Test Your Pets

Shane Doyle
Hardin Middle School
Hardin, MT

Research Host:
Barbara Horwitz, Ph.D.
University of California, Davis, CA

1999

Grade Level:
Middle-High School

Test Your Pets!

Teachers who own classroom pets are quite familiar with the upkeep responsibilities that accompany domesticated animals. However, many of us overlook the unique opportunities that pets can provide to enhance science education in our classroom. This lesson is a low-tech physiology inquiry designed for use with classroom pets, specifically small rodents (e.g., mice, hamsters, gerbils). This particular inquiry examines the relationship between energy expenditure and weight gain, an issue with which all students are somewhat familiar. The protocol that has been outlined for you is loosely structured, providing room for class discussion and guided facilitation. This experiment is longitudinal in nature, and may be completed over a period of three weeks, nine weeks, 12 weeks, or continued repeatedly throughout the course of the academic year - all depending on teacher preference.

Teachers who have done summer research with physiologists can introduce this activity when describing their summer experience to their class. For example, "I worked with rats in a science lab this summer ...How could we use our gerbils to create our own, simple science experiment here in class?" Once the students become intrigued by this idea, alert them to the concerns that they must first consider.

To begin with, your students must become familiar with the rules involved when using animals in scientific research. You can contact the American Physiological Society by phone or e-mail to request information about lab animal treatment (they have literature in a "student friendly" comic book format). Initiate a student discussion by posing thought provoking questions to the class: "Do animals have rights?," or "Should animals deserve rights?" and, "If they do have rights, what are they, and who ensures them if animals can't vote?" A wide range of opinions and diverse beliefs should be expected, recognized and considered by the class (either in whole class or small group format). Immediately following this discussion, provide students with some handouts that detail the legal guidelines that animal researchers must follow. Read through the literature with the class and discuss. Now aware of the ethics involved, your class is ready to be guided into using their class pets as the subjects of relatively simple, and basically harmless physiological inquiries.

Most students are aware of the direct correlation between eating and growing. In fact, most have a common knowledge about the ramifications of diet on physical appearance; i.e., not eating enough and being "too skinny," or eating too much and being "too fat." Within this broad sense, most students understand the general principle of energy balance. That's what makes this an excellent research topic; it is relevant and immediately accessible to students (it also doesn't require high-tech equipment). Use

their opinions as hooks to stimulate their curiosity. Pose questions to them to get them started; “Do gerbils prefer sweets to vegetables?,” or “What would happen if a gerbil ate only candy for six months?,” then guide them into forming their own simple, relevant questions, such as: “If both our hamsters eat the same amount, will they both weigh the same?,” or “When one gerbil eats more than the other, does the gerbil who eats more have more energy to exercise?.” The class should have plenty of questions related to eating and weight regulation. This process of formulating class questions, which may be initiated in the large group setting, should be completed within a small group format. After allowing some time for groups to reflect and discuss, they should exchange their ideas by presenting their questions to the rest of the class.

The students should then be directed to use one or more of their questions to form a consensus on a group hypothesis. Take this time to model to the class a simple and clear hypothesis. Encourage them to think of a reasonable hypothesis that they could test within the classroom environment. After each group has formed a consensus on their hypothesis, their next step is to design an experiment to test it.

Most students will require extensive guidance on how to design their experiments as logically and scientifically as possible - recognizing the limited time and resources available. The process of improving and streamlining each of the experiments should be guided, collaborative, and facilitated in the classroom setting. Ask a few of the groups to volunteer to have their experiment critiqued in front of the class. Critically review the experiment in a systematic, step-by-step manner; questioning, analyzing and evaluating each step in the experiment before moving on to the next. Throughout this critique, it is important to engage student interest by presenting a logical alternative method for each step in which the control could be “tightened.” An example could be: “This group wants to compare gerbils with hamsters. Wouldn’t it be better to compare two groups of gerbils? Why?” By allowing students to be a part of this method and discern the logic of having controls, they should realize that uncontrolled variables damage the validity of their experiment. Because most students will not be familiar with the importance of limiting uncontrolled variables in scientific experiments, most of the improvements will probably focus on control aspects. When your students come to understand that experiments without appropriate controls prove nothing, then they have acquired an important principle in science. The following outline is one example of a simple, logical, and appropriately controlled experiment.

Gerbil Energy Balance Experiment:
Hypothesis:
Gerbils that have an increased caloric intake will increase their physical activity as part of the body’s attempt to maintain energy balance.

Materials:

- 8-10 male gerbils from same parents to limit age and genetic variation
- 8-10 separate rat cages (including water bottles and feeding tray) for each gerbil
- 8-10 exercise wheels with accompanying odometers (to record the number of accumulated rotations)

- gram scale
- forceps or large tweezers
- a long-term supply of food pellets
- 2 bottles of Karo syrup
- supply of wood chips for floor of cages
- poster board, markers, tape measure and yardstick

Procedure

1. Acquire 8-10 male gerbils from the same parents. This will limit the genetic variability among the test subjects.

2. House each of the gerbils in their own cage, and provide each with their own exercise wheel. The wheels must be modified to include an odometer. This procedure can be simple if you use conventional bicycle odometers, which can be purchased at your local bike/hobby shop. Odometers are crucial because they provide a mechanism by which to quantify the physical activity of the gerbils. After an odometer has been attached to a wheel, it must be calibrated. For information on how to calibrate the odometer to your wheel, refer to Appendix #1.

3. Regulate the diet of the gerbils. Each of the gerbils should be provided with identical, and known daily rations of food and water for a three-week period. Include 2 separate water bottles in each cage, as well as small container for food. For information on how to calculate the caloric intake of an animal, refer to Appendix #2.

4. Record the pertinent data in a table format. Design a table to record the data that you will collect from the animals. Record the following information on your table three times a week (Mon., Wed., Fri.); the weight of each gerbil, the amount of water they consumed, their odometer reading, the weight of their food container, and the weight of. The latter will require that non-eaten pellet pieces be searched for, salvaged (using forceps) and weighed. From these measurements make the following calculations: amount of food eaten (initial weight of the container + food for given animal - the weight of container + food on day of measurement - the weight of food scattered about the cage on day of measurement), calories ingested (grams of food eaten x calories per gram), amount of water drunk, and distance the gerbil ran. After recording values for food & water & exercise, refill the food & water containers with fresh material and reweigh; reset the odometer to zero (these will be the "initial" values for the next feeding period.) For information on how to create a data table, see Appendix #3.

5. Verify that the gerbils have adjusted to the diet and environmental conditions. You will know the gerbils have adjusted when the data for each them (weight, # of wheel rotations, water consumption and eaten food) indicates a "relatively" consistent pattern. Do not expect individual gerbils to provide flat baselines of data. There will be day-to-day fluctuations in gerbil diet, weight and behavior. However, when these fluctuations illustrate a predictable pattern, the gerbils have stabilized.

6. Increase the caloric intake of half of the subjects. Divide the gerbils into separate diet groups; one for high calorie, and one for control. The cumulative weight of the groups at this time should be as similar as possible. You can achieve this by following the technique below. **First, weigh each of the gerbils and rank them in order, from heaviest to lightest. Then place the gerbils into two groups as follows:**

Heaviest
1. Group 1 Control
2. Group 2 High-Calorie
3. Group 2 High-Calorie
4. Group 1 Control
5. Group 2 High-Calorie
6. Group 1 Control
7. Group 1 Control

***Lightest 8*.**
Group 2 High-Calorie

Mark each cage to indicate which diet group the occupant belongs to. Mix a 10% solution of Karo syrup and water (a 500 ml water bottle would require a mixture of 50 ml of syrup, to 450 n-d of water. Use the nutritional information on the syrup bottle to find the number of calories per ml of syrup, and divide that number by 10 to calculate the number of calories per ml in the solution. Fill four drinking bottles with this sugar water, and place one bottle in the cage of each "high calorie" gerbil. Because drinking sugar water may increase the thirst of the "high calorie" gerbil, maintain a second bottle of plain water in the cage as an alternative. The controlled gerbils should also receive two bottles of plain water. Do not alter the gerbil's supply of solid food. Continue to provide the same allotment of food pellets for each animal.

7. Maintain the established diets for a three-week period. Keep the same feeding protocol throughout the entire experiment. Provide fresh water, food and syrup solution for the gerbils every other day.

8. Reestablish the original diets of gerbils. After three weeks of caloric increase, return all of the gerbils to their original diets. Continue to record data during the next three weeks.

9. Analyze the data and evaluate the hypothesis. Analyze the data and conclude if it supported your hypothesis. If the gerbils on the high calorie diet increase their total caloric intake and demonstrate an increase in wheel activity in comparison to the control group, then your results support your hypothesis. For information on how to analyze data, refer to Appendix #3.

Appendix #1 - How to Calibrate an Odometer to a Wheel
Calibrating odometers that record distance in miles

Purchase odometers that read to at least 0.01 miles/ kilometers. Read the instructions on your odometer to learn how to attach it to your wheel. The instructions will also tell you how to calibrate the odometer. These instructions will tell you to input the size of the wheel. Because the odometers are designed for wheels much larger than our exercise wheel, if you put in the size of the exercise wheel the system would not be sensitive enough to accurately measure the distance that the animals are running. So you need to fool your odometer. To do this, insert the largest number that the odometer will accept. For example, if the odometer wants you to input the diameter of the wheel, and the largest number it will accept is 30", then put in 30". If the odometer requests the

circumference of your wheel, then you should again input the largest number that it will accept (the information about the range of numbers that the odometer will accept should be in the instructions). Let's assume that you input the diameter of your running wheel as 30". This would mean that the circumference of the 30" diameter wheel is equal to 94.248" (circumference = 3.1416 x diameter). This means that every time the wheel rotates once, 94.248 " will be recorded. One hundred rotations would equal 9424.8 inches, which equals 785.4 feet, which equals 0.13 miles. So after one hundred rotations, the odometer will read 0.13 miles. Clearly, the gerbil has not run 0.13 miles. To get an accurate value, we must apply a correction factor. The correction factor equals the actual size of the exercise wheel divided by size that was inputed into the odometer. For example, we inputed a 30" diameter value for our wheel. If the actual size were only 5", then the 0.13 miles must be multiplied by 5"/30" or 1/6. The resulting product should then be multiplied by 5280ft/mile to give 130.9 ft. So the actual distance the gerbil ran in one hundred revolutions on a 5" wheel would be 130.9 ft.

Calibrating counters that record number of wheel rotations (i.e., they don't record distance)

Measure the circumference of each running wheel. This measurement will help you calculate the distance that each gerbil runs in their process of making one full rotation of the wheel. (Circumference = 3.1416xdiameter) For example, if a running wheel is two feet in circumference, then 100 rotations would indicate that the gerbil ran 200 feet.

Appendix #2 - How to Calculate Caloric Intake

Converting food intake into calories

Solid food

Read the nutritional information on your pet food package to determine how many calories are present per unit of weight (i.e., gram, oz., etc.) of solid food. Using this information, you can convert the weight of the eaten food into numbers of calories. For example, if 1 gram of pellets equal 10 calories, then a gerbil that consumes 2.1 grams of pellets will have ingested 21 calories.

Karo Syrup

1 ml of Karo syrup contains 4 calories (check this number for the syrup you use). Your solution will contain 10% Karo syrup and 90% water. This means that for every 100 ml of solution, there will be 10 ml of Karo syrup. With 4 calories per ml, your solution will contain 40 calories per 100 ml. If your gerbil drank 10 ml out of this solution, it would have consumed 4 calories; 5 ml = 2 calories, and so on. Use this formula to determine how many calories your animal has consumed: (ml drunk x calories per n-d of solution = number of calories consumed). Add the sum calories of both the food eaten and the solution drunk to determine how many total calories were consumed.

Appendix #3 - Methods of Analyzing Data

Create a data table

You must create a table for which to record your information each day. The table should be designed in a way that makes it easy to compare and contrast relevant data. The most efficient method to would be to create a table of rows and columns, using time as an independent variable. The table below is ideal for this experiment.

	Gerbil 1	Gerbil 2	Gerbil 3	Gerbil 4	Gerbil 5	Gerbil 6	Gerbil 7
Mon.							
Wed.							
Fri.							
Mon.							
Wed.							
Fri.							

This table will allow you to systematically input data for each animal on the same day. Put all of the data that you collect inside of each (gerbil weight, calories consumed, water drunk & distance ran). This table format makes it easier for you to compare the data results from each gerbil.

Graph your data

After your experiment is completed and you've recorded all of your data, it is now time to create graphs to visually display your findings. When making a graph, your first priority is to decide what information you wish to compare. The hypothesis of this experiment said that gerbils would increase their physical activity as a response to an increase in caloric intake. Therefore, you should make one graph that displays the exercise behavior of the "high calorie" gerbils in comparison to that of the control gerbils. In fact, you should make a separate graph for each distinct data category.