Updated 7 December 2021

CHEM 4120 Biomolecular Chemistry

Fall semester, 2020

INSTRUCTOR:

Dr. Zhihong Guo
Rm. 4519, Tel. 2358-7352
Email: chguo@ust.hk
Office hour: By appointment

TEACHING ASSISTANT:

(To be assigned)

COURSE SUMMARY:

This course will introduce the fundamental chemical principles underlying the structure, properties, and functions of biologically important molecules. Using the chemical concepts of bonding, structure, and structure-reactivity relationships developed in organic chemistry, this course will cover topics on the stereochemistry, structural diversity, physicochemical properties, and reactivity of amino acids, peptides, proteins, nucleic acids, carbohydrates, and lipids to understand the molecular basis of their biological functions. Another major topic of this course is the preparation of these important biological molecules for understanding of their functions and exploitation of their biotechnological and medicinal values, using available organic chemistry methods. *Prerequisite*: CHEM3120, Organic Chemistry II.

Lecture Time: Monday and Wednesday 9:00-10:20 am

Venue: Rm. 1511, mixed-mode teaching.

Course Website: http://canvas.ust.hk/, use ITSC user name and password.

Course Materials: From selective textbooks, research reviews, and research papers.

1. "*Organic Chemistry*" 8th edition by J. McMurry; Brooks/Cole, Cengage Learning. 7th edition, QD251.3 .M364 2008, 4 copies.
2. "*Peptide chemistry: a practical textbook*" 2nd edition, Miklos Bodanszky, Springer-Verlag, c1988. Call number: QP552.P4 B629 1988.
3. "Introducing Proteomics" Josip Lovrić, Wiley-Blackwell, 2011. Call number: QP551.L68 2011.
4. *"Biochemistry of Lipids, Lipoproteins and Membranes"* 4th and 5th editions, D.E. Vance and J.E. Vance (Eds.), Elsevier 2002 and 2008. 4th Ed: QP 751.B55.2002; 5th Ed: QP751.B55.2008eb, online access: http://catalog.ust.hk/catalog/archives/769210.

5. "*Carbohydrates: synthesis, mechanisms, and stereoelectronic effects*" by Momčilo Miljković , Springer c2009. Call number: QD321 .M55 2009eb. Online access through SpringerLink: http://www.springerlink.com/content/gm7201/?MUD=MP.
6. "*Carbohydrates: the sweet molecules of life*" by Robert V. Stick, Academic Press, c2001. Call number: QD321 .S84 2001.
7. "*Nucleic acids in chemistry and biology*" 3rd ed. / edited by G. Michael Blackburn et al., RSC Pub., c2006. Call number: QD433.N83 2006.
8. "*Principles of nucleic acid structure*" by Stephen Neidle, 1st ed. Elsevier: Academic Press, 2008. Call number: QD433 .N43 2008. Online access through Elsevier: http://www.sciencedirect.com/science/book/9780123695079.

EXAMS AND GRADING SCHEME:

1. Midterm exam: 50%.
2. Final exam: 50%

COURSE OBJECTIVES AND INTENDED LEARNING OUTCOMES:

This course is dedicated to fundamental principles governing the structure, properties, and functions of biologically important molecules. It is designed to better prepare chemistry majors and other students for careers related to biologically important molecules in industry, government agencies, or academic institutions. Upon the end of the course, students should be able to:

1 To understand and recognize the fundamental chemical principles underlying the structure, properties, and functions of biologically important molecules.

2 To explain the essential facts, principles, and theories of the behaviours and properties of molecules in biological processes.

3 To understand the favourable and unfavourable interactions of living organisms with nature and environment to better appreciate the significance of regulation of food safety and environmental pollution.

4 To use the biologically important molecules in elucidation of their biological functions.

5 To formulate synthetic strategy for preparation of biological molecules for biotechnological and medicinal purposes.

Syllabus

	Dates	Subjects
Week 1	Sept. 7	Introduction and Amino acids
	Sept. 9	Solid-state synthesis of peptides (1)
Week 2	Sept. 14	Solid-state synthesis of peptides (2)
	Sept. 16	Synthesis of proteins
Week 3	Sept. 21	Analysis of amino acids and proteins: Mass spectroscopy
	Sept. 23	Peptide fingerprinting of proteins
Week 4	Sept. 28	Proteomics (1)
	Sept. 30	Proteomics (2)
Week 5	Oct. 5	Lipids—Fatty acids, wax, and triacylglycerols
	Oct. 7	Lipids—Components and structure of cell membranes (1)
Week 6	Oct. 12	Lipids—Components and structure of cell membranes (2)
	Oct. 14	Biosynthesis of lipids and drug development
Week 7	Oct. 19	Carbohydrates—Stereochemistry and hemiacetal forms
	Oct. 21	**Mid-term exam, online exam to be set up.**
Week 8	Oct. 26	***No class, Chung Yeung Festival***
	Oct. 28	Carbohydrates—Reactions of monosaccharides
Week 9	Nov. 2	Carbohydrates—Di-, oligo- and polysaccharides
	Nov. 4	Carbohydrates—Synthesis of oligosaccharides
Week 10	Nov. 9	DNA structure, properties, and reactivity (1)
	Nov. 11	DNA structure, properties, and reactivity (2)
Week 11	Nov. 16	DNA replication and amplification
	Nov. 18	DNA chemical synthesis
Week 12	Nov. 23	DNA sequencing (1)
	Nov. 25	DNA sequencing (2)
Week 13	Nov. 30	RNA structure and properties
	Dec. 2	RNA functions
Week 14	Dec. 7-9	***Study break***
Final exam	Dec.12	12:30-15:30

Updated 7 December 2021

CHEM 4140 Intermediate Organic Chemistry

Fall Semester (2 Sept – 5 Dec, 2020)

INSTRUCTOR: Prof. HUANG, Yong
Office: 4530
Telephone: 3469 2625
E-mail: yonghuang@ust.hk

TEACHING ASSISTANTS:

TBA

LECTURE TIME: Tue, 16:30-17:50
Thu, 16:30-17:50

VENUE: Zoom meetings for the entire semester

COURSE DESCRIPTION:

[Previous Course Code: CHEM 313] Provides further training in the multistep organic synthesis of natural and unnatural products, and will focus on the retrosynthetic analysis, control of stereochemistry, carbonyl group chemistry, and pericyclic reactions with a brief coverage on new synthetic methodologies for efficient synthesis of compound libraries. A prerequisite for students wishing to take CHEM 5110/5120 as part of their undergraduate program. Prerequisite(s): CHEM 3120.

REFERENCE BOOKS:

1. "Advanced Organic Chemistry, Part A & Part B; 5th Ed", by Francis A. Carey and Richard J. Sundberg; New York : Springer, 2007.
2. "Organic Chemistry : an intermediate text; 2nd Ed", by Robert V. Hoffman; Hoboken, N.J. : Wiley-Interscience, 2004.
3. "Organic Synthesis; 4th Ed", by Michael B. Smith; Irvine, CA : Academic Press, 2017.
4. "Organic Synthesis : strategy and control", by Paul Wyatt and Stuart Warren; Chichester, England : John Wiley, 2007.
5. "Organic Synthesis : the disconnection approach; 2nd Ed", by Stuart Warren and Paul

Wyatt; Chichester, UK : John Wiley & Sons Ltd., 2008.
6. "Molecules That Changed The World", by K. C. Nicolaou and T. Montagnon; Weinheim: Wiley-VCH, 2008.

COURSE OBJECTIVES AND INTENDED LEARNING OUTCOMES:

The course will treat selected topics in synthetic organic chemistry from a mechanistic viewpoint and illustrate their usefulness in synthesis of designed organic molecules and natural products. The course aims to provide an introduction to multistep organic synthesis and new development in synthetic methodologies essential for pharmaceutical research and application. It also seeks to encourage students to raise an interest in a career in chemical research and development, either within a university or in industry.

Upon the end of the course, students should be able to:

1. Recognize and explain the essential facts, principles, and theories of organic chemistry including structures, stereochemistry, reaction mechanisms, and main transformations of carbon-derived compounds.
2. Demonstrate awareness and appreciation of synthetic organic chemistry topics relevance to advancement in social and daily life.
3. Formulate and analyze synthetic planning and products of multistep organic transformations by applying principles of retrosynthetic analysis.
4. Communicate effectively both orally and in writing synthesis of some designed organic molecules and natural products by using structural drawing tools and searching literature and databases.

EXAMS AND GRADING SCHEME:

SYLLABUS

1-Introduction: brief revision on atomic theory, periodic table, impact of molecules such as steroids and taxol on life, and importance of chemical synthesis including total synthesis of natural products.

2-Stereochemistry part I: molecular chirality, stereoisomers, Fischer convention, CIP convention, chiral center and axis, chirality and symmetry, optical activity, physical properties of enantiomers, prochiral relationship, stereochemical drawing techniques, stereochemical analysis, conformations of acyclic alkanes, alkenes, aldehydes and ketones, conformations of cyclohexanes, cyclohexenes and cyclohexanones, A values, 1,3-allylic strain, stereoelectronic effect, and anomeric effect.

3-Stereochemistry part II: Stereochemistry of Reactions: chemoselectivity, regioselectivity, and stereoselectivity, heterogeneous and homogeneous catalytic hydrogenation and polar group directing effects, hydride reduction of acyclic ketones and cyclohexanones, nucleophilic addition

to acyclic carbonyl groups, Cram's rule and Felkin–Ahn model, role of electronegative substituents in Felkin–Ahn model, 1,3-asymmetric induction on reduction of β-hydroxyketones, chelation control in reduction of α-hydroxyketones, β-ketoesters, and Grignard addition to α-alkoxyketones, the Houk conformation for reactions of alkenes with electrophiles, catalytic enantioselective hydrogenation of alkenes and carbonyl groups, Sharpless asymmetric epoxidation (AE), and Sharpless asymmetric dihydroxylation (AD).

4- Retrosynthetic Analysis & Synthetic Strategy: bond disconnection approach, valid retrosynthetic steps, advantage of convergent synthesis, normal and umpolung synthons, synthetic equivalents, functional group interconversion (FGI) and functional group addition (FGA), selected strategies for reaction control.

5-Functional Group Interconversion: Mitsunobu reaction, selected mild methods for conversion of alcohols into alkyl halides and sulfonates and reactions with cyanides, nitrogen, oxygen, sulfur, and phosphorus nucleophiles, selected methods for formation of esters from alcohols using acyl chlorides, acyl imidazolides, mixed anhydrides O-acyl isourea, and thiol esters, selected methods for formation of amides from amines and carboxylic acids, cleavage of ethers and esters using TMSI, selected hydride reagents for reduction of esters and Weinreb's amides to aldehydes, selective reduction of aldehydes and ketones in the presence of esters, reductive amination of aldehydes and ketones, CBS reduction of ketones to chiral alcohols, Swern oxidation, and Dess−Martin periodinane oxidation.

6-Carbonyl Group Chemistry I: preparation of Grignard reagents, preparation of organolithium via lithium–halide exchange, lithium–hydrogen exchange (α-lithiation, lateral lithiation, and DoM), and lithium–metal exchange, solution structures of organolithium and Grignard reagents, addition of organolithium and Grignard reagents with aldehydes, ketones, carboxylic acid derivatives, and CO2, Wittig olefination of unstabilized, semi-stabilized, and stabilized ylides, Horner–Wadsworth–Emmons (HWE) reaction, the Schlosser modification of Wittig reaction, the Horner–Wittig reaction, the Peterson reaction, the Julia reaction and variations, reactions of sulfur ylides.

7-Carbonyl Group Chemistry II: chemo- and regio-selectivity in enol and enolate formation, regio-, stereoselective aldol reactions, the Zimmermann−Traxler (chair-like) transition state, open transition state, anti-selective aldols of lithium enolates of hindered aryl esters, syn-selective aldols of boron enolates of phenylthio esters and ketones, syn-selective aldols of zirconium enolates of amides, thioesters, and cyclic ketones, aldols of silyl enol ethers via open transition state, chiral enolates of Evans oxazolidinones, syn-selective aldol reaction of boron enolates of chiral N-acyl oxazolidinones, anti-selective aldol reaction of boron enolates of chiral N-acyl oxazolidinones under Lewis acid catalysis, proline-catalyzed enantioselective aldol reaction, the Robinson annulation, Michael addition of organo-copper(I) compounds.

8-Pericyclic Reactions: the Diels−Alder cycloaddition, stereospecificity, endo-selectivity, "ortho" and "para" regioselectivity, intramolecular version, effect of aqueous media, organocatalysis, Lewis acid catalysis, chiral auxiliary-derived substrates.

9-Examples of Total Synthesis: total synthesis of amphidinolide T1−T5, Fürstner's total synthesis

strategy via ring-closing metathesis and hydrogenation, Dai's total synthesis via ring closing metathesis and asymmetric dihydroxylation.

10-Diversity-Oriented Synthesis & Multicomponent Reactions: diversity-oriented synthesis (DOS) vs. target-oriented synthesis (TOS), examples of complexity-generating reactions, examples of diversity-generating processes in terms of appendage diversity, stereochemical diversity, and skeletal diversity, types of multicomponent reactions (MCRs), examples of historically significant MCRs, mechanisms of Passerini three-component reaction (P-3CR) and Ugi four-component reaction (U-4CR), examples of U-4CR using 2-aminophenols and post Ugi annulation.

11-Microwave-Assisted Organic Synthesis, Solid-Phase Organic Synthesis & Combinatorial Synthesis: two mechanisms of microwave dielectric heating, difference of microwave vs. conventional thermal heating, major advantages of microwave heating, difference of solid-phase vs. solution organic synthesis, major advantages of solid-phase organic synthesis, types and roles of linkers used in solid-phase organic synthesis, difference in parallel synthesis and mix-split synthesis.

Week 1	Sept. 8	*1-Introduction*
	Sept. 10	*2-Stereochemistry part I: Stereochemical Principles*
Week 2	Sept. 15	*2-Stereochemistry part I: Stereochemical Principles (continue)*
	Sept. 17	*2-Stereochemistry part I: Stereochemical Principles (continue)*
Week 3	Sept. 22	*2-Stereochemistry part I: Stereochemical Principles (continue)*
	Sept. 24	*3-Stereochemistry part II: Stereochemistry of Reactions*
Week 4	Sept. 29	*3-Stereochemistry part II: Stereochemistry of Reactions (continue)*
	Oct. 1	*NO Class: public holidays*
Week 5	Oct. 6	*3-Stereochemistry part II: Stereochemistry of Reactions (continue)*
	Oct. 8	*3-Stereochemistry part II: Stereochemistry of Reactions (continue)*
Week 6	Oct. 13	*3-Stereochemistry part II: Stereochemistry of Reactions (continue)*
	Oct. 15	*4- Retrosynthetic Analysis & Synthetic Strategy*
Week 7	Oct. 20	*5-Functional Group Interconversion*
	Oct. 22	*NO Class: search & read reference materials and writing eassy*
Week 8	Oct. 27	*5-Functional Group Interconversion (continue)*
	Oct. 29	*Mid-term Examination*
Week 9	Nov. 3	*5-Functional Group Interconversion (continue)*
	Nov. 5	*6-Carbonyl Group Chemistry I*
Week 10	Nov. 10	*6-Carbonyl Group Chemistry I (continue)*
	Nov. 12	*7-Carbonyl Group Chemistry II*
Week 11	Nov. 17	*7-Carbonyl Group Chemistry II (continue)*
	Nov. 19	*7-Carbonyl Group Chemistry II (continue)*
Week 12	Nov. 24	*8-Pericyclic Reactions; 9-Examples of Total Synthesis*
	Nov. 26	*9-Examples of Total Synthesis (continue)*
Week 13	Dec. 1	*10-Diversity-Oriented Synthesis & Multicomponent Reactions*
	Dec. 3	*11-Microwave-Assisted Organic Synthesis, Solid-Phase Organic Synthesis & Combinatorial Synthesis*
Week 14	Dec. 7-11	*Study Break*
	Dec. 14-18	*Final Examination (TBD)*

EXAMS AND GRADING SCHEME:

1. Assignments/essay (20%)
2. Mid-term Examination (35%)
3. Final Examination (45%)

SUPPORTING READING MATERIALS AND SOLUTION MANNUAL:

Call Number QD251.2 .C36 2007eb
TITLE: Advanced Organic Chemistry, 5th ed.
AUTHOR: Francis A. Carey and Richard J. Sundberg
IMPRINT New York : Springer, c2007
Online access to the 4th ed. can be found at:
https://chemistlibrary.files.wordpress.com/2015/07/advanced-organic-chemistry-4ed-2000-part-a-structure-and-mechanisms-carey-sundberg.pdf

Call Number QD251.2 .H58 2004
TITLE: Organic Chemistry : an intermediate text, 2nd ed.
AUTHOR: Hoffman, Robert V
IMPRINT Hoboken, N.J. : Wiley-Interscience, c2004
Copies: 1 copy

Call Number QD262 .W284 2008
TITLE: Organic Synthesis : the disconnection approach, 2nd ed.
AUTHOR: Warren, Stuart G
IMPRINT Chichester, UK : John Wiley & Sons Ltd., 2008
Copies: 1 copy

Call Number QD262 .W89 2007
TITLE: Organic Synthesis : strategy and control
AUTHOR: Paul Wyatt and Stuart Warren
IMPRINT Chichester, England : John Wiley, c2007
Copies: 1 copy

Call Number QD262 .S65 2017
TITLE: Organic Synthesis, 4th ed.
AUTHOR: Smith, Michael
IMPRINT Amsterdam : Academic Press, c2017
Copies: 1 copy

Call Number QD262 .S65 2010
TITLE: Organic Synthesis, 3rd ed.
AUTHOR: Smith, Michael

IMPRINT [Irvine, CA]: Wavefunction, Inc., [2010]
Copies: 1 copy

Call Number QD262 .N53 2008
TITLE: Molecules That Changed The World
AUTHOR: Nicolaou, K. C
IMPRINT Weinheim : Wiley-VCH, c2008
Copies: 1 copy

Updated 7 December 2021

Items of Course Outlines CHEM4210 'Solid State Chemistry'

1. Instructor (s) – Name and Contact Details

   Name: Henry YAN

   Contact details: hyan@ust.hk, 2358-7366

2. Teaching Assistant (s) - Name and Contact Details

   Name: Siwei Luo

   Contact details: schenau@ust.hk, 2358-7386

3. Meeting Time and Venue – Lectures, Tutorials/ Laboratory

   Lectures:

   Date/Time: Mon Wed (10:30-11:50)

4. Course Description - Credit Points, Pre-requisite, Exclusion, Brief Information/synopsis

   Credit points: 3

   Pre-requisite: Inorganic chemistry (CHEM 2210)

   Structure and bonding in solids; metals, semiconductors and dielectrics; crystal chemistry of ceramics, silicate minerals and zeolites; electrical, optical and magnetic properties of solids; fullerene chemistry; introduction to x-ray diffraction, electron microscopy, etc.

5. Intended Learning Outcomes

   (State what the student is expected to be able to do at the end of the course according to a given standard of performance)

   Upon successful completion of this course, students should be able to:

No.	ILOs
1	Obtain key fundamental knowledge about what parameters determine the properties of solids.
2	Able to apply fundamental chemistry principles (periodic table, electronegativity, etc) to understand the structural-property relationship of solids.
3	Able to understand important applications of organic and inorganic solid-state materials and relate the applications with the main principles of solid-state chemistry.
4	Able to present the most important knowledge and principles learned in this course in a clear and simple presentation.

6. Assessment Scheme

Assessment Assessing Course ILOs

(Percentage + assessment tasks) *Assessment*	*(Respective course ILOs)* *Assessing Course ILOs*
50% exam	*1, 2, 3*
50% by presentation	*4*

7. Student Learning Resources - Lecture Notes, Readings

   Lecture Notes will be sent to students on a weekly basis

8. Teaching and Learning Activities -

   Scheduled activities: 3 hrs (lecture)

9. Course Schedule

   Keyword Syllabus:

   - Atoms, periodic table, bonding, difference between organic and inorganic solids
   - Atomic orbital vs band structure, bandgap, metal, semiconductor, insulator
   - Crystal structure, unit cell, crystal systems
   - Structure of metals, different structure types (e.g., AX, AX2, AX3 types, etc.)
   - Phase diagrams, thermodynamics of solids
   - Nanomaterials, fullerene, nanotubes
   - Applications of semiconductors, light-emitting diodes, solar cells
   - Organic solids, organic semiconductor, organic solar cell

Updated 7 December 2021

Materials Chemistry

CHEM4220

Fall Semester 2020

Department of Chemistry, HKUST

Instructor: Prof. Ben Zhong Tang
Office: CYT-6002; ext. 7375
E-mail: tangbenz@ust.hk

Dr. Jacky W. Y. Lam
Office: CYT-6004; ext. 7242
E-mail: chjacky@ust.hk

TA: Mr. Jianyu Zhang
Lab: CYT-6007; Phone: x 8801 or x 7396
E-mail: jzhangff@connect.ust.hk

Schedule: Zoom
3:00–4:20 pm; Wed & Fri

Evaluation:

Mid-term Test	40%
Final Exam	50%
Quiz	10%

COURSE MATERIALS http://canvas.ust.hk/

REFERENCES

(1) Cowie, J. M. G. *Polymers: Chemistry and Physics of Modern Materials*, 2nd ed.; Blackie: London, 1991.

(2) Li, X. C.; Moratti, S. C. In *Photonic Polymer Systems*; Wise, D. L., Wnek, G. E., Trantolo, D. J., Cooper, T. M., Gresser, J. D., Eds.; Marcel Dekker: New York, 1998; Chapter 10.

(3) Mei, J.; Leung, N. L. C.; Kwok, R. T. K.; Lam, J. W. Y.; Tang, B. Z. "Aggregation-Induced Emission: Together We Shine, United We Soar!" *Chem. Rev.* **2015**, *115*, 11718–11940. http://pubs.acs.org/doi/abs/10.1021/acs.chemrev.5b00263

LECTURE PLAN (15 weeks)

Chapter 1	Liquid Crystals	3.0 weeks
Chapter 2	Light-Emitting Materials	3.0 weeks
Course Review and Mid-term Test		1.0 *week*
Chapter 3	Aggregation-Induced Emission	
	Part 1	2.0 weeks
	Part 2	2.5 weeks
	Part 3	2.5 weeks
Course Review and Final Examination		1.0 *week*

Intended Learning Outcomes

At the end of the course, students should be able to:

1. Develop an understanding of the core ideas and concepts of materials science and technology.
2. Recognize the power of chemical synthesis and materials preparation and carry out investigative research work with independent judgment.
3. Apply chemical principles to formulate and analyze analytical and synthetic problems.
4. Conduct analysis and interpretation of experimental data.
5. Communicate problem solutions using correct materials chemistry terminology and good English.

CHEM 4240 Intermediate Inorganic Chemistry

Course Outline- Fall 2020

1. **Instructor**

Name: Wa-Hung Leung

Contact Details: e-mail: chleung@ust.hk, ext. 7360, office: Rm 4538

2. **Teaching Assistant**

Name: Mr. Hoang Long PHAM

Contact Details: e-mail: hlpham@connect.ust.hk, ext. 7374

3. **Meeting Time and Venue**

Lectures:

Date/Time: Monday, 15:00-16:20; Friday, 10:30-11:50

Venue: via Zoom

Tutorials:

Date/Time: To be arranged

Venue: To be arranged

4. **Course Description**

Credit Points: 3

Pre-requisite: CHEM 3220

Exclusion: NIL

Brief Information/synopsis:

Intermediate Inorganic Chemistry is a 3-credit elective course for all Year 3 chemistry undergraduate students. The curriculum is designed to cover a range of topics on bonding, structure and reactivity of inorganic complexes, with intended learning outcomes focusing on developing students' intellectual and generic skills.

5. Intended Learning Outcomes

Upon successful completion of this course, students should be able to:

No.	ILOs
1	Recognize fundamentals of chemistry, bonding, structures, reaction mechanisms, and spectral properties of inorganic compounds.
2	Explain essential facts, principles and theories of inorganic chemistry, e.g. spectral properties of inorganic complexes, mechanisms of inorganic reactions, Wades' rules

6. Assessment Scheme

a. Examination duration: 3 hrs

b. Percentage of coursework, examination, etc.:

Assessment	Assessing Course ILOs
8% by assignments and other assessments	1, 2
8% by PRS and participation	1,2
54% by quizzes	1,2
30% by presentation and written report	1, 2

c. The grading is assigned based on students' performance in assessment tasks/activities.

7. Student Learning Resources

Recommended Reading:

Text(s):

"Inorganic Chemistry", international edition, by M. Weller *et al.*, OUP (2018)

8. Teaching and Learning Activities

Scheduled activities: 3 hrs (lecture)

9. Course Schedule

Keyword Syllabus:

- Inorganic reaction mechanisms: Substitution (square planar and octahedral complexes). Redox reactions (outer-sphere and inner-sphere electron transfer). Intramolecular electron transfer.
- Electronic spectra: Russell-Saunder terms. Hund's rules. Spectral terms. Selection rules for electronic transitions. Tanabe-Sugano diagrams. Nephelauxetic effect. Ligand-field spectra. Charge-transfer spectra. Intervalence charge-transfer.
- Metal-metal multiple bonds: M_2X_8 complexes. Electron configurations. Bond order.
- Metal atom clusters: Lower and higher nuclearity carbonyl clusters. Magic numbers. Wade's rules. Capping Rule. Halide clusters.
- Lanthanides chemistry: Electron configurations. Trends of atomic and ionic properties. Oxidation states. Spectral and magnetic properties. Applications.
- Special topics: Metal-ligand multiple bonds: Bonding and structures and chemical reactivity. Photochemistry of inorganic complexes

Updated 7 December 2021

Stefan Nagl
last updated:
Sept. 09, 2020

CHEM 4320 Environmental Analytical Chemistry
Course Outline

Code: CHEM 4320
Title: Environmental Analytical Chemistry
Credits: 3 credits

Description:
Methods for the qualitative and quantitative chemical analysis of air, water and soil and their pollutants from high concentrations to ultratrace levels. Topics covered include local and global concentrations, properties and toxicity of environmental pollutants, fundamentals of sampling issues, sample pretreatment techniques, water analysis of major, minor and trace constituents; determination of inorganic and organic gas pollutants, atmospheric analysis of particulate matter, determination of soil pollutants and environmental control standards.

Enrollment requirements: CHEM 2310 or CHEM 2311 or similar
(CHEM 3320 or similar recommended)

Course objectives:
The course provides the students with knowledge in important aspects of chemical analysis of the environment and different measurements approaches for environmental samples. The course aims to sharpen students' skills and initiative in confronting and solving environmental analytical problems.

Intended learning outcomes:
On successful completion of the course students will be able to:

- Define major environmental analysis approaches;
- Describe different sampling approaches
- Differentiate commonly used pretreatment techniques for environmental samples;
- Reproduce the working principles of major, minor and trace constituents in water and aqueous samples
- Propose suitable sampling and analysis techniques for common gaseous inorganic and organic pollutants;
- Design suitable sampling and analysis techniques for major constituents and trace organic compounds in atmospheric particulate matter.
- Plan calibration and reference measurements for the quantification of a chemical species in environmental matrices.

- Formulate analytical solutions for environmental monitoring and testing hypotheses for environmental problems.

Teaching and learning activities:
Lectures, In-class exercises and Course project presentations (students form groups of two and present original research)

Grading, assessments and their weighting:
70% Course project
(40% Write-up and
30% Presentation)
30% Homework

Weekly course topics:
Week 1. Introduction to Environmental Analytical Chemistry
Week 2. Water Analysis – Major and Minor Constituents
Week 3. Water Analysis – Major and Minor Constituents
Week 4. Water Analysis – Trace Metals
Week 5. Water Analysis – Trace Organic Contaminants
Week 6. Water Analysis – Trace Organic Contaminants
Week 7. Soil Analysis
Week 8. Fundamentals of Air Pollutants
Week 9. Determination of Volatile Organic Compounds
Week 10. Determination of Polycyclic Aromatic Hydrocarbons
Week 11. Continuous Monitoring of Air Pollutants
Week 12. Guest Lecture and Field Visit
Week 13. Recap and Student Presentations

Required and recommended reading:
Recommended:
Environmental Analytical Chemistry, D. Perez-Bendito and S. Rubio, Elsevier, 1999.
Introduction to Environmental Analysis, Roger N. Reeve, Wiley, 2002.
Environmental Analytical Chemistry, F. W. Fifield and P. J. Haines, Wiley-Blackwell, 2000.
Environmental Chemical Analysis, S. Mitra, B.B. Kebbekus, CRC Press, 1997

Updated 7 December 2021

http://canvas.ust.hk/

CHEM4340: Bioanalytical Techniques

Instructor: Hongkai Wu
Office: Rm 4517
Lecture time: Tue & Thu, 9:00-10:20
Lecture venue: TBA
Tel: x7246
Email: chhkwu@ust.hk
Office hour: walk-in or with appointment

Fall, 2020

Course Overview

Part 1: Optical microscopy

Part 2: Biomolecules and their assays

Part 3. Microfluidics (biosensors)

Part 4: Literature research in bioanalytical techniques

Part 1: Optical Microscopy

A. Course introduction;

1. Basic of microscope
2. Optical microscopic techniques
- Fluorescence and fluorescence probes
- Images

Part 2: Protein/DNA and their assays

1. Protein
2. Enzyme
3. Enzyme immobilization and immunoassay
4. From DNA to protein
5. Protein/DNA sequencing
6. Electrophoresis and other separation techniques
7. Other techniques

Part 3: Microfluidics

1. Introduction to microfluidics
2. Applications of microfluidics in analytical chemistry
3. Biosensors

Evaluation

No homework

Oral Presentation (20 min): 50%

Time: will be announced in the week of Sept 21.

Final exam: 50%

Time: To be arranged by university

Updated 7 December 2021

CHEM 4410 - Physical Chemistry in Biological Applications

Fall 2020/21

1. Instructor:

Name: Prof. Jinqing Huang
Office: 4544
Email: jqhuang@ust.hk
Extension: 2627

2. Meeting Time and Venue

Lectures:

2 Sessions (1.5 hour each) every week
Mon, Wed: 12:00-13:20 am Online mode and mixed mode 5562

Office Hours:

	Time	Venue
Instructor	Mon. 15:00 – 17:00	4544

3. Course description:

Credit Points: 3
Pre-requisite: CHEM 3420 Physical Chemistry II
Exclusion: NIL
Brief Information/synopsis:

This course covers the applications of physical chemistry in biological science and emphasizes the capability in using the fundamental knowledge in physical chemistry to solve the latest research problems in the interdisciplinary areas. Topics include molecular interpretations of the laws of thermodynamics, free energy and physical equilibria in membranes, photochemistry and photobiology, enzyme kinetics, binding and conformation transitions, spectroscopy of biomolecular structures and interactions. For CHEM students only. Students with Minor in CHEM or other Major may seek instructor's approval for enrollment in the course.

4. Intended Learning Outcomes

At the end of the course, the student will be able to:

1. Understand how to interpret fundamental concept from physical chemistry in the application of biological science
2. Have the skill set to do literature review to gather information for the development of the industry and the academia in biological science.
3. Be able to apply the knowledge from physical chemistry to solve the problems in the application of biological science.
4. Be able to present and criticize the knowledge from physical chemistry in the application of biological science.

5. Assessment Scheme

Reading Assignments	20%	ILOs 1, 2
Midterm Presentation	30%	ILOs 3, 4
Final Project Report	30%	ILOs 2, 3

6. Student Learning Resources

Recommended Reading:
"*Physical Chemistry: Principles and Applications in Biological Sciences*" Tinoco, Sauer, Wang, Puglisi, Harbison, and Rovnyak, Prentice Hall, 5th Edition

7. Additional Teaching and Learning Activities

After lecture discussions

8. Course Topics and Schedule

Chapter 1: Molecular Interpretations of the Laws of Thermodynamics
Chapter 2: Free Energy and Physical Equilibria in Membranes
Chapter 3: Photochemistry and Photobiology
Chapter 4: Enzyme Kinetics
Chapter 5: Binding and Conformation Transitions
Chapter 6: Spectroscopy of Biomolecular Structures and Interactions

CHEM 4689 Capstone Project
Course Outline (*Fall 2020-2021*)

1. Course Coordinators:

Prof. Jason Chan	(kkjchan@ust.hk)	Rm 4543; Tel: 3469-2098
Prof. Emily Tsang	(chetsang@ust.hk)	Rm 4536; Tel: 3469-2100

Faculty Supervisors: (You will be assigned under one faculty)

Prof. Jason Chan	(kkjchan@ust.hk)	Rm 4543
Prof. Simon Chan	(chanwan@ust.hk)	Rm 4520
Prof. Qing Chen	(chenqing@ust.hk)	Rm 2544
Prof. Peter Cheung	(ppcheung@ust.hk)	Rm 4207B/Rm 4534
Prof. Philip Chow	(pcyc@ust.hk)	CYT 6007/Rm 4534
Prof. Wei Min Dai	(chdai@ust.hk)	CYT 6012
Prof. Ryan Kwok	(chryan@ust.hk)	Rm 4095
Prof. Jacky Lam	(chjacky@ust.hk)	CYT 6004
Prof. Zhenyang Lin	(chzlin@ust.hk)	Rm 4533
Prof. Fu Kit Sheong	(chemfksheong@ust.hk)	Rm 4207/Rm 4534
Prof. Jianwei Sun	(sunjw@ust.hk)	CYT 6010
Prof. Ding Pan	(dingpan@ust.hk)	Rm 4460
Prof. Emily Tsang	(chetsang@ust.hk)	Rm 4536
Prof. Ian Williams	(chwill@ust.hk)	CYT 6005/Rm 4512
Prof. Hongkai Wu	(chhkwu@ust.hk)	Rm 4517
Prof. Jianzhen Yu	(chjianyu@ust.hk)	Rm 4532

Sci-Tech Librarians:

Mr Samson Choi	(lbsamson@ust.hk)	Tel: 2358 6763
Mr Jacky Leung	(lbjacky@ust.hk)	Tel: 2358 6767
Mr Lewis Li	(lblewis@ust.hk)	Tel: 2358 6769

2. Class Time and Venue:

Date/Time: Fridays 9:30 – 10:20 (*refer to timetable)
Venue: Zoom Online Meeting

3. Course Description:

Credit Points: 3 Pre-requisite: CHEM 3550 and CHEM3555

Brief Information/synopsis:

Under the supervision of a faculty member or teaching staff, students will complete a capstone project which requires the integration of the chemical knowledge learnt from their previous courses. Students will carry out a literature review on a mutually agreed topic. A written report and an oral presentation are required to document their learning experiences.

4. Intended Learning Outcomes

1	Demonstrate awareness of chemical topics relevant to social and daily life
2	Analyze and interpret experimental data, critically assess data in literature and extract useful data from it.
3	Carry out directed research by selecting appropriate topics and procedures, and presenting the results
4	Communicate effectively both orally and in writing with professionals and/or lay audience
5	Demonstrate information technology skills, especially in the areas of information retrieval, literature searching and use of library database.
6	Show self awareness, work independently and collaborate effectively with other people in a team

5. Assessment Scheme

(Face-to-face mode of assessment)

Weight	*Assessment*	*Course ILOs*
10%	Participation	1, 2, 3, 4, 5, 6
20%	Poster Presentation and Library Training	2, 4, 5
40%	Literature Research Presentation	1, 4, 5, 6
30%	Literature Research Report	1, 2, 3, 4, 5

(Online mode of assessment)

Weight	*Assessment*	*Course ILOs*
10%	Participation	1, 2, 3, 4, 5, 6
20%	Submission of a Scientific Poster and Library Training	2, 4, 5
30%	Literature Research Presentation (recorded)	1, 4, 5, 6
40%	Literature Research Report	1, 2, 3, 4, 5

6. Student Learning Resources (Reference books):

- Catherine E. Housecroft and Alan G. Sharpe, *Inorganic Chemistry* 3rd edition, Harlow: Pearson Prentice Hall ©2008. [QD151.2 .H68 2008] ♠
- Douglas A. Skoog, F. James Holler, Stanley R. Crouch, *Principles of Instrumental Analysis* 6th edition, Thomson Brooks/Cole, ©2007. [QD79.I5 S58 2007]
- Jonathan Clayden, Nick Greeves and Stuart Warren, *Organic Chemistry* 2nd edition: Oxford University Press ©2012 [QD251.3 .O64 2012]
- T.D.H. Bugg, *Introduction to Enzyme and Coenzyme Chemistry* 3rd edition, Wiley ©2012. [QP601.B955 2012eb] ♠

♠ *Free access online via HKUST Library*

^ *other course materials can be downloaded from Canvas website by logging in using your ITSC username and password (http://canvas.ust.hk).*

CAPSTONE NINJA: English Lanugage Support App for CHEM capstone projects
Co-developed by Center for Language Education and Department of Chemistry

Capstone Ninja can be downloaded from

For Iphone, Ipad: (Apple Appstore) https://apps.apple.com/hk/app/capstone-ninja/id1352231678
For Andriod (Google Play Store) https://play.google.com/store/apps/details?id=hk.edu.polyu.edc.capstoneninja&hl=zh_HK

7. Teaching and Learning Activities

Scheduled activities:

Tutorials:
1. Literature Search Training I
2. SciFinder Workshop
3. Chemical Structure Drawing Training
4. Literature Search Training II
5. Poster design workshop

Consultations:	With supervisor (at least 3 times)
Individual Coaching:	With reference librarians (at least once)
Oral presentation:	10 minutes + 5 minutes Q&A
Poster mini-conference:	3 hours session at the end of semester

8. Course Schedule

Week	Date/Time	Activities [† *denotes follow-up work required*]	Venue/Instructor
1	11/9 (Fri) 9:30-10:20	**CHEM 4689 Course Introduction & Introduction to 'Capstone Ninja'** [† ***meet your supervisor for topic assignment***] [† ***upload topic to Canvas after assignment***]	**Zoom Meeting** Profs. J. Chan/E. Tsang
2	18/9 (Fri) 9:30-10:20	**Library – 'Literature Search Training I'**	**Zoom Meeting** Mr L. Li/ Mr S. Choi
3	25/9 (Fri) 9:30-10:20	**SciFinder Workshop** **Library – Lit. Search Individual Coaching Session** [***Compulsory***] (by appointment with reference librarian during Week 3-4)	**Zoom Meeting** SciFinder vendor °(by appointment on Zoom)
4	2/10 (Fri) Public Holiday	***2/10 Public Holiday (the day following the Chinese Mid-Autumn Festival)*** **Library – Lit. Search Individual Coaching Session** [***Compulsory***] (by appointment with reference librarian during Week 3-4)	°(by appointment on Zoom)
5	9/10 (Fri) 9:30-10:20	**Chemical Structure Drawing Training** [† ***submit Weekly Timetable to Canvas for scheduling Oral Presentation Time***]	**Zoom Meeting** Profs. J. Chan/E. Tsang°
6	16/10 (Fri)	**Consultation with supervisor #1** [† ***submit Research Plan***]	**Zoom Meeting** (by appointment with your supervisor)
7	23/10 (Fri) 9:30-10:20	**Library – 'Literature Search Training II'**	**Zoom Meeting** Mr L. Li/ Mr S. Choi
8	30/10 (Fri) 9:30-10:20	**Poster Design Workshop** **Consultation with supervisor #2**	**Zoom Meeting** Prof. J. Chan ° **Zoom Meeting** (by appointment with your supervisor)
9	6/11 (Fri)	*Work on your project*	
10	13/11 (Fri)	**Consultation with supervisor #3 (or in week 11 if presentation videos will be requested)**	**Zoom Meeting** (by appointment with your supervisor)
11	20/11 (Fri)	*Work on your project*	
12	27/11 (Fri)	**Oral Presentations (First Week)** [† ***submit Poster printing file to Canvas***]	TBA
13	4/12 (Fri) TBA	**Oral Presentations (Second Week)**	TBA
	7-9/12 ?? (Choose 1 day) 14:00-17:00	**Poster Mini-Conference**	Multi-Function Room (Library LG4)

	20/12 (Sun) 23:59	***Deadline for Literature Research Report***	*[Online on Canvas]*

- Week 3 – 4: Library - Lit. Search Coaching Session [***Compulsory***] (by appointment)
- Week 8 – 11: Library - Referencing Coaching Session [*Optional*] (by appointment)

Updated 7 December 2021

CHEM 4691 Capstone Research I

Course Outline (Fall 2020/21)

1. Course Description

Pre-requisite: CHEM 3550 and CHEM 3555

Exclusion: CHEM 4689

Instructor(s): Research Faculties of Chemistry Department

Reference Librarians:

Mr. CHOI, Samson (lbsamson@ust.hk) (Tel: 2358 6763)

Mr. LI, Lewis (lblewis@ust.hk) (Tel: 2358-6769)

Mr. LEUNG Jacky (lbjacky@ust.hk) (Tel: 2358-6767)

Brief Information/synopsis:

This is a project-based course that provides students an opportunity to integrate and apply their chemical knowledge learnt in regular lecture and lab courses. Students will carry out a research project under the supervision of a faculty member/teaching staff. At the end of the course, students are required to submit a written report and deliver an oral presentation to document their learning experiences. Students should seek instructor's approval prior to enrollment in the course.

2. Intended Learning Outcomes

Upon successful completion of this course, students are expected to be able to:

1	Demonstrate awareness of chemical topics relevant to social and daily life.
2	Analyze and interpret experimental data, critically assess data in literature and extract useful data from it.
3	Carry out directed research by selecting appropriate topics and procedures, and presenting the results.
4	Communicate effectively both orally and in writing with professionals and/or lay audience.
5	Demonstrate information technology skills, especially in the areas of information retrieval, literature searching and use of library database.
6	Show self-awareness, work independently and collaborate effectively with other people in a team.

3. Grading

Weight	Assessment	Course ILOs
50%	Lab Performance and Participation	1,2,3,4,5,6
30%	Written Research Thesis	1,2,3,4,5
20%	Oral Presentation	4,5,6

4. **<u>Mandatory</u> Library Trainings Schedule:**

The following library training sessions are ***mandatory***. Attendances will be taken and counted towards your course participation scores.

Date	Activity	Venue
18/9 (Fri, 9:30 – 10:20)	**Library Workshop I - Literature Search Training**	Zoom Meeting (Mr. J. Leung/Mr. S. Choi)
25/9 (Fri, 9:30 – 10:20)	**SciFinder Workshop**	Zoom Meeting (SciFinder vendor)
9/10 (Fri, 9:30 – 10:20)	**Chemical Structure Drawing Training**	Zoom Meeting (Prof. E. Tsang)
23/10 (Fri, 9:30 – 10:20)	**Library Workshop II – Referencing and Citation Training**	Zoom Meeting (Mr. L. Li/Mr. S. Choi)