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| **Title** | **Diet Analysis: Identifying Organic Macromolecules in Drosophila Diets** |
| **Introduction** | Students will test different prepared diet samples for concentrations of a specific protein using optical density. This lesson may be used in combination with lessons on macromolecule analysis as outlined by the North Carolina Standard Course of Study for recognizing organic macromolecules such as protein, carbohydrates and lipids. Specific instruction for this additional analysis has been integrated into this lesson. |
| **Learning Outcomes** | Students will be able to…   * Test unknown samples for the presence of carbohydrates, lipids and proteins. * Create a standard for a known pure protein sample to be used for measurement of optical density of unknown diet samples. * Test different unknown diet samples for the percentage of protein present in each solution. |
| **Time Required and Location** | To complete the optical density of different diets and compare to a standard will take 2 hours. This will allow time to explain the process, create a standard, and then prepare the appropriate dilutions for measurement. If you want to add additional diet analysis using carbohydrate and lipid indictors, allow 3 hours. |
| **Materials Needed** | * *Prepared fruit fly diets* * *Spectrometers and cuvettes* * *Pipettetes and tips for measuring small volumes to match cuvette size* * *Protein indicator* * *Biuret’s solution* * *Benedict’s solution* * *Sudan IV or brown paper bag* * *Samples of substances with varying pH (juice, household cleaner, milk, etc)* * *Samples of items with carbohydrates present (potatoes, paper, simple syrup, etc).* * *Samples of items without carbs present (water, protein powder)* * *Cabbage juice* * *Test tubes or containers for mixing substances.*   **Technology Resources:** Students will need access to spectrometers |
| **Participant Prior Knowledge** | **Pre-Activities:** Prior to completing the lab, students should have background knowledge already as to the different organic macromolecules. Students should understand the structural and functional difference of carbohydrates, lipids, proteins and nucleic acids and understand how they are functionally implemented in different types of organisms. The goal of this activity is to build off of this base of understanding by showing students how scientists can detect the presence of each of these in an unknown substance.  Additionally, it may be helpful for students to do a “dry run” of the different indicator testing. A very clear example is available at:  <http://www.occc.edu/biologylabs/Documents/Organic%20Compounds/Organic%20Compounds.htm> . |
| **Facilitator Preparations** | Prepare materials ahead of time and set up lab stations in your classroom. |
| **Activities** | 1. Set up a series of color changing indicator tests for students to play with. Have students work with iodine and substances (make sure you have some starch examples!) as well as red cabbage juice and substances of different pH values. Additionally, if liquid pH indicators are available – it’s fun for students to mix seemingly clear liquids into test tubes and watch them change colors! [20 minutes] 2. On small dry erase boards, have students in their lab partners write their explanations for why each of the substances changed colors. Students should share out their findings to the group [20 minutes]. 3. Inform students they are going to use the food samples they created for their fruit flies and test the presence of fats, carbohydrates and lipids using different testing processes. 4. Students will take a sample of the food they created in Lesson 1 (Design of Experiment – Fruit Fly Diet Creation). Measure out 80 grams of the sample and divide is equally into 4 dishes (20 grams each). Each of these samples will be used for analysis. [20 minutes]    1. Dish 1 will be used for testing for carbohydrates using iodine.    2. Dish 2 will be used for testing for carbohydrates using Benedict’s solution.    3. Dish 2 will be used for testing for proteins with biuret reagent.    4. Dish 3 will be used for testing for fats with Sudan IV. If Sudan IV is not available, you can use the “brown paper bag test” to look for translucence. 5. Students should record the results of each of their diet tests in their lab notebook. Once they have determined which macromolecules are present, students should “trace back” where each of the components came from with the original ingredients. Then, as a class assign the original ingredients to different student groups for testing. For example, if you provided the students with nutritional yeast, one group would test the yeast for all three molecules (carbohydrates, lipids, and proteins). Create 1 spreadsheet for the entire class and record each group’s data. Ideally, you can post this through your course Google Group as a shared document so students can access it individually. 6. Instruct students to verify that their conclusions (where each organic molecule source) were correct and that those items were present in the original ingredients. If not, have them correct their findings to reflect where the organic molecules actually came from. 7. Once students have analyzed their diets, you will move on to test the amount of protein present in each of their samples. To do this, students will be testing the samples using optical density – comparing the sample to a known standard. See the specific instructions (Protein Evaluation) for specific instructions. 8. Using their findings from the Protein Evaluation, have students share their protein amounts in comparison to that of their classmates. 9. Completing a class analysis, students should then use the protein analysis in conjunction with population growth to find any correlation between increase in population and protein percent present. While students may not be familiar with statistics, students are still able to investigate trends regardless of if they are statistically significant. |
| **Assessment** | Assessments for this assignment may vary. Some suggestions include:   * Students are provided with several unknown substances at different stations. Students can accurately identify the presence of different macromolecules using the techniques practiced in class. * Students can name which indicators are using for testing for carbohydrates, lipids, and proteins in substances. * Students accurately trace where different macromolecules came from given the list of initial ingredients for the diets they created. |
| **Critical Vocabulary** | carbohydrates  proteins lipids  nucleic acid enzyme amino acid glycogen starch glucose fats |
| **Extension Activities** | * Following introduction of the indicators, students can complete the “Lunch Murder Mystery” in which students use indicators to determine which macromolecules were present in the food in which a person was food poisoned. Students must be familiar with the different indicator tests and use deductive reasoning skills to solve a mystery! * Diet Analysis: Once students have learned about the different macromolecules, students can log their own diets over the course of a week and analyze what they are eating. There are several websites online that will allow students to create a log-in and track their food online AND provide a breakdown for them (fat, calories, sugars, protein, etc that they ate over the course of the week). Then, understanding the benefits and potential disadvantages of over or under consumption, students can write a reflection of their diet and the amount of macromolecules they consume. (myfoodpyramid.gov) |
| **Modifications** | * To save instructional time, the teacher can set up each of the indicators for the students so that they just need to add the sample and the students can record the differences between |
| **References** | Organic Molecules: http://www.occc.edu/biologylabs/Documents/Organic%20Compounds/Organic%20Compounds.htm |
| **Comments** | This lesson integrates the use of the diets formed with techniques used by biotechnology agencies (spectroscopy) to detect the presence of substances in a solution through optical density. The goal of approaching cellular chemistry in this fashion is to make the techniques relevant to “real lab” situations and deepen the understanding and integration of such techniques for each student. |
| **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) |