.
• Generate ideas as a team to solve a problem.
• Design a controlled experiment to demonstrate how cholesterol plaques impact flow rate in blood vessels.

Lesson 4.4: Heart Intervention (9 days)

Understandings Addressed in Lesson:

1. A blocked coronary artery can lead to tissue death causing a myocardial infarction, or heart attack.
2. Risk factors such as genetics, poor diet, high cholesterol, high blood pressure, diabetes, and smoking increase a person’s risk of developing heart disease.

Knowledge and Skills Addressed in Lesson:

It is expected that students will:

• Describe the function of an angiogram in diagnosing blocked vessels.
• Recognize that blocked blood vessels can be treated surgically using procedures that tunnel through or around the areas that disrupt normal blood flow.
• Explain how lifestyle changes as well as medication or medical treatment may help decrease heart disease risk.
• Demonstrate a technique used to open a blocked vessel.
• Analyze medical data and brainstorm causes of death linked to the cardiovascular system.
• Analyze heart disease risk and design a risk reduction program.

Unit 5: Infectious Disease (20 days)

Lesson 5.1: Infection (20 days)

Understandings Addressed in Lesson:

1. Infectious diseases are caused by infectious agents and are transmitted in a variety of manners.
2. Aseptic technique assures that contaminants are not introduced into a specimen and that infectious agents are not spread to people or laboratory surfaces.
3. Bacteria are characterized by their shape, colony morphology, metabolism, and reaction to the Gram stain.
4. The specific structures of the immune system function to protect the human body against foreign invaders.

Knowledge and Skills Addressed in Lesson:

It is expected that students will:

• Describe the mode of transmission and mode of reproduction of various infectious agents.
• Describe the prevention of and treatment for various infectious agents.
• Identify the basic structures of a bacterial cell.
• Describe how the immune system responds when an antigen enters the body.
• Demonstrate the transmission of a simulated infectious agent.
• Compare and contrast the biology and pathology of various infectious agents.
• Use proper aseptic technique to isolate bacterial colonies.
• Perform a gross examination of bacterial colonies to differentiate an unknown bacterial sample.
• Use proper Gram staining and microscope techniques to stain, observe, and classify bacteria.
• Chemically examine and identify unknown bacteria.

Unit 6: Post Mortem (8 days)
Lesson 6.1: Analyzing Anna (8 days)

Understandings Addressed in Lesson:

1. The human body is composed of multiple body systems working together to maintain good health.
2. Scientists need to make sure that what they present is accurate and is communicated in a way that keeps interest and focus.
3. Determining the cause of death involves the investigation of many aspects of the medical condition of a victim, the internal and external examination of the body, and the chemical and microscopic analysis of tissues and body fluids.

Knowledge and Skills Addressed in Lesson:
*It is expected that students will:*

• Explain the functions of different human body systems and list the major organs within each system.
• Describe how multiple body systems are interconnected and how those interconnections and interactions are necessary for life.
• Demonstrate the ways an illness affects the various body systems.
• Deliver a quality visual and oral presentation.
• Analyze autopsy reports and medical history documents to determine cause of death.