TO: The Faculty of the College of Engineering

FROM: The Faculty of the School of Biomedical Engineering

RE: New Undergraduate Course, BME 47000, Biomolecular Engineering

The faculty of the School of Biomedical Engineering have approved the following new course. This action is now submitted to the Engineering Faculty with a recommendation for approval.

BME 47000 Biomolecular Engineering
Terms offered: Fall or Spring, Lecture 3, Cr. 3
Prerequisites: BME 20100 AND BME 20500, OR BIOL 23000

Description: The course covers key chemical concepts one needs in order to:
- modify existing biomolecules
- link biomolecules with other (bio)molecules
- link biomolecules with inorganic entities
- create composite (bio)structures
- modify specific properties of biomolecules
- alter/enhance biomolecule functionality

Taken together, the rational application of these biological, chemical, and engineering tools can be used to; engineer new biomolecules, design sensors for molecular detection, create diagnostic tests, develop new imaging modalities, and design and test novel biomaterials, to name a few examples.

Reason: This course is beneficial within the undergraduate curriculum as one of the technical elective courses offered by the Weldon School of Biomedical Engineering. At least one BME 400-level technical elective course is a required part of the curriculum. This course, in particular, meets an identified need in the BME curriculum for upper level elective courses that integrate engineering, biology, and chemistry principles toward the engineering of biomolecules with novel function and application to solving biomedical and societal problems. This course integrates learning from previous required courses and provides a more in-depth understanding of the physiochemical properties of biomolecules.

The rational application of integrated principles in engineering, biology, and chemistry will allow the students to pursue careers in biotechnology and biomedicine wherein they may pursue any number of exciting career paths: engineering new biomolecules, designing sensors for molecular detection, creating diagnostic tests, developing new imaging modalities, and designing and testing novel biomaterials, to name a few examples.

This course has previously been offered three times as a 400-level experimental course with favorable reviews (4.5 or above) with enrollments of 18, 34 & 29.

George R. Wodicka

George R. Wodicka,
Dane A. Miller Head and Professor
Weldon School of Biomedical Engineering

Biomolecular Engineering - BME 495 (470)

Biomolecular Engineering - BME 495 (470)

Fall 2019, 3 credits
T, Th 3:00-4:15pm, MJIS 1083
Instructor: Prof. Tamara Kinzer-Ursem
Email: tursem@purdue.edu
Office: MJIS 3084
Office hours: by appointment, made via email or see me after class
Pre-requisites: BME 201 and BME 205, or BIOL 230
Class is open to juniors and seniors

Course Description:

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Taken together, the rational application of these biological, chemical, and engineering tools can be used to; engineer new biomolecules, design sensors for molecular detection, create diagnostic tests, develop new imaging modalities, and design and test novel biomaterials, to name a few examples.

Learning Outcomes:
At the end of this course students will be able to 1) describe and discuss the physiochemical properties of biomolecules, 2) conceptually design new molecules to perform new functions, and 3) be able to critically analyze literature on biomolecular engineering.

Course Overview:
The first part of the course (weeks 1-5) is designed to review the key physiochemical properties of the biomolecules that will be covered in the course (DNA, proteins, polysaccharides, and lipids). This includes structural, chemical, and functional concepts. We will also cover the ways in which these molecules are detected and their properties quantitatively measured.

The second part of the course (weeks 6-15) is designed to introduce some of the very many applications of biomolecular engineering. Key concepts of each application will be introduced and a journal article(s) will be discussed to highlight different features of each application. A team project to develop a biomolecular engineering research proposal based on NIH guidelines is due at the end of the semester. The goal of this proposal is to develop an R03 or R21 proposal that uses biomolecular engineering principles to solve a biological problem or develop a bio-based tool. This will allow students to gain deeper insight into a particular subfield of biomolecular engineering, and to develop a realistic experimental plan in order to implement the research.

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Academic Conduct:
You are expected to behave in a professional and ethical manner in all aspects of this course. Plagiarism or cheating will result in a zero for that particular assignment. Instances of unethical behavior will be reported to the Dean of Students Office and will result in a grade reduction of at least one letter grade. If an individual behaves unprofessionally or unethically during the semester, the instructor reserves the right to fail the student. For more information, see Purdue University Student Conduct Code at:
http://www.purdue.edu/usp/acad_policies/student_code.shtml .

Purdue prohibits "dishonesty in connection with any University activity. Cheating, plagiarism, or knowingly furnishing false information to the University are examples of dishonesty." [Part 5, Section III-B-2-a, Student Regulations] Furthermore, the University Senate has stipulated that "the commitment of acts of cheating, lying, and deceit in any of their diverse forms (such as the use of substitutes for taking examinations, the use of illegal cribs, plagiarism, and copying during examinations) is dishonest and must not be tolerated. Moreover, knowingly to aid and abet, directly or indirectly, other parties in committing dishonest acts is in itself dishonest." [University Senate Document 72-18, December 15, 1972]

Purdue's student guide for academic integrity:
https://www.purdue.edu/odos/academic-integrity/

Campus Emergency Response Procedures:
http://www.purdue.edu/fire/safety_handbook.pdf

- **Fire Alarm** – Evacuate MJIS 1061 through the south door (nearest the elevator); then, leave the building through the doors which exit to the east side of the building (back of the building near the construction of the Herrick Labs extension). Only gather personal items if it does not jeopardize your safety. Assist those who need help. Proceed to the front lawn Lilly Hall of Life Sciences (corner of State St. and S. Russell Dr.) **Report to a course instructor your name before leaving the emergency assembly area.**
- **All hazards warning** (Tornado, hazardous release, civil unrest, etc.) – When you hear the all hazards alarm immediately seek shelter (**Shelter-In-Place**) in a safe location. For a tornado, proceed to the basement of MJIS, using either the stairwell on the northwest side (by the police station) or the southeast side (across from MJIS 1087).

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control. Relevant changes to this course will be posted onto the course website or can be obtained by contacting the instructors or TAs via email or phone. You are expected to read your @purdue.edu email on a frequent basis.

See the University's website for additional information:
https://www.purdue.edu/ehps/emergency_preparedness/

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Use of Copyrighted Materials:
Students are expected, within the context of the Regulations Governing Student Conduct and other applicable University policies, to act responsibly and ethically by applying the appropriate exception under the Copyright Act to the use of copyrighted works in their activities and studies. The University does not assume legal responsibility for violations of copyright law by students who are not employees of the University.

A Copyrightable Work created by any person subject to this policy primarily to express and preserve scholarship as evidence of academic advancement or academic accomplishment. Such works may include, but are not limited to, scholarly publications, journal articles, research bulletins, monographs, books, plays, poems, musical compositions and other works of artistic imagination, and works of students created in the course of their education, such as exams, projects, theses or dissertations, papers and articles.

See the University Regulations on policies: http://www.purdue.edu/policies/academic-research-affairs/ia3.html

Nondiscrimination
Purdue University is committed to maintaining a community which recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her own potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. The University believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life.

Purdue University prohibits discrimination against any member of the University community on the basis of race, religion, color, sex, age, national origin or ancestry, genetic information, marital status, parental status, sexual orientation, gender identity and expression, disability, or status as a veteran. The University will conduct its programs, services and activities consistent with applicable federal, state and local laws, regulations and orders and in conformance with the procedures and limitations as set forth in Executive Memorandum No. D-1, which provides specific contractual rights and remedies. Any student who believes they have been discriminated against may visit www.purdue.edu/report-hate to submit a complaint to the Office of Institutional Equity. Information may be reported anonymously.

Purdue's nondiscrimination statement:
http://www.purdue.edu/purdue/ea_eou_statement.html

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Grading

Exam	25%
Assignments	40%
Proposal and peer review	25%
Class attendance and participation	10%

Grade Scale
The following grading scale is guaranteed: however, based upon student performance, final grades may be curved by the instructor:

90-100%	A
80-89%	B
70-79%	C
60-69%	D
<60%	F

Exam
One in-class exam will be used to test student's understanding of material introduced in the first part of the course. ***It is a closed book, closed note exam.*** Everything introduced in the fist part of the course is subject to examination (i.e. the exam will cover the fundamental properties and quantification of the biomolecules covered: DNA, proteins, lipids, steroids, and polysaccharides). The exam will be given in class on **Tuesday, Sept. 20.**

Assignments
Assignments will be a combination of in-class and take-home work. For the take-home work any notes, handouts, papers, electronic sources and reference textbooks may be used. It is important that you cite all sources you used in order to complete the assignment. There will be both individual and team assignments. Team assignments will relate to the team project. You are highly encouraged to communicate with everyone on to your team, but each student is responsible for turning in his or her own write up (or electronic version) of each assignment unless otherwise stated by the instructor. Simply copying or allowing somebody else to copy your work is plagiarism and will be dealt with as such. Assignments related to the team project should be submitted in an editable format such as Microsoft word .docx file. **All Assignments will be submitted in via Blackboard.**

Re-grade Policy
Students have the right to contest any grade throughout the semester. Once an assignment has been graded and returned, students have **1 week** to protest a grade; after this time grade disputes will not be accepted. In the event that a student feels an assignment has been inappropriately graded, the student must submit a one page, typed document indicating the source of the problem and an explanation for the re-grade submission. The original assignment must be returned with the protest explanation. Papers submitted for a re-grade will be completely reevaluated (i.e., the entire paper will be re-graded, not only the portion under protest), which means that students risk losing additional points for mistakes missed during the first grading process. Please note that all re-grade requests will be evaluated at the

end of the term and will only be considered for those students with a borderline grade (e.g., between an A and B).

Journal Article Discussions

Discussion of a journal articles will highlight application of particular biomolecular engineering techniques. When appropriate, the journal article will be distributed one week prior to discussion (typically Thursday). It is expected that the students will have read the article and participate in in-class discussion of the article. It is highly encouraged to ask questions about the article itself or the research topic and application being discussed.

Class Attendance and Participation

You are expected to be in class and participate during lecture, journal article review, in-class problem solving, participate in the team project and student presentations. Attendance and class participation constitute 10% of the total grade for the course.

Purdue attendance policy:

Students are expected to be present for every meeting of the classes in which they are enrolled. Only the instructor can excuse a student from a course requirement or responsibility. When conflicts or absences can be anticipated, such as for many University sponsored activities and religious observations, the student should inform the instructor of the situation as far in advance as possible...For unanticipated or emergency absences when advance notification to an instructor is not possible, the student should contact the instructor as soon as possible by email, or by contacting the main office that offers the course. When the student is unable to make direct contact with the instructor and is unable to leave word with the instructor's department because of circumstances beyond the student's control, and in cases of bereavement, the student or the student's representative should contact the Office of the Dean of Students.

The link to the complete policy and implications can be found at:
http://www.purdue.edu/studentregulations/regulations_procedures/classes.html

Project Proposal

You will be assigned to work with a team to develop a proposal for a novel research project. A CATME survey will be used to assign teams. Each team will be responsible for choosing a topic, researching the field, proposing a novel research question, and developing a set of experiments to address this research question. The research question may seek to, for example, answer outstanding question(s) in the field, develop a new method, develop a novel function, design and test a new material, and/or generally advance the filed in some way. It is encouraged that each team meet with the instructor at least once when developing the topic for the proposal, and once again when developing the methods to answer the research question. **The final project is to submit electronically as a written proposal no later than 11:59pm Friday, Dec 2.** Each team will present a summary of their project proposal during the last week of class, Dec 6th and Dec 8th. More detailed instructions for this requirement will be distributed later in the semester. Plan to be in class during this week unless you have a very serious medical problem or life emergency (email the instructor right away if something like that comes up at any point during the course).

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Tentative Schedule* (*subject to change)

Introduction to biomolecules

Week 1

Tues. Aug 23	In class survey, nucleotides, nucleic acids,
Thurs. Aug 25	DNA and RNA detection and quantitation, molecular biology primer

Week 2

Tues. Aug 30	Amino acids and peptides - **Homework 1 due**
Thurs. Sep 1	Protein chemistry, synthesis and manipulation

Week 3

Tues. Sep 6	Protein co- and post translational modifications
Thurs. Sep 8	Protein detection and quantitative measurement- **Hwk 2 due**

Week 4

Tues. Sep 13	Membrane lipids
Thurs. Sep 15	Polysaccharides, proteoglycans, glycoproteins. Exam material review– **Hwk 3 due**

Week 5

Tues. Sep 20	**Exam 1**
Thurs. Sep 22	Exam Review, Team project description

Applications of biomolecules and biomolecular engineering

Week 6

Tues. Sep 27	Software tools for biomolecular engineering (computer lab)
Thurs. Sep 29	Biomolecular conjugation.

Week 7

Tues. Oct 4	Click chemistry for biomolecular engineering
Thurs. Oct 6	**Class Canceled – BMES National Meeting**

Week 8

Tues. Oct 11	**No class – Fall Break**
Thurs. Oct 13	Biomolecular eng for pharmaceuticals and drug discovery. **Hwk 4 Due**

Week 9

Tues. Oct 18	Non-natural amino acid and fatty acids I
Thurs. Oct 20	Non-natural amino acid and fatty acids II- Journal article discussion

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Week 10	
Tues. Oct 25	Molecular motors I
Thurs. Oct 27	Molecular motors II. Journal article discussion
Week 11	
Tues. Nov 1	Biopolymers I
Thurs. Nov 3	Biopolymers II. Journal article discussion
Week 12	
Tues. Nov 8	DNA, RNA as self-assembled, self-healing material
Thurs. Nov 10	DNA, RNA as self-assembled, self-healing material. Journal article discussion
Week 13	
Tues. Nov 15	Guest Lecture – Non-natural nucleic acids, Elizabeth Phillips
Thurs. Nov 17	Guest Lecture - TBD
Week 14	
Tues. Nov 22	Biosensors
Thurs. Nov 24	**No Class - Thanksgiving**
Week 15	
Tues. Nov 29	Biosensors II
Thurs. Dec 1	Biomolecular engineering for diagnostic devices. Journal article discussion
Fri Dec 2	**Final written proposal due 11:59pm**
Week 16	**Undergraduate project presentations**
Tues. Dec 6	In-class presentations
Thurs. Dec 8	In-class presentations
	Exam Week Dec 12-17 - No Class

Disclaimer

This syllabus is subject to change.