INTRODUCTION

Look around at people's feet. You will notice that some people have longer feet than others. Do the individuals with longer feet also have longer legs? Are people with longer legs taller? Are the number of strides a person takes in a given distance different when he/she is running or walking? Does the person's stride length change with speed? Would the same hold true for birds? For dinosaurs? For early hominins? Can patterns of the present give you clues to patterns in the past?

Your job is to answer the following questions using the following lab procedures. You will gather data from classmates and family members to determine if there is a relationship between foot length, leg length, and height. You will also measure your stride while walking and running. Use the following terms when taking your measurements:

foot length: distance from back of heel to toe tip (without shoe).

leg length: distance from the base of the heel (calcaneus) to the hip joint (acetabulum).

hip Joint: top of femur on the outside of the hip joint (To find this spot, lift your knee until your thigh is parallel to the floor. Feel for the hip joint in your buttocks area, put your leg down, and measure from that point to the floor.)

height: distance from floor to the top of the head (without shoes on).

stride length: usually the distance from the back of the heel of one footprint to the back of the heel of the next footprint of that same foot; in other words, the distance of TWO steps.

pace length: distance from back of heal print of one foot to the back of heel print of the other foot in one step. Measure left-to-right pace, and right-to-left pace; those distances are often different.

OBJECTIVES: To find the relationships between:
   A. Foot Length and Leg Length
   B. Foot Length and Height
   C. Leg Length and Height
   D. Stride Length and Leg Length
   E. Stride Length and Speed

MATERIALS

Meter Stick, Data Table, Graph Paper

PROCEDURES

Part A

1. In your lab group, gather the following data from each member and record them in your Data Table 1: foot length, leg length, height (all measurements must be in centimeters)
2. Calculate the ratio of foot length (F) to leg length (L) for each group member and record in Data Table 1.
3. Calculate the ratio of foot length (F) to leg length (L) for each lab member and record in Data Table 1.
4. For homework, collect the above data from a minimum of three family members and/or friends.
5. Plot your data on a graph. Do this by placing foot lengths on the x axis, and leg lengths on the y axis; for each person, find where that person’s foot length and leg length coincide in the graph, and place a clear dot there. When done, you will see a scattering of dots suggesting a correlation, and they will likely follow a fairly straight path; draw a straight line through the middle of that path of dots.
Part B
1. Measure and mark off a distance of 2,000 cm (20m) (D).
2. Walk the length while counting the number of strides (Nw). Record in Data Table 2.
3. Run the length while counting the number of strides (Nr). Record in Data Table 2.
4. Calculate the stride length (S) by dividing the distance (D) by the number of strides (N)
   Walking: Sw = 2,000cm / Nw;    Running: Sr = 2,000cm / Nr
5. Measure and record your leg length.
6. Calculate the ratio of your stride length to leg length (S/L). Record in Data Table 2.
7. Graph (draw a graph using the data from as many people as possible, showing the relationship between stride length and leg length). Make a scatter graph for this, placing stride length on the x axis, and leg length on the y axis; for each person, place a clear dot where those two measurements meet in the graph; after data for all people are plotted, notice that there may be a clustered path of dots, suggesting a correlation; draw a straight line through the middle of that path of dots; use that line to estimate the likely leg length for a person with a particular stride.
8. Repeat #6 and #7, but comparing stride with height (S/H)

DISCUSSION
1. Do you see a pattern on the graph? Explain.
2. Superimpose all (or several of) the group's graphs and determine if there are any relationships between the variables.
3. Determine if foot length can be used to predict height. Test you hypothesis by measuring the foot lengths and corresponding heights of as many people as possible, then plot those points on a scatter graph. Now, take one foot length measurement and, using your graph, predict the height of that person. Now, measure the height of that person. How close are you to the actual height? Calculate your percent error (difference between predicted and actual, divided by the actual, then multiply this by 100). Explain.
4. Pool the class data for the ratio of Foot Length to Leg Length. What is the average F/L ratio for people based on the class data?
5. Paleontologists use the ratio of stride length divided by leg length (S/L) to tell whether a dinosaur is walking, trotting, or running. Paleontologists use the following ratios to determine how a dinosaur might have been moving. If ratio is less than 2, it was probably walking; if between 2 and 2.9, it was trotting; if more than 2.9, it was likely running. <2 = walking; 2 - 2.9 = trotting; >2.9 = running
   Examine the class data for the ratios of stride to leg length (Sw/L and Sr/L) to see if the values in the above chart would also apply to people. If not, what values would change?

ANALYSIS & APPLICATION
1. If a person's footprints were discovered in someone's backyard, what information could be determined about the person who made the footprints? What information about the person could not be determined from the footprints?
2. If you had a dinosaur trackway, how could you use the processes we learned in this activity to draw some conclusions about the dinosaurs that made the tracks?
3. Why did you count your stride over a 2,000cm length rather than make only one stride measurement?

4. A series of footprints were found in the mud outside school. Based upon their measurements (see below), calculate the **leg length** and **height** of the person. Who do you think the footprint belongs to? Write a paragraph describing what the person was doing. **Measurements:** Foot Length = 29 cm; Stride Length = 160 cm

SUGGESTIONS FOR FURTHER STUDY
1. Since criminals seldom go barefooted in your garden, see if you can figure out a way to estimate the height of a person walking through your garden with shoes on.

2. If you found some ancient footprints of some early humans that had been made in damp sand, then hardened and covered with sediments, how would you estimate the heights of those people? Would their footprints be the same size as their feet? Find out by walking on damp sand, and measuring your feet AND your footprints. Any difference? Get those measurements from as many people as you can, and determine the average difference between foot and footprint measurements.

3. How would you like to walk in the footprints of a 3.4 million year old person? If this sounds interesting, ask your teacher to do the **Footsteps in Time** lesson in your class.