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| **Title** | Molecular Biology – The Mouse’s Birthday Cake |
| **Introduction** | The 21st century lab uses precise measurements and scientific protocols to increase the accuracy of research data. When animals are involved, special care is taken to measure precisely every drop of water and morsel of food given each day. An Animal Care specialist and research scientists collaborate on the type, amount and time meals are provided to animals involved in an investigation. In a Lipid Science Laboratory, transgenic mice are often fed the fat equivalent of a slice of birthday cake everyday as part of their diet to see what effect it has on general health. As expected, the results are nothing to celebrate.  In this lesson the students will learn the types of tools used in a molecular biology lab and simulate the protocol of preparing food for research animals. Students will also create a food treat high in fats and carbohydrates then calculate the total number of calories per serving and biochemical food energy for cellular respiration.   As part of the multi-lesson unit, this lesson will show the process of caring for and experimenting with mice in a laboratory. **Lesson EQ**: How does food provide energy to organisms? |
| **Curriculum Alignment** | 8th Grade Science  Molecular Biology  8. L. 5 Summarize how food provides the energy and the molecules required for building materials, growth and survival of all organisms (to include plants).  Biotechnology  8. L. 2 Understand how biotechnology is used to affect living organism.  8 L.2.1 Summarize aspects of biotechnology including:   * Specific genetic information available * Careers   High School Essential Standards in Science  Biology  Bio.4.1 Understand how biological molecules are essential to the survival of living organisms  Bio.4.1.1 Compare the structures and functions of the major biological molecules (carbohydrates, proteins, lipids, and nucleic acids) as related to the survival of living organisms.  Bio.4.1.2 Summarize the relationship among DNA, proteins and amino acids in carrying out the work of cells and how this is similar in all organisms.  Bio 4.2 Analyze the relationships between biochemical processes and energy use in the cell.  Bio.4.2.1 Analyze photosynthesis and cellular respiration in terms of how energy is stored, released, and transferred within and between these systems.  Bio.4.2.2 Explain ways that organisms use released energy for maintaining homeostasis (active transport)  North Carolina Career and Technical Essential Educational Standards Strands of this topic are discussed in the following High School Technical Courses:Biomedical Technology- Course Number: 7200  * Exploring Biotechnology in Health Science- Course Number: 7205 |
| **Learning Outcomes** | * Through planning a treat for their mouse, students will learn the basics of calculating calories and food energy for cellular respiration * Students will construct a scientific protocol for measuring small amounts used during experimentation. * Students will demonstrate knowledge of measuring accurately but replicating their diet using their scientific protocol charts. |
| **Time Required and Location** | One 50-minute class period |
| **Materials Needed** | [Lesson](#Lesson) 2 Handout: Student Lab Sheet 2Graham cracker (or other rectangular cracker or cookie)Toppings: Sprinkles Jam/ or Jelly IcingChocolate syrup peanut butter (food allergy alert)Measuring Equipment:Spoons/Scoop Metric ruler Metric balance pipetteOptional: Calculator |
| **Safety** | Students in the class who have food allergies should not handle nor ingest the crackers with/ or without toppings.If a student is allergic to peanuts, do not use peanut butter products and check the crackers for peanut oil. |
| **Participant Prior Knowledge** | Student should have completed Lesson 1 of this unit and/ or be familiar with the term transgenic mice or knockout mice.  Students should also know how to accurately use measuring tools like balances, pipettes, measuring spoons, scoops and metric rulers. They should have a working knowledge of the metric system and the standard system for measuring teaspoons of ingredients. |
| **Facilitator Preparations** | Most of the materials for this lab are easy to obtain and can be substituted with other tactile objects. Lego’s can substitute for the entire construction of the diet if each piece is labeled a type of food.The teacher must find products that nutrient information like calories per serving can be displayed for the students to reference.Before handing out crackers- weigh the standard cracker and find the volume. (Length x width x height in centimeters) This measurement will be the standard for reference in the evaluation of student learning. |
| **Activities** | Engage:The teacher should brainstorm with the students questions about food and diet of mice;What type of food should be given to a laboratory mouse? (Mouse chow /kibble)Are wild mice overweight? Underweight? (No, wild animals are naturally lean)What would happen if we fed our mice birthday cake with their chow for every meal? (It depends on the type of protein/ genes that were added to the mouse during genetic engineering. Some mice will never gain weight- others will become grossly obese depending on the knockout gene inserted.)The teacher asks the student to hypothesize what they would eat for every meal if they knew they would never be overweight? (Remind them of nutrition and health)What would happen if they did not feed the mice at all? (The mouse would lose metabolic energy and then die)Does amount of food or quality of food affect mouse health? (Both)Exploration: Setting the stage for feeding their mice. The teacher should say –All of the mice are given a chow kibble mix which is represented by a small graham cracker in this activity. The destination of this lab is to be able to regulate and recreate the additional calories ingested by the mice each time they are fed.The teacher will give each student a thin rectangular cracker/ or cookie. (Graham crackers work well)To this cookie- the students can decide which type of “topping” they may want to use. Choices are sprinkles, icing, sugar, peanut butter, jelly or a combination of two.The students should make their cookie treat – but they can’t eat it.On their Student Lab 2 paper they must record what they have made. List type, the order and the exact amount added. They are encouraged to use the metric balance to weigh their ingredients in grams. (Both the Animal Care Specialist and the Molecular Scientist use these tools to ensure the experiment is followed exactly as planned.)The teacher should discuss the importance of accuracy in amounts and description so the diet can be remade in the same matter and method. This procedure is called a protocol.After they have written down their description – they bring their cookie on a napkin/ or clean paper with their name on it to a back table – out of sight.Using their protocol sheet- the students must make an exact copy of what they made earlier. Students should measure to the exact amount in grams their Sprinkles, sugar, etc.After they are finished, they can retrieve the original from the back and record their observations.The teacher should discuss what challenges they faced when remaking an exact copy of the original treat. (Most students will see the frustration of exact measuring. Point out - In order for a scientist to gain support for his/ or her experiment, laboratory protocols must be followed exactly.)Explanation:The physiological effect of the nutrients on the animals as well as plants can be affected by type of nutrient taken in, caloric content, amount given, and the genetic makeup of the organism.10. Using the chart of ingredients and calories each contain- estimate the calorie content of the cookie treat constructed in the activity.Teacher Note: This food energy is what fuels the cells during cellular respiration. Food energy is expressed in calories. (1 calorie is equal to 1.418 kilojoules) When nutrients react with oxygen - the cells energy is released.11. The students will determine total number of calories for their mouse diet then calculate biochemical (food) energy in kilojoules. Extension:  Power point presentation provided.  In this lesson**,** students use various scientific tools to measure diets for mice. There are many other tools that are used in biomedical research. To expose the students to the various types of equipment used by Molecular Biologists in a Pathology and Lipid Science lab present the PowerPoint presentation provided. |
| **Assessment** | Formative Evaluation: Student understanding of the concepts presented in this lesson will be evaluated on the accuracy of their lab sheet.Measurement Check: This activity requires students to measure accurately using a metric balance and ruler. Each answer should contain mass measured only in grams.Lab Sheet Evaluation - Data Analysis QuestionsA. Students must use the Nutritional Facts labels of each ingredient in their mouse diet to calculate the calories/ gram.Example of how this should be calculated using a Graham Cracker Nutrition Facts.  * Nutrition Facts * Serving Size 31g * Servings per Container about 13 * **Amount Per Serving**  |  |  |  |  | | --- | --- | --- | --- | | **Calories** | 130 | Calories from Fat | 25 |  Cracker: 1 serving size is 31 g. There are 130 calories in one serving size. Calculate calories per gram by dividing 130/31 which is 4.19 calories / gram.Students should then multiply the mass of their cracker used in the lab by 4.19. The amount calculated would be the calories in their cracker treat. Each topping should be calculated in the same way. A total of all calories ingested for their mouse dietData Analysis Question B. Students should calculate the total kilojoules by multiplying the total caloric intake by 1.418 kilojoules. This represents biochemical food energy ingested.Conclusion Responses:Did both diet samples end up exactly the same? (Answers will vary)Why is consistency important in lab research? (*Scientist’s rely on consistency in research so the data collected will be accurate. Flawed measurements, incomplete information and fabrication of results jeopardize the integrity of the Investigator and Laboratory facility.)* If every diet was high in fat and high calorie - how would that affect the health of the mouse?  *(The transgenic mouse would become overweight and suffer from heart disease*)  Assessment Rubric:   |  |  |  |  | | --- | --- | --- | --- | | 3 | 2 | 1 | 0 | | Students have measured correctly and filled out the science protocol table. All calculations are complete and correct. | Students have measured correctly and filled out the science protocol table. Most (75%) calculations are complete and correct. | Students have measured correctly and have completed 50% of the protocol sheet. Calculations have been attempted. | Students have not measured correctly or in another standard. Calculations were not attempted. | |
| **Critical Vocabulary** | Protocol- steps, a record of data or observations on a particular experiment or proceeding  Nutrient- a substance that provides nourishment  Cellular Respiration- the oxidation of organic compounds that occurs within cells, producing energy for cellular processes.    Calorie- the amount of heat exactly equal to 4.1840 joules. The unit is used to express the fuel or energy value of food. |
| **Modifications** | Students with food allergies should be given alternative materials for performing the activity. Assistance should also be given to students that may struggle with the mathematics associated with the lesson.  Calculators may be used for this activity and students can work in pairs... |
| **Alternative Assessments** | Students that received modified foods for the activity should also be given the Student Lab Sheet with the substitutions clearly marked in the materials section. They should be able to use the nutrition labels to calculate calories and kilojoules. |
| **References** | Calorie conversion website: <http://www.convertunits.com/from/calories/to/joules>  Cartoon on ATP energy: <http://www.biologyinmotion.com/atp/index.html>  Information on ATP: <http://www.answers.com/topic/adenosine-triphosshate.html>  Vocabulary definitions: [www.dictionary.com](http://www.dictionary.com) |
| **Supplemental Information** | The 21st Century Research Lab and the Laboratory Animal Facility are two separate environments connected by a common theme, science. One houses people, glassware, machines, lab tables and chemicals. The other has animals, cages, toys, food and water bowls, and noise. Both have unique smells. Each facility depends upon the other in this biomedical Pathology and Lipid Science Department. The molecular biologist, called Investigators, designs the experiment, the Animal Care Specialist, cares for and regulates the science. Each professional makes sure the other is doing their job daily.Everything that is given to the mouse during the experiment is part of a protocol. The time, type, and amount of food given are monitored by both professionals. In the Lipids lab, the amount and type of fats added to the mouse’s diet is followed closely. Both the control mice and the knockout mice will receive a basic chow diet of fiber and mouse food. The knockout mice will receive additives to his/or her food. The investigator will monitor the effects different foods have on the body. Some mice will receive a high concentration of fats each day in their diet; it is like having birthday cake for every meal! The investigators relate the science of a mouse’s diet to that of humans. Nutrients found in food provide energy to the organism through cellular respiration. When the nutrients react chemically with the oxygen inside of the cells energy is released. That **food energy** is expressed as food calories or kilojoules (kJ).  One food calorie is equal to 4.184 kilojoules of chemical energy. The joule is the Metric (SI) unit of measurement for work and energy. A kilojoule is 1000 joules.  So a Snickers Bar that is 266 calories provides 1113 kilojoules of energy (266 X 4.184)  There are many different types of nutrients that release energy during respiration. Carbohydrates (Sugars, starches and fiber), fats (lipids) and proteins are the basic macro nutrients and organic acids, polyols and ethanol also release food energy. When these nutrients react with the oxygen within the cell- chemical energy is released to the body where it is stored. Fats and ethanol release the greatest amount of energy (approx. 38-30 kJ/g), whereas carbohydrates and proteins release much less (17 kJ/g).  All the biochemical energy in a cell is stored and transported by a macromolecule called ATP **Adenosine-triphosphate**. This is a coenzyme that drives metabolism in all organisms. Movement, thinking, and growing are all a result of ATP releasing energy - changing into ADP (adenosine diphosphate) and cycling back again after eating. Every chemical reaction except photosynthesis (which is driven by the sun) is driven by the chemical energy transport of ATP. The process of converting biochemical energy from nutrients through the metabolic reactions of cellular respiration “recharges” the ATP chemical battery in most cells. Most living organism use aerobic respiration to recharge their ATP energy. Without it, all other processes throughout the body would stop. |
| **Comments** | The pictures in the PowerPoint and on the student lab sheet were taken in the Pathology and Lipid Science biomedical research facility at the Wake Forest Baptist Medical Center. They are printed with the permission of Carol Kent and Dr. Lawrence Rudel. |
| **Author Info** | This lesson was written by Martha Tedrow. She teaches eighth grade at Jefferson Middle School in Winston-Salem, NC. She has been teaching for 28 years, has Bachelors in Education from UNC – Chapel Hill and Masters in Education from Gardner Webb University. In 2004, she became Nationally Board Certified in Science. This curriculum module lesson was designed as part of a Kenan Fellowship and in cooperation with Carol Kent and Dr. Lawrence Rudel, molecular biologists at Wake Forest Baptist Medical Center’s Biotechnology Center. Martha’s mentor for the Fellowship was Robert Sox, a Professional Development Leader with North Carolina’s Department of Public Instruction. |

Lesson 2: Student Lab Sheet Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

*The Mouse’s Birthday Cake*

## Background Information: The 21st Century Research Lab and the Laboratory Animal Facility are two separate environments connected by a common theme, science. One houses people, glassware, machines, lab tables and chemicals. The other has animals, cages, toys, food and water bowls, and noise. Both have unique smells. Each facility depends upon the other in this biomedical Pathology and Lipid Science Department. The molecular biologist, called Investigators, designs the experiment, the Animal Care Specialist, cares for and regulates the science. Each professional makes sure the other is doing their job daily.

## Everything that is given to the mouse during the experiment is part of a protocol. The time, type, and amount of food given are monitored by both professionals. In the Lipids lab, the amount and type of fats added to the mouse’s diet is followed closely. Both the control mice and the knockout mice will receive a basic chow diet of fiber and mouse food. The knockout mice will receive additives to his/or her food. The investigator will monitor the effects different foods have on the body. Some mice will receive a high concentration of fats each day in their diet; it is like having birthday cake for every meal! The investigators relate the science of a mouse’s diet to that of humans. Laboratory mice model human response to diseases and disorders, so they can look for signs of obesity and heart disease and begin to formulate treatments.

Purpose: To create a diet for a mouse then calculate the food energy provided.

Materials:

Graham Cracker (simulates mouse chow – a high fiber nutrient kibble)

Various toppings: Sprinkles, icing, etc.

Napkin or Paper Towel (with your name written on it)

Balance metric ruler measuring spoons pipette

Procedure: (Scientific Protocol):

1. Select a graham cracker (mouse chow) and 2 toppings. (Additives that provide fats to the mouse diet.)
2. Determine the normal serving size using the Nutrition Facts label for each product then decide what would be an appropriate “mouse” size meal.
3. Record the exact amount selected in grams and size for the cracker and each topping and the placement of the topping on the cracker. Record any other protocol details you may need to replicate the treat you created.
4. Put your name on a napkin, then place your mouse diet on the napkin and return it to your teacher.
5. Using your protocol sheet. Construct a second diet sample that is exactly like the first.
6. Collect the first sample from the teacher then compare the first diet to the second.

Data: Mouse Diet Protocol

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| --- | --- | --- | --- | --- |
| One Cracker (g) and (cm3) | Topping 1 (g) | Topping 2 (g) | Description- placement | Protocol details |
| #1 |  |  |  |  |
| #2 |  |  |  |  |

## Data Analysis:

## A. Using a chart of ingredients for each item used in the diet- Calculate the calorie content of 1 gram of the cracker/ cookies and each topping used. Then multiply the calories per gram by the number of grams of each item used in the mouse diet.

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## *The diet provided for the mouse provides the molecular energy necessary for life. This biochemical food energy is what fuels the cells during cellular respiration. Food energy is expressed in calories. (1 calorie is equal to 1.418 kilojoules) When the nutrients react with oxygen - the cells energy is released*.

## B. Calculate the total kilojoules for your diet below: (Multiple total calories by 1.418 kilojoules)

## Conclusion:

## Did both diet samples end up exactly the same?

## Why is consistency important in lab research?

## This molecular biologist is measuring a diet for an Apo-1 transgenic mouse that is part of her experiment. List the scientific equipment that you see she is using?

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Ever feel tired when you are hungry? Your body needs the biochemical energy stored as ATP in your cells “battery” to be “recharged”. Eat!

If every diet was high in fat and high calorie - how would that affect the health of the mouse?

**Student Handout 1: Molecular Biologist – A Transgenic Mouse Tale**

After Week 3 – Your mouse is born. Cut out the mouse below- then cut off a toe/ or the tip of the tail to simulate DNA collection. Color your mouse according to the DNA sample extracted from the balloon you picked up from the samples. (Red ribbon /Protein A – black, blue ribbon /protein B – white, green ribbon/ protein C – brown) **Tape the DNA ribbon to the back of the mouse**