Biological Inorganic Chemistry (CHMD69H3)

Biological inorganic chemistry course (CHMD69H3) will bring you the world of inorganic chemistry in living systems. We shall predominantly concentrate on structure and reactivity of metalloproteins: proteins whose structure and/or function depend on the presence of one or more metallic centers; focusing on their structure, reactivity and role in the living systems. Applications of physical methods to the problems in biological inorganic chemistry will also be briefly discussed using specific examples. In order to follow the course material some background in following topics is very important and will be assumed through the course:

- Inorganic and coordination chemistry (transition metals in particular)
- 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: Intermediate inorganic chemistry (CHMC31Y3) and biochemistry courses (CHMB62H3 and/or BIOC12H3/C13H3).

Topics Covered

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

1. The chemical elements in the living systems
   - Journey through the periodic table from the point of view of a living system
   - Inorganic chemistry and origin of life
   - Homeostasis
2. Biocoordination chemistry
   - Coordination numbers and geometries (review)
   - Biological and inorganic ligands (overview)
   - Protein binding, folding and structure
   - Instrumental techniques (not covered in other courses)
3. Metal ion transport and storage
   - Control of metal ion concentration
   - Recognition of metal ions
   - Transport and storage of selected ions
4. Metal ion receptors and signaling
   - Metalloregulatory proteins
   - Role of Zn^{2+} binding domains
   - Role of Ca^{2+} in cells of higher organisms
5. Non-redox metalloenzymes
   - Overview
   - Metal dependent lyase and hydrolase
   - Aconitase
   - Carboxypeptidase
   - Carbonic anhydrase

6. Redox metalloproteins.
    - Electron carriers vs. oxido-reductases
    - Electron sources and electron chains in living systems
    - Iron sulfur proteins
    - Cytochromes
    - Copper proteins
    - Respiration
7. Further on oxygen metabolism.
    - Superoxide dismutase
    - Peroxidases
8. Hydrogen metabolism - hydrogenases
9. 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 the blackboard on **Monday, February 13th** and is due in class **Monday February 27th**.

You are required to write a paper (1800 to 2000 words in length) and give a 20 min lecture (15 min for your talk + 5 min for Q&A) on a topic you select. The list of suggested topics will be provided separately on the blackboard. You can also suggest a topic that is not on the list but you have to check the suitability of your choice with me. More details on the paper requirements will be provided with the list of possible topics. **The deadline for the submission of a hard-copy of your paper is Monday March 20th in class**. **You also have to upload an electronic copy of your work to TurnItIn.com no later than Sunday, March 19th, 11:59pm**! In this regard, please note the following:

"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."

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 the course blackboard. 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.

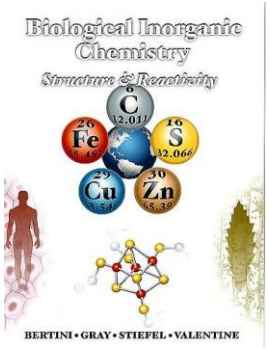
The exact date for the final exam will be announced during the semester. You can find examples of final exams on the library website. Apart from CHMD69 finals, you can also browse through CHM437 finals (CHM437 is downtown equivalent of CHMD69).

Office hours and contact info

My office is located in the new environmental sciences and chemistry building (behind the Instructional Center), 5th floor, room EV564. **The office hours schedule will be posted on the Blackboard portal (under 'Contact')**. If you would like to see me outside the office hours (for any reason), please e-mail me and we'll schedule the time. You can pay me a visit before the semester starts and before announcement of the regular office hours.

I can also be reached via e-mail: ahadzovic@utsc.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.

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

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.

Atkins, Overtone, Rouke, Weller, Armstrong and Hagerman. Shriver and Atkins' Inorganic chemistry. 6th ed. New York: W.H. Freeman and Company, 2014.

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: http://www.artsci.utoronto.ca/osai/students and http://www.utsc.utoronto.ca/~vpdean/academic_integrity.html

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/.