B.Sc. Semester-VI
Organic Chemistry
Paper-XIV

3. Heterocyclic Compounds

Coverage:
3. Furans, Pyrroles and Thiophenes : Methods For Synthesis

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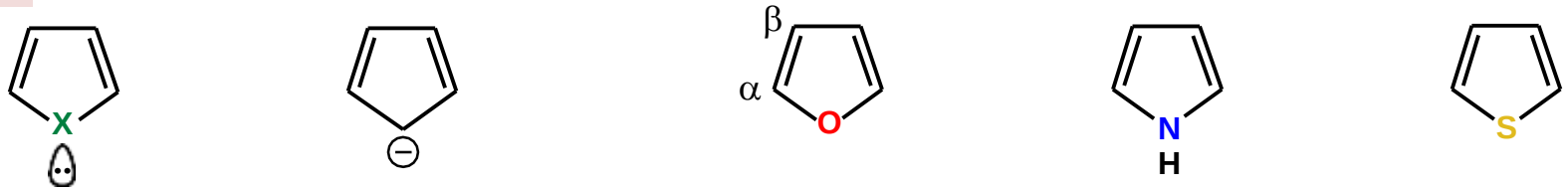
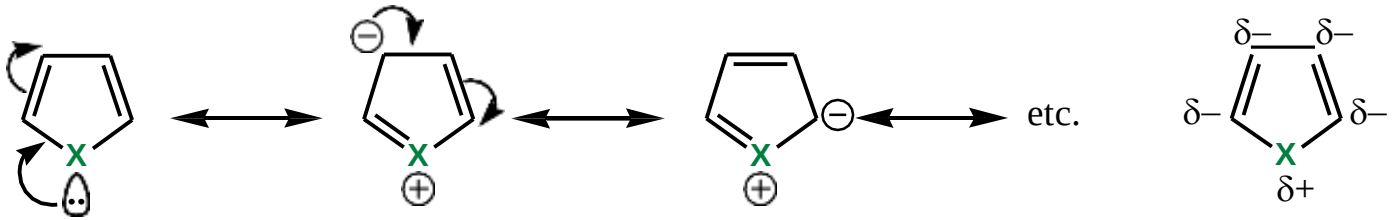
Furans, Pyrroles and Thiophenes

Structure

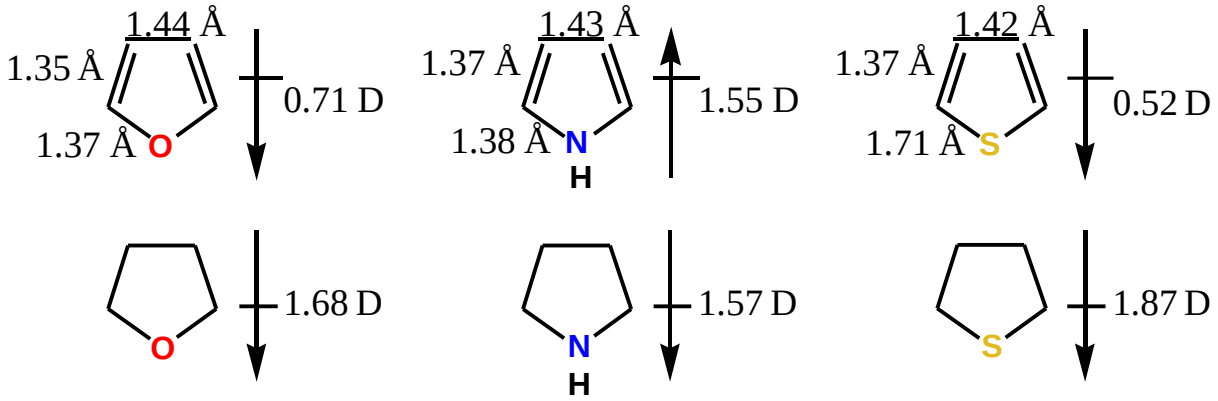


- 6 π electrons, planar, aromatic, isoelectronic with cyclopentadienyl anion

Resonance Structures



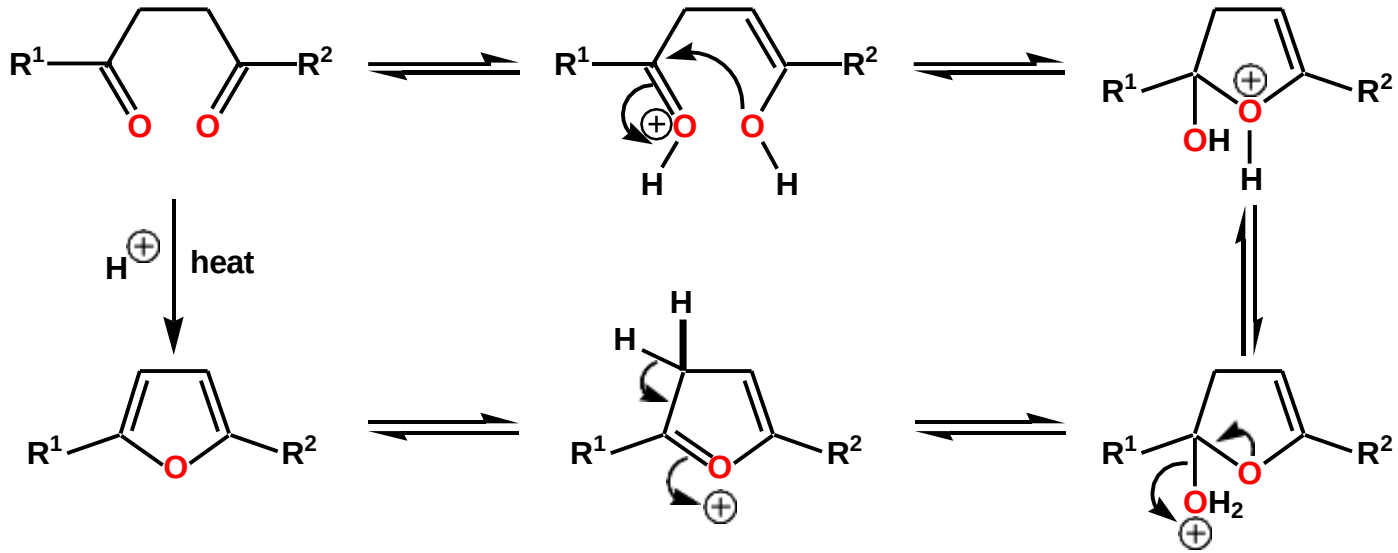
- Electron donation into the ring by resonance but inductive electron withdrawal



- *O* and *S* are more electronegative than *N* and so inductive effects dominate

Furans – Synthesis

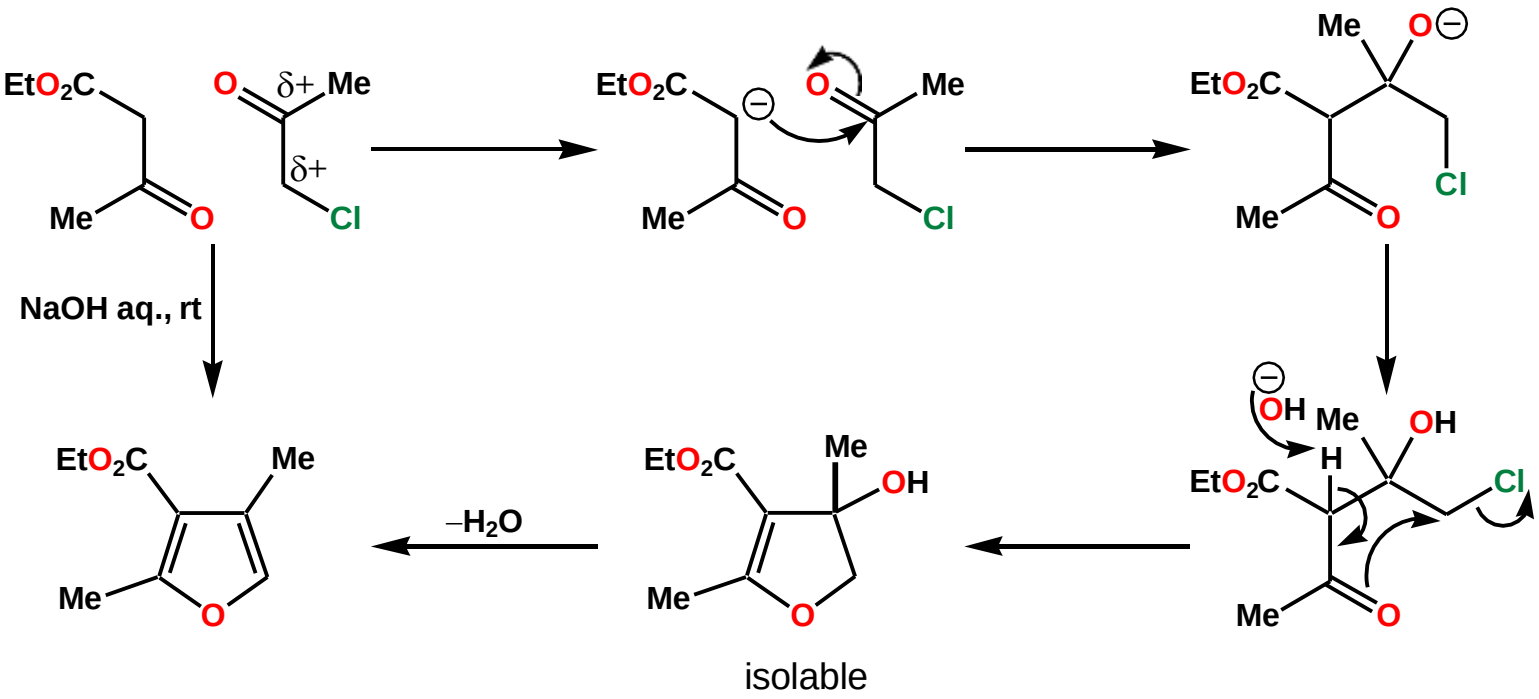
The Paal-Knorr Synthesis



- The reaction is usually reversible and can be used to convert furans into 1,4-diketones
- A trace of acid is required – usually TsOH (*p*-$MeC_6H_4SO_3H$)

Furans – Synthesis

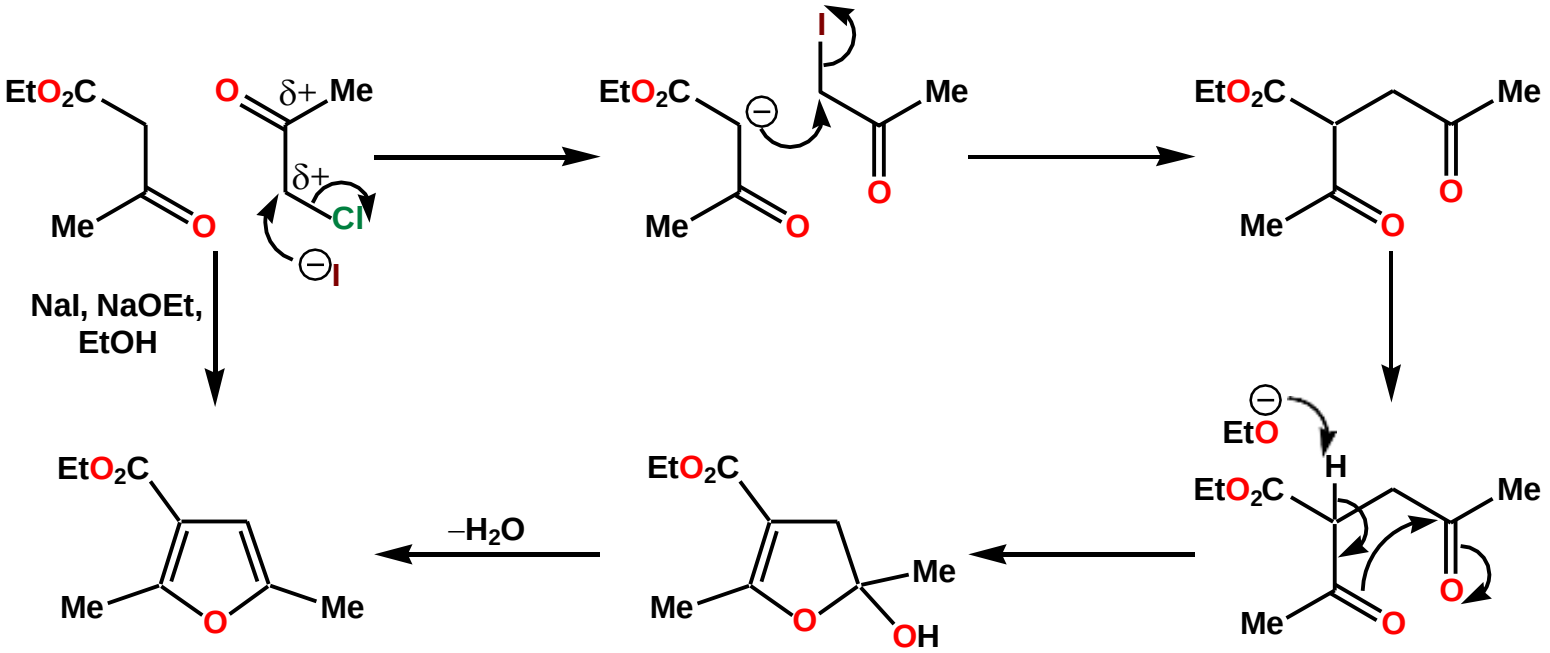
Feist-Benary Synthesis



- The product prior to dehydration can be isolated under certain circumstances
- Reaction can be tuned by changing the reaction conditions

Furans – Synthesis

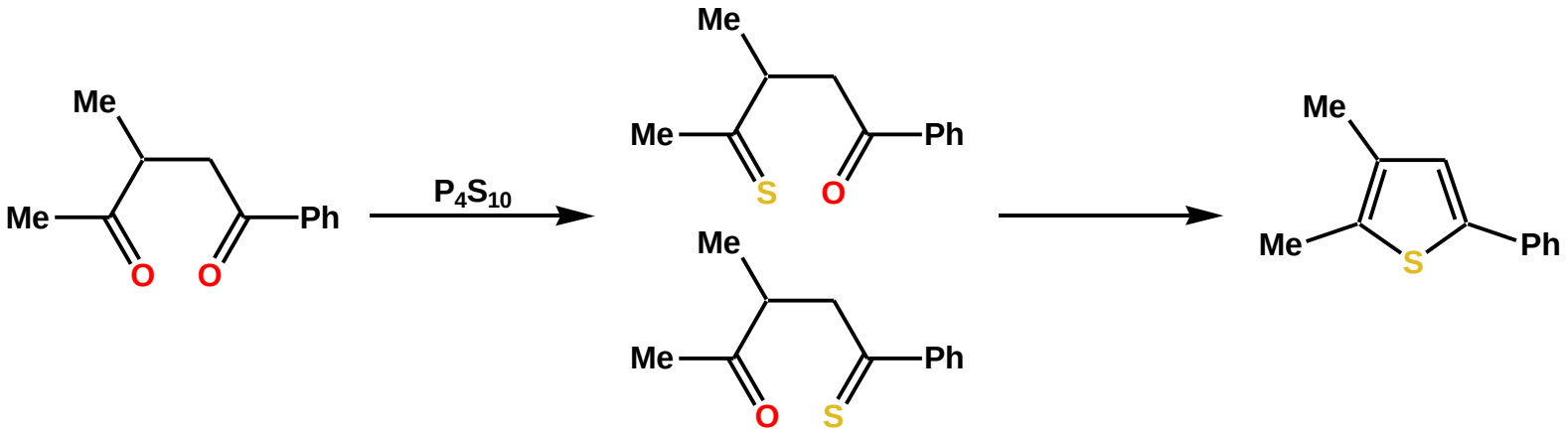
Modified Feist-Benary Synthesis



- Iodide is a better leaving group than Cl and the carbon becomes more electrophilic
- The Paal Knorr sequence is followed from the 1,4-diketone onwards
- The regiochemical outcome of the reaction is completely altered by addition of iodide

Thiophenes – Synthesis

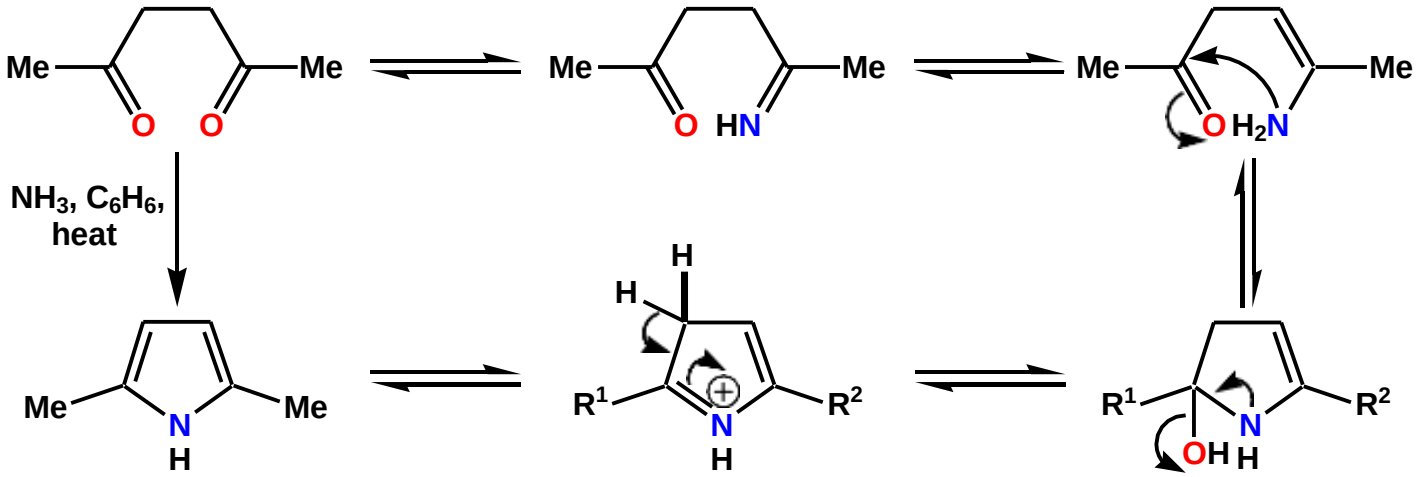
Synthesis of Thiophenes by Paal Knorr type reaction



- Reaction might occur *via* the 1,4-*bis*-thioketone

Thiophenes – Synthesis

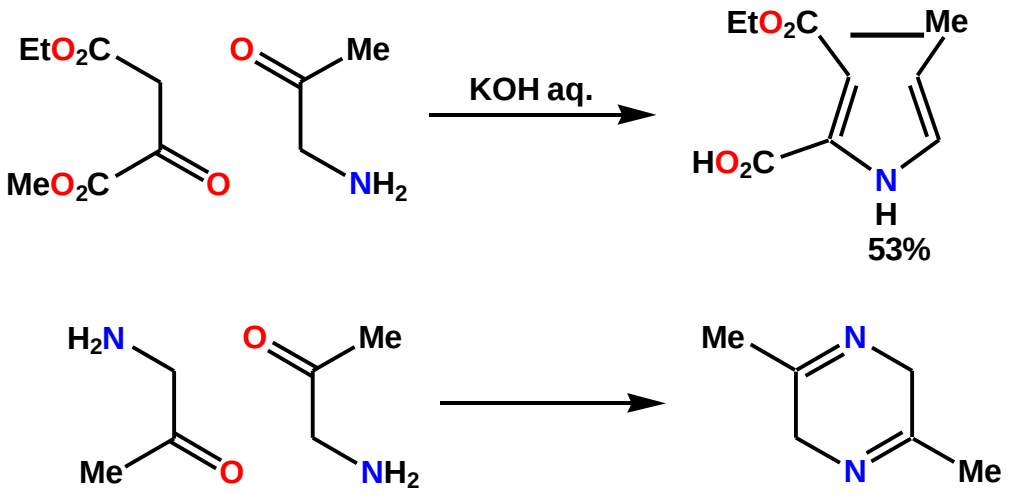
The Paal-Knorr Synthesis



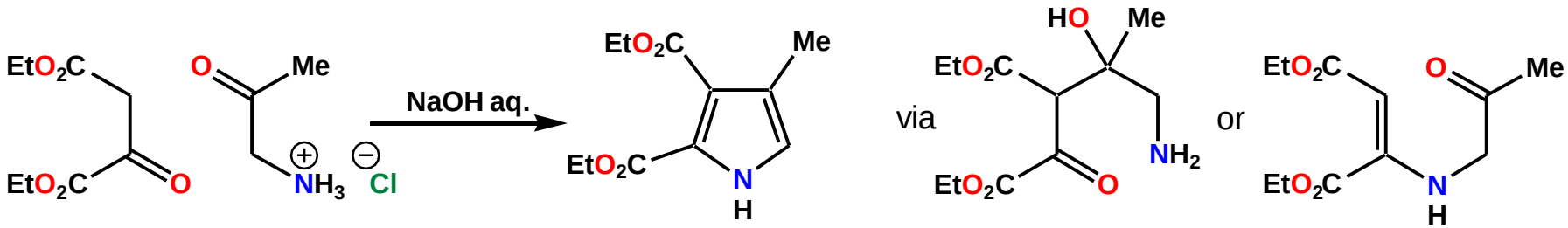
- Ammonia or a primary amine can be used to give the pyrrole or *N*-alkyl pyrrole

Pyrroles – Synthesis

The Knorr Pyrrole Synthesis



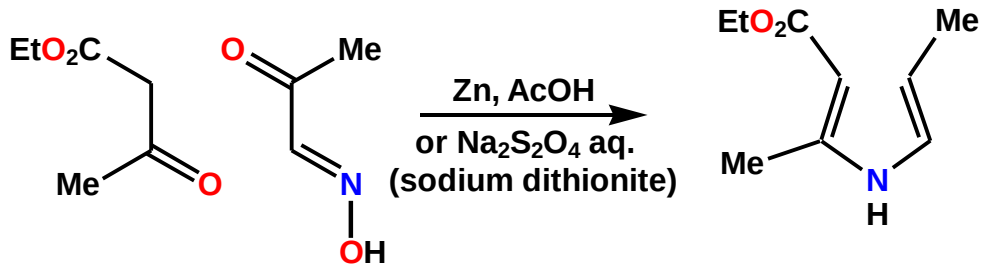
- Use of a free amino ketone is problematic – dimerisation gives a dihydropyrazine



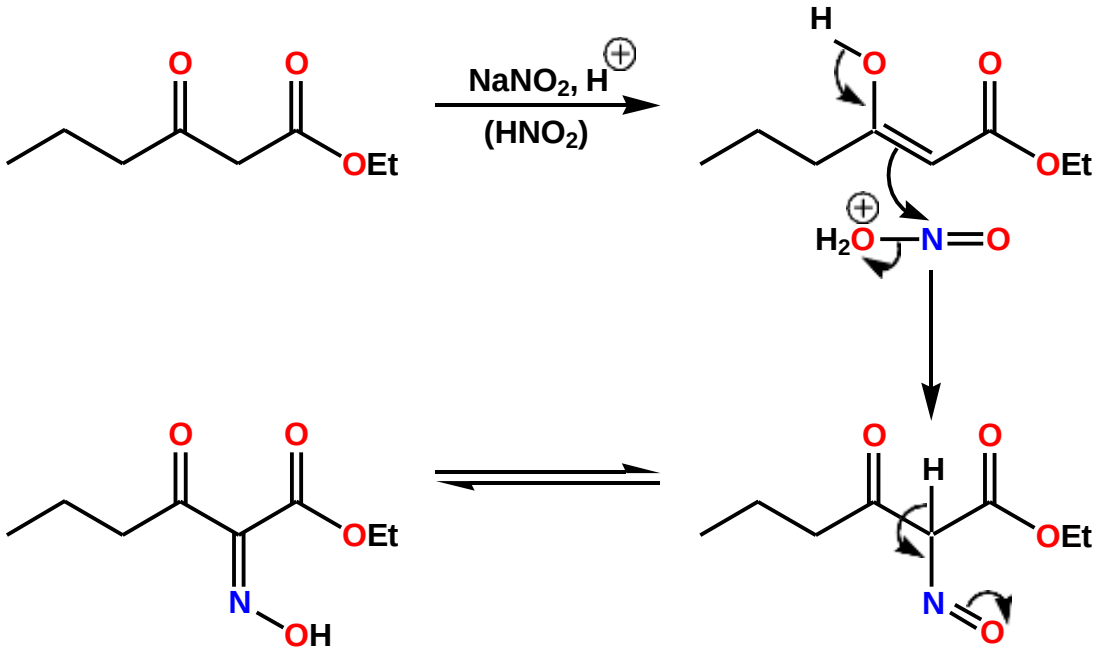
- Problem can be overcome by storing amino carbonyl compound in a protected form
- Reactive methylene partner required so that pyrrole formation occurs more rapidly than dimer formation

Pyrroles – Synthesis

Liberation of an Amino Ketone *in situ* by Oxime Reduction

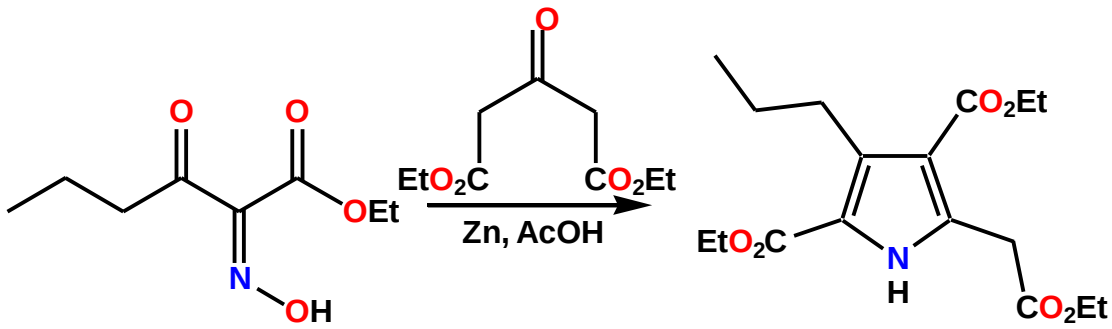


Preparation of α-Keto Oximes from β-Dicarbonyl Compounds

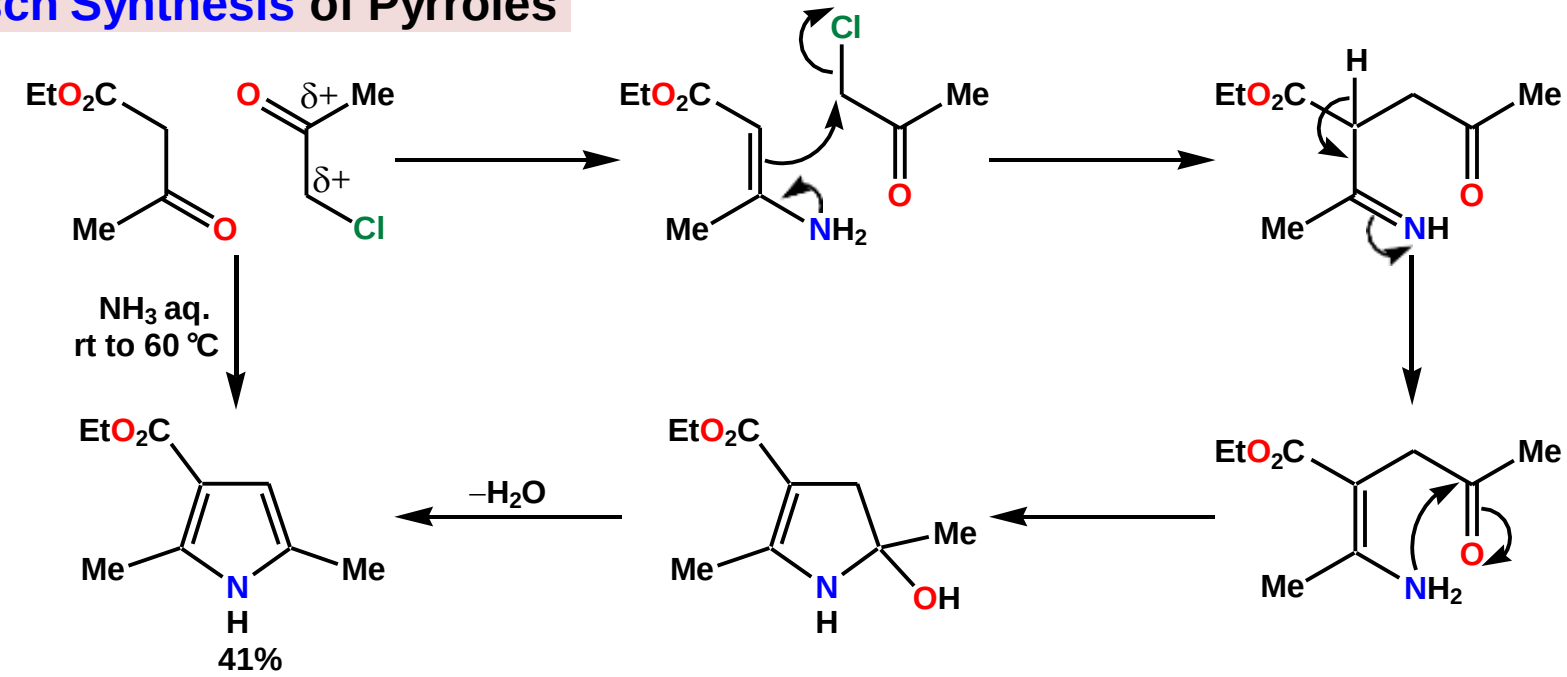


Pyrroles – Synthesis

One-Pot Oxime Reduction and Pyrrole Formation



Hantzsch Synthesis of Pyrroles



- A modified version of the Feist-Benary synthesis and using the same starting materials: an α-halo carbonyl compound and a β-keto ester

THANK YOU