EXPLORATIONS

Activity 11

Objectives

- To compare human body mass with blood volume
- To estimate your own volume of blood
- To interpolate and extrapolate from best-fit models
- To predict amounts of various blood components

The River of Life

In this activity you will

- examine data about blood.
- build a regression model using the data.
- estimate the volume of your blood.
- predict volumes of blood for other animals.

Introduction

Blood is a body part that often gets overlooked because it is made, in large part, of liquid. This liquid portion of the blood is called the plasma, while the solid portion is made up of the blood cells. Later, you will have an opportunity to research what the different components of the blood do for you. For now, however, you will examine the relationship between the body mass and blood volume of a human.

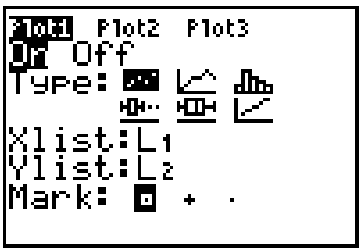
Problem

What is the relationship between body mass and blood volume? Look at the data table on the next page and discuss with a partner your observations about the relationship between body mass and blood volume.

Mass in kg	Blood Volume in Liters
30	2.5
40	3.4
50	4.3
60	5.2
70	6.1
80	7.0
90	7.9
100	8.8
110	9.7
120	10.6
130	11.5

Procedure

1. Press [STAT] [ENTER].
2. Press [▲] to move to the heading **L1**. Press [CLEAR] [ENTER]. Repeat this procedure for any list that has data.
3. Navigate back to **L1**, making sure that your cursor is in the first row of the list, and not at the very top. In **L1**, enter the data from the first column of data (**Mass in kg**) from the table above. To do this, type in the number and then press either [ENTER] or [▼] to move down to the next spot in the list. Repeat this until you have entered all of the data in **L1**.
4. Press [▶] to move to **L2**. Enter the data from the **Blood Volume in Liters** column. Make sure you have the same number of data entries in **L1** as you do in **L2**.
5. Press [2nd] [STAT PLOT]. Press [ENTER] to select **1:Plot1**. Set your TI-83 Plus as shown at the right.



6. Press [2nd] [FORMAT] and make sure the defaults are set.
7. Press [MODE] and make sure the defaults are set.

8. Press WINDOW and make appropriate settings for the size of your graph. Suggestion: set the **Xmin** value slightly lower than the lowest value in your data table, and the **Xmax** value slightly higher than the highest value in your data table. Follow the same procedure for the **Ymin** and **Ymax** values.

9. Press Y=. If there are any equations on this screen, press ▼ to place the cursor next to **Y1=**, and then press CLEAR to clear the equation. Repeat this sequence to clear all equations.

10. Press GRAPH.

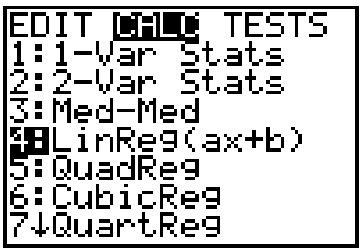
✎ *Answer the questions on the Data Collection and Analysis page.*

Extension

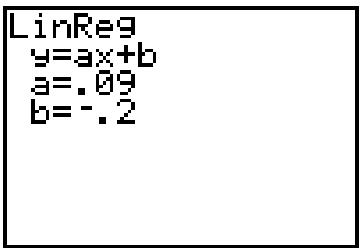
- Build a best-fit (regression) model for the data in your graph.

1. Go to the Home screen by pressing 2nd [QUIT].

2. Press STAT, and then press ▶ to highlight **CALC**. You will see a list of regression models from which to choose. Press ▼ until **4:LinReg(ax+b)** is highlighted, and then press ENTER.



You will now be back on the Home screen. Press 2nd [L1] , 2nd [L2] , VARS ▶ ENTER ENTER ENTER.



You just told the TI-83 Plus to build a linear regression model based on the data in **L1** (mass) and **L2** (blood volume), and then write the regression equation in **Y1**. To check this, press Y=. You should see an equation next to **Y1=**.

3. Press GRAPH to see your original data points and observe the best-fit line being drawn.

4. Press TRACE, and then press ▲ or ▼. Where do you see the cursor?

5. Press ◀ and ▶ and observe what is displayed at the bottom of the screen. What do these numbers mean?

Data Collection and Analysis

Activity 11: The River of Life

Name _____

Date _____

Data Analysis

1. According to the data table, what is the relationship between body mass and blood volume?

2. What is the change in mass from data point to data point? This is also known as ΔX, or delta X. Is the ΔX the same between each two consecutive X-values?

3. What is the change in blood volume from data point to data point? This is also known as ΔY, or delta Y. Is the ΔY the same between each two consecutive Y-values?

4. What is the significance of your answers to #2 and #3?

5. What is the formula for determining the volume of blood if you know your mass?

6. Using the regression model (best-fit line) you produced, estimate the volume of blood *you* have in *your* body. How did you make your estimation?

7. How much blood would there be in a person who had a mass of 75 kg?

8. Estimate the mass in kg of a person who has 5.4 liters of blood in his body.

9. How much blood would a 3.2 kg newborn baby have?

10. If this mass/blood volume relationship were true for other animals, too, how many liters of blood would there be in a horse that had a mass of 500 kg?

11. Estimate the mass of a person who has 7.6 liters of blood in his body.

12. If you decided to donate blood at the blood bank, you would donate 0.5 liters. Using your own mass, calculate the percentage of your blood you would be donating.

13. If 52% of your blood is water, what is the volume of water circulating in your blood vessels right now? Which of the two main blood components contains the water?

14. Sodium is an abundant ion in the bloodstream. Normally, there are about 2400 milligrams of sodium in one liter of blood. Approximately how much sodium do you have flowing through your blood vessels right now? Express your answer in both milligrams and grams.

15. One of the most important functions of the blood is to transport oxygen to all of your cells, and the cells that take care of this for you are called *erythrocytes*, or red blood cells. Red blood cells are by far the most numerous cells in the blood, averaging about 4.5×10^6 (4,500,000) cells per microliter (1000 microliter = 1 milliliter; 1000 milliliters = 1 liter). How many microliters are there in one liter? Using this information, calculate the approximate number of erythrocytes you have in your blood vessels right now.

16. *Leukocytes*, or white blood cells, are another major variety of blood cell in your body. On average, human blood contains about 7.0×10^3 leukocytes per microliter. Calculate the approximate number of leukocytes you have in your body right now.

17. White blood cells function mainly by defending you against infections. Explain why the number of white blood cells in a person's body may tend to fluctuate a lot more than the number of red blood cells does.

Teacher Notes

Activity 11

The River of Life

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Concepts

- Blood volume in humans
- Physiology of the circulatory system

Extension

2. Y= .0833 X + 0

4. The cursor will be on the data points.

5. Answers will vary, but the numbers represent the mass and blood volume.

Data Analysis – Answer Key

1. As the body mass increases, the volume of blood increases.

2. The change in mass from data point to data point is 10 kg.

Yes, the ΔX is the same between each two consecutive X-values.

3. The change in blood volume from data point to data point is .90 liters.

Yes, the ΔY is the same between each two consecutive Y-values.

4. There is a constant increase in liters of blood and kg of body mass.

5. Liters of blood $\approx$ mass $\div$ 11.5.

6. Answers will vary.

7. 6.5 liters.

8. 62 kg.

9. .27 liters.

10. 45 liters.

11. 87 kg.

12. Answers will vary.

13. Answers will vary.

Plasma contains the water.

14. Answers will vary.

15. There are 1,000,000 microliters in one liter.

Answers will vary calculating the approximate number of erythrocytes.

16. Answers will vary.

17. The number of white blood cells you have depends on your level of health at any given time.