CHM198H1 - Biosensor Technology and Applications for the Non-Scientist

Course Syllabus: Winter 2022

I CONTACTS

INSTRUCTOR

Name: Michael Thompson
Email: m.thompson@utoronto.ca
Office: Lash Miller 139
Online student hours: available by appointment at m.thompson@utoronto.ca

Instructor Bio: Professor Michael Thompson obtained his undergraduate degree from the University of Wales, UK and his PhD in analytical chemistry from McMaster University. Following a period as Science Research Council PDF at Swansea University he was appointed Lecturer in Instrumental Analysis at Loughborough University. He then moved to the University of Toronto where he is now Professor of Bioanalytical Chemistry. He has held a number of distinguished research posts including the Leverhulme Fellowship at the University of Durham and the Science Foundation Ireland E.T.S Walton Research Fellowship at the Tyndall National Institute, Cork City. He is recognized internationally for his pioneering work over many years in the area of research into new biosensor technologies and the surface chemistry of biochemical and biological entities. He has made major contributions to the label-free detection of biological macromolecule interactions and surface behavior of cells using ultra high frequency acoustic wave physics. He has also pioneered the development of anti-fouling surface modification, in particular antithrombogenic and anti-microbial adhesion materials. Thompson has served on the Editorial Boards of a number of major international journals including Analytical Chemistry, The Analyst, Talanta, Analytica Chimica Acta and Biosensors and Bioelectronics. He is currently Editor-in-Chief of the monograph series “Detection Science” for the Royal Society of Chemistry, UK. He has been awarded many prestigious international prizes for his research including The Robert Boyle Gold Medal of the Royal Society of Chemistry, E.W.R. Steacie Award of the Chemical Society of Canada, the Theophilus Redwood Award of the Royal Society of Chemistry, the E.T.S. Walton Award of the Science Foundation of Ireland and the

Fisher Scientific Award in Analytical Chemistry of the Chemical Society of Canada. He was made a Fellow of the Royal Society of Canada in 1999.

II COURSE OVERVIEW

COURSE DESCRIPTION:
The notion of a sensor device is common knowledge to all. The range of these structures in modern times is immense, ranging from simple physical measurements such as temperature to complex devices that incorporate human cells in their design. The number of applications is also numerous including industrial processing, pharmaceutical analysis, automotive operation, military technology and environmental signaling to name just a few areas of use. In this course, we introduce the basics of a special branch of sensor technology that deals with the detection of species of biological interest. The course proceeds from a description of sensor architecture, to devices types and finally to a variety of application including the detection of cancer and other diseases.

STUDENT LEARNING OUTCOMES:
Student will understand how sensor devices are fabricated and used in terms of applications with regard to practical problems. In particular, students will be able to:
1. Appreciate the chemistry involved in biosensor technology
2. Compare the performance of various biosensors
3. Description of a number of biosensor applications

PREREQUISITE COURSES:
This course assumes you have a basic understanding of chemistry principles; minor knowledge of biology is helpful.

READINGS:
Many readings are handed out as the course progresses. There is no specific course text book.

III HOW THE COURSE IS ORGANIZED

- Introduction to biosensor architecture

Types of sensors; components and design; ideal requirements

- Probes

Types of probe – antibodies, nucleic acids, enzymes, receptors etc.

- Methods for probe attachment to surfaces

Adsorption; chemisorption v physisorption; polymer trapping; covalent attachment; film deposition techniques; molecular imprinted polymers and biomimicry.

- Surface characterization
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What can be learned from surface analysis

- Electrochemical sensors

Types of device – potentiometric, amperometric, voltammetric; ion selective electrodes; history and design of the glucose electrode; nucleic acid –based electrochemical sensing

- Acoustic wave devices

The phenomenon of piezoelectricity; how this is used in acoustic biosensor technology

- Optical and electromagnetic radiation-based devices

Fiber optic-based systems for sensing; the phenomenon of surface plasmon resonance;

- Applications

Detection of cancer, epilepsy, modern glucose devices

IV EVALUATION/GRADING SCHEME

MARK BREAKDOWN

Peer Assignment = 40% total grade – due before March 5th, 2021
Final Course Essay = 50% total grade – due on the last day of the semester (April 9th, 2021).
Course Participation = 10% total grade (based on attendance and questions asked following lectures plus Zoom, email and phone discussion)

Note: if an unexpected technical issue occurs with a university system (e.g., Quercus services, network outage) that affects availability or functionality, it may be necessary to revise the timing or weighting of the assessments.

V COURSE POLICIES

- The University of Toronto is committed to equity, human rights and respect for diversity. All members of the learning environment in this course should strive to create an atmosphere of mutual respect where all members of our community can express themselves, engage with each other, and respect one another's differences. U of T does not condone discrimination or harassment against any persons or communities.

- Privacy language and appropriate use of course materials: https://teaching.utoronto.ca/ed-tech/audio-video/sample-statements/

- Deadlines for assignment submissions and late policy (e.g. 5% will be deducted daily).

- Submission methods – by email attachment to instructor
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- Process for requesting re-grading of course work, if applicable - regraded on request

Extensions or penalties for late work allowed in the case of illness or emergency.

VI TECHNOLOGY REQUIREMENTS

Specific guidance from the U of T Vice-Provost, Students regarding student technology requirements is available here: https://www.viceprovoststudents.utoronto.ca/covid-19/tech-requirements-online-learning/

Advice for students more broadly regarding online learning is available here: https://onlinelearning.utoronto.ca/getting-ready-for-online/

This course requires the use of computers, and of course sometimes things can go wrong when using them. You are responsible for ensuring that you maintain regular backup copies of your files, use antivirus software (if using your own computer), and schedule enough time when completing an assignment to allow for delays due to technical difficulties. Computer viruses, crashed hard drives, broken printers, lost or corrupted files, incompatible file formats, and similar mishaps are common issues when using technology, and are not acceptable grounds for a deadline extension.

VII INSTITUTIONAL POLICIES AND SUPPORT

ACADEMIC INTEGRITY

On Academic Integrity:
Academic integrity is essential to the pursuit of learning and scholarship in a university, and to ensuring that a degree from the University of Toronto is a strong signal of each student's individual academic achievement. As a result, the University treats cases of cheating and plagiarism very seriously. The University of Toronto's Code of Behaviour on Academic Matters (https://governingcouncil.utoronto.ca/secretariat/policies/code-behaviour-academic-matters-july-1-2019) outlines the behaviors that constitute academic dishonesty and the processes for addressing academic offences. Potential offences include, but are not limited to:

In papers and assignments:

1. Using someone else's ideas or words without appropriate acknowledgement.
2. Submitting your own work in more than one course without the permission of the instructor.
3. Making up sources or facts.
4. Obtaining or providing unauthorized assistance on any assignment.

On tests and exams:

1. Using or possessing unauthorized aids.
2. Looking at someone else's answers during an exam or test.
3. Misrepresenting your identity.

In academic work:

1. Falsifying institutional documents or grades.
2. Falsifying or altering any documentation required by the University.

All suspected cases of academic dishonesty will be investigated following procedures outlined in the Code of Behaviour on Academic Matters. If you have questions or concerns about what constitutes appropriate academic behaviour or appropriate research and citation methods, you are expected to seek out additional information on academic integrity from your instructor or from other institutional resources (see https://www.academicintegrity.utoronto.ca/).

Use of Turnitin
Normally, students will be required to submit their course essays to Turnitin.com for a review of textual similarity and detection of possible plagiarism. In doing so, students will allow their essays to be included as source documents in the Turnitin.com reference database, where they will be used solely for the purpose of detecting plagiarism. The terms that apply to the University's use of the Turnitin.com service are described on the Turnitin.com web site.

COPYRIGHT

If a student wishes to copy or reproduce lecture presentations, course notes or other similar materials provided by instructors, he or she must obtain the

instructor's written consent beforehand. Otherwise all such reproduction is an infringement of copyright and is absolutely prohibited. More information regarding this is available here: https://teaching.utoronto.ca/ed-tech/audio-video/copyright-considerations/

ACCESSIBILITY NEEDS
Students with diverse learning styles and needs are welcome in this course. The University of Toronto is committed to accessibility: if you require accommodations for a disability, or have any other accessibility concerns about the course, please contact Accessibility Services as soon as possible.

ADDITIONAL SERVICES and SUPPORT
The following are some important links to help you with academic and/or technical service and support

- General student services and resources at Student Life
- Full library service through University of Toronto Libraries
- Resources on conducting online research through University Libraries Research
- Resources on academic support from the Academic Success Centre
- Learner support at the Writing Centre
- Information for Technical Support/Quercus Support