Science Objectives

- Students will analyze a mathematical model for the graphical representation of a data set.
- Students will develop an understanding of the relationship between environmental temperature and animal metabolism.

Vocabulary

- dependent variable
- ectotherm
- endotherm
- independent variable

About the Lesson

- This lesson involves students using TI-Nspire technology to analyze a graph of data representing the relationship between the environmental temperature and the resulting metabolism of an endothermic animal.
- As a result, students will:
  - Draw conclusions about how temperature affects metabolism.
  - Compare the temperature effects on both endothermic and ectothermic animals.

TI-Nspire™ Navigator™

- Send out the *Watch_the_Birdie_Breathe.tns* file.
- Monitor student progress using Screen Capture.
- Use Live Presenter to spotlight student answers.

Activity Materials

- *Watch_the_Birdie_Breathe.tns* document
- TI-Nspire™ Technology

TI-Nspire™ Technology Skills:

- Download a TI-Nspire document
- Open a document
- Move between pages
- Add a line of best fit to a graph

Tech Tips:

Make sure that students know how to use the touchpad keys (◀, ▲, ▶, and ▼) to navigate through menus.

Lesson Materials:

Student Activity

- Watch_the_Birdie_Breathe_Student.doc
- Watch_the_Birdie_Breathe_Student.pdf

TI-Nspire document

- Watch_the_Birdie_Breathe.tns

Discussion Points and Possible Answers

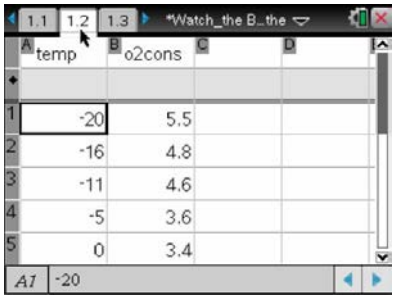
Temperature affects the metabolism of animals in different ways. Endothermic (warm-blooded) animals maintain a fairly constant body temperature, which gives them the advantage of being able to live in virtually any environment on Earth. Ectothermic (cold-blooded) animals have a body temperature that is, in large part, regulated by their external environment. Because of this, they are most abundant in warm environments and have a difficult time surviving in cold environments.

Birds and mammals, the only classes of endotherms, must eat more food in colder environments. This is because they lose so much heat to the environment. Ectotherms show the opposite behavior; eating more when it's warmer because of the increase in their metabolisms. The food energy that an organism consumes is "burned" during aerobic cellular respiration, which requires oxygen. Therefore, the higher the bird's metabolism, the higher the rate of cellular respiration and therefore oxygen consumption.

Students will explore this through data in this activity. After analyzing data in the spreadsheet, they will model the graph data with a regression model.

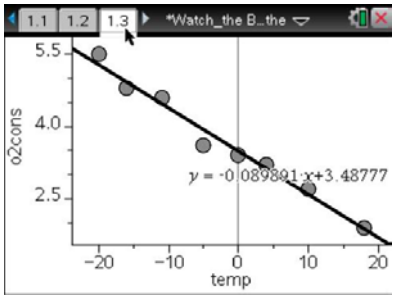
Move to pages 1.2–1.3.

1. Review the data in the spreadsheet. The temperatures represent the environmental temperatures in degrees Celsius and the oxygen used data is in mL/g of body weight/hour for a small bird, such as a sparrow.



Tech Tip: To analyze which variable should be the independent variable, students may wish modify the graph. The variable for an axis can be changed by clicking on a variable name at the bottom of the screen or left side of the screen or by **pressing Menu > Plot Properties > Remove X Variable** (or **Remove Y Variable**). Then add a variable by clicking on the box that appears on the screen or by **pressing Menu > Plot Properties > Add X Variable** (or **Add Y Variable**).

2. The regression equation in the form of $y = mx + b$ appears when the linear regression is generated. To generate the regression equation, press **Menu > Analyze > Regression > Show Linear (mx+b)**.



Move to page 1.4. Have students answer the questions on pages 1.4–1.18 here or on their worksheet.

Q1. Write the equation for your line of best fit: _____

Answer: $y = -0.09x + 3.488$

Q2. What is the rate of change (slope) of the relationship between temperature and oxygen consumption? Make sure you label the rate with units.

Answer: –0.09 mL / g / hour / °C

Q3. Which variable is the independent variable in the graph, temperature or oxygen consumption?

Answer: temperature (**temp**)

Q4. Which variable is the dependent variable in the graph?

Answer: oxygen consumption (**o2cons**)

Q5. Describe the appearance of the graph.

Answer: Answers will vary: As temperature goes up, oxygen consumption goes down.

Q6. What is the relationship between temperature and oxygen consumption?

Answer: Inverse

Q7. What is the source of the heat that an endotherm generates?

Answer: Burning of food via cellular respiration

Q8. The colder it gets, the more oxygen the bird uses. What is the process the bird uses to consume the oxygen that it inhales?

Answer: Cellular respiration

Q9. When would a bird need to eat more, in the summer or in the winter? Explain.

Answer: Winter, because they burn up their food faster in the winter in order to maintain their body temperature.

Q10. What are a bird's "choices" for finding and consuming food when the weather gets really cold?

Answer: Eat more or find somewhere warmer to live (migrate).

Q11. Why does a bird's oxygen consumption decrease as the temperature increases?

Answer: There is not as great a difference between body temperature and environmental temperature (not as steep of a temperature gradient), so heat is not lost as quickly.

Q12. What label should be attached to the rate of change (slope) in this problem? Describe what the rate of change means in the context of this problem.

Answer: mL O2/g/hour/degree C. For each degree increase or decrease, the oxygen consumption increases or decreases by a certain value

Q13. If the data in the original data table is from observations of a small bird like a sparrow or a robin, predict how the data would differ for a much larger bird, such as a bald eagle.

Answer: The oxygen consumption per gram would not have been as high because of the volume of the larger bird

Q14. Predict which birds, small birds or large birds, would need to eat more food per gram of body mass. Explain.

Answer: Small birds because they lose heat to the environment more quickly because of their high SA/V ratio

Q15. How do you predict the data and graph would be different if you were analyzing oxygen consumption for an ectothermic (cold-blooded) animal, such as a lizard or a turtle?

Answer: It would have been just the opposite: as temperature increased, the oxygen consumption would have increased

TI-Nspire Navigator Opportunities

Perhaps make a student a Live Presenter to demonstrate to the other students how to generate a linear regression.

Wrap Up

When students are finished with the activity, pull back the .tns file using TI-Nspire Navigator. Save grades to Portfolio. Discuss activity questions using Slide Show.

Assessment

- Formative assessment will consist of questions embedded in the .tns file. The questions will be graded when the .tns file is retrieved by TI-Nspire Navigator™. The TI-Nspire Navigator™ Slide Show can be utilized to give students immediate feedback on their assessment.
- Summative assessment will consist of questions/problems on the chapter test, inquiry project, performance assessment, or an application/elaborate activity.