BIO 362: Nanobiology
Instructor: Siddharth Ramakrishnan

Contact: WYE 329; TH 277
sramakrishnan@pugetsound.edu
Ph: 253-879-2698

Class times: TTH 11-1220pm; Lab W 1-350pm
Office Hours: T 4-450pm WYE 329; Th 1-150pm TH 277

Bulletin
This course offers students an introduction to the field of Nanobiology. Nanotechnology is becoming a new frontier in biological explorations and manipulation. Engineering tools and techniques have been used to expand biological research, enrich the medical field, as well as alter food and materials. Fast expanding, Nano-biology is becoming a part of the cultural lexicon, with ramifications in both ethical and cultural aspects of everyday life. This course will explore these themes, with overviews of methodologies and future technology.

Objective and Outcomes
• This course will cover cutting edge concepts and discoveries that are emerging from using nanotechnology in the field of Biology.
• You will discuss different tools and techniques that are being used in the field, and where these technologies are headed. You will learn about applications of nanobiology in terms of emerging areas such as Nano-medicine, Bio-mimicry to create Nano-materials, and Nano-biotechnology.
• You will gain an understanding of some of the ethical issues that are associated with the study of nanoscience, its place in law and policy making.
• You will get an insight into the current technology and where the field of biology is moving in the future.
• A laboratory based component will give you hands on experience in simple techniques of nanoparticle synthesis and observations, and their uses.
• As the field is evolving, readings will be from current journals and publications
• You will be encouraged to apply for the Nanotechnology summer internships offered as a part of Summer REU programs at various institutes
• You will gain experience in conveying scientific information to a lay-audience both through oral presentations and written work.
• You will also gain experience in concisely presenting facts that were conveyed in a scientific paper (as used in grant panels).
• You will gain expertise in searching for, choosing, reading, presenting and critiquing scientific papers
• You will be able to discuss and debate scientific principles and methodologies using insightful and supported arguments.
Pre-requisite: Intro to Biology, Intro to Physics, Intro to Chemistry

Main books
- Introduction to Nanosciences and Nanotechnology- Chris Binns (eBook)
  http://pugetsound.worldcat.org/oclc/649906274

Moodle
Readings will be posted on http://moodle.pugetsound.edu. While the syllabus serves as a guide, the moodle site will be constantly updated for latest readings


Labs:
You will need personal protective gear. Always wear clothing that covers your hands and legs. Only closed toed shoes will be allowed into labs. Also, some chemicals used may cause staining. Either bring a lab coat or an old full sleeved shirt/apron for extra protection. You will maintain a lab notebook for this class. This can be sheets of paper or a regular composition book. But dedicated for the class. Most labs will have assignments and sheets posted on moodle. Aside from this you will take notes during lab.

Tentative Lab Schedule
- 1. Sept7th: Scale and Measurement (Measurement/Blue Morpho)
  - Make Silver and Gold nanoparticles (2 diff methods)
- 2. September 14th: Nanotoxicity and brine shrimp; and silver socks
- 3. September 21st: Practice on SEM (With AMY)
- 4. September 28th: Lab on a Chip (Maker Space stuff?)
- 5. October 5th: Lipid Bilayers
- October 12th: Sensor Workshop
- 6. October 19th: UW NanoCenter Visit
- October 26th: Designing your final project
- Nov 2nd: Final Project Prep
- Nov 9th: Final Project Prep
- Nov 16th: Final Project Prep
- Nov: 23rd: Thanksgiving
- Nov30th: Final Project Prep
- December 7th: Final presentations
## Tentative Course Schedule:

<table>
<thead>
<tr>
<th>WEEK</th>
<th>DATE</th>
<th>TOPIC</th>
<th>• Readings/Links</th>
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| 1    | T: 30Aug | Introduction to Nanobiology | [http://htwins.net/scale2/](http://htwins.net/scale2/)  
• [http://www.howstuffworks.com/nanotechnology.htm](http://www.howstuffworks.com/nanotechnology.htm)  
|      |      | **Assignment 1:** You are a news reporter covering nanoscience. Write a short 50 word intro to the power of Nanotech in Biology. What is your concept of nanobiology? Nanoscience? Where is it at? What can it do? |
| Th: 1 | Sept | Scale scope and future  
Read Introduction and Chapter 1 (Pages 1-14, Fig1.5, 24-30).  
**Discussion:** Feynman – There is plenty of room at the bottom  
**READ BEFORE CLASS:**  
- Chapter 2 (sec2.2 [p38-41]; sec2.4 [45-46])  
- Chapter 4 Pages (Fig 4.3, p99-102; fig 4.9 pg 112-114; Fig 4.11 pg. 117; 120; 122 -125 Fig 4.14)  
**Assignment 2** Write down in your own words 2 ways of creating nanoparticles bottom-up.  
**W 7th September:** Lab – Synthesizing Nanoparticles |
| Th: 8th Sept | Tools and techniques in Nanoscience | Chapter 4 (4.2.1 Pg 128-134; Fig 4.23, 4.24, 4.25)  
**Discuss class:** Cellulose nanofibers manufacture paper in class |
| 3    | T: 13th Sept | Tools and Techniques in Nanoscience | Chapter 4 - Section 4.4.4 pg157-160;  
Section 4.4.5 (pg 162-163; fig 4.42);  
section 4.46 pg 165- 169  
**Discuss:** Nanotoxicology Papers |
### Assignment 4:
What is AFM, SEM, TEM. How are they used in Nanoscience

**Build a Lego AFM**  
*(W 14th September Lab: Nanotoxicology)*

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<th>Resources</th>
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**• Engineered Nanoparticles in Consumer Products: Understanding a New Ingredient**  

**Assignment 5: Food:** Identify 2 food products that contain nanoparticles. Cite your references. What kind of Nanoparticles do they contain? What is the purpose of these nanoparticles? Are they regulated?

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<th>Week</th>
<th>Date</th>
<th>Activity</th>
<th>Resources</th>
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Discussion about Midterm: Building sensors |
For Midterm: You need to identify a problem that you will be able to tackle using a biomimicry based approach. You will use Nanotech based techniques to create this biomimicry solution. For the midterm, you will i) identify a problem, ii) find a naturally/biological solution that you wish to mimic, iii) describe previous attempts at either solving this issue or using this biomimicry, iv) describe how you will use nanotech to create a solution. These will be presented as a 5 min presentation.

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<td>Th: 29th Sept</td>
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<td><a href="http://pubs.rsc.org.ezproxy.ups.edu/en/content/articlepdf/2013/cs/c3cs60198f">http://pubs.rsc.org.ezproxy.ups.edu/en/content/articlepdf/2013/cs/c3cs60198f</a></td>
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<td>Week 6</td>
<td>T: 4th Oct</td>
<td>Nanocarriers; Theranostics (W 5th October Lab: Bilayers)</td>
<td><a href="http://www.dovepress.com/genetically-engineered-nanocarriers-for-drug-delivery-peer-reviewed-article-IJN">http://www.dovepress.com/genetically-engineered-nanocarriers-for-drug-delivery-peer-reviewed-article-IJN</a></td>
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<td><a href="http://www.thno.org/v03p0141.pdf">http://www.thno.org/v03p0141.pdf</a></td>
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<td>Th: 13th Oct</td>
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<td>MIDTERM PRESENTATIONS (maybe shifted to class if sensor workshop is scheduled)</td>
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<td>More Neuro Nano papers TBA</td>
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<td>Week 8</td>
<td>T: 18th Oct</td>
<td>Fall Break</td>
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<td>Ethics games and paper discussions Nano Ethics Discussions</td>
<td><a href="http://www.bioethics.net/2009/04/the-">http://www.bioethics.net/2009/04/the-</a></td>
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Paper on nanoethics (15 points) Due November 21st. Papers will be discussed at end of semester and submitted to Nanoethics Journal at end of term (http://www.springer.com/social+sciences/applied+ethics/journal/11569)

|--------|-------------|----------------------------------------------------------|------------------------------------------------------------------------------|

**Presentation:** For the next 2 weeks, it will be student presentations and discussions. Presentations will be 30 minutes followed by discussion for 15 min. 1 primary paper will be given to each group. They will then pick 2 secondary papers to discuss alongside. The non-presenters will read the primary papers and bring in a one-two page write up (single space) of the paper (5 x 2 points = 10 points)

1. What the main goal of the paper is
2. What is the main problem/technology that the paper is trying to achieve
3. What is the primary technology being used to achieve this goal
4. What is the “nano” aspect of this paper?
5. What are the potential problems/pitfalls?
6. What is the future scope of this project?
7. Two factors that you think the researchers did well?
8. Two factors that you just did not understand.

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<tr>
<th>Week10</th>
<th>T: 1st Nov</th>
<th>Nano-medicine: Drug delivery 4 presenters</th>
<th>Papers TBA</th>
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<td>Th: 3rd Nov</td>
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<td>Week11</td>
<td>T: 8th Nov</td>
<td>Nano-medicine: Cancer treatment 5 presenters</td>
<td>Papers TBA</td>
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<td>Nov 10th</td>
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<td>Week12</td>
<td>Th: 17th Nov</td>
<td>No Class (Neuroscience Meeting)</td>
<td>Papers TBA</td>
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<td>NanoSensors, Next Gen Nano Nanoethics Papers Due</td>
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<td>Week 13</td>
<td>T: 22nd Nov</td>
<td>NanoSensors, Next Gen Nano</td>
<td>Papers TBA</td>
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<td>Week 14</td>
<td>T: 29th Nov</td>
<td>Nanoculture</td>
<td>Lefty, The Diamond Age, Ghost in the Shell</td>
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<td>Th: Dec 1st</td>
<td>Final Project Preparation; Revise Nanoethics Papers</td>
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<td>Week 15</td>
<td>Dec 6th</td>
<td>Review, Further Scope</td>
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<td>December 7th</td>
<td>FINAL PRESENTATIONS</td>
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**Evaluations**

**Mid term project** 30 points (15 points presentation; 10 points abstract; 5 points conceptualization):
Conceptual design of a nano-technology based product for use in a Biological application: Could be for medicine, for therapeutics, for new bio-materials etc. Concept should be presented as a 1 page abstract (single-spaced min: 500 words). And a conceptual diagram that schematizes the product, its application, and basic design process. You need to identify a problem that you will be able to tackle using a biomimicry based approach. You will use Nanotech based techniques to create this biomimicry solution. For the midterm, you will i) identify a problem, ii) find a naturally/biological solution that you wish to mimic, iii) describe previous attempts at either solving this issue or using this biomimicry, iv) describe how you will use nanotech to create a solution.

**Nanoethics Paper** 20 points paper (15 points paper/revision, 5 points review)
You will investigate a potential impact of nanotechnologies and write about how it influences society in terms of social justice, economic inequalities, human research, etc. Paper will be at least 2500 words. Follow guidelines in [http://www.springer.com/social+sciences/applied+ethics/journal/11569](http://www.springer.com/social+sciences/applied+ethics/journal/11569)

**Presentations** 30 points (20 points presentation, 10 points reports)
Presentations will be 30 minutes followed by discussion for 15 min. 1 primary paper will be given to each group. They will then pick 2 secondary papers to discuss alongside. The non-presenters will read the primary papers and bring in a one-two page write up (single space) of the paper (5 x 2 points = 10 points). **Assessment Rubric will be provided**

**Final Project** 45 points (Presentation/Report/Execution)
Based on the midterm concept, the final project will delve into the nano-aspect of your idea. You will investigate the biological specimen that you want to mimic/use in your product with the SEM and write about its physical properties. Then you will speculate on how this will be transformed into the product of your choice. Try and investigate into how this will be manufactured and potential costs and pitfalls – both in terms of economics and ethics.

**Points:**

- **Assignments**: 15 points
- **Lab**: 60 points (6 x 10 points)
- **Ethics Paper**: 20 points paper (15 points paper, 5 points review)
- **Mid Term**: 30 points (15 points presentation; 10 points abstract; 5 concept)
- **Presentations**: 30 points (20 points presentation, 10 points reports)
- **Final**: 45 points (Presentation/Report/Execution)
- **Total**: 200 points
**Names & Pronouns**
I want to call you by what you consider your name, no matter what the official roster might tell me. Similarly, I want to honor your pronouns. Please inform me how you want me to refer to you, and please keep me informed if your pronouns change.

**Academic Honesty:** All materials that you present in this course as your work must be the product of your own efforts. It is not honest to treat or represent work as if one were fully responsible for it when it is, in fact, the work of another person or work in which one received unacknowledged assistance. Therefore, you should not receive outside help except from a tutor at the Center for Writing, Learning, and Teaching or instructors of the course. We will enforce all rules pertaining to Academic Honesty as outlined in *The Logger*. [http://www.pugetsound.edu/student-life/student-handbook/academic-handbook/academic-integrity/](http://www.pugetsound.edu/student-life/student-handbook/academic-handbook/academic-integrity/)

**Bereavement Policy**
Upon approval from the Dean of Students’ Office, students who experience a death in the family, including parent, grandparent, sibling, or persons living in the same household, are allowed three consecutive weekdays of excused absences, as negotiated with the Dean of Students. For more information, please see the *Academic Handbook*.

**Accessibility and Accommodation**
If you have a physical, psychological, medical or learning disability that may impact your course work, please contact Peggy Perno, Director of the Office of Accessibility and Accommodation, 105 Howarth, 253.879.3395. She will determine with you what accommodations are necessary and appropriate. All information and documentation is confidential. Please notify me well in advance should you require accommodation in the class or lab.

**Emergency Response Procedures**
Please review university emergency preparedness and response procedures posted at [www.pugetsound.edu/emergency/](http://www.pugetsound.edu/emergency/). There is a link on the university home page. Familiarize yourself with hall exit doors and the designated gathering area for your class and laboratory buildings.

If building evacuation becomes necessary (e.g. earthquake), meet your instructor at the designated gathering area so she/he can account for your presence. Then wait for further instructions. Do not return to the building or classroom until advised by a university emergency response representative.

If confronted by an act of violence, be prepared to make quick decisions to protect your safety. Flee the area by running away from the source of danger if you can
safely do so. If this is not possible, shelter in place by securing classroom or lab doors and windows, closing blinds, and turning off room lights. Lie on the floor out of sight and away from windows and doors. Place cell phones on vibrate so that you can receive messages quietly. Wait for further instructions.

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