**Course title: BMEG 480 Cellular Machinery**

 

**Course number:** BMEG480 (CRN 15089)

**Class location :** ESB-E251

**Class time:** 11:00 am - 12:15 pm on TR

**Credit hours:** 3 h

**Prerequisites:** Junior Standing and BIOL 115 or Consent

**Office hours:** 9:45-10:35 a.m. on TR

**Instructor**: Prof. Cerasela Zoica Dinu

Department of Chemical and Biomedical Engineering

Statler College of Engineering and Mineral Resources

**Office location:** ESB 525

**Office phone #:** 304-293-9338

**E-mail address:** zcdinu@mix.wvu.edu

**Course description:**

By teaching the fundamentals of cell structure, organization and function and how the interactions within the cells, whether physical or functional, are instrumental in understanding the cellular machineries, this multidisciplinary course provides an overview of the “cell like a chemical factory”. The course also reveals practical examples of how cellular components can be manipulated in synthetic environment for applications in biology, medicine, bioengineering and biotechnology.

This is an eligible elective course for those pursuing the Biomedical Engineering minor.

**Student learning outcomes**:

Upon successful completion of this course, **Students will be able to**:

1. Identify and demonstrate the characteristics and main elements of the metaphor: “The cell is a chemical factory” by outlining historical and structural, etc., aspects of the cell
2. Analyze, apply and evaluate the relationship between cellular structure and function both *in vivo* and *in vitro* using engineering-based technologies
3. Apply and evaluate what engineering principles can tells us about the cell structure and how a cell’ functions
4. Evaluate the framework for measuring and controlling cells activities and functionalities for synthetic applications
5. Justify the ability of cellular machineries to perform *in vitro*
6. Apply knowledge of cellular functions to create the next generation of bio-related synthetic applications
7. Identify, interpret, create and revise what biological and engineering principles can be used to build a bio-related hybrid
8. Students will increase their proficiency in the written and oral communication while working in teams.

**Note:** This below is a mapping on how the listed outcomes fulfill ABET requirements. This was not shared with the students.

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| **No** | **Course Learning Outcomes** | **Student Outcomes** |
| 1 | Identify and demonstrate the characteristics and main elements of the metaphor: “The cell is a chemical factory” by outlining historical and structural, etc., aspects of the cell | ***1, 7*** |
| 2 | Analyze, apply and evaluate the relationship between cellular structure and function both *in vivo* and *in vitro* using engineering-based technologies | ***1, 7*** |
| 3 | Apply and evaluate what engineering principles can tells us about the cell structure and how a cell’ functions | ***1*** |
| 4 | Evaluate the framework for measuring and controlling cells activities and functionalities for synthetic applications  | ***7*** |
| 5 | Justify the ability of cellular machineries to perform *in vitro*  | ***1*** |
| 6 | Apply knowledge of cellular functions to create the next generation of bio-related synthetic applications | ***2, 7*** |
| 7 | Identify, interpret, create and revise what biological and engineering principles can be used to build a bio-related hybrid | ***2, 7*** |
| 8 | Students will increase their proficiency in the written and oral communication while working in teams | ***3, 5*** |

**Reference texts:**

  

1. “Mechanics of Motor Proteins and the Cytoskeleton”, (Howard)
2. “An Introduction to Molecular Biotechnology” (Wink)
3. “Biosensors for health, environment and biosecurity” (InTech)
4. “Biocatalysts and enzyme technology” (Wiley)

Related textbooks should be available at the Evansdale Library. Students are encouraged to read outside the assigned class reading; suggested topics will be presented with the class material. Throughout evaluation of the available literature will help with understanding and integrating the material. If you do not read outside the assigned class readings, your grasp of the material will be average.

**Course assessment/measures:**

**Homework** will be assigned and it is due at the beginning of the following class; the homework will be discussed in the class after the due date.

**Tests** will cover the material presented in the class and the homework. No collaboration is allowed during any of the tests.

**Design Projects/Presentations:**

In this class you will learn that living cells have unique complex structures and functions; they also are in continuous changes of their states.

Biomedical engineers can harness the characteristics of living cells or their cellular components to build the next generation of technological tools or hybrid biosystems and biodevices to thus help identify cellular-based features and/or tackle human-related problems with applications in medicine, energy, or environment, etc.

To demonstrate the practicality of these statements and how a biomedical engineer could get involved to fulfill them, there are two design projects introduced in this class, i.e. a theoretical and a hands-on one, respectively.

1. The theoretical project will identify the characteristics of an instrument that could help evaluate cell structure and/or function. Specifically, the students (groups of 2-4) will be tasked to propose and design a live cell imaging system. They will need to identify the characteristics of such a physical tool as well as what type of measurements would be able to perform. Pertinent instructions will be given in the class.
2. The hands-on project will use the emerging cellular and engineering design principles and view cells or cellular components as machines able to perform an extra-cellular engineered function. Specifically, considering that cells are chemical factories and that cellular components are working together to maintain cell function and structure as well as considering that “chain” reactions that happen in the cell are responsible for maintaining individual integrity of the cellular machines, groups of students (4-6) will be tasked to build a “prototype of a bio-based (cell or cellular components) hybrid” using every day materials. Each group will need to consider the following:
* Choose one cellular function that the biohybrid will measure: i.e., changes in cell potential, changes in cell pH, changes in cell morphology, changes in cell mechanics etc.
* Identify the “responsible players” for the changes in that function
* Propose ways to measure or mitigate adverse effects based on the designed biohybrid-based prototype.

Pertinent instructions will be given in the class.

Each design project will be presented to both the instructor and cohort. Paper will be due for the projects; the paper will need to provide the justification for the prototype, the intellectual and broader impact of the proposed design and the specific objectives and methods that will be used to produce such a prototype.

Specific details on the design projects and the papers due will be given in advance to ensure that both students have a full understanding of what is expected of them as well as they have the access to the means to fulfill such expectations.

**Grading criteria:**

The nominal grading scale is ≥90% A

 ≥80% B

 ≥70% C

 ≥60% D

 <60% F

The final grade for the course will be determined as follows:

 Two Tests @ 12.5% 25%

 Homework 5%

 Theoretical project paper 10%

 Theoretical project presentation 10%

 Group project paper 25%

 Presentation\* 25%

 **Total 100%**

\*You must be in the audience for all of the projects/presentations. Failure to do so will result in reduction by one full letter on your project/presentation grade.

**General about course grading:**

If you believe that an error was made in grading, you should see me during the office hours. Write a short justification of your claim and attach it to the original graded in question. Place the justification and the graded exam in my mailbox. Your concern will be reviewed and I will respond to you directly during the office hours. Note that for the exam, the entire exam will be re-graded not only the point in question.

**Other course policies:**

* The course lectures will introduce each topic. Material presented in the lecture is unique and will be included in testing.
* A portion of the in-class lecture time will be devoted to open courseware and may include visuals, class activities, and assignments in groups related to the topic that is being presented. Note that for students miss any classes, related class materials will not be available online.
* Office hours are meant to correct fundamental conceptual problems and to not act as a problem solving session.
* There are no make-up exams and a late assignment means no assignment.
* Any classes canceled due to inclement weather (or for any other reason, such as fire alarms) will be rescheduled. If the fire alarm goes off during an exam, the resolution of the situation is solely at the discretion of the instructor.
* Your cellular phone should be turned off during class. If your cellular phone rings during class, if you are observed texting during class, or if you are observed using the internet during class, your final grade will be reduced by one percentage point, and you will be asked to leave the class and not return on that day. You will still be responsible for all material covered in class. If you are observed texting or using the internet during an exam, you will automatically receive a zero for that exam.
* Project/presentation assignments that are obviously copied will receive no credit. Credit will be deducted for sloppy work that is hard to follow.

**Disability:**

If you believe that you have a disability that may affect your performance in this course, it is your responsibility to contact the WVU Office of Disability Services at (304) 293-6700. Written documentation from Disability Services must be provided to me in-person before any accommodations can be granted. If you are authorized for and wish to receive accommodations for an exam, you must notify me at least one week in advance. If you do not arrange accommodations in advance, they will not be given. Any rescheduled exams must be taken during the same calendar week (Monday-Friday) as the original date.

**Social justice:**

West Virginia University is committed to social justice and fostering a nurturing learning environment based upon open communication, mutual respect, and non-discrimination. Our University does not discriminate on the basis of race, sex, age, disability, veteran status, religion, sexual orientation, color or national origin. Any suggestions as to how to further such a positive and open environment in this class will be appreciated and given serious consideration.

**Academic integrity:**

Student-teacher relationships are built on trust. For example, students must trust that teachers have made appropriate decisions about the structure and content of the courses they teach, and teachers must trust that the assignments that students turn in are their own. Acts that violate this trust undermine the educational process. The integrity of the classes offered by West Virginia University solidifies the foundation of its mission and cannot be sacrificed to expediency, ignorance, or blatant fraud. Therefore, I enforce rigorous standards of academic integrity in all aspects and assignments of this course. For the detailed policy of West Virginia University regarding the definitions of acts considered to fall under academic dishonesty and possible ensuing sanctions, please see the Student Conduct Code <http://studentlife.wvu.edu/office_of_student_conduct/student_conduct_code> . Should you have any questions about possibly improper research citations or references, or any other activity that may be interpreted as an attempt at academic dishonesty, please see me *before* the assignment is due to discuss the matter. The WVU Handbook of Student Rights and Responsibilities define various forms of Academic Dishonesty and you should make yourself familiar with these. It is possible that you will work with other class members to complete your assignments. All submitted work must be your original work and must be clearly indicate with whom you have collaborated. If you have any question concerning this policy before submitting an assignment, please ask for clarification. All matters of academic integrity are to be brought to my attention immediately. Value for honesty, integrity, self-discipline, respect, responsibility, punctuality, dependability, courtesy, cooperation, consideration, and teamwork would be emphasized as an integral part of this class learning. A grade of zero will be given on the first assignment where a violation is detected. All cases of academic misconduct will be submitted to the Office of Student Conduct; if you are found guilty of academic misconduct you will be on academic integrity probation for the reminder of the years at WVU and may be required to report your violations on future professional school applications.

**Examples of cheating:**

* It is cheating to give another student access to your directory and your account for copying any of the homework assignments. Your campus account is for your use alone.
* You will be assigned topics during week 7 of this class. It is cheating for you and another student to work on the same presentation (on the same topic) and for both of you to submit it as your own work.

**Tentative Course Calendar**

This is a tentative schedule and subject to change depending upon the progress of the class.

Color coding:

* Red: highly influencing your grading
* Blue: out of class experience

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| **Class no.** | **Tentative Class Name** |
| 01/8 | Introduction/ Class syllabusEvolution and constant change/The history of cell theory |
| 01/10 | Cell like a chemical factory: why name it so?Universal features of cellsCell chemistry/ biosynthesis/ cellular driven chemical processesAFM principles |
| **01/15** | **Visualization and manipulation of cells and cellular components in synthetic environment (AFM demo)** |
| 01/17 | Visualization and manipulation of cells in synthetic environment (we need light!) |
| 01/22 | Visualization and manipulation of cells in synthetic environment (Optical and Confocal Microscopy) |
| 01/24 | Visualization and manipulation of cells in synthetic environment (Optical and Confocal Microscopy) |
| 01/29 | Visualization and manipulation of cells in synthetic environment (Electron microscopy: TEM, and general on SEM) |
| 01/31 | Homework 1: groups of 3 (design a theoretical live cell imaging system/ details)Working in groups and establishing the bases |
| **02/05** | **Visualization and manipulation of cells and cellular components in synthetic environment- (SEM demo)** |
| **02/07** | **Visualization and manipulation of cells and cellular components in synthetic environment- (SEM demo)** |
| **02/12** | **Design presentations** |
| **02/14** | **Design presentations** |
| **02/19** | **Design presentations** |
| 02/21 | Cell as individual biosensors (I) |
| 02/26 | Cell as individual biosensors (II)Homework 2 |
| 02/28 | Homework 2: DiscussionLab on a chip- cell manipulation and applications |
| 02/20 | Synthetic biology in mammalian cells: next generation research tools and therapeuticsNanocellbiology  |
| 02/22 | Purification and its engineering  |
| 02/27 | Cellular compartments manipulation in synthetic environmentHomework 3 |
| **03/05** | **Homework 3: Discussion****TEST 1** |
| 03/07 | Main players in cellular processes (proteins and enzymes) |
| 03/19 | Cytoskeleton, i.e., proteins; molecular recognition |
| 03/21 | Molecular motors/ Steps and forces/ Biomachines  |
| 03/26 | Cytoskeleton and roles for therapiesHomework 4 |
| 03/28 | Homework 4: DiscussionEnzyme, catalysis and the use of energy by cellular machines |
| 04/02 | Catalysts in synthetic environment/ Rational design  |
| 04/04 | Biosensors, diagnostic devices |
| **04/09** | **TEST 2** |
| 04/11 | Test discussionHands-on project discussion/ Example/ Strategies/ Work in teams |
| **04/16** | **Design project** |
| **04/18** | **Design project** |
| **04/23** | **Design project** |
| 04/25 | Last class |