PHYS 233: Lab 1 – How do you quantify motion?

This lab is a bit different from the others because it starts with a simple exercise involving using Excel to make plots involving motion, and a second part where you analyze motion from video files. You might spend all of the first session on just Part 1, which is fine, but if you get done early proceed directly to Part 2.

Note: Assign roles in your team (journalist, data interpreter, critic, and checker; see the Roles & Rules document). These won't matter for Part 1, which should involve the whole team, but needs to be followed for turning in the Lab Report for on Part 2.

Part 1:

Your lab group has been provided with a copy of the movement of *Dictyostelium discoideum*. (Or, download it from the lab web page and print it.) This motion is shown as a sequence of outlines of the amoeba cell at 3.0-minute intervals. From the outlines, your task is to record and analyze the motion of the amoeba—specifically, the position, **instantaneous** and **average** speed, and **instantaneous** and **average** acceleration. Rather than do all of the mathematical calculations by hand, Excel (or any spreadsheet program) can help you do the calculations much more quickly and efficiently. Today you will practice and master the skills necessary to bend Excel to your will and make it do the grunt work. (You got a head start on this last week.) After today, you will ALL be expected to be experts at these skills so take turns and help each other learn.

At the end of the lab today, your group will submit one set of graphs (y vs. t, v vs. t, and a vs. t). **How will you do this?** These will be reviewed by the TA for completeness & accuracy & conventional structure. Good attention to detail now will save you time later! Remember, your TA is here to help you with equipment and Excel, but the physics is up to you and your group! (The bridge between the Physics and Excel is up to you, too!)

Physics Skill Goals:
Analyze 1-D motion from a stop-motion image sequence
Tabulate the position-at-time for an object's motion
Calculate average/instantaneous speed
Calculate average/instantaneous acceleration
Analyze graphs of motion (y vs. t, v vs. t, a vs. t)

These lab instructions are based on labs developed by the NEXUS team at the University of Maryland.

Part 2:

In this part we will be learning how to use ImageJ to analyze videos of cell motion. **The Scenario: A patient has a wound, in the process of healing, that is infected with bacteria. Will the patient need antibiotics?** To explore this scenario, you will be analyzing videos of: 1) wound healing, 2) neutrophil motion, and 3) bacteria motion. Clearly, the relative speeds of the wound healing, the neutrophils, and bacteria will affect your decision. Thus it becomes important that we learn how to quantify the motion of cells and to analyze videos.

Your lab group has been provided with six video files—a long and a shorter version of each of the three processes, wound healing, neutrophil motion, and bacteria motion. Each video is a sequence of images called 'frames.' Taken together, each video is an 'image sequence' or 'stack.' The wound healing videos, 'WoundHealing,' show breast tissue cell sheet migration. The 'Neutrophils' videos show white blood cells responding to six different concentrations of fMLP— the chemical indicator of bacteria. The bacteria videos show E. coli motion. By viewing the longer video files, you can begin to examine the qualitative aspects of our scenario. These videos are rich in detail but the files contain too much data to be analyzed in our limited lab time. From the shorter videos, your task is to perform a quantitative analysis, with ImageJ and Excel, of the rates of motion of these cells. This quantitative analysis should help you problem-solve within this scenario. Today you will practice and master the skills necessary to analyze motion using ImageJ. After today, you will ALL be expected to be experts at these skills, so take turns and help each other learn. Take notes for the future if you are worried that you will forget.

After the first hour, each lab group will report to the class on what they have seen and learned. The final 20 minutes or so will allow you to adjust your lab report based on what you have heard from the other groups.

At the end of the lab today, your group will submit one lab report. Good attention to detail now will save you time later! Remember, your TA is here to help you with equipment and ImageJ, but the physics is up to you and your group!

Video Files:

A. Video files for **qualitative** analysis (long videos—large files)

1. Wound healing: WoundHealing.avi
2. White blood cells: Neutrophils.avi
3. Bacteria: E_Coli.avi

B. Video files for **quantitative** analysis (shorter/smaller chunks of the long/large video files)

4. Wound healing: WoundHealing_25fps.avi; **All students analyze this!**
   (Technical specifications of video: 0.65 µm/pixel, 6.0 min/frame, playing at 25 frames/sec)

5. White blood cells: Neutrophils_25fps.avi; **Half of the groups analyze this.**
   (Technical specifications of video: 1.326 µm/pixel, 7.2 sec/frame, playing at 25 frames/sec)

6. Bacteria:E_Coli_25fps.avi; **The other half of the groups analyze this.**
(Technical specifications of video: 156 pixels/µm, 0.050 sec/frame, playing at 25 frames/sec)

Biology Skill Goals:
Qualitatively compare videos of motion for cell sheet migration, neutrophils, and bacteria
Understand the need for quantitative analysis
Quantitatively compare these videos of motion
Use the quantitative analysis to make a prediction and determine what other factors might need to be investigated