Organic Chemistry c3444y

Course Review

1. Aromaticity.

   a. Recognizing/understanding aromaticity and antiaromaticity - 4n+2 rule, and polygon in circle (Frost) method.

   b. Differences in resonance energy from benzene to naphthalene to anthracene to phenanthrene.

   c. Predicting reactivity based on knowledge of aromaticity and antiaromaticity.

   d. Heterocyclic aromatic compounds: pyridine, the difference between the two nitrogens of imidazole, etc.

2. Electrophilic Aromatic Substitution, Nucleophilic Aromatic Substitution/Benzyne

   a. Mechanism and theory. What is the basic mechanism of EAS? Why are different groups ortho/para or meta directors? What does it mean for something to be a deactivator or an activator? The special nature of the halides. S_NAr mechanism and benzyne mechanism, and how to tell which one is/will be operative. Understanding the requirements for S_NAr mechanism.

   b. Synthesis. (And mechanisms of) Friedel-Crafts alkylation and acylation, nitration, halogenation, sulfonation. Various uses of S_NAr and benzyne to synthesize substituted benzene rings. Diazotization/Sandmeyer Reactions.

3. Aldehydes and Ketones.

   a. Structure and theory. π-bond formed from p orbital on C and p orbital on O. IR C=O stretch - why do α,β-unsaturated aldehydes and ketones show up at lower frequency than their saturated counterparts? Why are protons on the α-carbon acidic (enolizable)? Why does protonating the oxygen of a carbonyl make it more susceptible to nucleophilic attack? Why do Michael additions occur?

   b. Mechanism. Simple nucleophilic attack; hydrate, enol, hemiacetal and acetal formation and hydrolysis; imine/iminium ion formation and hydrolysis; Wittig; Baeyer-Villiger oxidation; Aldol addition and condensation (both backwards and forwards!); Michael addition; Mannich reaction; Enamines as a good substitute for enolate chemistry

   c. Synthesis. **Retrosynthetically, an α,β-unsaturated aldehyde or ketone means aldol condensation.** Understand how to "disconnect" to two carbonyls. Understand how to "disconnect" an acetal. Know at least one way to reduce aldehydes and ketones to alcohols and one way to oxidize alcohols to aldehydes and ketones. Use of Baeyer-Villiger, Wittig, Michael and Mannich reactions in synthesis.

4. Carboxylic Acids and Derivatives, and β-Dicarbonyl chemistry.

   a. Structure and theory. Resonance and hybridization of all relevant atoms in esters and amides. IR C=O stretch of esters, amides and acid chlorides vs. eachother and vs. aldehydes and ketones. Extra stability of enolate derived from a β-dicarbonyl.

   b. Mechanism. Fischer esterification (not very different from acetal formation); Amide formation using DCC; saponification of esters (what is the driving force?); acidic and basic hydrolysis of amides; formation of acid chlorides; simple acylations using acid chlorides or anhydrides; decarboxylations; Claisen (and Dieckmann) condensations (what is the driving force? what happens if this driving force is not possible?).

   c. Synthesis. Claisen (Dieckmann): β-ketoester (When will a backwards Claisen (Dieckmann) happen?). Use of β-ketoesters or β-diesters for alkylation or Michael addition followed by saponification and decarboxylation (malonic ester and acetoacetic ester syntheses).

5. Amines.

a. Structure and theory. Not a lot. Basicity of Amines vs. anilines vs. pyridine vs. imidazole.

b. Mechanism. Reductive amination; Curtius and Hoffman rearrangements; diazotization.

c. Synthesis. Reductive amination; Curtius and/or Hoffman rearrangements; reduction of nitro to NH_2; diazotization of amino acids.

6. Carbohydrates.

a. Classification, naming, and stereochemistry. D vs. L; pyranose vs. furanose; α vs. β; aldose vs. ketose; triose, tetrose, pentose, hexose etc.; drawing Fischer projections from chair forms and vice versa.

b. Mechanism. Mostly just acetal and hemiacetal chemistry, and the isomerizations with ^-OH.

c. Synthesis. Again mostly acetal/hemiacetal chemistry, the Kiliani-Fischer Synthesis, the Wohl degradation and the Danishefsky synthesis of polysaccharides.

7. Amino acids and Proteins.

a. Structure of amino acids and polypeptide chains. Structure of amides relevant here.

b. Synthesis of amino acids. Strecker synthesis and the other methods which are simply versions of chemistry we have seen before. Also, amide bond formation (e.g. DCC) relevant here.

c. Secondary structure of polypeptide chains: β-pleated sheets, α-helices and β-turns.

d. Basic enzyme catalysis mechanisms.

e. Cofactors; how thiamine and pyridoxal can act as electron sinks for decarboxylations and other reactions; NAD^+ and NADH for oxidation/reduction chemistry.