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| **Title** | Applying the Results – Understanding Population Dynamics |
| **Introduction** | Students will use the growth of fruit flies in a small, contained space to understand population dynamics in drosophila populations. They will grow a colony of flies in a limited area providing the population with “new food” in a constant amount on a regular schedule. They will record the number of fruit flies in the containers over a series of 4 weeks. This may be done in conjunction with the Design of Experiment – Growth of Fruit Flies Lesson. |
| **Learning Outcomes** | Students will be able to…   * Recognize density dependent factors, such as competition for resources that limit exponential population growth. * Identify exponential and logistic growth curves when analyzing the changing number of fruit flies in their populations. |
| **Time Required and Location** | Time required for this lesson is contingent upon if the class is also going to be completing the lesson on design of experiment using diet development for fruit flies. If so, the instructor will need 3 class periods or 1.5 block periods to set up the experiments, as per the instructions for the DOE lesson, and additionally 90 more minutes for analysis and discussion of the data collected.  If the instructor is choosing to do this independently of the DOE lesson, students will need 45 minutes to properly set up their vials with their fruit flies given a provided diet. Then, 10 minutes every 2-3 days to collect data over a 4 week period. Following the data collection, students will need the final 90 minutes for data analysis. |
| **Materials Needed** | * *Drosophila melanogaster* (6 per vial, minimum 3 vials per group) * Vials (minimum 3 per group) * Aerated stoppers (can use cotton balls) – 1 per vial * Anesthetizing agent for Drosophila melanogaster: carbon dioxide, cooling, or ether. * “Fruit fly food” – food provided with fruit flies upon ordering or a banana would suffice! * Brewer’s yeast * Sugar source (glucose, sucrose, fructose, etc). * Protein source (whey protein, soy protein, nutritional yeast, etc). * “Don’t Spill the Beans” board game (1-10 sets depending on availability).   **Technology Resources:** Students will need computers with access to a graphing program. If a specific program is not available, it is suggested that students sign up for a Google account and use the “Google Docs” program with the spreadsheet option to make the graphs. |
| **Participant Prior Knowledge** | It is suggested that prior to completing this lesson, students complete the “Design of Experiment: Optimizing Diets for Drosophila” lesson. Students will be well informed as to the life cycle of the fruit fly, the impact of diet on the population growth, and how to handle/work with small insects. |
| **Facilitator Preparations** | Prepare materials ahead of time and set up lab stations in your classroom. |
| **Activities** | 1. Hook: “Don’t Spill the Beans”. Either in lab groups, or as a demo with 4 volunteers, have students play a few rounds of “Don’t Spill the Beans”. After students play a few rounds, ask students to discuss strategies for not spilling the beans. Have one student per group “share out” what their group came up with. Use this as a jumping off point to discuss what environments can hold. Space will be an easy connection for students to see, but then use this to continue talking about other resources. Hopefully your students will list space food, disease, competition, etc. You’re going for density-dependent factors. [20 minutes] 2. If students have been working with fruit flies already, instruct students to take out their data of the population numbers they have been collecting over the four week period. Instruct students to use their data to make a graph of the populations of their different vials using Microsoft Excel or another graphing program. Depending on the level/experience of students, clear directions may need to be provided for students to make graphs that are clearly labeled and easily understandable by the reader. If computers are not available, students can make graphs using graph paper. [40 minutes] 3. Once the graphs are completed, have students write a summary statement that describes the change in population in each of their vials from beginning to end. [20 minutes, suggested as a homework assignment] 4. Direct Input: Using the preferred method of instruction, teach students the different between exponential and logistic growth. Students should be familiar with the conditions under which populations would experience such grow AND how to easily recognize this growth. [20 minutes] 5. Using their notes, have students analyze the statements they wrote regarding their fruit fly populations and identify which type of growth their fruit flies underwent. [5 minutes] 6. Wrap up: Using the data collected and their conclusions about what type of growth occurred, have students consider different “alternative” endings. Consider using the questions: What would happen if the fruit flies were given an indefinite amount of time in the vials? How would the results have differed if the flies received more/less food in the vials weekly? How could you determine carrying capacity of your vial and the amount of food provided for these fruit flies? How could you determine carrying capacity for a different organism in a given environment? |
| **Assessment** | * Production of graphs of the changing fruit fly populations created on Excel, or another graphing program. It is suggested that students create their graphs and then share them with the class, using a shared folder on the computer network or through file sharing programs such as Google Docs. Then students can compare their results to different groups in the class. The teacher should provide clear guidelines about how to make an effective graph (providing clear titles, axis labels, etc). * Provide students with graphs have them identify type of growth and what carrying capacity is for that population. |
| **Critical Vocabulary** | Exponential growth curve  Logistic growth curve  Carrying capacity  Generations |
| **Extension Activities** | Have students explore what would cause one specific population to grow exponentially. Then, have students think through or research what would happen to other populations in that ecosystem if that population did begin to increase. How would food chains be impacted? How would habitat space be impacted? Etc. |
| **Modifications** | * If fruit flies are not readily available, there are simulators online that enable you to virtually order and breed fruit flies. This could be used in lieu of actually collecting and breeding the organisms but still allowing students to see how data is collected in a real lab environment. * Students may need to be provided with specific instructions for creating and sharing a document on “Google Groups.” The teacher must first create an account and then invite students to join the group (if it is private) or tell them to add the group if you leave it public access. |
| **Alternative Assessments** | * Provide students with scenarios, have them create graphs and decide whether the population was growing exponentially or logistically. * Have students complete the “House of Flies” activity – where they think about the growth rate of flies in different situations. |
| **References** | Cohen, A.C. (2004). *Insect diets: science and technology*. Boca Raton, FL: CRC Press.  Students  Practice Sexing Fruit Flies: <http://www.biologycorner.com/fruitflygenetics/sex.htm>  Ordering and mating fruit flies virtually: <http://www.sciencecourseware.org/vcise/drosophila/>  Sample activities using the “Science Course Ware” fruit fly simulator: <http://www.biologycorner.com/worksheets/drosophila_simulation.html>  Simple website to mate fruit flies with specific characteristics: <http://bioweb.wku.edu/courses/biol114/vfly1.asp> |
| **Comments** | This lesson provides a clear way for students to see the growth of a population in a new habitat over time. Because the life cycle of a fruit fly is so short, students can quickly see fruit flies mature and reproduce to populate a confined space. Using limited nutrients, such as a specified diet amount provided on a limited schedule, students should be able to see how competition for resources plays out and how space can be an issue if populations begin to grow exponentially. |
| **Author Info** | Sarah Kaneko is a biology and earth science teacher at CE Jordan High School in Durham, North Carolina. She began working at Jordan after completion of her M.A.T. at Duke University in the fall of 2007. She was drawn to the school because of the Freshman Academy program which activity works to support the transition and growth of ninth graders to high school through modes such as increased communication between each students core teachers, increased parent contact, academic skill building through a freshman seminar, and a structured study hall program to assist students with reviewing course material and working on homework assignments. She currently serves as team leader in this program.  Prior to pursuit of her MAT degree, Ms. Kaneko worked for two years at Durham Nativity School in Durham, North Carolina as a science and math teacher. Her interest at DNS began as a volunteer while she was a senior in college; she assisted with the after school homework and tutorial program as well as worked with the headmaster of the school with student recruitment. She began working at DNS following the completion of her B.S. in Biological Anthropology and Anatomy at Duke University. It was at DNS, her love of teaching became evident and returned to Duke to pursue a master’s degree in teaching and certification in teaching high school science.  Sarah Kaneko was supported during her Kenan Fellowship summer research by Dr. Allen Cohen, Director of Insect Diet and Rearing Research, LLC (IDRR). Prior to opening IDRR, Dr. Cohen worked for the USDA at Mississippi State University as a research entomologist and research leader for the ARS Biological Control and Mass Rearing Research Unit. In addition to his work in industry, Dr. Cohen also has an extensive history in teaching biology and entomology at the collegiate level and has been supporter and mentor for teachers in science education. This Kenan Fellowship was funded by NC BioTechnolgy Education Center (NC BTEC) |