

# Test 3 Topic Summary – Chapters 20-22

## Chapter 20: Carboxylic Acids

- Naming Carb. Acids, Acid Halides, Anhydrides, Amides, Esters, Nitriles
- Acidity of Carb. Acids - fine tuning with electron withdrawing/donating groups
- Substituted Benzoic Acids - acidity and correlation to benzene reactivity in Electrophilic Aromatic Substitution reactions
  
- Synthesis of Carb. Acids
  - $\text{KMnO}_4$  cleavage of alkyl benzenes
  - $\text{KMnO}_4$  cleavage of alkenes
  - Jones Oxidation of  $1^\circ$  alcohols and aldehydes ( $\text{CrO}_3$ ,  $\text{H}_2\text{SO}_4$ , acetone)
  - $\text{Ag}_2\text{O}$  Oxidation of aldehydes ( $\text{Ag}_2\text{O}$ ,  $\text{NH}_4\text{O}$ )
  - Acidic or basic hydrolysis of nitriles - **mechanism** (chapter 21)
  - Grignard addition to  $\text{CO}_2$  – **mechanism**
  
- Reactions of Carboxylic Acids
  - $\text{LiAlH}_4$  Reduction to  $1^\circ$  alcohols (1.  $\text{LiAlH}_4$  2.  $\text{H}^+$ )
  - $\text{BH}_3$  Reduction to  $1^\circ$  alcohols (1.  $\text{BH}_3$  2.  $\text{H}^+$ ) (selective for carb. acids)

## Chapter 21: Carboxylic Acid Derivatives – Acyl Substitutions

- Reactivity trend (acid halides > anhydride > ester > amide)
  
- Synthesis of Acid Halides:
  - Thionyl chloride ( $\text{SOCl}_2$ ) reaction of carb. acid to make acid chloride - **mechanism**
  - Phosphorous tribromide ( $\text{PBr}_3$ ) reaction of carb. acid to make acid bromide
  
- Reactions of Acid Halides
  - Treatment with  $\text{H}_2\text{O}$  and pyridine to make carb. acid – **mechanism**
  - Treatment with  $1^\circ$  or  $2^\circ$  amine and pyridine to make amide – **mechanism**
  - Treatment with 1)  $\text{LiAlH}_4$  and 2)  $\text{H}^+$  to form  $1^\circ$  alcohol – **mechanism**
  - Treatment with Grignard reagent to give  $3^\circ$  alcohol – **mechanism**
  - Treatment with Gilman ( $\text{R}_2\text{CuLi}$ ) to form ketone
  - Treatment with alcohol and pyridine to form ester – **mechanism**
  
- Synthesis of Acid Anhydrides from Acid Halide and Carboxylic Acid
  
- Reactions of Acid Anhydrides – same as Acid Halide reactions (unsymmetrical anhydrides give product mixtures)

- Other formation of Ester: Fischer Esterification (carb. acid + alcohol) – **mechanism**
- Reactions of Esters
  - Hydrolysis to alcohol and carb. acid under acidic **or** basic conditions – **mechanisms**
  - Treatment with 1° or 2° amine to form amide – **mechanism**
  - Treatment with LAH to give 1° alcohol – **mechanism**
  - Treatment with DIBAL to give aldehyde
  - Treatment with Grignard or alkyl lithium to give 3° alcohol – **mechanism**
- Reactions of Amides
  - Hydrolysis to carb. acid and amine under acidic **or** basic conditions – **mechanisms**
  - Reduction with LAH to form amine – **mechanism**
- Formation of Nitriles
  - Via S<sub>N</sub>2 pathway – CN<sup>-</sup> attack of 1° alkyl halide – **mechanism**
  - Via 1° amide with thionyl chloride (SOCl<sub>2</sub>) – **mechanism**
- Reactions of Nitriles
  - Hydrolysis to carb. acid and ammonia under acidic **or** basic conditions – **mechanisms**
  - Reduction with 1) LAH and 2) water to form 1° amine
  - Reduction with 1) DIBAL and 2) water to form aldehyde
  - Reaction with 1) Grignard reagent and 2) H<sup>+</sup> to form ketone

## Chapter 22: Carbonyl Alpha Substitution

- Ketone / Enol equilibrium
- Enol Halogenation with X<sub>2</sub> and acetic acid – **mechanism**
- Hell-Volhard-Zelinski α-Bromination of Carboxylic Acids with 1) PBr<sub>3</sub>, Br<sub>2</sub> and 2) water
- α-Hydrogen acidity
- Haloform reaction: Treatment of methyl ketone with X<sub>2</sub> and NaOH to give carb. acid and CHX<sub>3</sub>
- Malonic Ester Synthesis – **mechanism**
- Acetoacetic Ester Synthesis – **mechanism**
- Other enolate alkylations (S<sub>N</sub>2) – **mechanism**