In general, exam questions are based on topics that we covered in the lectures. However, in some cases the textbook provides 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. I anticipate that you are familiar with basic concepts of organic nomenclature, stereochemistry, and reactivity that were taught in Chem 109A and Chem 109B.

**Molecular Orbital Theory**
- Acids, bases, electrophiles, nucleophiles: connection with their electronic structure
- Familiar examples from Chem 109A, B (addition of HBr to alkenes, hydroboration)
- Bonding, nonbonding, and antibonding orbitals
- Drawing molecular orbital diagrams
- Frontier orbital theory; recognizing HOMO and LUMO orbitals in ground state molecules
- Description of chemical reactions as flow of electrons from one orbital to another
- Electron delocalization
- Stability of the allyl cation; reactions of allyl halides
- Conjugated vs. non-conjugated π systems
- Conjugation in amide; properties of the amide bond
- Properties and molecular orbitals of dienes; the Diels–Alder Reaction

**Ultraviolet Spectroscopy**
- Lambert–Beer law (not covered in lecture; you should know it!)
- n → π* and π → π* transitions
- Effect of conjugation in π system on λ_{max}
- London dispersion as the main force between nonpolar solute and solvent
- Dipole–dipole interaction as the force between polar solute and polar solvent
- MO-based explanation for the red shift in π → π* transitions in apolar alkenes
- MO-based explanation for the blue shift in n → π* transition in carbonyl compounds

**Reactivity due to the α-carbon in carbonyl compounds.**
- The acidity of the α-hydrogen in different systems
- Keto-enol tautomerization
- Reactivity of enols and enolates as good nucleophiles
- Halogenation at the α-carbon in aldehydes, ketones, and esters
- Halogenation at the α-carbon in carboxylic acids
- Alkylation of the β-carbon in α,β-unsaturated aldehydes and ketones.
- Aldol addition and aldol condensation: basic mechanisms
- Claisen condensation of esters: basic mechanism
- Possibility of formation of product mixtures in mixed Aldol and Claisen condensations
- What is so special about benzyl aldehyde?
- Structure and properties of LDA
- Modern synthetic strategies for carbon-carbon bond formation using enolate chemistry.
- Decarboxylation of 3-oxocarboxylic acids; relevance in biochemistry
Carbohydrates

**Structural aspects:**
- General formula and functional groups
- Classification based on number of carbons
- Classification based on the nature of the carbonyl functionality
- Classification based on the extent of polymerization (mono-, di-, oligo-, polysaccharides)
- Classification into D- and L-isomers
- Fisher projections, R, S nomenclature
- Enantiomers, diastereomers, epimers
- Structure of D-glyceraldehyde and L-glyceraldehyde
- Structures of D-ribose, D-glucose, D-mannose, D-galactose and D-fructose (open chain)
- Structures of D-ribose, D-glucose, D-mannose, D-galactose and D-fructose (cyclic, Haworth)
- Aldonic acids and aldaric acids
- Nomenclature of disaccharides: how to specify the linkage
- Be able to recognize simple disaccharides: maltose, cellobiose, trehalose, lactose, and sucrose

**Chemical reactions:**
- Oxidative chemistry of the aldehyde functionality: aldonic acids
- Oxidative chemistry of the primary alcohol functionality: aldaric acids
- Tollens test with aldoses and ketoses; enolization of ketoses
- Reductive chemistry of the aldehyde functionality
- Nucleophilic addition to carbonyl carbon
- Chain elongation: Kiliani-Fisher synthesis
- Chain shortening: Ruff degradation and Wohl degradation
- Formation and properties of hemiacetals
- Formation and properties of acetals, oxocarbenium ion mechanisms
- Intramolecular hemiacetal formation: cyclic structures
- α,β anomers; conformational stability in glucose
- Furanoses and pyranoses
- Formation of disaccharides
- Reducing and non-reducing disaccharides
- Acylation of free hydroxyl groups with acetic anhydride
- Alkylation of free hydroxyl groups with methyl iodide
- Reactions of 1,2-diols with periodic acids

**Analysis and properties:**
- Chiral properties of polyhydroxyaldehydes
- Chiral properties of aldonic acids
- Chiral properties of aldaric acids
- Identification of monosaccharides (e.g. Fisher’s proof of glucose structure)
- Mutarotation as tool to distinguish hemiacetals from acetals
- Determination of ring size via exhaustive methylation analysis
- Determination of disaccharide structures via exhaustive methylation analysis