Chem 4240/6240 – Chemical Biology

Spring Semester 2019
Tuesday and Thursday 2:15 – 3:30 pm
Classroom South 203

Required Textbook
Introduction to Bioorganic Chemistry and Chemical Biology by David Van Vranken and Gregory A. Weiss (2012)

Instructor
Dr. Jun Yin
NSC 571, office hours by appointment
Phone: 404-413-6090; Email: junyin@gsu.edu

Learning outcomes and objectives of the course

The objective of the course is to teach students the chemical basis of biological transformation, and the design principle of developing chemical tools to study biology. The students will learn how to describe a biological transformation using the language of organic chemistry, and how to solve biological problems with a chemical toolbox.

Topics to be covered

1. Chemical Language of Biology.
2. Reactivity of DNA, RNA and Proteins.
3. Chemical Control of Cell Signaling.
4. Manipulating Biology by Chemistry.

Prerequisites of the course

One year of Organic Chemistry or equivalent courses, **or** one semester of Biochemistry or equivalent courses. Undergraduate can take this course after taking Chem 3400 – Structure and Reactivity of Biomolecules.

Format of the course

The professor will focus the lecture time on explaining the textbook and additional literatures. The students need to read the test book and literature assignment (preferably before the lecture), attend the lectures, and complete the midterm and final exams. The midterm and final exams are open-book. Students are allowed to refer to text books and lecture notes during the exam.

Grading criteria

Midterm exam I	30%
Midterm exam II	30%
Final exam	40%

One lowest score of the midterm exam will be dropped.

Course Schedules

Week	Date	Topics
1	01/15	**Chapter 1. The Fundamentals of Chemical Biology** • The scope and approach of Chemical Biology.
	01/17	• Combinatorial approaches in chemistry and biology. • Forward and reverse chemical genetics.
2	01/22	**Chapter 2. The Chemical Origins of Biology** • Review of bioorganic concepts – chirality, acid and base, nucleophilicity
	01/24	• Stereoelectronic effects of biomolecules.
3	01/29	• Prebiotic chemistry and the RNA world.
	01/31	**Chapter 3. DNA** • DNA structure and reactivity • DNA methylation, acetylation and epigenetics
4	02/05	• DNA replication • Next-generation sequencing • Synthetic genome
	02/07	• Recombinant DNA and molecular cloning.
5	02/12	Genome editing tools • CRISPR/Cas9 • Cre recombinase
	02/14	DNA damage and drugs targeting DNA • UV damage of DNA • Folate and Inhibitors of thymidine biosynthesis • Alkylating DNA
6	02/19	• DNA recognition by synthetic ligands • Radical cleavage of DNA
	02/21	**Chapter 4. RNA** • RNA structure, folding, and ribozyme
7	02/26	**Midterm exam 1**
	02/28	• Ribonuclease and RNA interference
8	03/05	• Translation of RNA and unnatural amino acid incorporation • RNA library selection
	03/07	**Chapter 5. Peptide and Protein Structure** • Solid phase peptide synthesis • Expressed protein ligation
9	03/12	Protein folding • Stereoelectronic effect of peptide bond

		• Disulfide links • Protein modules for structural recognition
	03/ 14	• Protein conformational change • Kinase regulation
10		**Spring break, no class**
11	03/26	**Chapter 6. Protein Function** Protein recognition of ligand and substrates • Protein-ligand interaction • Enzyme-substrate interaction • Inhibitor of enzymes
	03/28	• Regulation of enzyme activity – kinase as an example • Enzyme catalysis – protease as an example • Protease inhibitor • Enzyme cofactors
11	04/02	• Protein evolution • Phage display • Yeast cell surface display • High throughput screening
	04/04	**Midterm exam 2**
12	04/09	**Chapter 9. Chemical Control of Signal Transduction** Signal transduction • Chemical signals • Basic signaling pathways • Nuclear receptors Signaling through cell surface receptors • Receptor tyrosine kinases • MAP kinase cascades • Secondary messengers • Sensing of chemical messengers
	04/11	G protein-coupled receptors and ion channels • Structure and function of GPCR • Structure and function of ion channels • Sensing of ions
13	04/16	Protein posttranslational modification • Mechanism • Drug development targeting protein modification
	04/18	**Chapter 7. Glycobiology** Structure of the glycans • Monosaccharide and oligosaccharide • Reactivity of the glycosidic bond • Glycosidase • Glycosyltransferase
14	04/23	Glycoproteins • N-linked glycans • O-linked glycans

		• O-GlcNAc modification • Recognition of glycans
	04/25	Glycoprotein functions • Glycan as vaccine • Glucose metabolism and diabetes
15	04/30	**Final Exam**