



College of Medicine



Aldehydes and Ketones

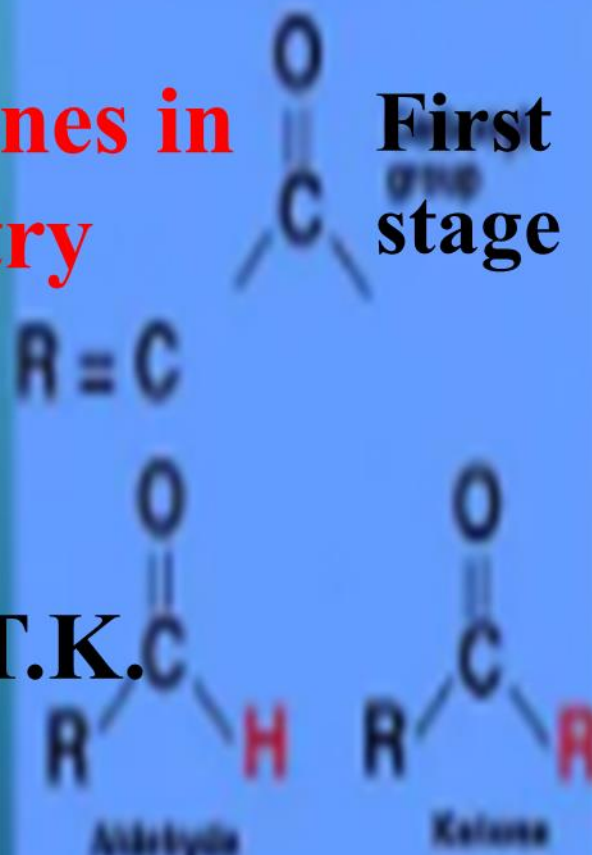
Medical Chemistry

Lecture
No. 2

**Aldehydes and Ketones in
Medical Chemistry**

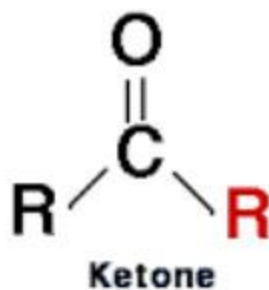
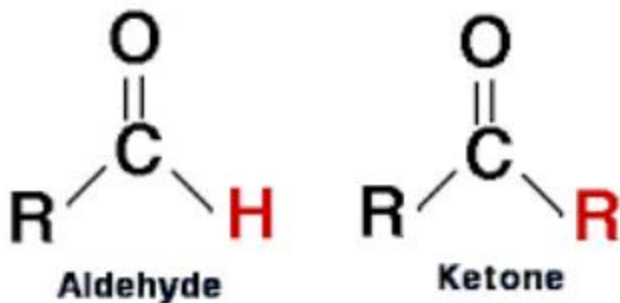
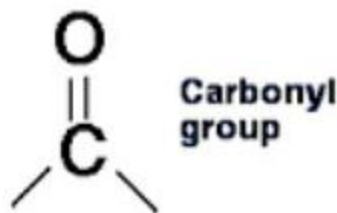
**First
stage**

Prof. Dr. Talat T.K.



Aldehydes and Ketones in Medical Chemistry

Aldehydes and ketones are important organic compounds containing the carbonyl (-C=O) functional group. They play a crucial role in medical chemistry due to their involvement in biological metabolism, pharmaceutical applications, and drug synthesis.



1. Structure and Classification

Aldehydes (-CHO)

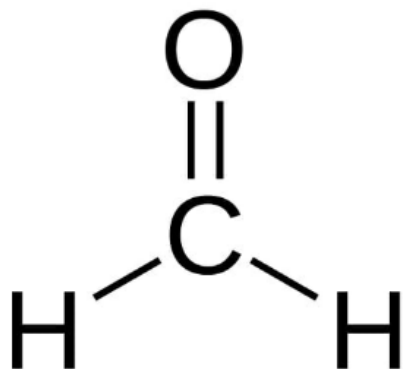
The carbonyl group is at the end of the carbon chain.

General formula: **R-CHO**

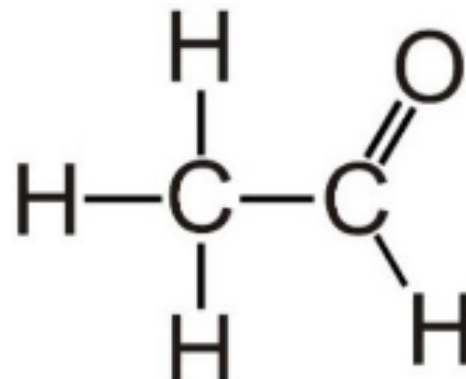
Naming: Replace -e of the parent alkane with -al (e.g., Methanal (Formaldehyde), Ethanal (Acetaldehyde)).

Example:

Formaldehyde (HCHO),



Acetaldehyde (CH₃CHO)



ketones (-CO-)

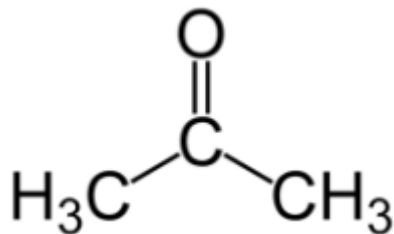
The carbonyl group is within the carbon chain (between two carbon atoms) or (not at the end).

General formula: R-CO-R'

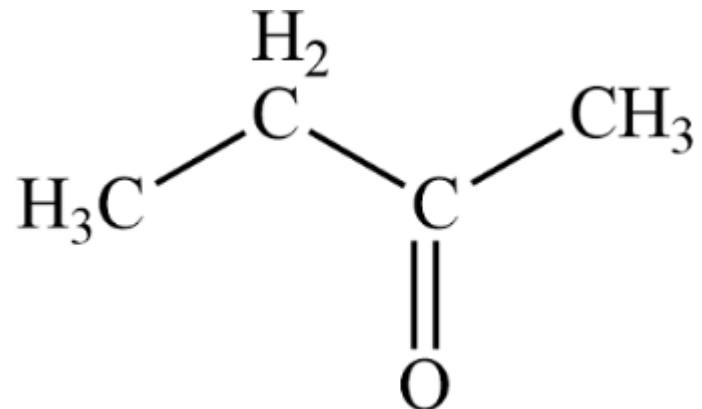
Example:

Naming: Replace -e of the parent alkane with -one (e.g., Propanone (Acetone), Butanone).

Acetone (CH_3COCH_3),



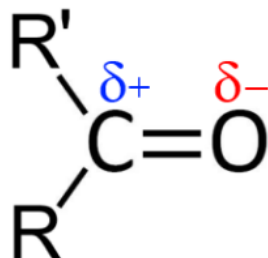
Butanone ($\text{CH}_3\text{COCH}_2\text{CH}_3$)



2. Physical and Chemical Properties

Physical Properties

Polarity: Both are polar due to the carbonyl group.



Solubility: Short-chain aldehydes and ketones dissolve in water, but solubility decreases with longer carbon chains. Aldehydes and ketones are water-soluble due to hydrogen bonding

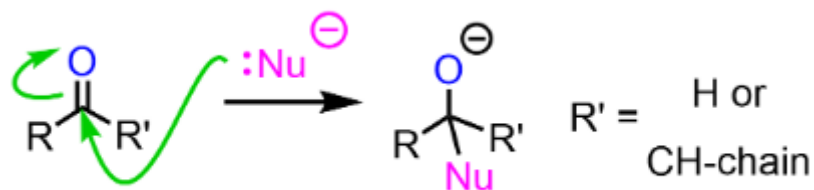
Boiling Points: Higher than alkanes but lower than alcohols due to dipole-dipole interactions

Chemical Properties

1. Nucleophilic Addition Reactions

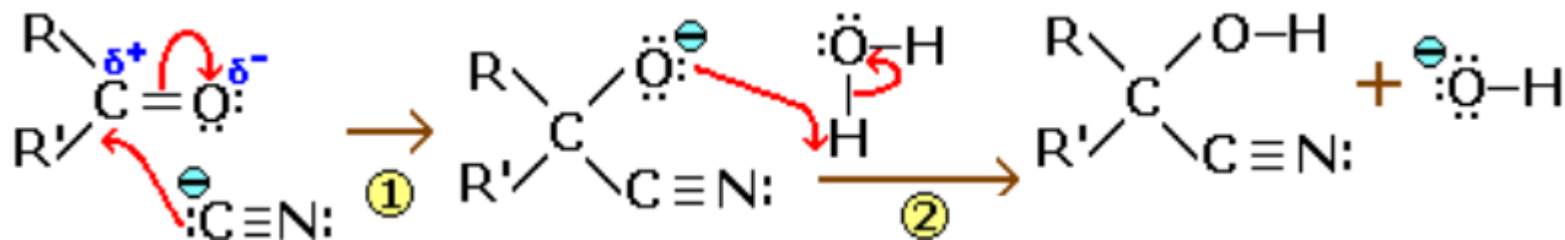
Aldehydes and ketones undergo nucleophilic addition reactions, important in drug synthesis and biochemical reactions. (In chemistry, a nucleophile is a chemical species that forms bonds by donating an electron pair)

Examples:

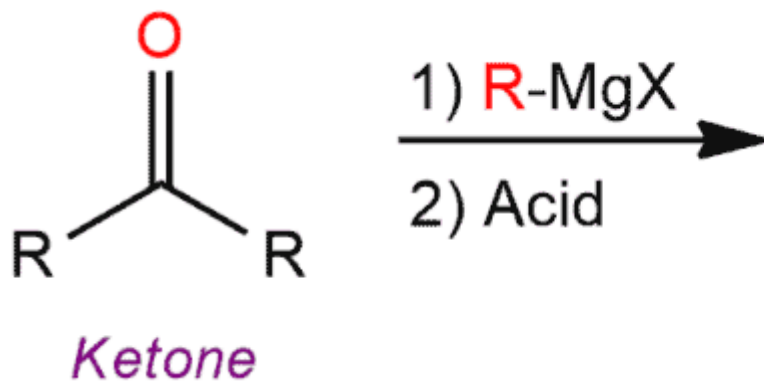
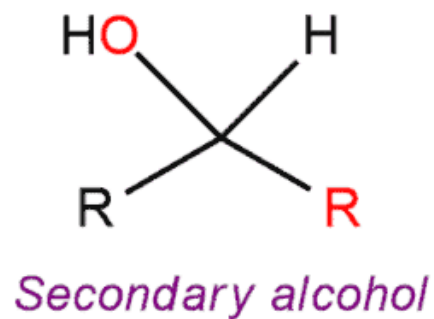
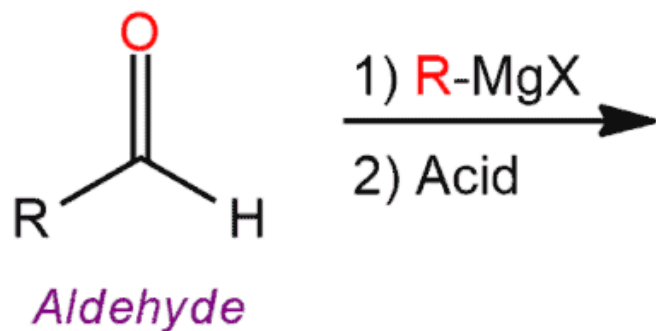
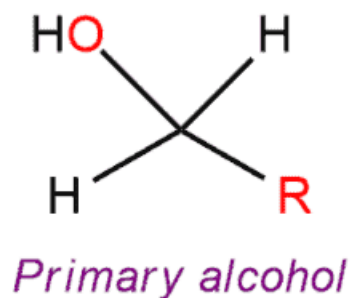
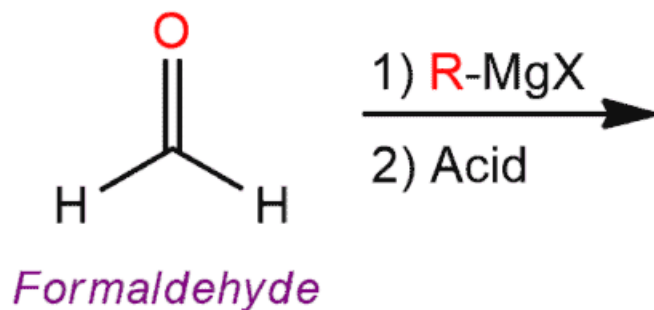


attack due to the partial positive charge on the carbonyl carbon.

Addition of hydrogen cyanide (HCN) $\rightarrow$ Cyanohydrin formation

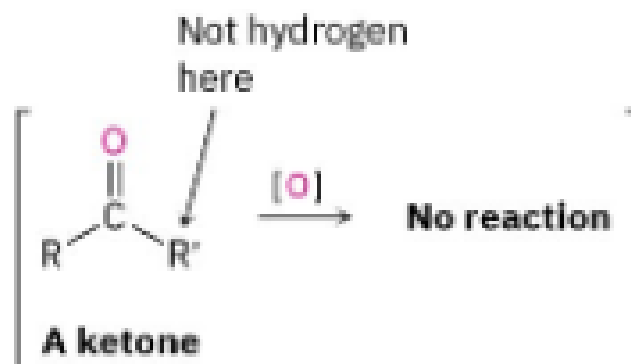
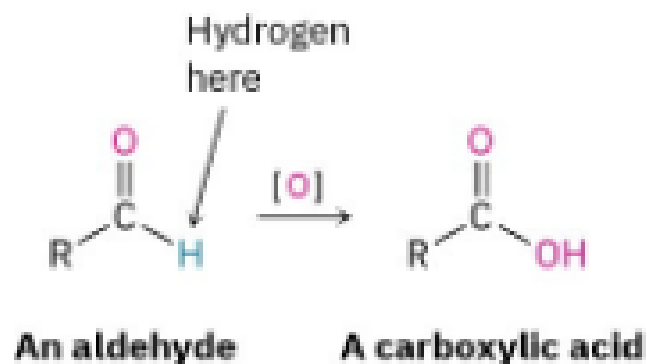


Addition of Grignard reagent (RMgX) → Alcohol formation



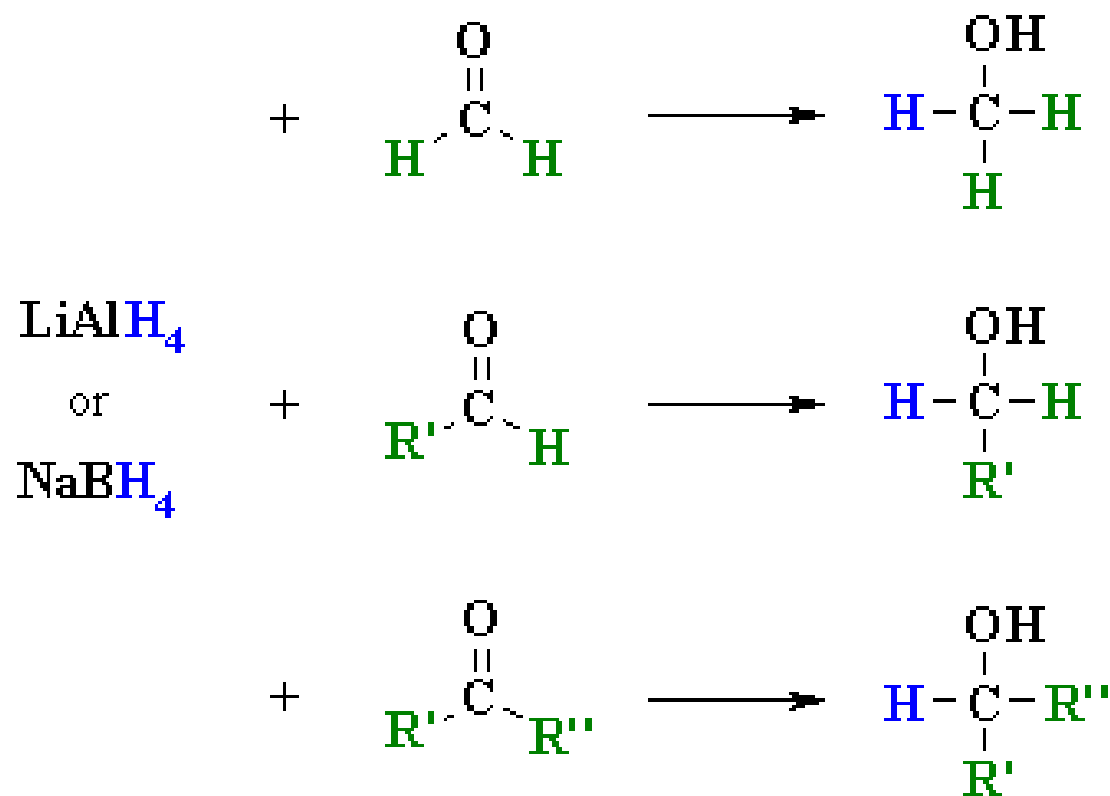
2. Oxidation

Aldehydes are easily oxidized to carboxylic acids (e.g., Benedict's and Fehling's test). Ketones are more resistant to oxidation.



3. Reduction

Aldehydes and ketones can be reduced to alcohols using reducing agents such as: Lithium aluminum hydride (LiAlH_4) and Sodium borohydride (NaBH_4).



3. Role in Medicinal Chemistry

Aldehydes and ketones are found in various biologically active compounds, including:

1- Drugs and Pharmaceuticals

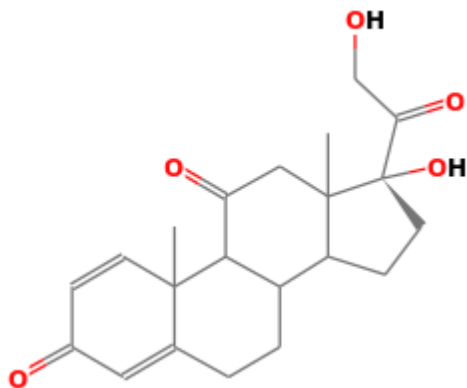
Formaldehyde: used as a disinfectant and preservative in hospitals and laboratories

Acetone: Used as a solvent in pharmaceuticals.

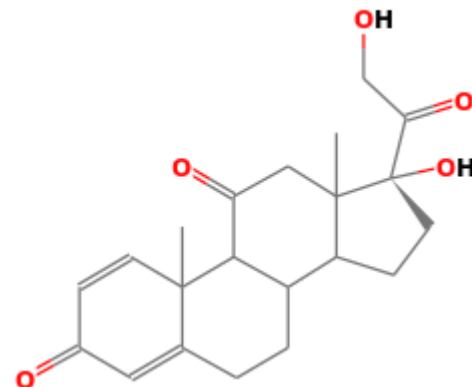
Corticosteroids (e.g., Prednisone, Dexamethasone): Contain ketone functional groups. **Prednisone:** a synthetic drug similar to cortisone, used to relieve rheumatic and allergic conditions and to treat leukaemia.

Dexamethasone: a drug that is a more potent synthetic analogue of cortisol, used chiefly as an anti-inflammatory agent.

Prednisone

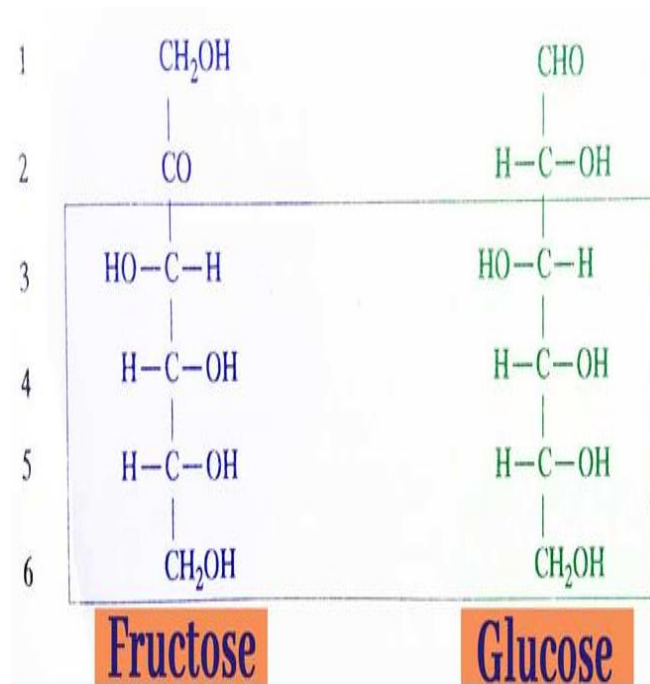


Dexamethasone

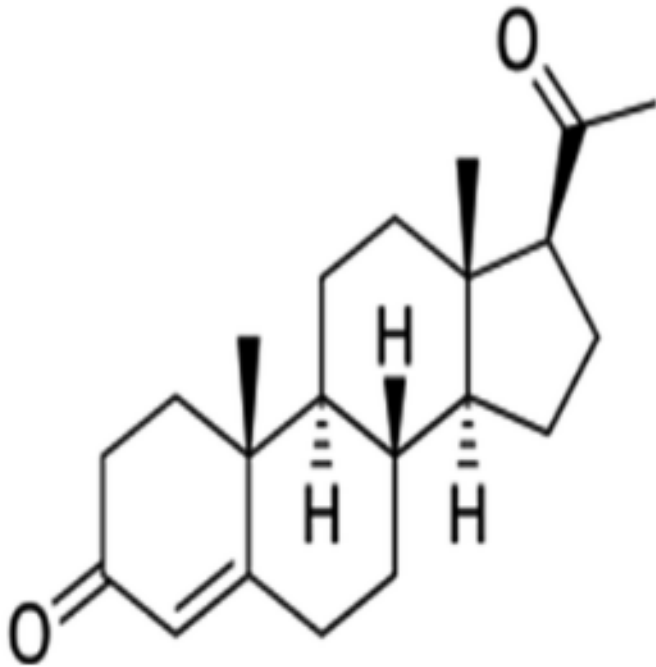


2. Natural Biomolecules

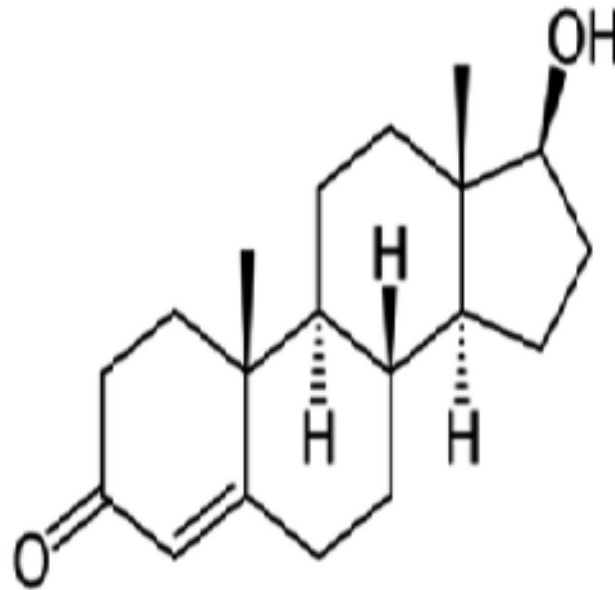
Glucose (an aldehyde sugar) and Fructose (a ketone sugar) play a key role in metabolism.



3-Steroids and Hormones (e.g., Testosterone and Progesterone) contain ketone groups.



Progesterone



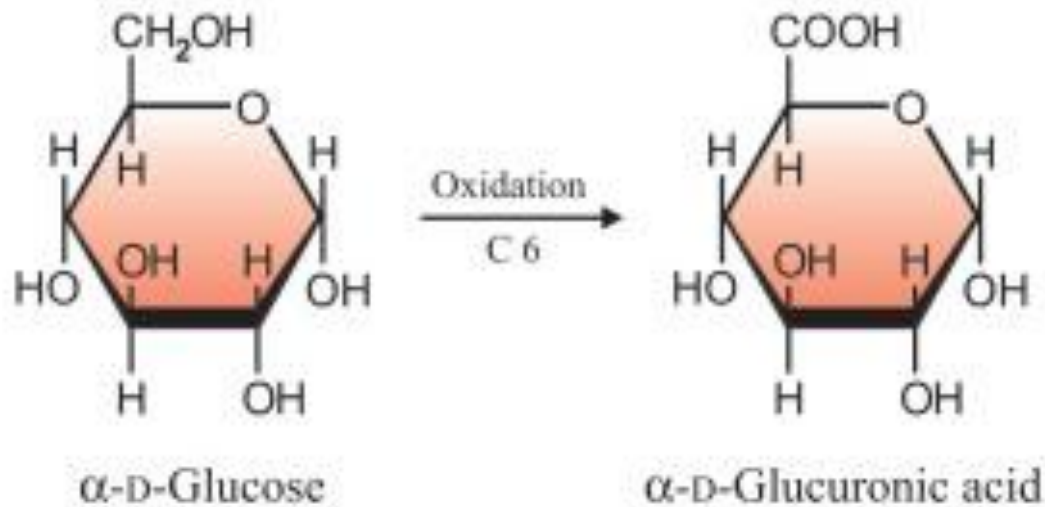
Testosterone

Biological and Medical Importance

Role in Metabolic Reactions

1. Glucose Metabolism:

Glucose, an important carbohydrate, contains an aldehyde group and is metabolized into glucuronic acid in the liver.



2. Pyruvate and Acetone:

Pyruvate (a ketone derivative) is a key intermediate in the Krebs cycle.

Acetone is one of the ketone bodies produced during fat metabolism.

3. Diabetes and Ketone Bodies:

In uncontrolled diabetes, excessive production of ketone bodies can lead to diabetic ketoacidosis (DKA).

Test of carbonyl group

1. Fehling's and Benedict's Test

Aldehydes reduce Fehling's and Benedict's solution, producing a red precipitate.

Aldehydes  **red precipitate.**

2- 2,4-DNP Test (Dinitrophenylhydrazine Test)

Both aldehydes and ketones form a yellow/orange precipitate with 2,4-DNP reagent

aldehydes and ketones  **a yellow/orange precipitate**