**Summary:**
The curricula developed for use with the StepStone software provides a motivating and engaging learning environment. Specific details for using the software are provided in an accompanying “StepStone How-To” document.

The vaccination and infectious disease module covers the concepts of organizing and analyzing data using the topics of vaccination and infectious diseases. Students will have the opportunity to guide their own learning through a variety of “learning objects” intended to provide critical thinking about and application of required science standards.

**Keywords:** acquired immunity, bar graph, controlled variable, data, data table, dependent variable, epidemic, graph, independent variable, infectious disease, line graph, mean, median, mode, natural immunity, pandemic, pie chart, range, vaccine, variable, virus

**Subject TEKS:**

* Scientific Processes All Sciences:
	+ 2 (A) plan and implement comparative and descriptive investigations by making observations, asking well defined questions,
	+ 2 (D) construct tables and graphs, using repeated trials and means, to organize data and identify patterns
	+ 2 (E) analyze data to formulate reasonable explanations, communicate valid conclusions supported by the data, and predict trends
	+ 3 (A) analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning
* Biology 4 (C) compare the structures of viruses to cells, describe viral reproduction, and describe the role of viruses in causing diseases such as human immunodeficiency virus (HIV) and influenza.
* Biology 10 (A) describe the interactions that occur among systems that perform the functions of regulation, nutrient absorption, reproduction, and defense from injury or illness in animals
* Biology 11 (A) summarize the role of microorganisms in both maintaining and disrupting the health of both organisms

**NGSS Science and Engineering Practices:**

* Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students’ own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (MS-LS1-5),(MS-LS1-6).
* Use an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-LS1-4)
* Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence. (MS-LS1-8)

**Grade Level:** 6th - 9th

**Learning Objectives:**

1. Define data and provide examples of types of data.
2. Correctly use pie charts, bar graphs, and line graphs according to the type of data to be represented.
3. Analyze infectious disease and vaccination data using mean, median, mode, and range.
4. Analyze data to formulate conclusions and predict trends related to vaccinations and infectious diseases.
5. Define infectious disease.
6. Describe how the immune system and vaccinations work together to fight infectious diseases.
7. Analyze influenza data to compare and contrast seasonal and pandemic flu.

**Time Required:** will vary depending on lesson implementation and learning objectives chosen

**Materials:**

* Devices with internet access
* **Infectious Disease Spread Activity**
	+ Saturated baking soda solution (baking powder dissolved in water until no more can dissolve)
	+ Distilled water
	+ Vinegar
	+ Numbered clear plastic cup for each student
	+ Stickers
	+ Phenolphthalein indicator solution (water from boiled red (purple) cabbage can be used as a substitution; instructions provided in activity plan)
* **Spread of Infectious Disease Worksheet**
	+ Colored pencils and straight edge/ruler for graphs
* **Influenza Claim Evidence Reasoning Activity**
	+ Device with internet connection
	+ Student activity worksheet
	+ Butcher paper, poster board, or sticky easel pad
	+ Markers, colored pencils, or other art supplies
	+ Straight edge, ruler, or meter stick

**Background and Concepts for Teachers:**

Data Types

 Organized data allows for ease of interpretation and analysis. Commonly used organization methods include data tables, pie or circle graphs, bar graphs, and line graphs.

 Data tables allow for accurate recording of observations and measurements. Data tables should include a title, which describes the information recorded, variables – the information being studied, recorded as labeled rows and columns, and units (when necessary).

 Pie or circle graphs uses a circle divided into sections to display data as parts (percentages or fractions) of a whole.

 Bar graphs compare data. They can show relationships among data, but not necessarily change over time.

 Line graphs show the relationship between two variables and can show how a variable changes over time. These graphs are particularly useful in recognizing patterns or trends.

Data Analysis

After organizing data, scientists must think critically to determine what the data means. Looking for patterns or trends, performing statistical analyses, and then drawing conclusions from the information are methods for analyzing and interpreting data.

When interpreting data, one should return to the research/experimental question originally posed and evaluate if there appears to be a relationship between the independent variable(s) and the dependent variables (outcomes).Quantitative interpretation can include calculation of the mean, median, mode, and range. The mean of a data set is the arithmetic average found by adding the numbers in the data set and dividing by the number of items in the set. The median is the middle number in a data set that has been ordered from least to greatest. The mode is the number in a data set that appears most often. The range is the difference between the largest and smallest numbers of a data set.

After interpreting data, scientists are better able to draw valid conclusions. Conclusions will often state whether the original hypothesis was supported or not. Valid conclusions rely on accurate data and must avoid bias. A conclusion should not be stated if it is not supported by the data. Often times, additional data must be collected in order to form valid conclusions.

Infectious Disease

Several types of microorganisms cause infectious diseases, which can affect different body systems. The microorganisms most commonly responsible for disease include viruses, bacteria, fungi, and parasites. Transmission of pathogens can occur in various ways including physical contact, contaminated food, body fluids, contaminated objects, airborne inhalation, or through vector organisms.

Infectious diseases and their spread are a cause of national attention due to the risk of outbreaks. Many of the recent infectious disease outbreaks are due to viruses. A virus is a tiny, infectious particle that can reproduce only by infecting a host cell. Viruses are not made of cells; in fact, they are much smaller than cells and not visible with light microscopes. Viruses also do not metabolize food for energy. For all of these reasons, many scientists do not classify viruses as living organisms. However, similar to other living organisms, viruses do contain genetic material (DNA or RNA) and can evolve.

When pathogens like viruses infect the body, the immune system fights back! The immune system is made up of special cells, proteins, tissues, and organs which work together to form an immune response. When the immune system encounters foreign substances, or antigens, it begins to produce antibodies to attack and destroy them. Antibodies are specialized proteins created by the immune system to attach to and remove specific antigens. Once antibodies are produced, they remain in the body and, if the same antigens appear again, the antibodies can quickly respond.

Vaccinations boost the immune system by introducing antigens to a specific disease in a way that does not cause illness, but does create an immune response; including the production of antibodies. The antibodies will then protect the individual from a future attack by the microorganism that produces that particular disease.

**Vocabulary / Definitions:**

* **Acquired immunity** - immunity developed by exposure to a disease (infection or vaccination)
* **Bar graph** - a graphical display of data using rectangular bars with heights or lengths proportional to the values that they represent
* **Controlled variable -** a variable that remains unchanged or held constant to assess or clarify the relationship between two other variables
* **Data** – a collection of observations, measurements and/or facts for the purpose of studying or analyzing information
* **Data table -** a display of information in tabular form, with named rows and/or columns
* **Dependent variable -** the variable being tested and measured in a scientific experiment **Epidemic -** The occurrence in a community or region of cases of an illness or other health-related events clearly in excess of normal expectancy
* **Graph –** a visual representation or a diagram that represents data or values in an organized manner
* **Independent variable –** the variable that is changed in an experiment in order to see what effect it has on the outcome
* **Infectious disease -** A disease that is caused by a microorganism, such as a bacterium, virus, parasite, or fungi
* **Line graph –** a graph which shows the relationship between two variables
* **Mean –** the mathematical average of a set of data
* **Median –** the middle number in a data set when the data are arranged in numerical order
* **Mode –** the number that appears most often in a data set
* **Natural immunity –** immunity that is present without prior exposure to a pathogen; gained from the mother in the womb or through antibodies in the mother’s milk
* **Pandemic –** a disease that occurs over a wide geographic area and affects an exceptionally high proportion of the population
* **Pie chart –** a graph which uses a circle divided into sections to display data as parts (fractions or percentages) of a whole
* **Range –** the difference between the largest and smallest number in a data set
* **Vaccine –** a substance used to stimulate the production of antibodies and provide immunity against one or several diseases
* **Variable –** any item, factor, or condition that can be controlled or changed in an experiment
* **Virus -** A microorganism that is smaller than a bacterium and that cannot grow or reproduce apart from a living cell.

**Lesson Introduction / Motivation:**
Students begin by taking the “pre-test” in order to assess their current knowledge and understanding. This may also enable students to recognize concepts about which they would like to learn more or to which they need to pay particular attention.

The student-centered design of this module allows for multiple introduction/motivation activities. Students may begin the unit on their own by reading the “Meet a Scientist” biography or “Backpack Adventure” stories or by watching one or more “Scientist Videos”. Each of these learning objects provide students with insights into the history or application of the organization and analysis of data as well as viruses and the immune system and should motivate students to dig deeper into the required standards presented/studied later. These learning objects also contain processing questions that can be answered and shared in class or in an on-line portfolio such as Google docs.

Alternately, teachers could introduce the module to their classes by having students explore the interactive graph from “Our World in Data” that describes the worldwide deaths caused by vaccine preventable diseases (<https://ourworldindata.org/grapher/deaths-caused-by-vaccine-preventable-diseases-over-time> ). As students interact with the graph, instruct them to record information they find interesting or important. They might also provide the following guiding questions:

* How many and what types of diseases are included in the graph?
* What years are included in the graph
* What was the highest number of deaths, the lowest?
* Do you notice any patterns or trends?
* What conclusions about diseases, deaths, or vaccinations might you draw from this graph?

Give students about 5 minutes to record their information and then share ideas with the entire class. Use these ideas to introduce the concept of data; and how proper data analysis can provide important information to scientists. This activity incorporates the student-centered classroom philosophy, as students will be developing ideas and theories on their own as the teacher facilitates the activity.

**Exploration/Explanation:**
Students should next examine the required concepts (standards) of data organization and analysis as well as infectious diseases and the immune system. Setting up classroom stations can promote student collaboration, problem solving, and critical thinking. Stations also provide students with a common base of experiences. These stations may include any or all of the following learning objects:

* *Essential Knowledge* – students use various types of note outlines to record information about required content from an interactive video presentation. Students can then compare and discuss their notes to ensure the acquisition of key concepts.
* *Backpack Adventures* – students read (independently or as a read aloud) a fictional story with factual content about key concepts and individuals related to infectious disease and data analysis. Students can then answer questions, create timelines, compare fact vs. fiction, or perform other related activities to reinforce required concepts.
* *Meet a Scientist* – students read (independently or as a read aloud) a short biography about a scientist instrumental to the development of vaccinations. They will then answer questions relating to the scientist and his work. Students could also role-play and describe how they would have solved the problem/answered the question facing the scientist. Additionally, students could ask additional questions they have about vaccinations, infectious diseases, or the immune system after reading about the scientist’s work.
* *Scientist Videos* – students learn how real scientists study the impact of infectious diseases on the body systems in various short videos describing research, careers, or other aspects of the field. Students will then answer questions and/or discuss how the concepts they learn in class are applied in the real world.
* *Real Science Review* – students read an actual research article related to vaccinations and infectious diseases (edited to middle school readability) and then review it using the scientific method as scaffolding. For instance, students will identify the hypothesis, data collection methods, relevance, etc.
* *Practice* – students can choose various on-line activities to gain or reinforce knowledge about data organization/analysis, viruses, and the immune system. Activities include videos, matching/labeling games, flashcards, mnemonics, quizzes, etc.

Another option for utilizing this module is to have students choose either “Backpack Adventures”, “Meet a Scientist”, “Scientist Videos”, or “Real Science Review” and complete (read/watch and answer questions) accompanying activities at home. They would journal on paper or through an on-line portfolio such as Google Docs about three main ideas, provide three vocabulary words and definitions, and/or construct three questions. As a class or in small groups students would share information and use it to complete note outlines, practice activities, or other class activities (see “Elaborate” section).

**Elaborate:**

* Influenza Case Study – students will use case study templates found in the “Make a Note of That” learning object to analyze influenza data from the Centers for Disease Control and World Health Organization. An accompanying teacher instruction page provides details for using the case study templates.
* Infectious Disease Spread Activity – students will model the spread of an infectious disease, then collect and analyze related data. An accompanying teacher instruction page provides activity details.
* Influenza Claim Evidence Reasoning Activity – students will demonstrate scientific reasoning by analyzing data and using their understanding of infectious diseases to answer a teacher-posed question. An accompanying teacher instruction page provides activity details.

**Assessment/Evaluation:**

The Vaccination and Infectious Disease Module includes a post-test, which can be used for an overall learning assessment. Other opportunities for assessment include student output at any of the learning object stations, journaling requirements as detailed in the “Explore/Explain” section above and/or any of the “Elaborate” activities.

Please email us your comments on this lesson: cvmpeer@cvm.tamu.edu
In your email, please include the title of the lesson and the grade level to which the lesson was applied.