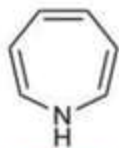
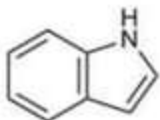


# CONTENT

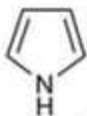
Properties, synthesis, reactions & medicinal uses of...



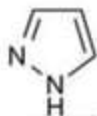
azepine



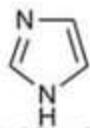
indole



pyrrole



pyrazole



imidazole



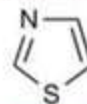
furan



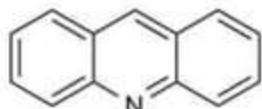
oxazole



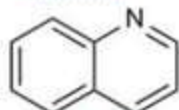
thiophene



thiazole



acridine



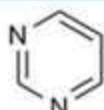
quinoline



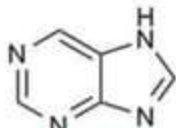
isoquinoline



pyridine



pyrimidine

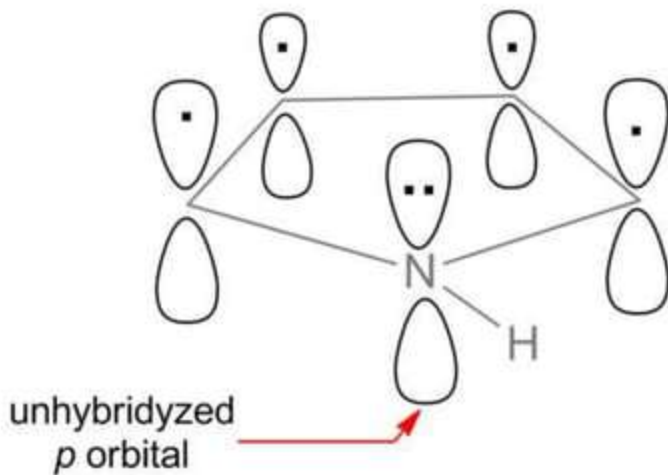


purine

# PYRROLE

## Properties

### 1. Aromaticity



## Properties

### 1. Aromaticity

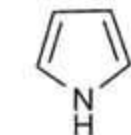
- Pyrrole have 4 C and 1 N , all are  $sp^2$  hybridized
- $sp^2$  hybridization is **planar**, it makes a planar pyrrole ring structure.
- Each ring atom also contains unhybridized  $p$  orbital that is perpendicular to the plane of  $\sigma$  bonds (plane of ring).
- Here  $p$  orbitals are parallel to each other, so overlapping btwn  $p$  orbitals is possible.
- the total nu of non bonding e- are 6 (4 of four C, 2 from one N)
- The resonance of 6 e- follows the Hückel's rule
- So the pyrrole is aromatic .

# PYRROLE

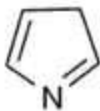
## Properties

### 2. Tautomerism

- Rapid migration of hydrogen from N to the C.



1H-pyrrole

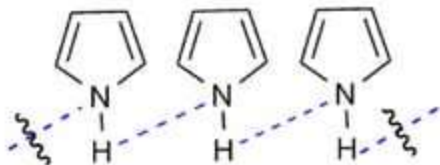


3H-pyrrole

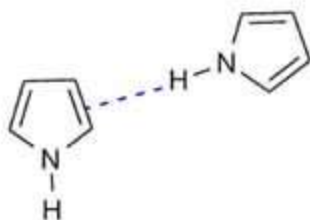


2H-pyrrole

### 3. Hydrogen bonding



Intramolecular H-bonding  
(rise b.p.)



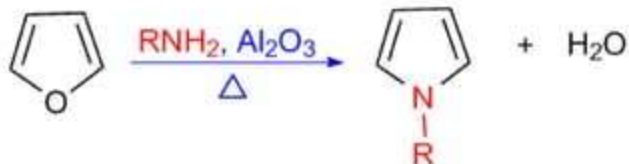
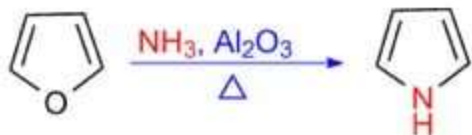
Intramolecular H-bonding  
btwn N-H &  $\pi$ -e- system

# PYRROLE

## Synthesis

### 1. From Furans

- Industrial process
- Passing furan over **ammonia** in presence of **alumina** as catalyst at high temp.

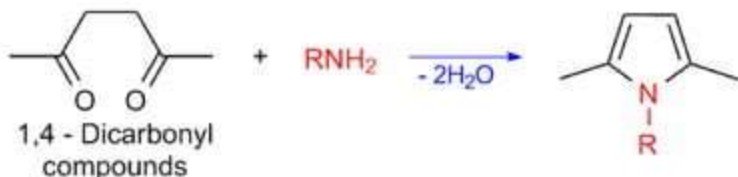


# PYRROLE

## Synthesis

### 2. Paal-Knorr synthesis

- 1,4 - Dicarbonyl compounds react with **ammonia** or **primary amines** to give pyrroles.



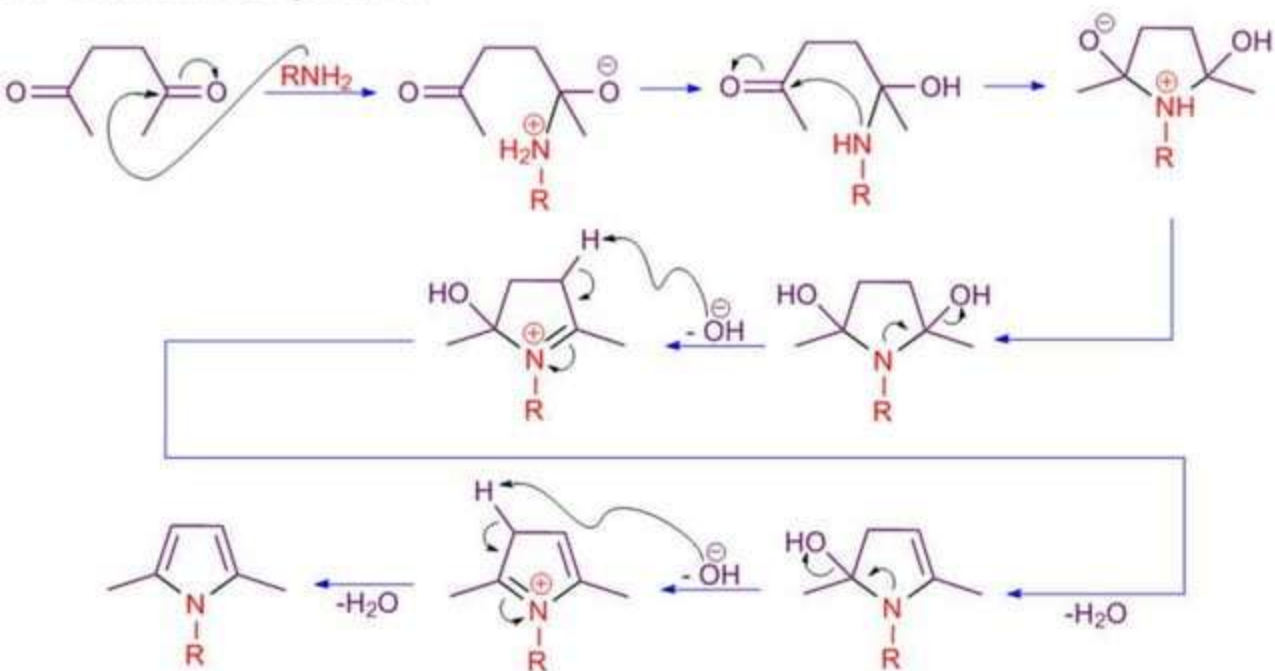
## Mechanism

- Successive nucleophilic additions of the amine nitrogen to each of the two carbonyl carbon atoms, imine formation and the dehydration represent the net course of the synthesis.

# PYRROLE

## Synthesis

### 2. Paal-Knorr synthesis

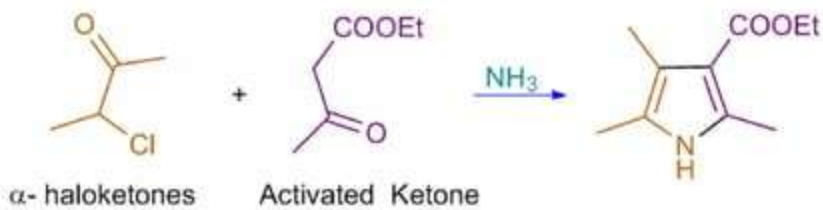


# PYRROLE

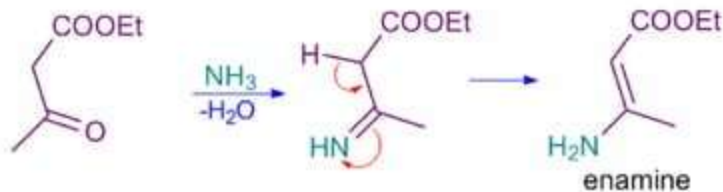
## Synthesis

### 3. Hantzsch Pyrrole synthesis

- Reaction of  $\alpha$ -haloketones with  $\beta$ -ketoesters and ammonia results in pyrrole



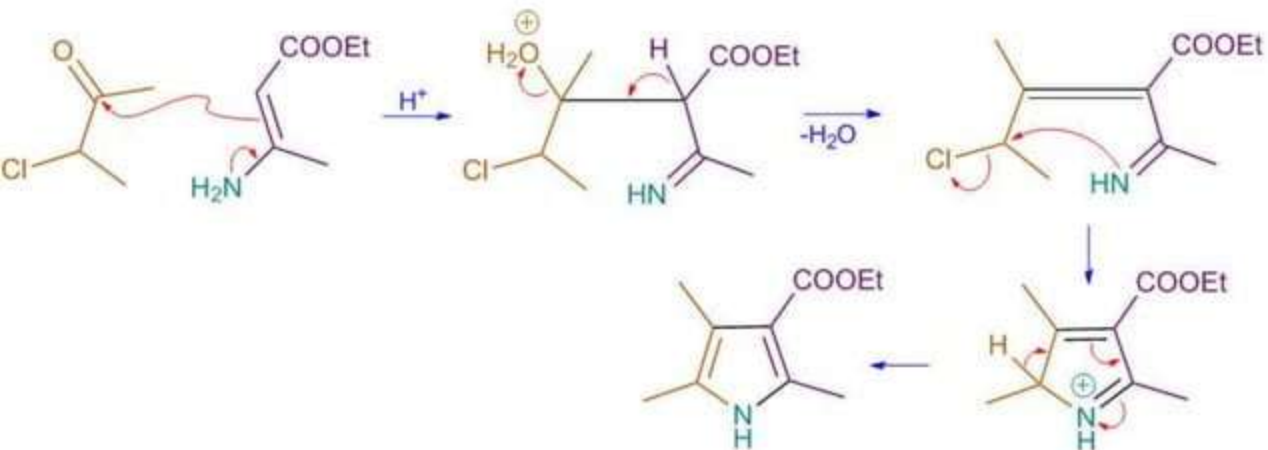
## Mechanism



# PYRROLE

## Synthesis

### 3. Hantzsch Pyrrole synthesis

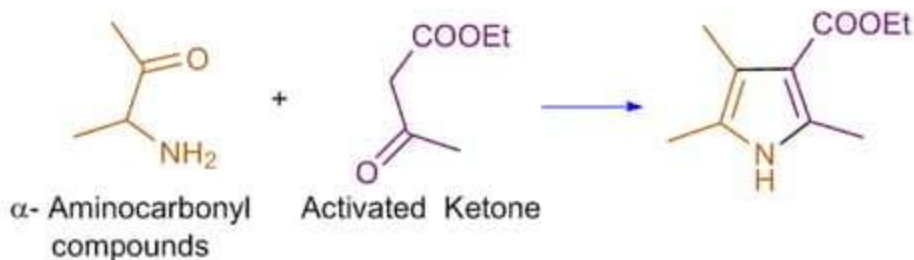


# PYRROLE

## Synthesis

### 4. Knorr synthesis

- Condensation of  $\alpha$ -aminocarbonyl component with 2<sup>nd</sup> component containing an electron-withdrawing group (e.g. an ester)  $\alpha$  to a carbonyl group

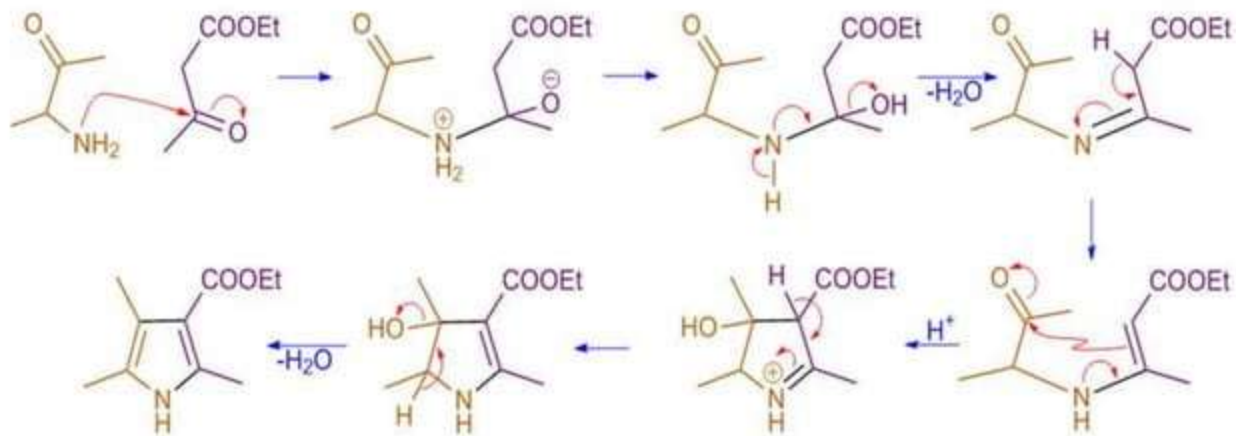


# PYRROLE

## Synthesis

### 4. Knorr synthesis

#### Mechanism

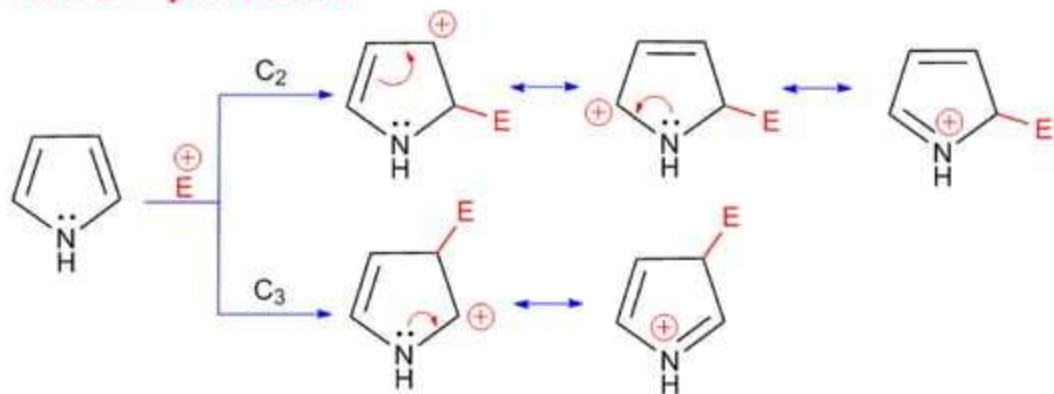


# PYRROLE

## Reactions

### 1. Electrophilic substitution

Pyrrole undergoes electrophilic substitution reaction at 2<sup>nd</sup> position



2 reasons...

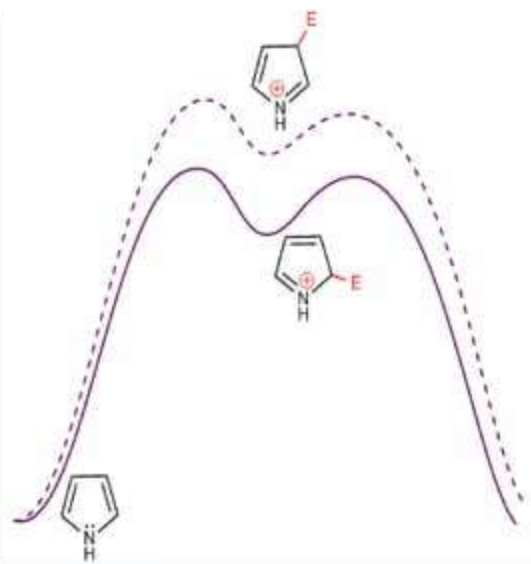
- C2 attack gives more resonance contributing structures than C3.
- Extra stable contributing structure generates upon C2 attack

# PYRROLE

## Reactions

### 1. Electrophilic substitution

Pyrrole undergoes electrophilic substitution reaction at 2<sup>nd</sup> position

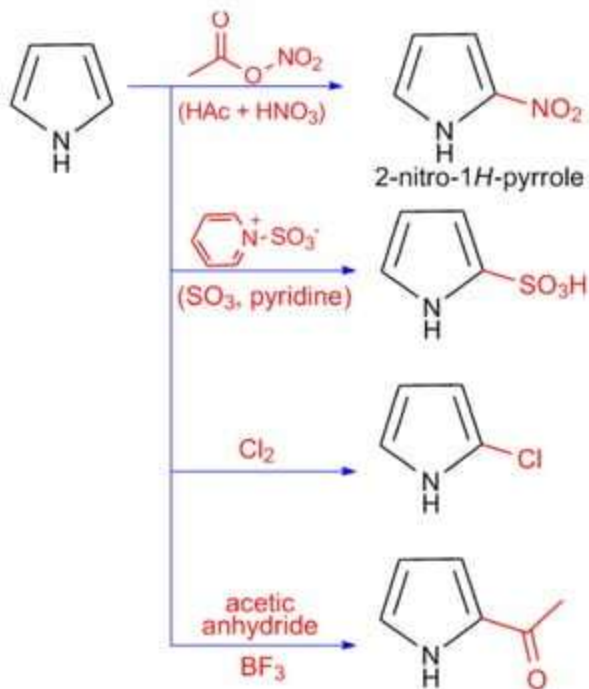
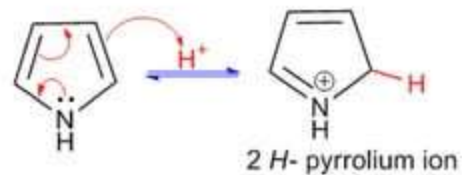
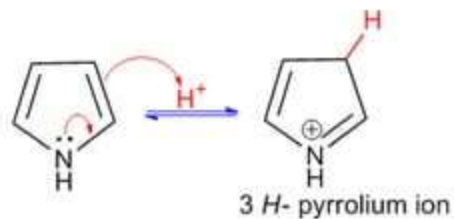


- Energy diagram shows C2 attack forms more stable intermediate than C3
- Hence C2 preferred over C3

# PYRROLE

## Reactions

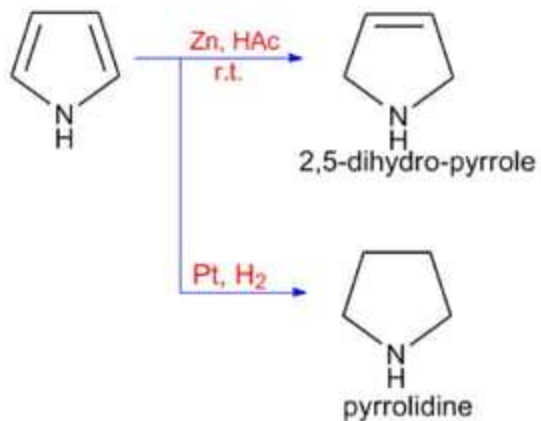
### 1. Electrophilic substitution



# PYRROLE

## Reactions

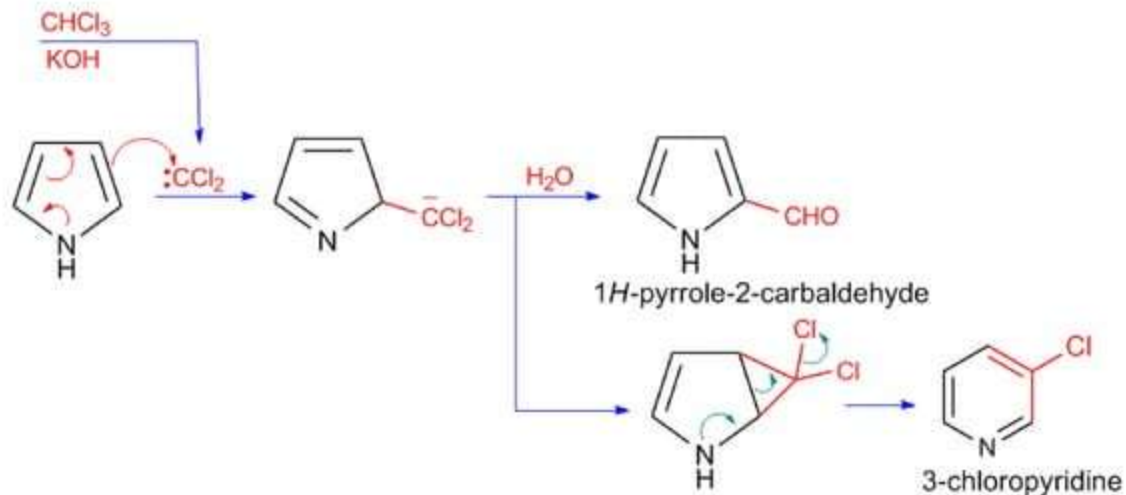
### 2. Reduction



# PYRROLE

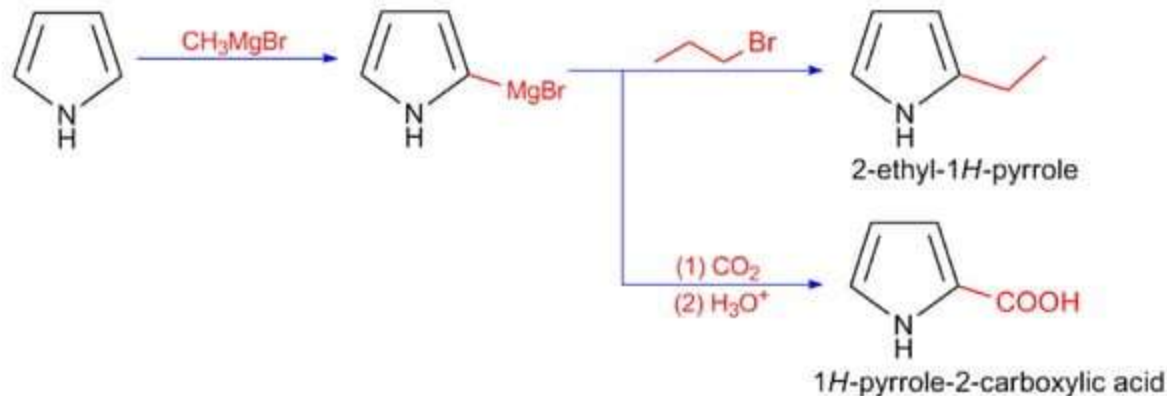
## Reactions

### 3. Reimer Tiemann reaction



# PYRROLE

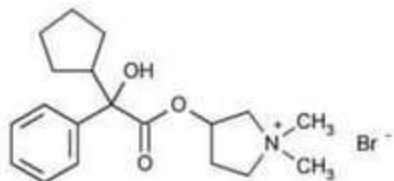
## Reactions



# PYRROLE

## Medicinal uses

(1) *Glycopyrrolate*, anticholinergic drug: used in Peptic ulcer



(2) *Atorvastatin* used in management of high cholesterol and high blood pressure.

