THE STUFF OF LIFE (PHYSICS 199)	PROFESSOR RAGHUVEER PARTHASARATHY (**Par**-tha-**sa**-ra-thī)
Spring 2009 Monday, Wednesday 2:00-3:20 pm Willamette 112	Office: 174 Willamette Hall *EMAIL: raghu@uoregon.edu*

SYLLABUS

1 COURSE DESCRIPTION

What are you made of? This simple question both puzzles and fascinates scientists. It is easy to make a list of your "components" – cells, bones, muscles, etc. – but this is neither interesting nor illuminating. What is it about your flesh that makes you "squishy?" Would you be better off with a skeleton of wood rather than bone? If you shrank a whale to the size of a bacterium, could it swim the same way? These questions, like many at the forefront of contemporary science, bring together concepts from a variety of disciplines, mixing together biology, chemistry, and physics.

This course will explore topics in biophysics and biomaterials. We will use readings, discussions, and hands-on exercises to study the physical properties of biological materials, as well as the constraints these properties place on living organisms. We'll also explore the behavior of "complex" soft materials – for example gels and foams – and their connections to biological materials. There are no scientific prerequisites, and mathematics in the course will be at the level of basic algebra. Beyond exploring exciting areas of contemporary science, our goals will be to improve critical reasoning abilities and writing and presentation skills, especially with respect to quantitative data.

2 COURSE STRUCTURE / ACTIVITIES

- **Readings and Lectures.** Readings will consist largely of articles and sections of books at the "Scientific American" level – i.e. with minimal mathematics. Readings from more technical sources will be accompanied by explanatory commentaries. Reading assignments should be done **before** the days at which they are listed. In class, students will be called upon to present explanations of the content of the readings, including, importantly, identification of issues that were confusing or unclear. The readings will be supplied as PDFs via *Blackboard*.
- **Writing assignments.** Assignments will ask students to (*i*) explain scientific concepts, (*ii*) explain in words the meaning of quantitative data (e.g. a graph), (*iii*) perform and explain simple numerical estimates of physical parameters, and (*iv*) evaluate whether various data support or contradict concepts discussed in class. As in the course in general, emphasis will be placed on critically examining similarities and differences between seemingly disparate systems. For example, we might, based on descriptions of their structure, compare the bones that hold up our bodies and the "microtubules" that provide the internal scaffolding of our

cells. Both are hollow tubes, a structure with mechanical attributes explored in class (aim (*i*)), whose stiffness we can comment on by examining experimental data (aims (*ii*) and (*iv*)), and whose characteristic values of load borne to cross-sectional area, for example, we can estimate and compare (aim (*iii*)).

- **Laboratory exercises.** Laboratory exercises will stress exploration and observation of the properties of materials. A written report will be required for each exercise, stressing clear prose descriptions of both the activities themselves and any results.
- **Final project.** Students will work in small groups to prepare a presentation on a biophysical or biomaterial topic that was not explored in class, but that involves physical mechanisms that we have studied. (A suggested list of topics and readings will be provided.) The presentation will be approximately 20 minutes long, delivered during the university's Final Exam period, and can take the form of a lecture or computer-based presentation. The students will also prepare a writing assignment like those assigned during the course that would, if assigned, aid other students' learning.

3 EVALUATION

Participation / Preparedness – 25%. Based on asking and answering questions related to the assigned readings or present discussion topic. We may also make use of the Blackboard "Course discussion" site. *Absences*: More than three unexcused absences will result in a reduction of the final course grade by one full letter grade. (See Section 6 for examples of excused and unexcused absences.)

Laboratory Assignments – 20%
Writing Assignments – 30%
Final Project – 25%
Final Grade: A=86-100%; B=71-85%; C=56-70%; D=41-55%; F=0-40%.

4 SUCCEEDING IN THIS COURSE

Plan ahead and start early! The reading assignments are a vital part of this course, and it is important to start reading them early not only to understand the subject matter but to be able to articulate what you *don't* understand – in class lectures and discussions will build on your reading experiences. Note that the reading assignments must be done **before** the days at which they are listed in the schedule below. In general, it will be crucial to keep up with the course and not fall behind; later topics will build on earlier ones.

Make use of available resources. If you have questions about lectures, assignments, readings, or other matters, please visit Prof. Parthasarathy during office hours, or communicate by phone or email. Individual appointments can certainly be arranged to accommodate schedule conflicts with the regular office hours.

The University's Academic Learning Services (ALS) center provides a variety of workshops, individual consultations, writing assistance labs, and more to assist UO students. For more information please see als.uoregon.edu, or call (541) 346 3226.

5 University Academic Honesty Policy

As discussed in the University's Policy on Academic Dishonesty: Your work in this course must be your own, and you must acknowledge and cite the ideas and words of others. The presentation of un-cited or un-acknowledged material acquired from any source – written, verbal, on-line, etc. – is defined as plagiarism. Violations are taken seriously and are noted on student disciplinary records. Please consult the instructor if you have any questions about the definition of plagiarism.

6 Policy on Missed Deadlines, Absences & Incompletes

Only the following unforeseen and uncontrollable emergency situations are acceptable excuses for absences or missed deadlines:

- Documented serious illness/injury;
- Documented death in the *immediate* family.

All of the following are **unacceptable** – note that they include "personal" as well as "technological" excuses:

- Special occasions (e.g. weddings, birthdays, anniversaries etc.)
- Work and school conflicts: "I had to work extra hours," "I have a huge midterm tomorrow in another class…"
- Couldn't get to campus (alarm didn't ring; missed the bus; etc.)
- Being generally "busy" or having "a lot going on right now…"
- Forgot or "mixed up" the assignment or due date
- No access to computer or printer
- Assignment completed on computer is "missing," was accidentally erased, or is inaccessible
- Printer ran out of ink or paper

7 Topics

Note:

- The following is a rough guide to the course topics and schedule. If you're curious to see a more detailed schedule, feel free to ask. However, as stressed during the first class, the schedule is very "fluid" for several reasons. One important reason for fluidity is that I am happy to spend more or less time on particular topics as students' interests dictate. If you would like to request particular topics, don't be shy!
- Reading assignments should be done **before** the days at which they are listed.

Week 1	Introduction, Motivation, and Illustrations Scale and Powers of 10 – *In which we get a sense of the size of things*
Week 1-2	Randomness and Diffusion – *In which we explore the perpetual motion of small things, both its unavoidable causes and its far-reaching consequences*

Week 3	Surfaces and surface tension – *In which we explore the consequences of surface tension on the functioning of your lungs and ask: why can't you walk on water*
Week 4	Soap films, cell membranes – *In which we examine similarities between the two, and also look more generally at materials that assemble themselves.*
Week 5	Squishy materials – *In which we ask: Why are you soft? We'll examine structural similarities between biomolecules and the components of other "soft" materials*
Week 6	Rubber bands and DNA – *In which we examine similarities between the two*
Week 7	Frontiers of Microscopy – *A look at how we know what we know, focusing on recent optical tools and techniques*
Week 8	Size, shape, and fractals – *In which we ponder how the size and shape of an organism might affect its properties*
Week 9	"Common" Biomaterials – *In which we examine ways to characterize solids, and the properties of wood, bone, spider silk, and other biological materials*
Week 10	Life at Low Reynolds Number – *In which we ask: Why don't bacteria swim like whales?*