CB 7 Temperature & Heartbeat Rate in Earthworms

You are aware that the temperature of your body normally stays very constant. But is this true of organisms which are not mammals? What about invertebrates such as earthworms? Can the temperature of an earthworm be influenced by the environment? If so, will it change the rate at which the worm carries out bodily processes, such as circulation? In this inquiry you will investigate "What will be the effect of changing the temperature of an earthworm's environment upon the rate of its blood circulation?"

Materials (per pair of students)
- earthworm (a large, healthy nightcrawler)
- aluminum cooking pan at least 12 inches long
- tap water and ice
- warm water bath or faucet source of hot water
- paper towels
- Vernier temperature sensor and Casio EA-100 **or** laboratory thermometer and clock with second hand
- Casio fx 2.0 graphing calculator
- Casio QV2800 Digital Camera Visual images of worm heart

Procedure
1. Place the earthworm in the pan dorsal (back) side up. The dorsal side will be much darker and rounder than the ventral (front) side. Moisten the worm with a few drops of room temperature tap water.
2. Find the dorsal blood vessel running directly down the crown of the dorsal surface. Find the part of the vessel for which you can most easily see the actual pulsing of the vessel. Take a trial count of the number of heart beats in one minute.
3. Construct an hypothesis which relates the temperature of the worm's environment to the pulse of the dorsal blood vessel. Design an experiment to test this.
4. You will want to expose the worm to at least five different temperatures from nearly freezing (ice water) to warm, but not hot. (The worm will die at temperatures greater than about 45° C.) This can be accomplished by mixing different amounts of warm and cool water (or ice) to achieve the desired temperatures and adding them to the dish to a depth of 1-2 cm. The exact temperatures are not important. It is important to use as wide a range of temperatures as possible and to measure accurately each temperature at which you count the pulse rate.
5. If your worm is healthy, it will tend to wiggle, making it difficult to count the pulse beat. You will find that a moistened piece of paper towel laid over the head of the worm will quiet it down enough to allow you to proceed with the experiment. If your worm is still too active, you many wish to exchange it for another worm.
6. Working in teams of two, determine the beat rate per minute under each temperature condition. Be sure that you let the worm adjust to each temperature for at least three minutes before you begin your counts. Lay the temperature sensor probe or the thermometer in the pan so that the bulb is submerged and read the temperature immediately before counting the pulse rate. Be sure to pour off the water and let the worm "breathe" for at least two minutes between each change of water.

7. Take a digital picture of your complete set up. Try to fill the frame with the pan containing the worm, water and temperature probe.
8. When you are finished collecting data, return your worm to the place designated by your instructor. The worms can be turned loose in someone's garden or your class compost pile.
9. Construct a table to organize your data. Determine which factor is the independent variable and which factor is the dependent variable. Then construct a graph of these data being sure to place the independent variable on the horizontal (X) axis and the dependent variable on the vertical (Y) axis.

Analysis and Conclusions

1. How was your hypothesis supported? Explain.
2. Why is it important to wait a few minutes before counting the pulse rate?
3. Why must the water be poured off to allow the worm to breathe?
4. What is the experimental advantage of starting either with the coldest or warmest temperature and working gradually in the other direction, instead of skipping around to different temperatures?
5. Describe any patterns revealed by the curve on your graph and relate them to temperature maintenance in the earthworm.
6. What are some flaws or sources of error in this experimental procedure?
7. If you were to design your own experiment to investigate temperature maintenance in ectotherms, how would you design it? How would your design reduce the sources of error you listed above?
8. How has the use of technology improved this experiment?

Casio FX2.0 Calculator Procedures for CB 7

It will be helpful to first construct a table like the one shown below. For the temperatures, either begin with a cold temperature and warm it up gradually with warm water, or start with a warm temperature and cool it down gradually with ice cubes. Be sure that the temperature does not exceed 45°C or you will kill the worm.

Temperature	Pulse Rate

Enter your data into the table, then transfer the information to your calculator for graphing.

☞ From the Main Menu, choose STAT by pressing [2].

☞ If the first two lists are not empty, you may do one of the following three things.

1) Delete the data from the lists.
   Move the cursor so that List 1 is highlighted. Press [F4]
   for DEL-A (delete all). Then press [EXE] for Yes. Do a similar procedure to delete data for other lists, highlighting the list name that you wish to delete entries from.
2) Use empty lists.
   Each File contains 20 lists, so you can cursor over until you find 2 empty lists side by side. Just be sure that you remember the name of the lists because when you set up the graph you will need to enter the correct list numbers into the XList and YList.
3) Change Data Files.
   You can change the "drawer" into which you are filing information. From the main stat screen, press [CTRL] (the green button), followed by [F3] for SET UP. Cursor down to the third line, List File. Press [F1] for FILE then enter a number 1 through 6, excluding from your choice the number of the current file listed on the screen. Then press [EXE], then [ESC]. This will take you back to the main stat screen. If there is still data listed, you can either delete it or follow the procedure again and change the List File number.

☞ For the sake of uniformity in this example, we will enter the data into List 1 and List 2 of whatever file the calculator is currently operating in. Enter the temperatures in List 1, following each entry with [EXE]. Enter the pulse rates into List 2, following each entry with [EXE].

☞ Press [CTRL] followed by [F3] for SET UP. Be sure that the StatWind is set to Auto. If it is not, press [F1]. Press [ESC].

☞ Press [F1] for GRPH, then press [5] for Set. We will set up our graph for StatGraph 1, so if 1 is not the number showing beside StatGraph, press [F1].

- ☞ Cursor down to Graph Type. We want to graph either a scatter plot or a broken line graph. You may want to look at each of these and compare the advantages and disadvantages of each. For a scatter graph, press [F1] for Scat or for the broken line graph press [F2] for XY.
- ☞ Cursor down to XList. You want List 1 to be the independent XList. If List 1 is not listed, then press [F1] for LIST, [1] for List 1, then [EXE].
- ☞ Cursor down to YList. You want List 2 to be the dependent YList. If List 2 is not listed, then press [F1] for LIST, [2] for List 2, then [EXE].
- ☞ Cursor down to Frequency. This should be 1. If it isn't, press [F1] for 1.
- ☞ Cursor down to Mark Type. Choose the mark type you prefer by pressing [F1], [F2], or [F3].
- ☞ Press [ESC] to return to main stat screen.
- ☞ Press [F1] for GRPH, then [1] for S-Grph1.