CHMD79H3F
TOPICS IN BIOLOGICAL CHEMISTRY
FALL 2021 SYLLABUS

Course Instructor
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Office hours: Fridays 1-3 pm live on Zoom or by making an appointment for an alternate date by posting a request message in the Discussion Board. The Zoom links will be posted as Announcement emails on the course page. Students are encouraged to discuss about their assignments and practice for their oral presentations with Dr. Kerman during the office hours.

Course time: Thursdays 2-4 pm live on Zoom. The Zoom links will be posted as Announcement emails on the course page. If you miss the live lectures, the video recordings will be posted in the Files section each week.

Discussion Board: Students are encouraged to post their questions and inquiries on the Discussion Board so that the answers of Dr. Kerman can be seen by all the students.

Reference Texts:
There is no individual textbook assigned for the course and students should rely on course notes, literature articles, and lectures for the topics covered. The following is a list of suggested texts you may use for extra reading on covered topics:

1. Quantitative Chemical Analysis by Daniel C. Harris, 8th edition, W. H. Freeman and Company. **Chapter 7:** Activity and the Systematic Treatment of Equilibrium, **Chapter 13:** Fundamentals of Electrochemistry, **Chapter 14:** Electrodes and Potentiometry, **Chapter 16:** Electroanalytical Techniques.

2. Bioelectrochemistry: Fundamentals, Experimental Techniques and Applications Edited by Philip Bartlett, 2008 John Wiley & Sons, Ltd.

3. Encyclopedia of Electrochemistry, Volume 9: Bioelectrochemistry Volume editor: George S. Wilson, 2002, Wiley-VCH.

4. Analytical Electrochemistry by Joseph Wang, 3rd Edition, Wiley-VCH.

5. Understanding Voltammetry by Richard G. Compton and Craig E. Banks, World Scientific Books.

All textbooks can be found as digital-copy or hard-copy in the UTSC Library and Gerstein Science Library.

Course Objectives:
This course is meant to provide an overview of the field of bioelectrochemistry with a focus on the development of biosensors. It covers the principles, technologies, methods, and recent applications of electrochemical biosensors.

Course Topics
Sept. 9 Introduction to Biosensors and Bioelectrochemistry
Learning objectives: Fundamentals of biosensors and bioelectrochemistry

Sept. 16 Electrodes and Voltammetry-1

Learning objectives: Solid electrodes (Glassy carbon, carbon paste, metal electrodes), mercury electrodes, microelectrodes, screen-printed electrodes, reference electrodes, cyclic voltammetry-1

Sept. 23 Voltammetry-2

Learning objectives: Cyclic voltammetry-2, differential pulse voltammetry, square wave voltammetry, stripping voltammetry, amperometry

Sept. 30 Electrochemical Impedance Spectroscopy

Learning objectives: AC voltammetry, Nyquist plot, Bode plot, Equivalent circuits.
Recommended Reading: Electrochemical impedance spectroscopy: an overview of bioanalytical applications, Edward P. Randviir and Craig E. Banks, *Anal. Methods* **2013**, *5*, 1098-1115.

Oct. 7 Potentiometry

Learning objectives: pH electrodes, membrane electrodes, chronopotentiometric stripping analysis.
Recommended Reading: Electroanalysis with membrane electrodes and liquid-liquid interfaces, Eric Bakker, *Anal. Chem.* **2016**, *88*, 395-413.
Potentiometric sensing, Elena Zdrachek and Eric Bakker, *Anal. Chem.* **2021**, *93*, 72-102.

Oct. 14 Reading Week

Oct. 21 Biosensors-1

Learning objectives: Challenges and future of biosensors
Recommended Reading: Electrochemical sensing directions for next-generation healthcare: Trends, Challenges, and Frontiers, J. F. Hernandez-Rodriguez, D. Rojas, A. Escarpa, *Anal. Chem.* **2021**, *93*, 167-183.
Nonspecific binding – Fundamental concepts and consequences for biosensing applications, A. Frutiger, A. Tanno, S. Hwu, R. F. Tiefnauer, J. Voros, N. Nakatsuka, *Chem. Rev.* **2021**, *121*, 8095-8160.
Lighting up biosensors: Now and the decade to come, F. S. Ligler and J. J. Gooding, *Anal. Chem.* **2019**, *91*, 8732-8738.

Oct. 28 Biosensors-2

Learning objectives: Glucose biosensors
Recommended Reading: Electrochemical glucose biosensors, J. Wang, *Chem. Rev.* **2008**, *108*, 814-825.
Anchoring PQQ-glucose dehydrogenase with electropolymerized azines for the most efficient bioelectrocatalysis, A. A. Komkova, A. K. Orlov, A. A. Galushin, E. A. Andreev, A. A. Karyakin, *Anal. Chem.* **2021**, https://doi.org/10.1021/acs.analchem.1c02664

Printable nonenzymatic glucose biosensors using carbon nanotube-PtNP nanocomposites modified with AuRu for improved selectivity, T. N. H. Nguyen et al., *ACS Biomater. Sci. Eng.* **2020**, *6*, 5315-5325.

Nov. 4 Biosensors-3

Learning objectives: DNA biosensors
Recommended Reading: DNA Biosensors and microarrays, A. Sassolas, B. D. Leca-Bouvier, L. J. Blum, *Chem. Rev.* **2008**, 109-139.
Das, J. et al. **An ultrasensitive universal detector based on neutralizer displacement**. *Nat. Chem.* **4**, 642–648 (2012).
J. Das, **Reagentless biomolecular analysis using a molecular pendulum**, *Nat. Chem.* **2021**, *13*, 428-434.
P. S. Mousavi, et al., **A multiplexed, electrochemical interface for gene-circuit-based sensors**, *Nat. Chem.* **2020**, *12*, 48-55.
Y. Wu and N. Aroyo-Curras, **Advances in nucleic acid architectures for electrochemical sensing**, *Curr. Opin. Electrohem.* **2021**, *27*, 100695.

Nov. 11 Biosensors-4

Learning objectives: Immunosensors, Aptasensors, Wearable sensors
Recommended Reading: Recent advances in electrochemical immunosensors, W. Wen, X. Yan, C. Zhu, D. Du, Y. Lin, *Anal. Chem.* **2017**, *89*, 138-156.
Molecular diagnosis of COVID-19: Challenges and research needs. W. Feng, et al., *Anal. Chem.* **2020**, *92*, 10196-10209.
Multiplexed immunosensors and immunoarrays, A. Jones, L. Dhanapala, R. N. T. Kankanamage, C. V. Kumar, J. F. Rusling, *Anal. Chem.* **2020**, *92*, 345-362.
Perspectives on the future role of aptamers in Analytical Chemistry, Y. Wu, I. Belmonte, K. S. Sykes, Y. Xiao, R. J. White, *Anal. Chem.* **2019**, *91*, 15335-15344.
Wearable chemical sensors: Emerging systems for on-body Analytical Chemistry, J. R. Sempionatto, I. Jeerapan, S. Krishnan, J. Wang, *Anal. Chem.* **2020**, *92*, 378-396.
Wearable and mobile sensors for personalized nutrition, J. R. Sempionatto, V. R.-V. Montiel, E. Vargas, H. Teymourian, J. Wang, *ACS Sens.* **2021**, *6*, 1745-1760.

Nov. 18 Biosensors-5

Learning objectives: Biosensors for neurodegenerative diseases
Recommended Reading: Analytical techniques in Neuroscience: Recent advances in imaging, separation, and electrochemical methods. M. Ganesana, S. T. Lee, Y. Wang, B. J. Venton, *Anal. Chem.* **2017**, *89*, 314-341.
Advances in electrochemical detection for probing protein aggregation, S. Andreescu and A. Vasilescu, *Curr. Opin. Electrochem.* **2021**, *30*, 100820.
Electrochemical approaches for the detection of amyloid-β, tau, and α-synuclein, Q. Hassan, K. Kerman, *Curr Opin Electrochem,* **2019**, *14*, 89-95.
Electrochemical biosensors for biometal-protein interactions in neurodegenerative diseases, S. Li, K. Kerman, *Biosens. Bioelectron*. **2021**, *179*, 113035.
Electrochemical biosensors for the detection and study of α-synuclein related to Parkinson's disease – A review. Q. Hassan, S. Li, C. Ferrag, K. Kerman, *Anal. Chim. Acta* **2019**, *1089*, 32-39.

Nov. 25 Oral presentations-1

Dec. 2 Oral presentations-2

Evaluation:

The grading scheme for the course is shown in the table below:

Take-home Mid-term	**30%**	**From October 20th , Wednesday 9 am to October 22nd, Friday 5 pm (EST)** Mid-term will contain reading articles and critically reviewing them as well as short-answer and multiple-choice questions. The mid-term questions will be posted in the Files folder of the course page. The students will submit the completed mid-term as a Word or PDF file through the Quercus Assignments page.
Take-home Final Exam	**40%**	**From December 13th , Monday 9 am to December 17th, Friday 5 pm (EST)** Final exam will contain reading articles and critically reviewing them as well as short-answer and multiple-choice questions. Entire course topics including the assignments and oral presentations will be included in the exam with more emphasis on the topics covered after the mid-term. The final exam questions will be posted in the Files folder of the course page. The students will submit the completed final exam as a Word or PDF file through the Quercus Assignments page.
Assignment	**15%**	The students will prepare a short review (approximately 2000 words excluding the references) on the topic of their oral presentations. You will follow the guidelines for authors of the journal "*Current Opinion in Electrochemistry*". Each student will have to post their choice of topic/paper on the Discussion Board, so that there would be no overlaps. More details to be given in lectures. The guidelines for authors can be downloaded following the link below: **https://www.elsevier.com/journals/current-opinion-in-electrochemistry/2451-9103/guide-for-authors**
Oral presentation	**15%**	The students will prepare a 15-min oral presentation about a recent interesting topic or a cutting-edge technology in electrochemical biosensors. Each student will have to post their choice of topic/paper on the Discussion Board, so that there would be no overlaps. More details to be given in lectures.

Course Policies and General Information:

Course Announcements: Announcements, updates to readings, assignment topics, requirements, and evaluation, etc. will be posted to the course site. Students are responsible for checking the course website regularly. **Please, arrange your UTORONTO emails to accept the course announcements.**

Office Hours: Students are welcome to ask questions or resolve course-related problems by contacting the Course Instructor either by joining Zoom during scheduled office hours or by making an appointment by posting a request message on the Discussion Board. Students are responsible for work missed as a result of absence; the
Course Instructors will not re-teach material covered in the lectures and lab sessions

e-mail Communication: The Course Instructors may be contacted via the course email addresses to get clarification on course-related issues, or to ask brief questions. The Course Instructor will endeavour to provide responses to emails within 48 h. Urgent issues must be communicated in person or by telephone (with a follow up email message).

Missed Mid-term Test: The exact dates of the mid-term tests are provided in the Course Topics schedule. Students who miss the term test will be assigned a mark of zero for the test unless they can document a compelling reason for missing it. Students in that position must submit a written request to the Course Instructor with appropriate documentation as listed below:

https://www.utsc.utoronto.ca/physsci/self-declaration-absence-form-0

For the **Fall 2021** term, missed term tests due to medical illness will require ***ALL*** of the following:

1. Completed Student Absence form
2. Self-Declaration on ACORN

All items must be submitted **within three (3) business days** of the term test date. If a request is accepted for the mid-term test, the weighting of the mid-term will be in an extra-assignment. **There will be no make-up mid-term tests.**

Access*Ability*: Students with diverse learning styles and needs are welcome in this course. In particular, if you have a disability/health consideration that may require accommodations, please feel free to approach me and/or the Access*Ability* Services Office as soon as possible. The sooner you let us know your needs the quicker, we can assist you in achieving your learning goals in this course.

Cell Phones: During lectures and labs please put your cell phones in silent mode to avoid disruption of the class. If circumstances warrant use of your cell phone and you must receive an emergency call, please inform the Course Instructor at the beginning of the session in advance and then excuse yourself from the session to respond to the call outside the lecture hall or laboratory.

Academic Calendar: Further information about academic regulations and course withdrawal deadlines can be found in the UT Calendar. You are encouraged to read this material.

Academic Integrity: Honesty and fairness are considered fundamental to the University's mission, and, as a result, all those who violate those principles are dealt with as if they were damaging the integrity of the University itself. When students are suspected of cheating or a

similar academic offence, they are typically surprised at how formally and seriously the matter is dealt with - and how severe the consequences can be if it is determined that cheating did occur. The University of Toronto treats cases of cheating and plagiarism very seriously.

Examples of offences for which you will be penalized include (but are not limited to):

• Using any unauthorized aids on an exam or test (e.g., "cheat sheets")
• Representing someone else's work or words as your own - plagiarism (see web document "How not to plagiarize" available online at http://www.utoronto.ca/writing/plagsep.html
• Falsifying documents or grades
• Purchasing an essay
• Submitting someone else's work as your own
• Submitting the same essay or report in more than one course (without permission)
• Looking at someone else's answers during an exam or test
• Impersonating another person at an exam or test or having someone else impersonate you
• Making up sources or facts for an essay or report.

As a student it is your responsibility to ensure the integrity of your work and to understand what constitutes an academic offence. If you have any concerns that you may be crossing the line, please, read from the website http://www.utoronto.ca/academicintegrity/resourcesforstudents.html and always consult your instructor. Your instructor can explain, for example, the nuances of plagiarism and how to use secondary sources appropriately; he or she will also tell you what kinds of aids - calculators, dictionaries, etc. - are permitted in a test or exam. Ignorance of the rules does not excuse cheating or plagiarism.

This information is taken from the brochure, "*Academic Integrity*" and website, part of a series of UT publications to help students understand the University's rules and decision making structures. For copies, visit the Office of the Registrar at UT. All of the policies and procedures surrounding academic offences are dealt with in one policy: "*The Code of Behaviour on Academic Matters*". The full text is located in the back of the UT Calendar.