# CHEM:5115  Biophotonics
## Spring 2022

**Instructor:** Professor M. Lei Geng  
330 IATL, Department of Chemistry  
Phone: 335-3167  
Email: Lei-Geng@uiowa.edu

**Lectures:** 8:00-9:15 am TTh, C139 PC  
**Office Hours:** 9:30-11:00 am TTh, 330 IATL or by appointment

**References:** Gerd Keiser, *Biophotonics: Concepts to Applications*, Springer.  

**Course Description:** Biophotonics involves the use of light to probe, image and manipulate biological systems, including biomolecules, organelles, cells, tissues and organisms. It employs photonics, the technology of generating and harnessing light, to advance biomedicine. The course will discuss (1) fundamentals of light and its interaction with biological systems, (2) principles, techniques and applications of bioimaging, (3) sensing and probing of biological systems, and (4) manipulation of biological molecules and assemblies with photons. The course is designed for advanced undergraduate and graduate students in chemistry, biology, and engineering for preparation in the fields of biological spectroscopy, biosensing, bioimaging, and bionanotechnology. In addition to the textbooks, the course will heavily rely upon current literature in biophotonics.

### Topics of the Course

1. **Fundamentals of interaction of light with biological systems**  
   - Overview of biophotonics  
   - Fundamentals of biophotonics: optics, light sources, detectors and optical fibers  
   - Biomolecules, organelles, cells, tissue and organisms  
   - Interaction of light with biological systems (absorption, emission, and scattering)

2. **Bioimaging: principles, techniques and applications**  
   - Concepts and principles of microscopy  
   - Resolution and diffraction limit  
   - Optical imaging of organelles, cells, tissues and organisms  
   - Fluorescent labeling and fluorescence imaging  
   - Raman microscopy and nonlinear optical microscopy of cells  
   - Confocal microscopy of cells  
   - Super-resolution fluorescence microscopy beyond the diffraction limit  
   - Optical coherence tomography
3. Optical biosensors and diagnostics
   - Vibrational spectroscopy of biological systems
   - Electronic spectroscopy of biological systems
   - Optical biosensors
   - Drug delivery: diagnostics and therapy
   - Flow cytometry
   - Microarray technology for genomics and proteomics
   - Miniaturized analysis tools: lab-on-a-chip and lab-on-fiber technologies

4. Optical manipulation of biological systems
   - Light activated therapy: photodynamic therapy
   - Tissue engineering with light
   - Laser tweezers and laser scissors

Course Web Site:
Course materials will be available on the CHEM:5115 ICON site. Course syllabus, announcements, lecture notes, assignments and grades are posted on this site.

Grading: Problem Sets 30%; Presentation 25%; Exams 45%.

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Assignment</th>
<th>Points</th>
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<tbody>
<tr>
<td>4</td>
<td>Problem Sets</td>
<td>300</td>
</tr>
<tr>
<td>2</td>
<td>Exams</td>
<td>450</td>
</tr>
<tr>
<td>1</td>
<td>Literature Presentation</td>
<td>250</td>
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<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>1000</strong></td>
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Plus/minus grades will be assigned.

(1) Problem Sets, 300 points: Four problem sets (75 points each) will be assigned during the semester. Problem Sets 1 – 3 will be based on class materials and Problem Set 4 will be based on assigned research articles from the literature. Problem sets will be due a week after the initial assignment, and will be submitted on course ICON site.

(2) Exams, 450 points: There will be two exams in the course. The first exam (200 points) will be in class and based on lecture materials. As the exam date overlaps with PittCon schedule, the exam will be administered online through ICON. The exam will be 120 minutes long and will be available Mar. 10-21. The second exam (250 points) will be take-home and based on two assigned literature articles. In the exam, we will apply the principles learned in the course to understand the research articles, analyze data presented in the papers in detail with our own calculations, answer about 20 questions, and propose potential future directions in the research.

(3) Literature Presentation, 250 points: Each student will select a topic in biophotonics and give a twenty-minute presentation in class. The presentations are scheduled for the final week of the classes.
Administrative Information

DEO of the Chemistry Department:
Professor Len MacGillivray  
E331 CB, Department of Chemistry  
Phone: 335-0200

Accommodations for Disabilities:  
Please inform me if you have a disability which requires seating modifications, testing accommodations or accommodations of other class requirements, and we will make appropriate arrangements for you. Please contact me as soon as possible.

Policy on Plagiarism:  
All work performed in this course is expected to be your own. Plagiarism and any other activities when students present work that is not their own are academic fraud. Academic fraud is a serious matter and is reported to the departmental DEO and to the Associate Dean. Instructors and DEOs decide on appropriate consequences at the departmental level while the Associate Dean enforces additional consequences at the collegiate level. You will receive no credit if it is determined that the work you turn in is not your own. For College of Liberal Arts and Sciences policies, see the CLAS Code of Academic Honesty in the Academic Policies Handbook: http://clas.uiowa.edu/students/handbook/academic-fraud-honor-code.

COLLEGE OF LIBERAL ARTS AND SCIENCES (CLAS)  
Spring 2022

ATTENDANCE AND CLASSROOM EXPECTATIONS  
Students are responsible for attending class and for knowing an instructor’s attendance policies, which vary by course and content area. All students are expected to attend class and to contribute to its learning environment in part by complying with University policies and directives regarding appropriate classroom behavior or other matters.

ABSENCES  
Students are responsible for communicating with instructors as soon they know that an absence might occur or as soon as possible in the case of an illness. Delays in communication could result in a forfeit of what otherwise might be an excused absence.

ABSENCES: ILLNESS, UNAVOIDABLE CIRCUMSTANCES, AND UNIVERSITY SPONSORED ACTIVITIES  
Students who are ill, in an unavoidable circumstance affecting academic work, or who miss class because of a University sponsored activity are allowed by UI policy to make up a missed exam. Documentation is required by the instructor except in the case of a brief illness. Students are responsible for communicating with instructors as soon as the absence is known (https://opsmanual.uiowa.edu/students/absences-class#8.1).

ABSENCES: HOLY DAYS  
The University is prepared to make reasonable accommodations for students whose religious holy days coincide with their classroom assignments, test schedules, and classroom attendance expectations. Students must notify their instructors in writing of any such Religious Holy Day conflicts or absences within the first few days of the semester or session, and no later than the third week of the semester. If the conflict or absence will occur within the first three weeks of the semester, the student should notify the instructor as soon as possible. See Operations Manual 8.2 Absences for Religious Holy Days for additional information.
ABSENCES: MILITARY SERVICE OBLIGATIONS
Students absent from class due to U.S. veteran or U.S. military service obligations (including military
service-related medical appointments, military orders, and National Guard Service obligations) must be
excused without penalty. Instructors must make reasonable accommodations to allow students to
make-up exams or other work. Students must communicate with their instructors about the expected
possibility of missing class as soon as possible. (For more information, see
https://opsmanual.uiowa.edu/iv-8-absences-class%20-%200).

ACADEMIC MISCONDUCT
Plagiarism and the process for addressing academic misconduct of graduate students are defined in
Section IV, Article F “Plagiarism by Graduate Students” of the UI Graduate College Manual of Rules and
Regulations. Please contact the CLAS Associate Dean for Graduate Education for any necessary
assistance in navigating the process mandated by the Graduate College.

ACADEMIC ACCOMMODATIONS
The University is committed to providing an educational experience that is accessible to all students. If a
student has a diagnosed disability or other disabling condition that may impact the student’s ability to
complete the course requirements as stated in the syllabus, the student may seek accommodations
through Student Disability Services (SDS). SDS is responsible for making Letters of Accommodation (LOA)
available to the student. The student must provide a LOA to the instructor as early in the semester as
possible, but requests not made at least two weeks prior to the scheduled activity for which an
accommodation is sought may not be accommodated. The LOA will specify what reasonable course
accommodations the student is eligible for and those the instructor should provide. Additional
information can be found on the SDS website. Note that accommodations are not granted retroactively
but from the time of the student’s request to the instructor onward. Graduate students serving as
Teaching Assistants, Research Assistants, or Fellows must contact Faculty and Staff Disability Services
(https://hr.uiowa.edu/support/faculty-and-staff-disability-services) for assistance with
accommodations.

CLASS RECORDINGS: PRIVACY AND SHARING
Course lectures and discussions are sometimes recorded or live-streamed. These are only available to
students registered for the course and the intellectual property of the faculty member. These materials
may not be shared or reproduced without the explicit written consent of the instructors. Students may
not share these recordings with those who are not enrolled in the course; likewise, students may not
upload recordings to any other online environment. Doing so is a breach of the Code of Student Conduct
and could be a violation of the Federal Education Rights and Privacy Act (FERPA); also see

COMMUNICATION: UI EMAIL
Students are responsible for all official correspondences sent to their UI email address (uiowa.edu) and
must use this address for any communication with instructors or staff in the UI community (Operations
Manual, III.15.2). Emails should be respectful and brief, with complex matters addressed during the
instructor’s drop-in hours, for example. Faculty are not expected to answer email after business hours or
during the weekends.

FREE SPEECH AND EXPRESSION
The University of Iowa supports and upholds the First Amendment protection of freedom of speech and
the principles of academic and artistic freedom. We are committed to open inquiry, vigorous debate,
and creative expression inside and outside of the classroom. Visit Free Speech at Iowa for more
information on the University’s policies on free speech and academic freedom:
https://freespeech.uiowa.edu/.
COMPLAINTS ABOUT ACADEMIC MATTERS
Students with a complaint about a grade or a related academic matter should first visit with the instructor and then with the course supervisor (if applicable), and finally with the director of the school, department, or program offering the course. If a graduate student has not been able to resolve the issue through the director of the school, department, or program, they should contact the associate dean for graduate education in the College of Liberal Arts and Sciences.

FINAL EXAMINATION POLICIES
The final exam schedule is published during the fifth week of the fall and spring semesters or on the first day of summer classes; students are responsible for knowing the date, time, and place of their final exams. Students should not make travel plans until knowing this information. A student with exams scheduled on the same day and time or who have more than two final exams on the same day should visit this page for how to resolve these problems by the given deadline (https://registrar.uiowa.edu/makeup-final-examination-policies). No exams are allowed the week before finals, but with some exceptions made for labs, language courses, and off-cycle courses (https://registrar.uiowa.edu/final-examination-scheduling-policies).

HOME OF THE COURSE
The College of Liberal Arts and Sciences (CLAS) is the home of this course, and CLAS governs the policies and procedures for its courses. Graduate students, however, must adhere to the academic deadlines set by the Graduate College. See https://grad.uiowa.edu/academics/deadlines.

MENTAL HEALTH
Students are encouraged to be mindful of their mental health and seek help as a preventive measure or if feeling overwhelmed and/or struggling to meet course expectations. Students are encouraged to talk to their instructor for assistance with specific class-related concerns. For additional support and counseling, students are encouraged to contact University Counseling Service (UCS). Information about UCS, including resources and how to schedule an appointment, can be found at counseling.uiowa.edu. Find out more about UI mental health services at: mentalhealth.uiowa.edu. Student Health can also address related concerns (https://studenthealth.uiowa.edu/). These visits are free to students. After hours, students are encouraged to call the Johnson County Community Crisis Line at (319) 351-0140 or dial 911 in an emergency.

NON-DISCRIMINATION STATEMENT
The University of Iowa prohibits discrimination in employment, educational programs, and activities on the basis of race, creed, color, religion, national origin, age, sex, pregnancy, disability, genetic information, status as a U.S. veteran, service in the U.S. military, sexual orientation, gender identity, associational preferences, or any other classification that deprives the person of consideration as an individual. The university also affirms its commitment to providing equal opportunities and equal access to university facilities. For additional information on nondiscrimination policies, contact the Director, Office of Institutional Equity, the University of Iowa, 202 Jessup Hall, Iowa City, IA 52242-1316, 319-335-0705, oie-ui@uiowa.edu. Students may share their pronouns and chosen/preferred names in MyUI, which is accessible to instructors and advisors.

SEXUAL HARASSMENT
The University of Iowa prohibits all forms of sexual harassment, sexual misconduct, and related retaliation. The Policy on Sexual Harassment and Sexual Misconduct governs actions by students, faculty, staff and visitors. Incidents of sexual harassment or sexual misconduct can be reported to the Title IX and Gender Equity Office or to the Department of Public Safety. Students impacted by sexual harassment or sexual misconduct may be eligible for academic supportive measures and can learn more by contacting the Title IX and Gender Equity Office. Information about confidential resources can be found here. Watch the video for an explanation of these resources.