

**Relationship Between CO2 Absorption and Plant Growth**

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| **6-11 th Grade** | |  | |
| **Topic:**  Carbon Dioxide Absorption and Plant Growth | | **Materials:**   * COSMOS Toolkits * COSMOS Toolkit Framework * IoT nodes * Mobile Nodes * Carbon Dioxide Sensors * Rulers * Clip board * Post-it Chart Paper * Markers * Graph Papers * Graphing Calculators * Graphic Organizers | |
| |  |  |  | | --- | --- | --- | | **Science & Engineering Practices (SEPs)**  Developing and Using Models  Modeling in 6–8 builds on K–5 experiences and progresses  to developing, using, and revising models to describe, test,  and predict more abstract phenomena and design  systems.  Develop and use a model to describe phenomena.  **(MS-LS1-2)**  Develop a model to describe unobservable  mechanisms. **(MS-LS1-7)**  Planning and Carrying Out Investigations  Planning and carrying out investigations in 6-8 builds on K-  5 experiences and progresses to include investigations that  use multiple variables and provide evidence to support  explanations or solutions.  Conduct an investigation to produce data to serve as  the basis for evidence that meet the goals of an  investigation. **(MS-LS1-1)** | **Disciplinary Core Ideas (DCIs)**  **LS1.A: Structure and Function**  All living things are made up of cells, which is the  smallest unit that can be said to be alive. An organism  may consist of one single cell (unicellular) or many  different numbers and types of cells (multicellular).  **(MS-LS1-1)**  Within cells, special structures are responsible for  particular functions, and the cell membrane forms the  boundary that controls what enters and leaves the cell.  **(MS-LS1-2)**  In multicellular organisms, the body is a system of  multiple interacting subsystems. These subsystems are  groups of cells that work together to form tissues and  organs that are specialized for particular body functions.  **(MS-LS1-3)**  **LS1.B: Growth and Development of Organisms**  Animals engage in characteristic behaviors that increase  the odds of reproduction. **(MS-LS1-4)**  Plants reproduce in a variety of ways, sometimes  depending on animal behavior and specialized features  for reproduction. **(MS-LS1-4)**  Genetic factors as well as local conditions affect the  growth of the adult plant. **(MS-LS1-5)**  **LS1.C: Organization for Matter and Energy Flow in Organisms**  Plants, algae (including phytoplankton), and many  microorganisms use the energy from light to make  sugars (food) from carbon dioxide from the atmosphere  and water through the process of photosynthesis, which  also releases oxygen. These sugars can be used  immediately or stored for growth or later use. **(MS-LS1-6)**  **PS3.D: Energy in Chemical Processes and Everyday**  **Life**  The chemical reaction by which plants produce complex  food molecules (sugars) requires an energy input (i.e.,  from sunlight) to occur. In this reaction, carbon dioxide  and water combine to form carbon-based organic  molecules and release oxygen. **(secondary to MS-LS1-6)**  Cellular respiration in plants and animals involve  chemical reactions with oxygen that release stored  energy. In these processes, complex molecules  containing carbon react with oxygen to produce carbon  dioxide and other materials. **(secondary to MS-LS1-7)** | **Crosscutting Concepts (CCs)**  **Cause and Effect**  Cause and effect relationships may be used to  predict phenomena in natural systems. **(MS-LS1-8)**  Phenomena may have more than one cause, and  some cause and effect relationships in systems can  only be described using probability. (**MS-LS1-4),(MS-**  **LS1-5)**  Scale, Proportion, and Quantity  Phenomena that can be observed at one scale may  not be observable at another scale. **(MS-LS1-1)**  Systems and System Models  Systems may interact with other systems; they may  have sub-systems and be a part of larger complex  systems. **(MS-LS1-3)**  Energy and Matter  Matter is conserved because atoms are conserved in  physical and chemical processes. **(MS-LS1-7)**  Within a natural system, the transfer of energy  drives the motion and/or cycling of matter. (MS-LS1-6)  Structure and Function  Complex and microscopic structures and systems can  be visualized, modeled, and used to describe how  their function depends on the relationships among its  parts, therefore complex natural structures/systems can be analyzed to determine how they function.  **(MS-LS1-2)** | | | | |
| **Math Common Core Standards:**  **6.EE.9**  Use variables to represent two quantities in a real-world problem that change in relationship to  one another; write an equation to express one quantity, thought of as the dependent variable, in  terms of the other quantity, thought of as the independent variable.  Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation. For example, in a problem involving motion at constant speed, list and graph ordered pairs of distances and times, and write the equation d = 65t to represent the relationship between distance and time.  **7.RP.2**  Recognize and represent proportional relationships between quantities.  a. Decide whether two quantities are in a proportional relationship, e.g., by testing for  equivalent ratios in a table or graphing on a coordinate plane and observing whether the graph is a straight line through the origin.  b. Identify the constant of proportionality (unit rate) in tables, graphs, equations, diagrams,  and verbal descriptions of proportional relationships.  c. Represent proportional relationships by equations.  **7.EE.3**  Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically.  Apply properties of operations to calculate with numbers in any form; convert between forms as  appropriate; and assess the reasonableness of answers using mental computation and  estimation strategies.  **8.EE.5** Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare  two different proportional relationships represented in different ways. For example, compare a  distance-time graph to a distance-time equation to determine which of two moving objects has  greater speed.  **Solve real-world and mathematical problems involving area, surface area, and volume.**  **6.G.1**  Find the area of right triangles, other triangles, special quadrilaterals, and polygons by  composing into rectangles or decomposing into triangles and other shapes; apply these  **7.G.6** Solve real-world and mathematical problems involving area, volume and surface area of two-  and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right  prisms  techniques in the context of solving real-world and  **Summarize and describe distribution**s.  **6.SP.4** Display numerical data in plots on a number line, including dot plots, histograms, and box plots.  **6.SP.5** Summarize numerical data sets in relation to their context, such as by:  a. Reporting the number of observations.  b. Describing the nature of the attribute under investigation, including how it was measured  and its units of measurement.  c. Giving quantitative measures of center (median and/or mean) and variability (interquartile  range and/or mean absolute deviation), as well as describing any overall pattern and any  striking deviations from the overall pattern with reference to the context in which the data  were gathered.  d. Relating the choice of measures of center and variability to the shape of the data  distribution and the context in which the data were gathered.mathematical problems.  **7.SP.1**  Understand that statistics can be used to gain information about a population by examining a  sample of the population; generalizations about a population from a sample are valid only if the  sample is representative of that population. Understand that random sampling tends to  produce representative samples and support valid inferences.  **Summarize, represent, and interpret data on two categorical and quantitative variables**  **S-ID.5** Summarize categorical data for two categories in two-way frequency tables. Interpret relative  frequencies in the context of the data (including joint, marginal, and conditional relative  frequencies). Recognize possible associations and trends in the data. ★  **S-ID.6** Represent data on two quantitative variables on a scatter plot, and describe how the variables  are related.  a. Fit a function to the data; use functions fitted to data to solve problems in the context of the  data. Use given functions or choose a function suggested by the context. Emphasize linear,  quadratic, and exponential models. 10  b. Informally assess the fit of a function by plotting and analyzing residuals. 11  c. Fit a linear function for a scatter plot that suggests a linear association. 12  Interpret linear models  **S-ID.7** Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the  context of the data.  **S-ID.8** Compute (using technology) and interpret the correlation coefficient of a linear fit. ★  **S-ID.9** Distinguish between correlation and causation. ★  **Apply geometric concepts in modeling situations**  **G-MG.1** Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a  tree trunk or a human torso as a cylinder).  **G-MG.2** Apply concepts of density based on area and volume in modeling situations (e.g., persons per  square mile, BTUs per cubic foot).  **G-MG.3** Apply geometric methods to solve design problems (e.g., designing an object or structure to  satisfy physical constraints or minimize cost; working with typographic grid systems based on  ratios). ★  **Build a function that models a relationship between two quantities**  **F-BF.1 40**  Write a function that describes a relationship between two quantities.   1. Determine an explicit expression, a recursive process, or steps for calculation from a context.   **S-ID.6 62**  Represent data on two quantitative variables on a scatter plot, and describe how the variables are related. Fit a function to the data; use functions fitted to data to solve problems in the context of the  data. Use given functions or choose a function suggested by the context. Emphasize linear,  quadratic, and exponential models. | | | |
| **Essential Question:**  How does the amount of Carbon Dioxide absorption affect plant growth? | | | |
| **Learning Target** | I can perform the experiment by observing the amount of carbon dioxide absorption and find out how it affects plant growth.  I will be able to analyze the relationship of this carbon dioxide absorption to different variables involved in plant growth such as height of the plant, leaf length and area, root length and overall weight of the plants. | | |
| **Engage** | 1. Teacher and students will perform the experiment by observing and recording the amount of CO2 absorption using the sensors and the COSMOS Toolkit Framework. They will also complete a See, Think, Wonder ( graphic organizer ) 2. Students engage in a see, think, wonder of the chronograf and the csv file as shown on the Smartboard or Promethean Board.    1. See: What do you notice?    2. Think: What do you think your noticing mean?    3. Wonder: Create a question that you would like to explore further based on your noticings and conjectures? 3. Discuss with the students their conjectures and wonderings. | | |
| **Explore** | The students will explore this experiment for two weeks.  **Day 1**- Teacher will introduce the carbon dioxide sensor and the IoT nodes, mobile nodes and how data is read in the COSMOS Toolkit Framework. Expectations and rationale of this experiment will be given to prepare the students for the whole activity.  **Day 2-** The class will be divided into four groups. Group 1 and 2 will do the Experiment A while Groups 3-4 will perform Experiment B. Each team will have a pot and germinate their own plants. The members are responsible for taking care of their set-up.  **Day 3-7** Nurture germination and growth for a week. The students will spend 10 minutes, before every class, watering their plants, making sure the temperature is at least 20C and exposed to light. The Brassica rapa plants should be breaking the surface and sprouting leaves very soon!  **Day 8- 14** Students will start observing the results on the chronograph and record them in their graphic organizer.  **Experimental Group A**  These group of plants will be exposed to the sunlight and must be placed near the window from Day 2-14.  **Experimental Group B**  These group of plants will not be exposed to sunlight and must be placed inside the closet from Day 8-14.  **Constant Variables:**  amount of water, fertilizer, humidity, size of the pots, | | |
| **Explain** | 1. Within their groups, the students will discuss their observations, their findings, questions, multiple representations of the results and trends based on the data. 2. In a gallery walk/powerpoint presentations, the students will present all of their data and make connections across the different groups. They can use this space to discuss results and trends across the groups. 3. The class will be able to find out how the amount of carbon dioxide absorbed affects plant growth based on their findings. 4. Questions will be entertained by the group presenting for clarifications. 5. A rubric will be given for them to give feedback/peer evaluations | | |
| **Extend** | A possible extension of this experiment will be to investigate on different types of plants. Students on both groups will use 3-5 types of common plants and find out similarities as well as differences of the results. | | |
| **Evaluate** | Find out if the students were able to accomplish the main goal/learning target/essential questions posted before the experiment started.  Let students present their findings and let them discuss among their classmates and entertain questions regarding the results.  Students and teacher will evaluate the success of the experiment of the other groups by asking relevant questions based on their presentations. A rubric will be used to give specific feedback to the work of their peers. | | |
| **Differentiation** | Students will be grouped heterogeneously. Each group will be expected to meet the same standards. Graphic organizers and vocabulary sheets will be available for students to use. | | |