

CHEM 410: Bioanalytical Chemistry

Trinity College

Spring 2023

Class Meetings

T 1:30-4:10 pm
McCook 305

Instructor

Prof. Michelle Kovarik
860-297-5275
michelle.kovarik@trincoll.edu

Office Hours

Tuesdays 11 am-12 noon
Thursdays 4-5 pm
and by appointment

Inside this syllabus

Tips for Success	2
Resources.....	2
Important Dates	3
Grading	3
Course Policies	3-4
FAQs.....	4-5
Schedule.....	6

Course Objectives

This seminar course is focused on the challenges and opportunities of chemical measurements in living systems and is taught from the primary literature.

After completing this course, you should be able to:

- describe how reactions in living cells differ from those that occur *in vitro* and the resulting challenges to chemical analyses of living systems
- propose solutions for making measurements of biological samples, including in living tissues
- compare the chemical and physical characteristics of engineered systems that recapitulate organs or organisms
- describe techniques to measure chemical interactions between organisms and their environments
- reliably obtain and communicate information from the primary literature

Course Format

During class we will alternate between lectures, discussions, workshop periods, and student presentations. You should do the pre-class reading and assignments in order to participate and make the most of your time in class. Sometimes I may call on you randomly to answer a question instead of asking for volunteers. I want to make sure everyone is contributing their ideas, but I know that “cold calls” can be stressful. You will also make multiple presentations to your classmates. Our goal is to create a classroom environment where it’s OK to get something wrong or not know an answer. If you are anxious about these parts of class, please let me know so we can discuss strategies for your participation.

For homework you will read the literature and prepare presentations. Many students find reading scientific articles to be a challenge at first. It is normal and expected that you will not completely understand the papers you read, especially on the first pass. I recommend starting by reading the abstract and looking at the figures before returning to the introduction. Keep track of unfamiliar words, and look them up if you cannot discern their meaning from context. Although Wikipedia is not a suitable final source for formal work, it is an excellent place to find a quick tutorial on a new concept. Feel free to email me with questions if you find you are truly lost, but be sure to give me plenty of time (at least 24 hours, preferably 48 hours) to respond.

Tips for Success

You should plan to spend 6-12 h per week outside of class time in order to be successful.

Before class read the article(s) that introduce the next topic and complete any accompanying worksheets. Keep notes of questions you would like to ask about the readings and unfamiliar terms that you have looked up.

During class participate often and ask questions. If there is something you do not understand, it is very likely that others do not understand it either!

After class review your notes and reflect on how the new material fits together with our previous discussions. Make notes of anything you found particularly interesting that may make a good topic for your final presentation.

Before presentations start by reading your article carefully and making notes. Do not start by opening Powerpoint. Use the handout on effective presentation preparation. Practice your talk at least once to make sure you know what you want to say and can finish in the allotted time. Consider preparing extra slides to address likely questions. If desired, you may pre-record your presentation.

During presentations speak clearly and slowly. Try to make eye contact with your audience. Hold the laser pointer with two hands, or brace the laser against your body to avoid shaking. Do not read directly from your slides, but do refer to them and explain everything that you display. If possible, introduce the next slide before clicking through to it. (In studies, this has been shown to give the audience the impression that the speaker is more intelligent!) Pause for questions if people look confused.

After presentations reflect on what went well and what could be improved. Make note of these things for your next talk. If you were asked a question that you could not answer, spend a little time researching and offer to share what you learned at the start of the next class meeting.

Moodle & Email

Moodle and e-mail will be used extensively. Students are expected to consult the course Moodle site frequently for assignments, announcements, course materials and external links.

Resources

Accessibility Requests

Please let me know if there are circumstances that might affect your participation in class. If you need accommodations, talk with me as soon as possible and contact Joel Copperthite in the Student Accessibility Resource Center at 860-297-4025 or sarc@trincoll.edu.

Required Readings

We will not use a textbook. Instead, readings will come from the scientific literature. Links are available on Moodle. You should bring a hard copy to class, and we will discuss options for printing.

Article Searching Tools

I recommend using SciFinder Scholar, Web of Science, and Google Scholar when looking for articles. Each has its own strengths, and they often produce different results for the same search terms. Links are on Moodle.

ACS Style Guide

All references must be in ACS style. You can review the relevant chapter of the *ACS Style Guide* using the [link](#) on Moodle, the Trinity library website, or the hard copies in the main library and the Chemistry library.

Emergency & Equity Fund

Financial support to help ensure the academic success of all students. More information and an application is available at <https://www.trincoll.edu/dean-of-students/campus-life-resources/student-emergency-fund/>

Course Policies

Late Work, Extensions, and Make-up Presentations

Article worksheets are due at the start of class. Late assignments will be accepted with a penalty of -10% per day, and late presentations must be recorded so that they can be watched outside class time. (You will also be required to provide written answers to any follow-up questions.) Extensions will only be granted for presentations. All requests for extensions must be received by email at least 24 hours before the original deadline and be accompanied by evidence that you have started the assignment (e.g., an outline or part of a Powerpoint presentation beyond what you finished during the in-class workshop). Presentation sign-ups and outlines count toward your participation grade and should be completed by the start of class on workshop days. Articles for presentations are “first come, first served” so sign up as soon as you choose an article.

Sometimes unexpected (and often unwelcome) events intrude on our plans – mental and physical illness, family needs, etc. may affect your class performance this semester. To the extent that you are comfortable sharing this information with me, I would like to know as soon as possible. If you miss a presentation due to illness, injury, or a family emergency, you should provide some confirmation of the event directly to me or to the Dean of Students office. If needed, presentations may be made remotely via Zoom or recorded in advance or after the fact. If you will miss class for a scheduled, College-sanctioned event (e.g., religious observance, athletics), you should discuss your absence with me in advance (preferably at least 3 days prior).

How do you earn your grade?

Article Worksheets (8)	40%
Participation	10%
Presentations (5)	50%

We will discuss 8 articles as a class. Each article has an accompanying worksheet due at the start of our class discussion.

Class will take a number of formats, including lectures, article discussions, workshops, and presentations. You are expected to participate during all formats by asking questions, contributing to discussions, working actively on your presentation, and being attentive to your peers' presentations. A rubric for the participation grade is on Moodle, and you will receive written feedback at midterm.

You will make 5 presentations of about 10 minutes each (plus questions) on articles of your choosing. More information about these assignments is on Moodle.

Important Dates

Drop/Add Deadline	2/1
Presentation 1.....	2/21
Withdraw Deadline.....	3/14
Presentation 2.....	3/14
Presentation 3.....	4/11
Presentation 4.....	5/2
Presentation 5.....	TBD

A complete schedule is at the end of the syllabus.

Academic Integrity

Each student should be familiar with the Trinity College Student Integrity Contract and the section on Intellectual Honesty in the Student Handbook.

References: Any ideas in your writing assignments that (i) did not spring from your own mind and (ii) are not common knowledge to high school science students should be cited at the end of each assignment. Direct quotes are usually unacceptable: rewrite all ideas in your own words *and* cite them. **Note that this policy applies to your article worksheets.** If you have a question about whether or not your rewording is acceptable, ask before turning in the assignment. Use the *ACS Style Guide* to format your references. Plagiarism and academic dishonesty – copying from another student, copying from another source including the internet, failing to cite a reference, etc. – will be addressed as needed through the College's jury system.

Homework: I encourage you to discuss homework with your classmates. Your peers should be a primary resource if you are uncertain about how to proceed (although I am happy to help, too). **You should acknowledge which classmates worked with you on an assignment by listing their names on the first page.** Additionally, I expect each of you to do your own work. Discussing homework with your classmates is acceptable; copying your classmate's answers or work is not. If I find evidence of copying or allowing work to be copied, we will go through the College's academic honesty proceedings. If you have any questions about whether or not your collaboration with a classmate complies with my expectations, please talk to me about it *before* turning in an assignment.

On the first day of class, I will ask you to sign the Student Integrity Statement to affirm your commitment to academic integrity. You may choose not to sign; however, whether you sign or not, you are expected to behave in accordance with the statement:

"In accordance with Article II of the Trinity College Student Integrity Contract, I hereby pledge that the papers, exams, and other academic exercises I submit for this course will represent my own work; that I will properly acknowledge and attribute any and all information and ideas that I have used from other sources; and that no collaboration unauthorized by the instructor of the course will occur in the course of its completion."

I also expect you to conduct yourselves with integrity as persons. There are persistent, pervasive, and pernicious issues in academic science concerning discrimination based on race, sex/gender, sexual orientation, disabilities, religion, body type, etc. Such violations take many forms from overt harassment to seemingly smaller transgressions (unwanted comments, bullying, patronizing). While some issues may seem less serious, their cumulative effect on the recipient's career and well-being can be just as detrimental as more obvious offenses. Treating others with dignity is as integral to the proper conduct of science as keeping a good lab notebook. Discrimination and harassment persist because our scientific culture has not historically valued diverse perspectives, backgrounds, and contributions. I invite you to help me foster a community of mutual respect by reflecting on your own biases and supporting your peers to do the same. This means speaking out when you observe abuse and apologizing when your peers point out negative impacts of your behavior. I will model this openness to feedback if you notice behavior of mine that has a negative impact and bring it to my attention. Together, we can foster a climate free from bullying, harassment, and discrimination where we all can thrive and learn.

Frequently Asked Questions (FAQs)

What should I do if I have to miss class?

Class attendance is critical to your success in the course, so please be on time and do not miss class if at all possible. If you will be absent, please do the following:

- (1) Notify me as soon as possible, preferably before class and by email.
- (2) Email me any assignments that are due, drop them in CT208, or send them to class with a friend.
- (3) Contact a classmate to get the notes and schedule an appointment with me to address any questions you have about missed material.

What should I do if I cannot access a copy of an article I want to read?

The library maintains a [chemistry research](#) guide with links to useful databases of chemistry articles. For many articles from these databases and publishers, you will be able to access the full-text directly as long as you are on the Trinity network. For example, Trinity holds an electronic subscription to all

American Chemical Society journals. If you are interested in a specific paper, you can check whether or not Trinity subscribes to the journal where it was published using [OneSearch](#) or through the search box on the [library homepage](#). For some journals, Trinity uses token access, which means that the College pays a fee to access individual articles. You should feel free to use tokens to access articles when that is an option. Token access lasts only 48 hours so remember to save a copy of any article you access via token for future reference. You should not ever pay for an article yourself. Instead, if the article is not available through a Trinity subscription, there are several options:

- 1) Many relevant articles for this class will be posted as “author copies” in the [PubMed Central](#) database. This is a repository used to make NIH-funded research freely available to the public.
- 2) You may be able to find an author copy online by searching on Google using the search phrase filetype:pdf followed by the article title in quotation marks. Similarly, some authors will share their work publicly or privately via sites like [ResearchGate](#).
- 3) You can request a copy of the article using [Interlibrary Loan](#) using the direct link or the red icon on the [library homepage](#). The library staff are very responsive to these requests, but you should still plan to wait several hours and up two days to receive a copy of the article.

If you want some one-on-one assistance with searching the literature and accessing full texts, consider [scheduling an appointment](#) with one of the College’s research librarians.

How can I tell what my current grade is?

Your current overall grade and your grades for individual assignments will always be available in the grade book on Moodle. You will receive written feedback on your class discussion participation at midterm. If you have questions or would like to discuss the class at any time, please attend office hours or make an appointment.

Can I do extra credit?

There will be no extra credit in this class. Please don’t ask! My philosophy is that you should spend your valuable time succeeding at the primary objectives for the course. If you have not completed them, you should not be spending time on additional work. If you have completed them, your grade should not be in need of a boost.

Tentative Schedule

Date	Activities	Readings / Preparation
<i>Week 1</i>		
Jan 31	intro to the course	Overview of course topics, assignments, and policies How to read and search the literature <i>Please bring a laptop</i>
Jan 31, cont'd	lecture	Topic: Molecular crowding in cells and traditional techniques for measuring molecules in cells (flow cytometry, microscopy and immunochemistry) Recommended Reading: Kate Luby-Phelps, "The physical chemistry of cytoplasm and its influence on cell function: an update," <i>Mol. Biol. Cell</i> , 2017 , <i>24</i> , 2593-2763. A.E. Depince-Berger, <i>et al.</i> , "New tools in cytometry," <i>Morphologie</i> , 2016 , <i>100</i> , 199-209.*
<i>Week 2</i>		
Feb 7	paper discussion	Read Arnold J. Boersma, Inge S. Zuhorn, and Bert Poolman, "A sensor for quantification of macromolecular crowding in living cells," <i>Nature Meth</i> , 2015 , <i>12</i> , 227-229 and complete the worksheet.
Feb 7, cont'd.	lecture	Topic: Stochasticity in <i>in vivo</i> reactions, extrinsic and intrinsic biological noise Recommended Reading: Edgar A. Arriaga, "Determining biological noise via single cell analysis," <i>Anal. Bioanal. Chem.</i> 2009 , <i>393</i> , 73-80.
<i>Week 3</i>		
Feb 14	paper discussion	Read Michael B. Elowitz, <i>et al.</i> "Stochastic gene expression in a single cell," <i>Science</i> , 2002 , <i>297</i> , 1183–1186 and complete the worksheet.
Feb 14, cont'd	presentation workshop	Read "Giving a great talk" on Moodle and the article you intend to present before class. Bring a laptop to class. To make best use of your time, consider starting the workshop worksheet in advance.
<i>Week 4</i>		
Feb 21	presentations	Remember to upload your presentation to Moodle before class

Feb 21, cont'd.	lecture	<p>Topics: -omics techniques for nucleic acids and proteins (genomics, transcriptomics, and proteomics)</p> <p>Recommended Reading: Elaine R. Mardis, "Next-generation sequencing platforms," <i>Annu. Rev. Anal. Chem.</i> 2015, 6, 287-303. Ruedi Aebersold and Matthias Mann, "Mass spectrometry-based proteomics," <i>Nature</i>, 2003, 422, 198-207.</p>
<i>Week 5</i>		
Feb 28	paper discussion	Read Ji Eun Lee, <i>et al.</i> "Quantitative peptidomics for discovery of circadian-related peptides from the rat suprachiasmatic nucleus," <i>J. Proteome Res.</i> 2013 , 12, 585-593 and complete the worksheet
Feb 28, cont'd.	lecture	<p>Topics: -omics measurements of small molecules (metabolomics and glycomics)</p> <p>Recommended Reading: Xiaojing Liu and Jason W. Locasale, "Metabolomics – a primer," <i>Trends Biochem. Sci.</i> 2017, 42, 274-284.</p>
<i>Week 6</i>		
Mar 7	paper discussion	Read Rosemary M. Onjiko, Sally A. Moody, and Peter Nemes, "Single-cell mass spectrometry reveals small molecules that affect cell fates in the 16-cell embryo," <i>Proc. Natl. Acad. USA</i> , 2015 , 112, 6545-6550 and complete the worksheet.
Mar 7, cont'd.	presentation workshop	Read the article you intend to present before class. Bring a laptop to class. To make best use of your time, consider starting the workshop worksheet in advance.
<i>Week 7</i>		
Mar 14	presentations	Remember to upload your presentation to Moodle before class
Mar 14, cont'd.	lecture	<p>Topic: Cell signaling, effects of cell-cell interactions, 3D structure, etc. and methods for chemical measurement in intact tissues and live organisms</p> <p>Recommended Reading: Bruce Alberts, <i>et al.</i> Chapter 15: General Principles of Cell Communication in <i>Molecular Biology of the Cell</i>, 4th ed., New York: Garland Science, 2002.* Maura C. Belanger, <i>et al.</i> "Spatially resolved analytical chemistry in intact, living tissues," <i>Anal. Chem.</i> 2020, 92, 15255-15262.</p>
<i>Week 8 – Spring Break</i>		
<i>Week 9</i>		

Mar 28	paper discussion	Read David E. Scott, <i>et al.</i> "Development of an on-animal separation-based sensor for monitoring drug metabolism in freely roaming sheep," <i>Analyst</i> , 2015 , 140, 3820–3829 and complete the worksheet.
Mar 28, cont'd.	lecture	Topic: 3D tissue culture, microfluidics, and organ-on-a-chip technology Recommended Reading: Jamil El-Ali, Peter K. Sorger, and Klaus F. Jensen, "Cells on chips," <i>Nature</i> , 2006 , 442, 403-411. Chak Ming Leung, <i>et al.</i> "A guide to the organ-on-a-chip," <i>Nat. Rev.Methods Primers</i> , 2022 , 2, 33.
<i>Week 10</i>		
Apr 4	paper discussion	Read Raghuram Dhumpa, <i>et al.</i> "Negative feedback synchronizes islets of Langerhans," <i>Biophys. J.</i> 2014 , 106, 2275-2282 and complete the worksheet.
Apr 4, cont'd.	presentation workshop	Read the article you intend to present before class. Bring a laptop to class. To make best use of your time, consider starting the workshop worksheet in advance.
<i>Week 11</i>		
Apr 11	presentations	Remember to upload your presentation to Moodle before class
Apr 11, cont'd.	lecture	Topics: chemistry between organisms and environments (quorum sensing, chemotaxis) Recommended Reading: Marvin Whitely, Stephen P. Diggle, and E. Peter Greenberg, "Progress in and promise of bacterial quorum sensing research," <i>Nature</i> , 2017 , 551, 313-320. Monica A. Thomas, Andrew B. Kleist, and Brian F. Volkman, "Decoding the chemotactic signal," <i>J. Leukocyte Biol.</i> 2018 , 104, 359-374.
<i>Week 12</i>		
Apr 18	paper discussion	Read Eric C. Carnes, <i>et al.</i> "Confinement-induced quorum sensing of individual <i>Staphylococcus aureus</i> bacteria," <i>Nat. Chem. Biol.</i> 2010 , 6, 41-45 and complete the worksheet.

Apr 18, cont'd.	lecture	<p>Topics: techniques for studying chemistry between organisms and environments (whole-cell based sensors, mass spectrometry imaging)</p> <p>Recommended Reading: Niharika Gupta, <i>et al.</i> "Cell-based biosensors: Recent trends, challenges and future perspectives," <i>Biosens. Bioelectron.</i> 2019, <i>141</i>, 111435. Amanda Rae Buchberger, <i>et al.</i> "Mass spectrometry imaging: A review of emerging advancements and future insights," <i>Anal. Chem.</i> 2018, <i>90</i>, 240-265.</p>
Week 13		
Apr 25	paper discussion	Read Amina Bouslimani, <i>et al.</i> "Molecular cartography of the human skin surface in 3D," <i>Proc. Natl. Acad. USA</i> , 2015 , <i>112</i> , 5261-5262 and complete the worksheet.
Apr 25, cont'd.	presentation workshop	Read the article you intend to present before class. Bring a laptop to class. To make best use of your time, consider starting the workshop worksheet in advance.
Week 14		
May 2	presentations	Remember to upload your presentation to Moodle before class
May 2, cont'd.	presentation workshop	Read the article you intend to present and upload your annotated bibliography before class. Bring a laptop to class. To make best use of your time, consider starting the workshop worksheet in advance.
Final Exam Period: Student Presentations 5		

* Indicates articles for which Trinity subscriptions do not include copyright permission to reproduce in a course pack.