SPARC Activities

THE PENNSYLVANIA SOCIETY FOR BIOMEDICAL RESEARCH

Narrative

The Pennsylvania Society for Biomedical Research (PSBR) is a 501(c)(3) non-profit science education organization formed in 1990. PSBR's mission is to promote a better public understanding of the importance of biomedical research and its contributions to human and animal health, with the goal of offering any person, regardless of age, gender, or income level, the opportunity to engage in scientific exploration and career-connected learning. PSBR carries out this mission by providing in-person activities, presentations, and experiences that support science and healthcare education, career awareness, and professional development opportunities.

In 2019, PSBR established its SPARC (Science Program and Research Coach) program. Through SPARC, PSBR provides mobile, hands-on, career-infused biomedical science programming designed to inspire students to pursue further science-related education and careers. SPARC connects students to the biomedical science field in order to enhance student STEM-related skills and to inspire students to pursue higher education and regional careers in the sector. By doing so, SPARC seeks to enhance students' career opportunities and livelihoods while developing local talent for the growing biomedical industry.

SPARC Program Description

PSBR's SPARC program delivers engaging, hands-on and age-appropriate biomedical science curricula embedded with career awareness and readiness information. SPARC demonstrates laboratory methodologies used in biomedical research to introduce concepts surrounding the scientific method, genetic and biomedical engineering, genome editing, nanotechnology, neuroscience, and laboratory animal science. During each SPARC session, students will have the opportunity to delve into relevant, engaging, and rigorous scientific tasks while working with real-world equipment. Information on career paths from a variety of professionals in science-related fields, including those within local industry partners, will also be presented during the program. Importantly, by providing accurate, relevant, and medically-related programming during the pandemic, students are better able to understand their current situation and how biomedical science plays a role in finding therapies and vaccines to stop the virus. Details of programming options can be found below. Example grade levels are provided.

- **DNA Extraction and modeling (all grades)**
  Students will have the opportunity to extract DNA from their own cheek cells and make a DNA molecule out of candy. Along the way, they will learn about this very important bio-molecule and how it acts as the instructions for life.

- **Career Guidance (all grades)**
  Students will learn about non-traditional professional opportunities in the field of biomedical science, with an emphasis put on local industry partners.

- **Micropipette Art (Gr. 1-10)**
  The Micropipette Art lesson is a perfect introductory activity, allowing students to gain experience with the tools and techniques used in other SPARC modules. In this lab,

students work with small amounts of liquid to create artwork. Students will also learn how to carefully read and follow a scientific protocol. This activity is adapted to accommodate various grade levels.

- **Microscopy (Gr. 1-6)**
  By observing living invertebrate specimens and comparing them to their own bodies, students learn about and how to use a common piece of lab equipment - The Microscope.

- **Think, Sense, Move (Gr. 3-6)**
  The basic functional unit of the brain is the neuron. A neuron is a specialized cell that can produce different actions due to of its precise connections with other neurons, sensory receptors, and muscle cells. In this module students learn about the key role of the brain as the body's control center and about equipment and methodologies used in the field of neuroscience. For example, students will use their problem solving skills to identify brain specimens embedded in lucite and in the process learn about brain anatomy. They will also use electromyography to investigate the electrical activity produced by their forearm muscle during different types of contractions.

- **Flies On Ice (Gr. 6-10)**
  Students utilize live organisms, *Drosophila melanogaster* (fruit flies), to learn the scientific process and explore basic concepts of neuroscience. Throughout this two-day lesson, students make observations, ask questions, understand independent vs. dependent variables, while collecting and analyzing experimental data.

- **BYO Gel Electrophoresis (Gr. 6-10)**
  Gel electrophoresis is a commonly used technique in most molecular biology and biomedical research laboratories. Additionally, it is a topic covered in AP Biology. In fact, it is also used in many of SPARC's more advanced lessons and activities. But how the technique actually works is often difficult for students to grasp. In this lesson, students will learn the basic theory and components of gel electrophoresis by building the system themselves. This is a great introductory lesson to some of SPARC's more advanced modules.

- **Case of the Broken Beaker (Gr. 6-10)**
  Restriction enzymes are molecular scissors that can cut DNA into fragments. These fragments can then be separated and analyzed by gel electrophoresis to create a DNA profile. Following a fictitious crime scene description, students will obtain four different DNA samples that were obtained from four potential suspects. Students will cut and separate the DNA using restriction enzymes, and gel electrophoresis, in hopes of creating a DNA profile for each suspect. Students will be able to analyze and compare these suspect samples with DNA isolated from the crime scene to help investigators determine the guilty party.

- **Mystery of the Crooked Cell (Gr. 6-10)**
  Sickle cell anemia is a hereditary disease that is passed down to an individual from their parents. The disease causes red blood cells to form into an abnormal crescent shape which prevents the cells from efficiently carrying oxygen to the body's tissues. This crescent, or sickle, shape is due to a mutation in the gene that codes for a protein in red

blood cells called hemoglobin, the component of red blood cells which binds to oxygen. In particular, the mutation leads to a change in one of the amino acids in the hemoglobin protein.

- **BioBits (Gr. 8-12)**
  The central dogma of molecular biology explains the flow of genetic information, whereby DNA is able to code for RNA, and RNA is able to code for protein. In today's activity students will use the BioBitsTM cell-free system to visualize the flow of genetic information and monitor the processes of transcription and translation in real time. Protein synthesis is usually carried out inside living cells, but BioBitsTM pellets allow this process to be carried out without cells. Using DNA that encodes for green and red fluorescent markers, students will be able to observe both the production of RNA and of protein as they occur in real time. They will also explore ways to interrupt specific steps in the molecular flow of information from DNA to protein.

- **A Roundabout We Go (Gr. 8-12)**
  This activity allows students to directly compare behavioral phenotypes and consider the genetic and molecular causes. Although observation of larval fruit fly behavior could be used as an hook to engage students in study of genetics, these activities would work best to contextualize existing understanding of basic genetics including inheritance patterns and the mechanism by which genotype determines phenotype. Students should already be familiar with the concept of genes, alleles, Mendelian patterns of inheritance, Punnett squares, and gene expression through transcription and translation. Familiarity with mutations as changes in nucleotide sequence is helpful.

- **GMO Identification (Gr. 10-12)**
  Humans have been modifying plants since the dawn of civilization through the domestication of crops. Modern biotechnology and genetic engineering allow scientists and breeders to rapidly confer very specific traits by introducing particular genes directly into plants. This activity allows students test for genetically engineered elements from foods and plant tissues using PCR. Students engage in a real-world biotechnology application relevant to agriculture, environmental science, and the food industry.

- **Scanning Electron Microscopy (Gr. 10-12)**
  The desktop scanning electron microscope (SEM) is a perfect opportunity for students to explore the invisible properties of materials and organisms. In this lesson, students will explore how an SEM works, compare various types of microscopes, learn about magnification/resolution, explore items on the nanoscale, and observe everyday objects using an SEM.