Motion of an Amoeba – Scaling an Image[1]

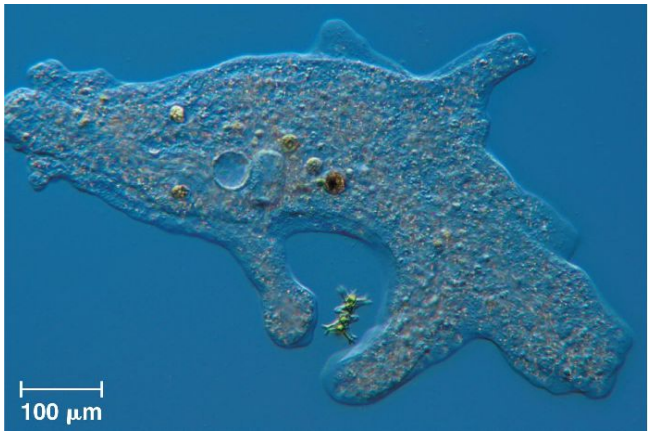

Figure 1: Image of an Amoeba

This week we will learn how to use Excel to analyze the 1-D motion of an amoeba from stop-motion images. This will be a first foray into motion analysis and one which we will examine motion without gravitational effects. In this way – we examine how the amoeba moves in the horizontal plan – on a slide in water.

Today's laboratory has been developed with the following goals at the end of the laboratory session:

1. Students will be able to determine how to properly scale image measurements.
2. Students will be able determine how to calculate velocity form position data.
3. Students will be able to evaluate graphs of position, velocity, and acceleration to determine whether a single cell organism, in this case an amoeba, is accelerating across the slide.

A copy of the movement of *Dictyostelium discoideum* at 3.0 minute intervals is found the in the 'amoeba_darktracks.pdf' file on Blackboard. From the outlines shown in the file, your group's task is to record and analyze the motion of the amoeba – specifically the position, average velocity from each track to the next track, and average acceleration over that same track. Your group should also analyze and report the total average velocity and acceleration over the entire stop motion images and compare this average of the total motion to each individual velocity and acceleration.

Students will be calculating these values using Excel. Make sure you come to class knowing how to enter a basic equation into Excel (see links under Resources for Excel help) and how to make an x-y scatter graph. As this is required to complete this laboratory, it is assumed all students can do this in Excel.

At first after reading this assignment students may think this a trivial exercise. But, you need to think carefully about how an amoeba moves. Its lack of rigidity (see videos on Blackboard) means that calculating changes in position is more challenging than movement of a rigid ball. How precisely your group determines where to record each 'position' to make measurements is up to the group. Make sure to discuss how to measure after reviewing at least a couple of the amoeba motion videos AND the dark tracks page on your lab table printed out for you.

Once your group has decided upon measurement procedures, write these down clearly. Students should describe HOW measurements were taken for the distances between the 3.0-minute timed intervals and JUSTIFY this approach in measurements for the position of the amoeba at each time stop. It is likely that more than one measurement of each step may be needed to adequately determine the motion of the amoeba in a reliable method that others can follow. Remember, your procedure should be able to be READ and REPEATED by others not present during your discussion or subsequent measurements and find similar results.

[1] Experiment adapted from University of Maryland NEXUS Physics for Biologist course

Finally make graphs of the position, velocity, and acceleration of the amoeba and discuss the questions below:

1. Look at the shapes of the graphs for the stepped values of position, velocity, and acceleration – would your group hypothesize that the velocity for most of track is constant? Why? Discuss.
2. How does each stepped velocity compare with the overall average velocity from the first track to the final track?
3. Find the average stepped velocity from your measurements and the standard deviation of these values. Is the total average velocity of the motion within the range of the average of the stepped velocities plus and minus the standard deviation? Discuss.
4. Repeat #3 for the acceleration stepped values. Discuss.
5. Are there locations on the track where the amoeba seems to stop? Where? Describe?
6. How does the total average velocity compare to the general range of 0.5x10-6m/s up to 5.0x10-6m/s? Discuss. (Note your data should show an average value within the micrometer range – if your group's data doesn't show the velocity within this range your made an error in the scaling of the measurements. Your group MUST go back and correct this error. Make sure to let your instructor know if this occurs.)

At the end of today your group should turn in to your instructor

1. Your group's procedure for measuring the stepped positions – what assumptions your group made – where did your decide to measure.
2. A table including measurements of position, calculated velocities (with average stepped velocity and the standard deviation of the stepped velocities) and accelerations (with the averaged stepped acceleration and standard deviation of the stepped accelerations) in tabular form.
3. The total average velocity and acceleration for comparisons to values shown in step 2 and the known rate of motion for an average amoeba.
4. Graphs of position, velocity, and acceleration with title and axes labels in correct units.
5. Answers to all questions above.

Make sure to send all relevant Word and Excel files to all group members so that each student has a record of the laboratory.

This is a group report due at the end of class so make sure that your group has determined who will do specific steps so that the group is efficient and has time to analyze results and complete assignment.