Arizona State University
Topic: Nanobiotechnology: From Nanoscience to Biomedicine
Spring 2019

Last Update: 11/01/18

Time and place: **M W F 01/07 - 04/26 12:55 PM 1:45 PM Tempe - ECGG236**
Textbook: Journal publications related to the course topic.
Instructor: **Dr. Chao Wang** (wangch@asu.edu, 480-965-2056)
Office hours (Tentative): **TBD** Room: ERC 539

Course Description:
Biotechnology and nanotechnology are both exciting fields, covering broad spectra of areas that have significant implications to national security, energy, and public health. The two are merging at a fast pace, creating new multidisciplinary research areas and new industries. The course is designed to train and prepare graduate students as next-generation work force in these exciting areas. The course will cover broad topics from nanoscale physics and molecular fundamentals, to nanostructure- biomolecule interactions, and to applications in nanophotonics and quantum optics.

Course contents: We expect to cover the following topics in the lectures.

1. Nanolithography and nanostructure characterization.
   - Nanostructures and ITRS.
   - Conventional photolithography methods
   - Nanoimprint lithography
   - Self-assembly (intro of DNA origami)
   - Optical, and SEM, AFM, TEM characterization
2. Subcellular biology.
   - Cells.
   - DNA and RNA.
   - DNA and RNA structural biology for self-assembly.
   - Proteins and antibodies.
   - Macrovesicles and exosomes.
   - Molecular biomarkers, cancer, and neurodegenerative diseases
3. DNA/RNA sequencing.
   - PCR
   - Sanger sequencing
   - Second-generation sequencing
   - Solid-state DNA sequencing
4. Micro and nanofluidics.
   - Fluidic dynamics at small scales
   - Biopolymer fluidic dynamics
   - DNA mapping.
   - Biomolecular separation and purification techniques.
   - Liquid biopsy
5. Nanophotonics for biology.

- Maxwell equations.
- Fluorescent dyes and fluorescence imaging
- Raman and IR spectroscopy.
- Propagating surface plasmon and localized surface plasmon
- Optical nanoantennas.
- Metamaterials and metasurface
- Fano resonance
- Purcell effect
- Quantum strong coupling

6. Biological sensors and Assays
   - DNA arrays.
   - SPR (surface plasmon resonance)
   - ELISA (enzyme-linked immunosorbent assay)
   - Colorimetric assays
   - Isothermal nucleic acid amplification.
7. Grant application discussions
   - NSF: how it works; your project summary matters
   - NIH: how to write your first specific aims

Grading: Your letter grade will be calculated as per the following table. These thresholds will be set at the instructor's discretion.

Letter grade	Course numerical score
A+	95 and above
A	85 and < 95%
B+	75 and < 85%
B	70 and < 75%
C	65 and < 70%
D	60 and < 65%
E	< 60 %

The grade will not be adjusted, but opportunities for extra credit may be provided to boost your score based on your attendance and progress in the course. The approximate grading scheme is

Topical Literature Summary	30%
Research Proposal summary/Specific Aims	20%
Final Proposal Presentation evaluated by students	20%
Final Research Proposal evaluated by instructor	30%

Homework/Literature Summary (30%): No homework assignment. However, a topical literature summary (10 to 15 page in powerpoint) will be required after each of the six topics (1-6) covered in this lecture: 1. Nanolithography and nanostructure characterization. 2. Subcellular biology. 3. DNA/RNA sequencing. 4. Micro and nanofluidics. 5. Nanophotonics for biology. 6. Biological

sensors and Assays. The quality of the literature summary will be evaluated and accordingly scored.

Proposal practice (70%):
This class provides guidance to write NSF and NIH proposals. Depending on its nature of study, the research in the field of nanotechnology and biotechnology usually goes to National Science Foundation (NSF) or National Institute of Health (NIH). The course provides the students with the following practice on writing proposals.
The students should identify the research topic they want to propose, and discuss with the instructor **using their prepared slides at least 2 weeks before the proposal summary/aims are due.** The topic should be scientifically sound and interesting and closely related to one of topics discussed in this class. Then there are three parts related to this proposal.

1. Proposal summary (for NSF) and specific aims (for NIH).
   The students will then identify the nature of their study and determine if they will submit to NSF or NIH. Then they will write one-page proposal summary or specific aims. The instructor will grade and provide feedback to the students.
2. Final proposal presentation
   In the final two to three weeks, presentations will be organized, and all the students are required to participate. The presentations will be graded by all the other students.
   Guidelines for presentation:
   - 7 min presentation + 3 min Q/A
   - Recommend to use the template provided by the instructor.
   - Graded by other students, 15%.
   - Your own grading efforts, 5% (coming late will affect score, missing the presentation will void your efforts).
   - Practice

   Review criteria to ask when grading
   - How you evaluate the topic. (Is the topic interesting?)
   - Did the presenter give enough information so that you understand the problem and background information?
   - Was the presenter able to explain the concepts clearly (including Q/A) and present logically?
   - Evaluate the overall presentation quality (did you learn something new that could be useful to you?)
3. Final research proposal
   Guidelines:
   - 5-6 pages. Figures and tables included. No more than four display items (figures or tables).
   - Include title, background, your proposed research goals/aims, your proposed designs, experiments, structures, *etc*, and references.
   - Single column, single line spacing, Arial font size 11. Page margin 0.5 inch each side.
   - Cite literatures and organize your reference; reference page does NOT count towards the total page number.
   - Should NOT contain any confidential information.
   - No need to add budget.

Grading criteria

- Topic (25%): closely related to the lectures (nanobiotechnology, 10%) and novelty (15%)
- Background/introduction (20%): explain the motivation of this paper, *e.g.* scientific problem/challenges you want to discuss.
- Research goals/aims (15%): articulate the concepts clearly and write concisely.
- Your proposed designs, experiments, structures (30%): describe clearly and in sufficient details with assistance of schematics, plots, figures, and tables where needed (15%); explain what is your plan to achieve the desired performance of the technology you propose, use timeline table (Gantt chart) if needed (10%); Identify potential risks and suggest risk mitigation plans (5%).
- References (10%): well organized, citations given where necessary.

Attendance:
Accommodations will be made for religious observances provided that students notify the instructor at the beginning of the semester concerning those dates. Students who expect to miss class due to officially university-sanctioned activities should inform the instructor early in the semester. Alternative arrangements will generally be made for any examinations and other graded in-class work affected by such absences. The preceding policies are based on ACD 304–04, "Accommodation for Religious Practices" and ACD 304–02, "Missed Classes Due to University-Sanctioned Activities."

Classroom Behavior: Cell phones and pagers (must be/or state alternative rule) turned off during class to avoid causing distractions. The use of recording devices is not permitted during class. Any violent or threatening conduct by an ASU student in this class will be reported to the ASU Police Department and the Office of the Dean of Students.
Laptop/Tablet Policy: allowed if you are using it in connection with the class; for instance, taking notes. Not Permitted: if you are surfing the web, checking email, etc.

Academic Integrity: All students in this class are subject to ASU's Academic Integrity Policy (available at http://provost.asu.edu/academicintegrity) and should acquaint themselves with its content and requirements, including a strict prohibition against plagiarism. All violations will be reported to the Dean's office, who maintain records of all offenses. Students are expected to abide by the FSE Honor Code (http://engineering.asu.edu/integrity/). Literature Study and final research proposal should be completed by each student independently. **Copying online without proper citation will be viewed as plagiarism and void your credits.** Be advised of the University's Code of Academic Integrity, which sets strict penalties.

Sexual Discrimination: Title IX is a federal law that provides that no person be excluded on the basis of sex from participation in, be denied benefits of, or be subjected to discrimination under any education program or activity. Both Title IX and university policy make clear that sexual violence and harassment based on sex is prohibited. An individual who believes they have been subjected to sexual violence or harassed on the basis of sex can seek support, including counseling and academic support, from the university. If you or someone you know has been harassed on the basis of sex or sexually assaulted, you can find information and resources at https://sexualviolenceprevention.asu.edu/faqs. As a mandated reporter, I am obligated to report

any information I become aware of regarding alleged acts of sexual discrimination, including sexual violence and dating violence. ASU Counseling Services, https://eoss.asu.edu/counseling, is available if you wish discuss any concerns confidentially and privately.