SYLLABUS

Chemical Elements in Living Systems (CHMD69H3)

CHMD69H3, Winter 2022

Instructor Information

Instructor	Email	Office	Office hours:
Alen Hadzovic	alen.hadzovic@utoronto.ca	EV568	considering current situation, office hours will be online and by appointment (**please e-mail me to set up the time**)
Sarah Forbes (librarian)	s.forbes@utoronto.ca	EV368	

General Overview

Chemical Elements in Living Systems course (CHMD69H3) focuses on the world of inorganic chemistry in living systems. We shall concentrate on structure and reactivity of metalloproteins: proteins whose structure and/or function depend on the presence of one or more metallic centers; emphasizing their structure, reactivity and role in the living systems. Applications of analytical methods to the problems in biological inorganic chemistry will also be briefly discussed using specific examples. To follow the course material some background in following topics is very important and will be assumed through the course:

- Inorganic chemistry: periodic table, electronic configurations, chemical reactivity, oxidation states/numbers, molecular geometry
- Basic concepts from biochemistry (proteins, DNA and RNA)
- Basic principles of structural methods in inorganic chemistry
- Cell structure

Most of the background comes from the courses that are prerequisite for CHMD69H3: Introduction to inorganic chemistry (CHMB31H3) and biochemistry courses (CHMB62H3 and/or BIOC12H3/C13H3).

Important note on the course delivery for Winter 2022 semester: As you are aware the pandemic-related public health situation is changing frequently. University's current plan is to have on-line course delivery until January 31st, after this date we would move to in-person delivery. Thus, you should be prepared to be on campus from February 1st. For all in-person activities strict public and university health measures and protocols will be followed. Some general details can be found at Your guide to the 2021-22 school year at U of T | University of Toronto (utoronto.ca) and Students - UTogether | University of Toronto Scarborough (utoronto.ca) *More course-specific details will be provided to you at the end of January.*

These are *current* plans for the Winter 2022 course delivery. The situation, however, can change rapidly so stay tuned!!

Topics Covered

Some of the topics covered in the course are as follows (not necessarily in order)

1. The chemical elements in the living systems
   - Journey through the periodic table from the point of view of a living system
   - Availability of elements (abundance) and biogeochemical cycles
   - Homeostasis
   - Inorganic chemistry and origin of life
2. Origins of life: from inorganic to organic and living
3. Biocoordination chemistry
   - Basic coordination chemistry: coordination numbers and geometries
   - Biological and inorganic ligands (overview)
   - Metal-protein interactions
   - Instrumental techniques (not covered in other courses)
4. Metal ion transport and storage
   - Control of metal ion concentration
   - Recognition of metal ions
   - Transport and storage of selected ions: Na^{+}, K^{+}, $Fe^{2+/3+}$
5. Dioxygen transport
6. Metal ion receptors and signaling
   - Metalloregulatory proteins
   - Role of Zn^{2+} binding domains
   - Role of Ca^{2+} in cells of higher organisms
7. Non-redox metalloenzymes
   - Overview
   - Metal dependent lyase and hydrolase
   - Aconitase
   - Carboxypeptidase
   - Carbonic anhydrase
8. Redox metalloproteins.
   - Overview: electron carriers vs. oxo-reductases
   - Electron sources and electron chains in living systems
   - Iron-sulfur proteins
   - Cytochromes
   - Copper proteins
   - Respiration and photosynthesis
9. Further on oxygen metabolism.
   - Superoxide dismutase
   - Peroxidases
10. Hydrogen metabolism - hydrogenases
11. Nitrogen metabolism – nitrogenases

Course Evaluation

Assignment	10%
Abstract of your paper/talk	5%
Review paper	20%
Lecture based on paper	20%
Final exam	45%

The assignment is going to be posted on Quercus on **Thursday, February 17th** and will be due **Thursday March 3rd**. You will be able to upload your work through Quercus, even if we are back for in-person lectures. *A penalty of 2% per day will be applied for late assignments.* The assignment format will be communicated to you when the assignment is posted.

You are required to write a paper (1800 to 2000 words in length) and give a 15 min lecture (approximately divided in 10 min for your talk and 5 min for Q&A) on a topic you select. The list of suggested topics will be provided separately on Quercus. You can also suggest a topic that is not on the list, but you have to check the suitability of your choice. *Please, inform me of your topic choice as early as possible (regardless of if you are picking a topic from the provided list of topics or choosing a topic of your own!)* More details on the paper requirements will be provided with the list of possible topics. **The deadline for the submission of an electronic copy of your paper is Thursday March 18th on Quercus**. *A penalty of 2% per day will be applied for late assignments.*

You will also have to submit a one-page abstract on your topic. This abstract should be submitted in electronic form. The abstract should contain **5 important concepts/ideas/points** from your chosen topic, a figure and one or two key references (a slide will be provided to you to see how it is supposed to look like). The collected abstracts will be posted on Quercus. The final exam is going to have question(s) based on these abstracts, **thus this minimum knowledge from your lectures is required material and is testable**.

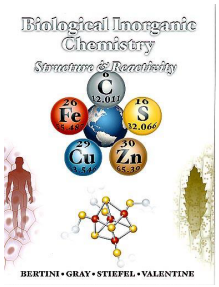
The exact date for the final exam will be announced during the semester. You can find examples of final exams on the library website. Apart from CHMD69 finals, you can also browse through CHM437 finals (CHM437 is downtown equivalent of CHMD69).

Office hours and contact info

My office is in EV (Environmental Science and Chemistry) building, 5th floor, room EV564. Considering current public health situation, it is (unfortunately) very unlikely we'll meet in person there. If you need any assistance during the semester, please e-mail me and we'll set up the time for an online meeting (via Zoom or MS Teams – your preference). Based on my experiences from last semester, some flexibility in office hours/meeting times is needed (rather than fixed times of the week).

I can be reached via e-mail: alen.hadzovic@utoronto.ca.

Course readings



The course textbook is:
Bertini, I., Gray, H. B., Stiefel, E. I., and Valentine, J. S. (Eds.). *Biological inorganic chemistry: Structure and reactivity*. Mill Valley, CA: University Science Books, 2007.

This textbook is available as an ebook through the UofT library system, so you do not need to buy it.

Another important on-line source is *The Guided Tour of Metalloproteins*.

Also useful is your inorganic chemistry textbook:

Weller, Overton, Rourke, and Armstrong. **Shriver and Atkins' Inorganic chemistry**. 7th edition. Oxford University Press, 2018 (older editions are also acceptable)

Some other useful books are (can be found in the library):

Housecroft, C.E. and Alan G. Sharpe. Inorganic Chemistry. 4th ed. Harlow: Pearson – Prentice Hall, 2008.

Kaim, W., and Schwederski, B. Bioinorganic chemistry: Inorganic elements in the chemistry of life – An introduction and guide. Chichester: John Wiley & Sons, 1994.

Ochai, E. Bioinorganic chemistry: A survey. Amsterdam: Elsevier – Academic Press, 2008.

Frausto da Silva, J.J.R., and Williams, R. J. P. The biological chemistry of the elements: The inorganic chemistry of life. 2nd ed. Oxford: Oxford University Press, 2001.

Cowan, J. A. Inorganic biochemistry: An introduction. 2nd ed. New York: VCH, 1993.

Kraatz, B., and Metzler Nolte, N. Concepts and models of bioinorganic chemistry. New York: Wiley, 2006.

Crichton, R. Biological inorganic chemistry: An introduction. Amsterdam: Elsevier: 2008.

Important references from current literature will be provided throughout the course on the lecture slides.

Academic Integrity

Academic integrity is one of the cornerstones of the University of Toronto. It is critically important both to maintain our community which honors the values of honesty, trust, respect, fairness and responsibility. It also protects you, the student within our community as well as the value of the degree towards which you are all

working so diligently. Detailed information about how to act with academic integrity, the Code of Behavior on Academic Matters, and the processes by which allegations of academic misconduct are resolved can be found online Student Academic Integrity | Faculty of Arts & Science (utoronto.ca) and FAQ | Vice Principal Academic & Dean (utoronto.ca)

Section B of the University of Toronto's Code of Behaviour on Academic Matters (http://www.governingcouncil.utoronto.ca/policies/behaveac.htm) lists actions that are considered academic offences. Some of the most common offences are:

- To use someone else's ideas or words in their own work without acknowledging that those ideas/words are not their own with a citation and quotation marks, i.e. to commit **plagiarism**.
- To include **false**, **misleading** or **concocted** citations in their work.
- To obtain **unauthorized** assistance on any assignment.
- To provide **unauthorized** assistance to another student. *This includes showing another student completed work*.
- To submit their own work for credit in **more than one course** without the permission of the instructor.
- To **falsify** or **alter** any documentation required by the University. This includes, but is not limited to, doctor's notes.
- To use or possess an unauthorized aid in any test or exam.

There are other offences covered under the Code, but these are by far the most common. Please respect these rules and the values which they protect. Offences against academic integrity will be dealt with according to the procedures outlined in the Code of Behavior on Academic Matters.

Accessibility

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 AccessAbility Services Office (ability@utsc.utoronto.ca) as soon as possible. I will work with you and AccessAbility Services to ensure you can achieve your learning goals in this course. Enquiries are confidential. The UTSC AccessAbility Services staff are available by appointment to assess specific needs, provide referrals and arrange appropriate accommodations. More details are available at: http://www.utsc.utoronto.ca/ability/.