***Midterm II Guide for Chem109C***
***(Kahn, Spring 2007)***

Midterm II will be held on Wednesday, May 30th, 10–10:50 AM in Chem1179.

In general, exam questions are based on topics that we covered in the lectures since the first midterm. However, in some cases the textbook provides additional or more detailed examples of these topics and you are expected to be familiar with this material as well. Topics covered in quizzes and vitamin problems may be revisited in the exam. Furthermore, I anticipate that you are familiar with basic concepts of organic nomenclature, stereochemistry, and reactivity that were taught in Chem 109A and Chem109B.

**The exam questions are designed to test your knowledge and understanding of the following topics:**

**Amino Acids, Peptides and Proteins**

α-aminocarboxylic acids as a special group of amino acids
General structure of α-aminocarboxylic acids
D, L nomenclature
R, S nomenclature
Names and structures of:
- glycine,
- alanine,
- valine,
- serine,
- cysteine,
- aspartic acid,
- glutamic acid,
- asparagine,
- glutamine,
- phenylalanine,
- tyrosine,
- tryptophan, and
- lysine.

Acid-base properties of amino acids
Calculation of pI in amino acids and peptides (no more than three ionizable groups)
Separation of amino acids by electrophoresis and ion-exchange chromatography
Visualization of amino acids with ninhydrin
Hell-Vollhard-Zelinski synthesis of amino acids
Resolution of racemic mixture of amino acids with aminoacylase enzyme
Formation and structure of the peptide bond
Biological function of peptides
Structure, use, and hydrolysis of aspartame
Chemical synthesis of peptides: protecting and activation strategies
Merrifield solid-phase peptide synthesis

Formation and cleavage of disulfide bonds
Analysis of amino acid composition of peptides and proteins
Determination of N-terminal amino acid with phenyl isothiocyanate
Partial enzymatic hydrolysis with trypsin and chymotrypsin
Deduction of peptide sequences based on above analytical methods
Main secondary structure elements of proteins: α-helix and β-sheet
Interactions responsible for formation of tertiary and quaternary structure

**Catalysis**

Reasons for Biocatalysis in living cells
Reaction coordinate diagrams
The concept of transition state
Lowering the energy of transition state as means of catalysis
Intramolecular reactions, effective molarities, and catalysis by approximation
Chemical mechanisms of catalysis: principles and examples of:
- Acid base catalysis
- Covalent catalysis (nucleophilic catalysis)
- Metal ion catalysis
- Electrostatic catalysis

Catalytic mechanisms in
- Ketosteroid isomerase
- Haloalkane dehalogenase
- Alcohol dehydrogenase
- Chorismate mutatse
- Chymotrypsin, structure and the function of the catalytic triad

**Coenzymes**

Catabolism and anabolism as the two sides of metabolism
Apoenzyme, cofactors and holoenzyme
Vitamins and their relation to coenzymes
Structures of niacin (vitamin B3) and nicotinamide
Structure and chemistry of the redox cofactor $NAD^+$/NADH
Structure of chemistry of the redox cofactor $NADP^+$/NADPH
Mechanism of stereospecific oxidation of alcohols by alcohol dehydrogenase
Structure of flavin, riboflavin (vitamin B2), FAD, and $FADH_2$
FAD as oxidizing cofactor toward organic substrates with saturated alkyl groups
FMN as oxidizing cofactor toward NADH
Mechanism of oxidation of dihydrolipoate by FAD
Mechanism of activation of oxygen by $FADH_2$
Mechanism of reductive and oxidative half-reactions in cholesterol oxidase
Difference between oxidases and mono-oxygenases
Structure of tetrahydrofolate (THF) and Dihydrofolate (DHF)
Structure and mechanism of synthesis of methionine
Mechanism of thymidylate synthase
Inactivation of thymidylate synthase by 5-fluorouracil in cancer therapy

**Lipids**

General properties and biological roles of lipids
Classification into simple and complex lipids
Fatty acids: systematic nomenclature
Fatty acids: structures and common names of palmitic, and stearic acids
Physical properties of saturated fatty acids
Monounsaturated fatty acids: structure and properties of oleic and elaidic acids
Structure and physiological significance of polyunsaturated fatty acids
Oxidation of polyunsaturated fatty acids
Fats: structure and function in living organisms
Glycerophospholipids: general structure and function
Waxes and sphingolipids: general structure
Structure and function of cholesterol
Structure and function of testosterone
Biological role of estradiol
Synthesis of geranyl pyrophosphate from dimethylallyl pyrophospahate and isopentenyl pyrophosphate
Formation of farnesyl pyrophosphate
Pathways to cholesterol and retilal

**Nucleosides, Nucleotides, and Nucleic Acids**

Structures of heterocyclic compounds piperidine, pyridine, and imidazole
Structures of purine and pyrimidine
Structures of five common nucleobases
Structures of ribofuranoside and 2'deoxyribofuranoside
Phosphomonoesters, phosphodiesters, and phosphotriesters
Distinction between nucleobases, nucleosides, and nucleotides
Distinction between 3'nucleotides and 5'nucleotides
Complete chemical structures of ATP, GTP, UMP, CTP, TTP
Structure and biological role of cAMP
Biological function of ATP
Thermodynamics of ATP hydrolysis
Coupling of favorable and unfavorable reactions as means to make unfavorable reactions possible
Chemistry of phosphoryl transfer reactions
Biological significance of deoxyribonucleicacid (DNA)
The primary structure of DNA

**Miscellaneous**

Principles of organic reactivity
Basic instrumental/analytical techniques in organic chemistry (UV-Vis, MS, …)