

**CHM 6580**  
Special Topics in Physical Chemistry: Protein-Polymer Bioconjugates  
Spring 2021

**Lecture Times:** M | W Period 4 (10:40 AM - 11:30 AM)

**Classroom/Zoom.** This class will be conducted completely via synchronous online instruction via Zoom. ZOOM link is provided in canvas.

**Instructor:** Prof. Coray Colina  
Office Hours: TBD, [colina@chem.ufl.edu](mailto:colina@chem.ufl.edu), via ZOOM

**Prerequisites:** Organic Chemistry or Biochemistry, **and** Physical Chemistry or Thermodynamics.

**Textbooks (recommended):**

Proteins: Any textbook for introduction to biochemistry.

Polymers: Any textbook for Introduction to polymer science.

Bioconjugates: Any textbook for introduction to bioconjugates.

**Course Description:**

Solving the most urgent problems of a rapidly-changing world demands researchers who can adapt to new challenges. Nanoparticle-based drug delivery systems have been demonstrated as having high carrier capacity, good stability, and feasibility of variable routes of administration. Recent advances in this area have expanded into studying protein-polymer hybrids in systems where polymers are either covalently or non-covalently attached. In particular, nanoparticles incorporating protein-polymer conjugates have been adopted as drug delivery systems for several type of medications. For example, opioid peptide with polyethylene glycol (PEG) has been explored for the buccal mucosa, increased brain delivery, and to increase therapeutic index and improve selectivity. Moreover, several of the latest COVID-19 vaccines also include PEG, a FDA approved synthetic polymer.

Protein-polymer conjugates have advanced beyond PEGylated systems, including zwitterionic, anionic and cationic polymers. Understanding protein-polymer interactions, dynamic changes over time, and subtle polymer-induced changes to the bioconjugates' structure is central to the main goal of this course.

**Course Objective:**

In this course we will survey the advances on PEGylated systems and discuss the most promising directions to protein-polymer conjugates beyond PEGylation. Additionally, recent literature will be discussed as well as recent perspectives and grand challenges in the focus areas (*i.e.* the rational design of next generation protein-polymer conjugates, the health and development grand challenges identified by the Bill and Melinda Gates Foundation, *etc.*)

Upon completion of this course, a successful student will be able to:

- Discuss the basic concepts of bioconjugation;

- Demonstrate understanding of synthetic bio-conjugation chemistry, mechanisms of bioconjugation, and structure-property relationships;
- Describe historic and modern techniques of macromolecular bioconjugation characterization
- Present and teach the basic thermodynamic and dynamic details of PEGylation ;
- Explain how emerging bioconjugation (zwitterionic, anionic, cationic) is relevant in living organisms and to the world at large.

**Course Website:** This course has a Canvas page for notes and announcements.

All students have access to the e-Learning website: <https://elearning.ufl.edu/> Login with your Gatorlink account username and password. Lecture outlines will be posted on e-Learning prior to class. *Check e-Learning often*; the posted lecture notes should be downloaded and/or printed before each class so that you can bring them with you. You will need them. The site will also be used for making announcements, recording grades, and listing recommended reading.

### **Outline of Course:**

The topics to be covered include:

#### **Introduction. (1.5 weeks)**

- A. Introduction to bioconjugates. (01/13)
- B. Therapeutic applications. Industrial applications. (01/15)
- C. Introduction to PEG-based bioconjugates. (01/20)

#### **Proteins (1 week)**

- C. (01/25) Amino acids. Peptides. Proteins.
- D. (01/27) Three-dimensional structure of proteins. Proteins dynamics.

#### **Synthetic Polymers (1 week)**

- E. Macromolecular synthesis. Polymers in solution. (02/01)
- F. Polymer conformations. Dispersity. Average end to end distance, radius of gyration. (02/03)

#### **PEGylation (2 weeks)**

- G. Introduction to PEG-based bioconjugates. (02/08)
- H. Protein-Polymer interactions. Effect of polymer chain length. (02/10)
- I. Bioconjugation site effect.
- J. Multi PEGylated architectures. (02/15)

#### **Bioconjugates- Beyond PEGylation (1.5 weeks)**

- J. (02/17) Positive and Negative charge polymer bioconjugates.
- K. (02/22) Zwitterionic polymer bioconjugates.
- L. (02/24)

#### **Case Studies (8 weeks, 1 week per case)**

##### **Examples:**

- Case 1.** PEGylated BSA (03/01- 03/03)
- Case 2.** PEGylated Lysozyme (03/08-03/10)
- Case 3.** Multi PEGylated BSA (03/15-03/17))

**Case 4.** Effects of Polymer Initiators for ATRP Bioconjugation (03/22-03/24)

**Case 5.** Anionic Bioconjugates (03/29-03/31)

**Case 6.** Cationic Bioconjugates (04/05-04/07)

**Case 7.** Zwitterionic Bioconjugates(04/12-04/14)

**Case 8.**  $\alpha$ -chymotrypsin Bioconjugates (04/19-04/21)

#### **Assessment Tools:**

1. Reading materials and in-class discussions that allow student collaboration and team-work.
2. One oral presentation on a selected topic from the outline provided above.

#### *Presentation requirements.*

For the sake of consistency across presentations, a few rules must be followed by all presenters.

- Presentations should be designed to last for 20-25 min, leaving roughly 15-20 min for questions and discussion.
- Slides must be made using the template and guidelines provided by the instructor via Canvas.
- Citations must be provided for all literature sources from which information is derived. These citations must be in ACS format (i.e., Journal Name YEAR, Volume, FirstPage-SecondPage).

#### **Attendance:**

Lecture attendance is essential for your success in this class. *Participation in our class is fundamental since in-class discussion is a key objective of the course. Thus, students are required to have their cameras on from start to finish during our classes on Zoom. A default setting for our sessions in Zoom is that participants will be muted when they enter, so you will unmute yourself when you comment orally during our whole-group conversations and when you are in small groups. Your instructor may also ask students to reply in the chat box for specific activities. Oral comments on camera and written comments in the chat box are considered activities for participation. If you have technical issues, please immediately consult UF IT Help to resolve them and then contact your instructor. **Zoom sessions will not be recorded by the instructor and may not be recorded by students.** As in all courses, unauthorized recording and unauthorized sharing of recorded material is prohibited.*

Attendance for lectures is mandatory. While discouraged, two lectures may be missed without penalty.

#### **Lecture Absence Policy:**

This course administers all conflicts with scheduled assessments and examinations in accord with University policy. As such, certain unavoidable absences by students from examinations are allowed, if properly documented and disclosed to Prof. Colina at least one week before the anticipated conflict. Such allowed absences include, but are not limited to, religious observances, sanctioned sporting events, military obligations, and court-imposed legal obligations. In such cases, provided documented notice was made to Prof. Colina one week in advance of the exam date, students will be given an excused absence. In this event, recorded lectures may be available. Unpredicted absences due to medical emergencies are not covered under the above absence policy. If the time and severity of the emergency is severe enough to make continuation in scholastic activity impossible for the rest of the term, a medical withdrawal is strongly advised. If the condition warranting the absence at a scheduled exam is unexpected and can be recovered from in

short order, the student must provide verifiable documentation of the medical emergency to Prof. Colina within a timely fashion of the scheduled assessment date.

**Grading Policy:**

- 1) In-class presentation (100 point)
  - 2) Attendance (50 points total)
  - 3) Participation (50 points total)
- Total = 200 possible points

Note: For reasons of privacy, grades will not be discussed by email. All grades will be posted on e-Learning. If you have questions about your grade, you should come to office hours to discuss your questions/concerns with me. Current UF grading policies for assigning grade points will be followed: <https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

Presentation grades will be determined based on the quality, depth, and timing of the oral presentation and lecture slides. Lecture slides will be assessed for their detail, clarity, organization, quality, and conformance to the template guidelines. The goal of each presentation is to teach the fundamentals of the topics being discussed. Presentations should primarily focus on fundamentals (history of development, mechanism, scope, thermodynamics, dynamics, utility) of the assigned topic. Presentations should not primarily be reviews of literature. Questions throughout the lectures are welcomed and expected. Participation grades will be determined by engagement, primarily as determined by a student's willingness to ask questions and engage in discussion.

*Cheating and Plagiarism.* Cheating and/or plagiarism will not be tolerated. All images and text derived from literature sources must be accompanied by the appropriate citation using the format outlined in the ACS Style Guide. Plagiarism consists of passing off as one's own the ideas, words, writings, etc. that belong to someone else. You are committing plagiarism if you copy the work of another person and turn it in as your own, even if you have that person's permission. You should also be aware that self-plagiarism won't be allowed. See: <https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>

All handouts used in this course will be distributed to the class and instructor.

**Students Requiring Accommodations:**

Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, [www.dso.ufl.edu/drc/](http://www.dso.ufl.edu/drc/)) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.

**Course Evaluation :**

Students are expected to provide feedback on the quality of instruction in this course by completing online evaluations at <https://gatorevals.ua.ufl.edu/>. [Click here for guidance on how to give feedback in a professional and respectful manner.](#) Evaluations are typically open during the last two or three weeks of the semester, but students will be given specific times when they are open.

Summary results of these assessments are available to students at <https://gatorevals.aa.ufl.edu/>.

**Honor Code:** UF students are bound by The Honor Pledge which states,

**“We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code.”**

On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: ***“On my honor, I have neither given nor received unauthorized aid in doing this assignment.”***

The Honor Code specifies a number of behaviors that are in violation of this code and the possible sanctions. [Click here to read the Honor Code](#). Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

**Class Demeanor:**

Students are expected to arrive to class on time and behave in a manner that is respectful to the instructor and to fellow students. Please avoid the use of cell phones and restrict eating to outside of the classroom. Opinions held by other students should be respected in discussion, and conversations that do not contribute to the discussion (even via chat) should be held at minimum, if at all.

**Zoom etiquette:**

We will follow the “Tips for Meeting Attendees” provided at <https://www.technology.pitt.edu/blog/zoom-tips>

**Cell Phones:** Please put all cell phones and other digital devices on “silent mode” during all class periods.

**Materials and Supplies Fees :**

There are no additional fees for this course.

**Counseling and Wellness Center:**

Contact information for the Counseling and Wellness Center: <http://www.counseling.ufl.edu/cwc/Default.aspx>, 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.