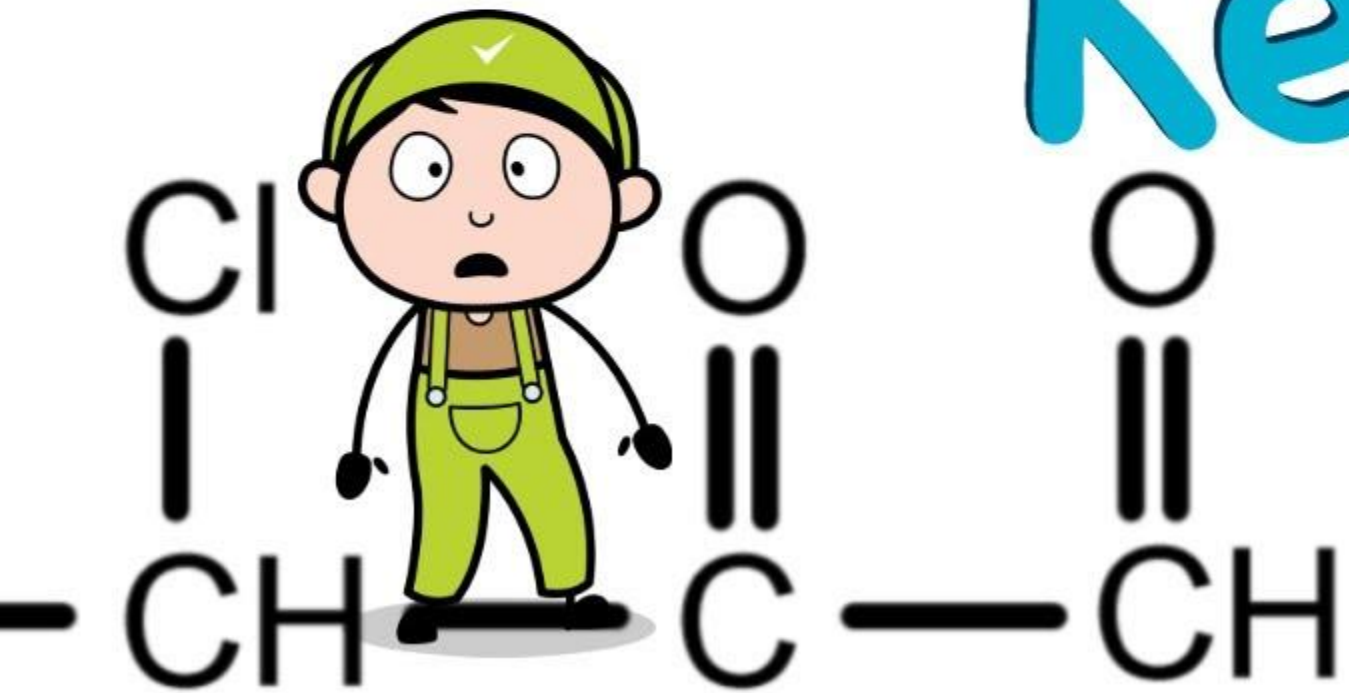
Aldehydes & Ketones



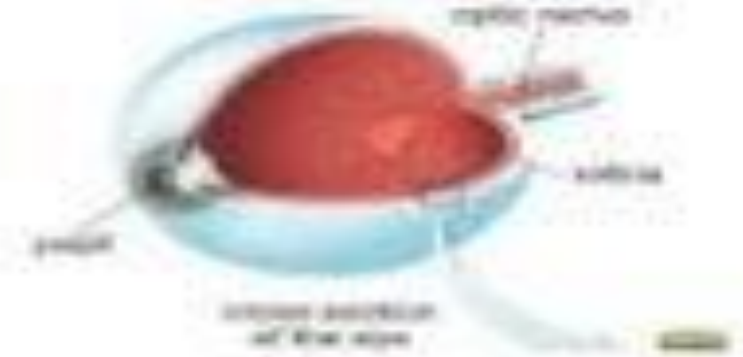
Prof. Dr. May Jaleel

Aldehydes and Ketones

- These classes of organic compounds contain a carbonyl functional group (C=O) with structures CHO for aldehydes and RC(=O)R' for ketones. Here, R and R' denotes substituents of carbon. They also refer to as the methanoyl group or formyl group. Aryl or alkyl group or its substituents fill in the remaining bonds of carbon atom in this group.
- However, if the substituents in neither of the 2 remaining bonds are hydrogen, then the organic compound is a ketone. However, if one of the substituents is hydrogen then the organic compound is an aldehyde. The properties of aldehydes and ketones play a very important role in the uses of aldehydes and ketones.

Aldehyde can be found in Human Body and Fragrance Chemical

Retinal (retinaldehyde) is one of the many forms of vitamin A and the chemical basis of Human and animal vision. It allows certain microorganisms to convert light into metabolic energy.



Citronellal
Found in citronella oil;
used as an insect repellant

Uses of Aldehydes and ketones

- Aldehydes and ketones find application in different sectors such as pharmaceutical, food, fragrance, cosmetics because of their chemical properties. Refer below to learn more about the various applications and uses of aldehydes and ketones.

Uses of Aldehydes

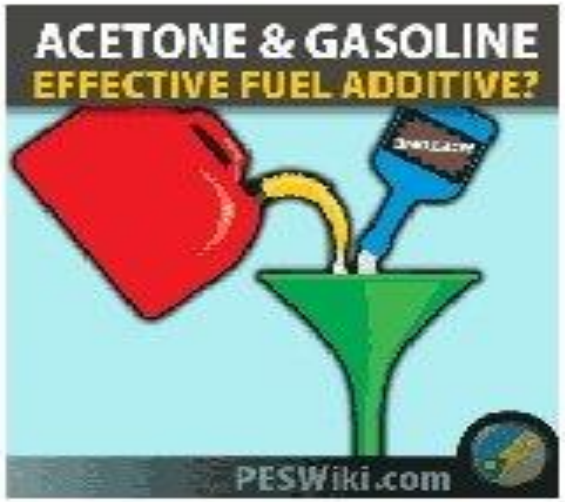
Uses of Aldehydes

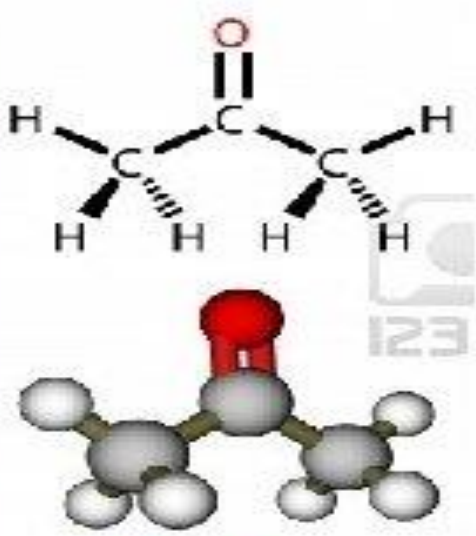
- Formaldehyde is found in the gaseous form. However, formaldehyde with 40% solution in water forms formalin. Formalin helps in the preservation of biological specimens.
- Formaldehyde reacting with phenol forms a compound Bakelite. Bakelite finds its application in plastics, coatings, and adhesives.
- The compound- formaldehyde is essential during many industrial processes such as embalming, glue preparation, tanning and manufacture of polymeric products.
- It acts as germicide, insecticide, and fungicides.

- Formaldehyde helps in the testing of drugs. It is also used in photography.
- Production of acetic acid and pyridine derivatives is possible from the compound “acetaldehyde.”
- Benzaldehyde (aldehyde) is an essential component for the production of perfumes, cosmetic products, and dyes. It is added to incorporate almond flavour into various food products. It also acts as a bee repellant.


Homo

Ketones in Nature





Acetone

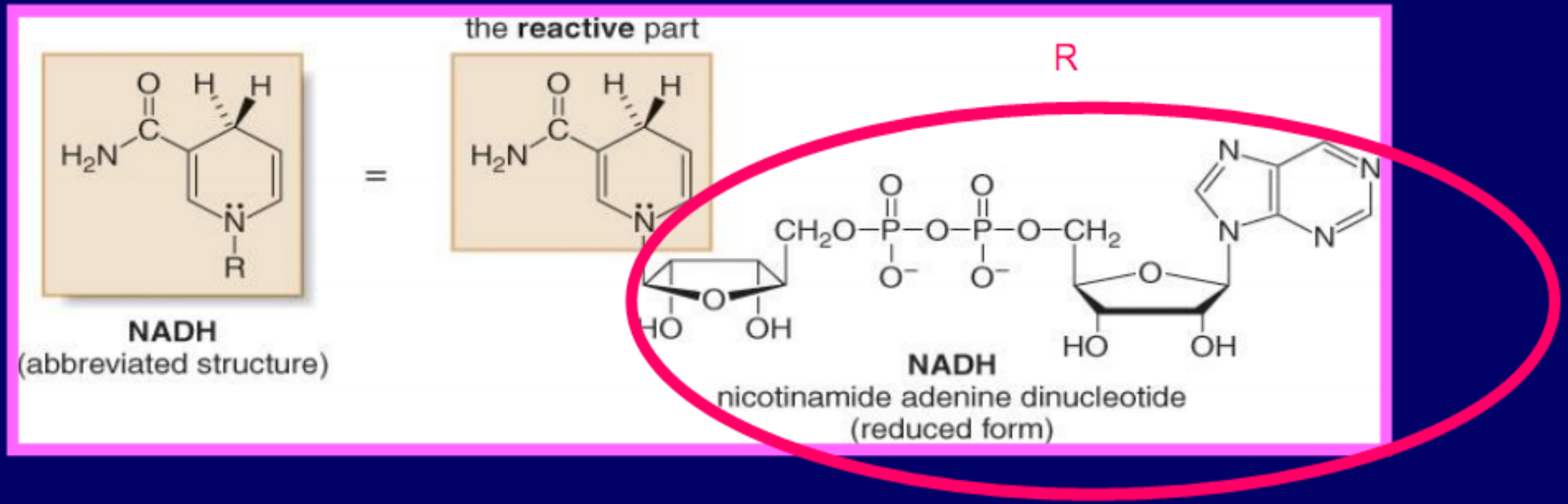
Uses of Ketones

- Ketone behaves as an excellent solvent for certain types of plastics and synthetic fibres.
- Acetone act as a paint thinner and a nail paint remover.
- It also is used for medicinal purposes such as chemical peeling procedure as well as acne treatments.
- Butanone, also known as methyl ethyl ketone, is one of the common solvents. It is used in textile production, varnishes production, paint remover production, paraffin wax production, plastic production, etc.
- Another important ketone is cyclohexanone which is an important component in nylon production.

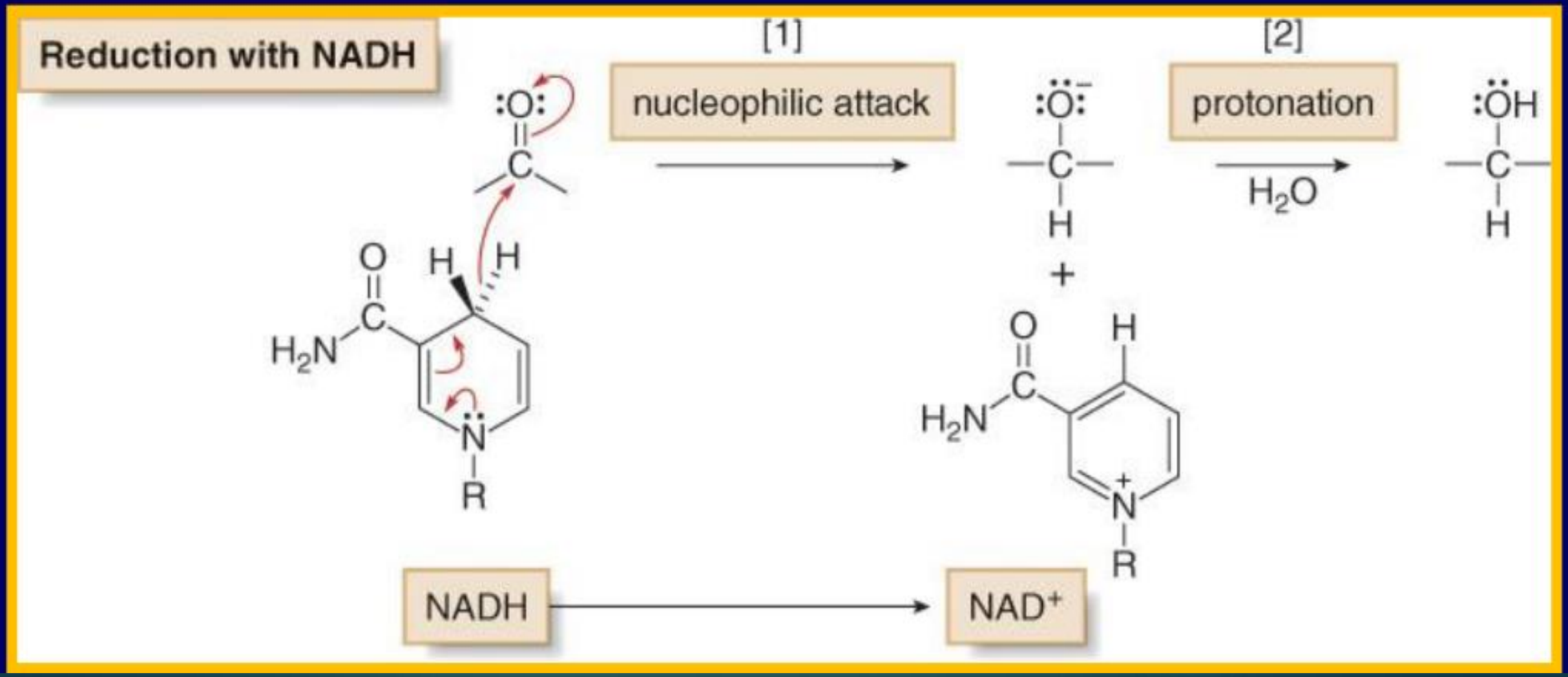
- Compounds of plants and microorganisms containing aldehydes and ketones include cinnamaldehyde in cinnamon bark, Citra in lemongrass, vanillin in vanilla bean, carvone in spearmint and caraway, helminthosporal- a fungal toxin, and camphor in camphor trees. Hormones of animal and human origin contain aldehydes and ketones such as muscone in musk deer, female sex hormone- progesterone, male sex hormone-testosterone, and adrenal hormone- cortisone.
- A famous ketone "methadone" helps in curing addiction of opiates such as heroin, opium, and morphine. In this topic, we will study the many uses of aldehydes and ketones.


Aldehydes and Ketones in Living System

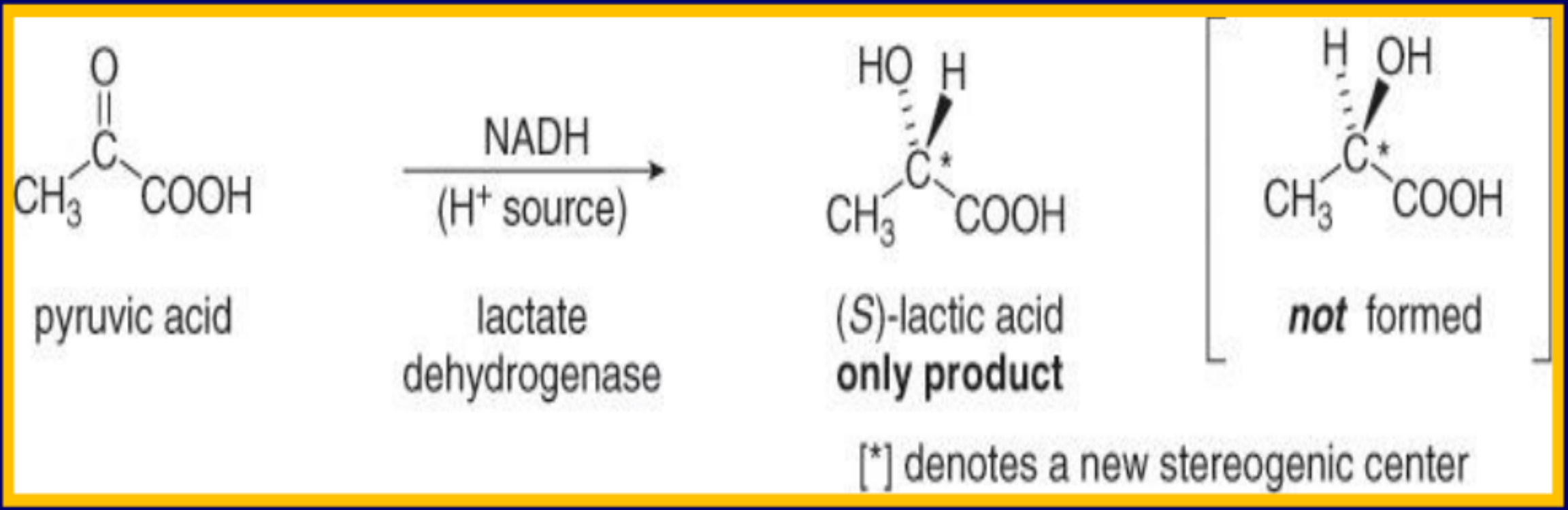
- Biological reductions that occur in cells always proceed with complete selectivity, forming a single enantiomer.
- In cells, the reducing agent is NADH.
- NADH is a coenzyme—an organic molecule that can function only in the presence of the enzyme.



- The active site of the enzyme binds both the carbonyl substrate and NADH, keeping them in close proximity.
- NADH then donates $H:^-$ in much the same way as a hydride reducing agent.

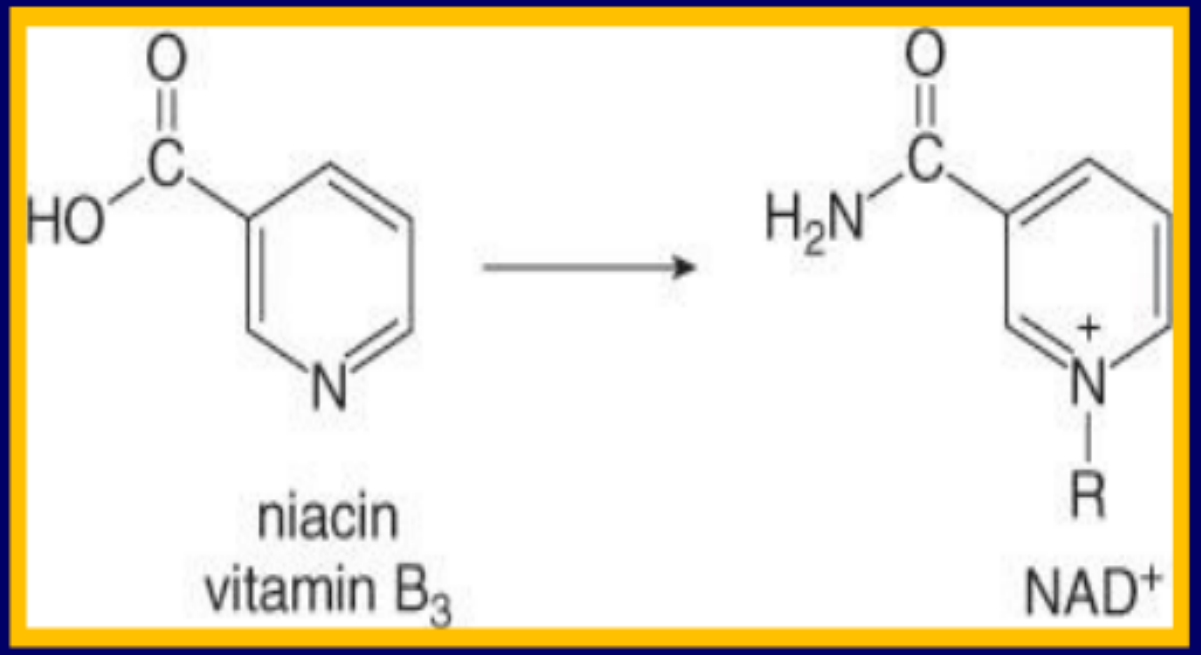


- The reaction is completely enantioselective. For example, reduction of pyruvic acid with NADH catalyzed by lactate dehydrogenase affords a single enantiomer with the *S* configuration.
- NADH reduces a variety of different carbonyl compounds in biological systems. The configuration of the product (*R* or *S*) depends on the enzyme used to catalyze the process.

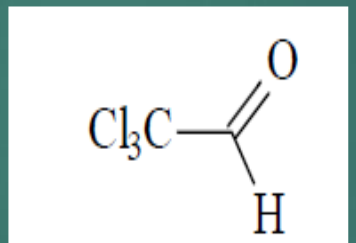


- NAD^+, the oxidized form of NADH, is a biological oxidizing agent capable of oxidizing alcohols to carbonyl compounds (it forms NADH in the process).

- NAD^+ is synthesized from the vitamin niacin.

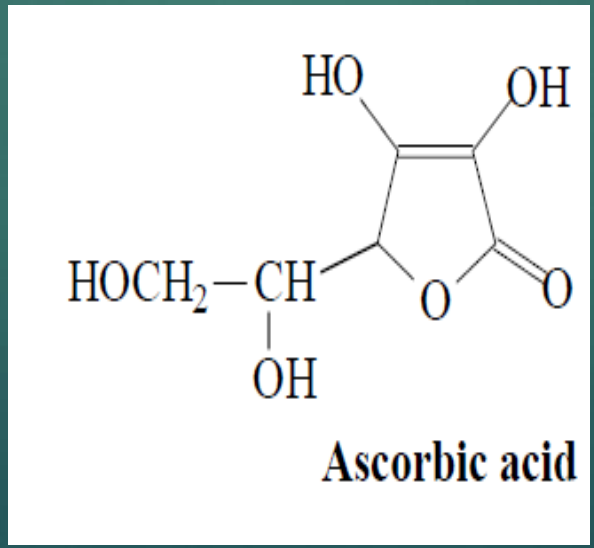


- 3. Trichloroacetaldehyde (Chloral) is a very effective sedative-hypnotic drug. The aldehyde form is an oil and difficult to formulate as a solid dosage form. The hydrate form, known as chloral hydrate, is a crystalline solid and is often used to prepare solid dosages. the structure of chloral hydrate shown bellow .



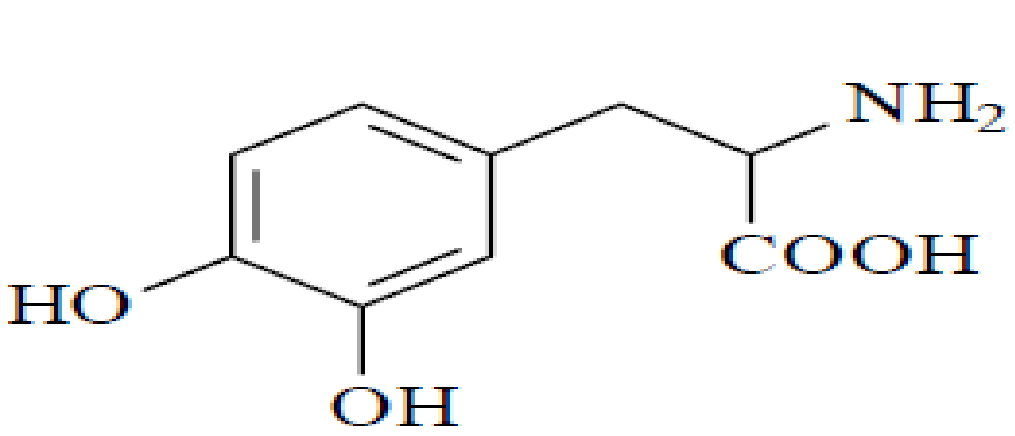
Chloral

- Ascorbic acid (vitamin C) is often used in solutions of pharmaceutical products to prevent
- oxidative decomposition of the drug species in solution. This antioxidant property of ascorbic
- acid is mediated by its' relative ease of oxidation. Show the product resulting from the
- antioxidant effects of ascorbic acid



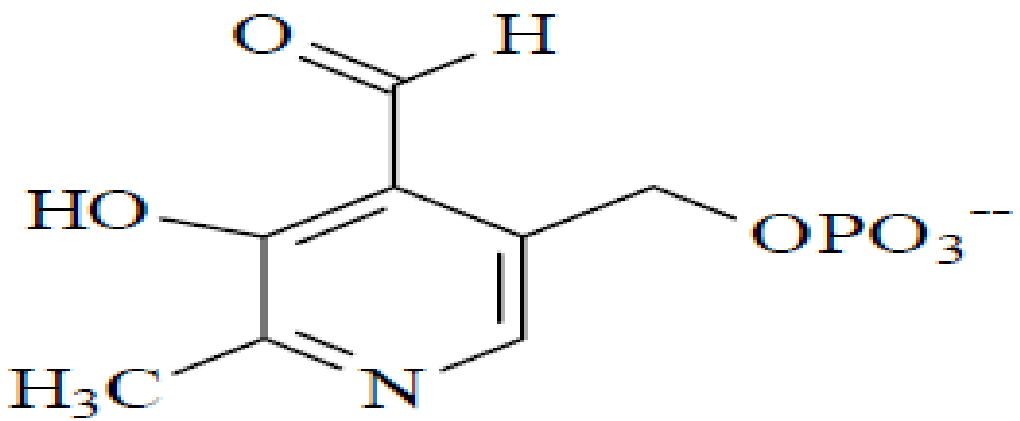
Ascorbic acid

- The antiparkinson drug L-DOPA is decarboxylated to dopamine (DA) post-administration. This reaction is mediated by the enzyme L-aromatic amino acid decarboxylase and the cofactor pyridoxal phosphate. The initial step of this reaction involves the formation of an imine (Schiff base) between L-DOPA and pyridoxal on the surface of the enzyme. Draw the structure of this imine intermediate. Also, explain the role of pyridoxal in the decarboxylation reaction that follows imine formation



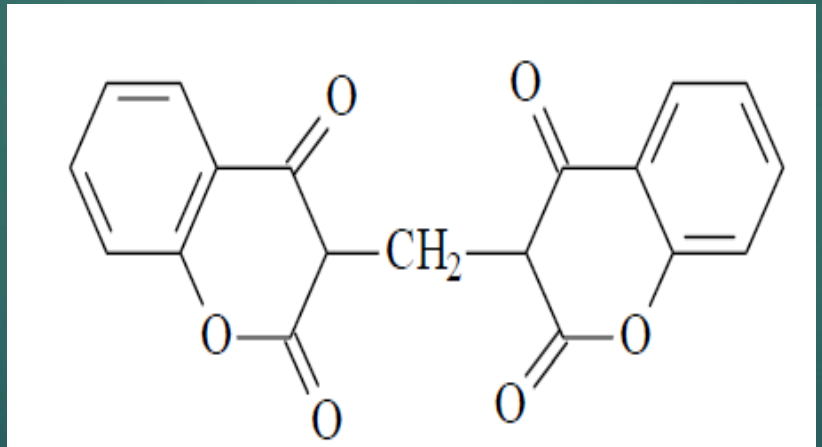
L-DOPA

+



Pyridoxal Phosphate

- Dicumarol is an anticoagulant drug used alone or in combination with heparin to prevent intravascular clotting. One of the structural features for anticoagulant activity in this class of
- compounds is the ability to form an enol tautomer under physiologic conditions. In fact,
- dicumarol probably exists as a di-enol.



Dicumarol

Frequently Asked Questions

- How are Aldehydes and Ketones Different?
- The carbonyl carbon of an aldehyde has a hydrogen atom attached to it whereas that of a ketone is attached to two alkyl or aryl groups. The C-H bond in aldehydes makes them easily oxidizable (they are strong reducing agents).
- Why are Aldehydes more Reactive towards Nucleophilic Substitutions than Ketones?
- The two alkyl/aryl groups in ketones offer steric hindrance during substitution reactions. Since the hydrogen atom is relatively small, it barely offers any steric hindrance. This is the primary reason why aldehydes are more susceptible to nucleophilic substitutions. Also, the partially positive charge on the carbonyl carbon is stabilized by the two R groups in ketones.

- Why are the Boiling Points of Ketones Higher than those of Aldehydes?
- The presence of two electron-donating R-groups in ketones makes them more polar than aldehydes. The dipole moments that arise from this polarity account for the higher boiling points of ketones.
- What are the uses of Ketones?
- Ketones are used as excellent solvent in industry, acetone is used as a nail paint remover and paint thinner. They are also used in medicine , textiles, varnishes, plastics, paint remover, paraffin wax etc.

- What are the uses of aldehydes?
- The 40% solution of formaldehyde forms Formalin which is used in preserving biological specimens. It is also used in embalming, tanning, preparing glues and polymeric products, as germicides, insecticides, fungicides for plants, drug testing and photography etc. Acetaldehyde used in the production of acetic acid and pyridine derivatives.Benzaldehyde is used in perfumes, cosmetic products, and dyes. It is added to provide almond flavour to food products and also used as a bee repellent .


Thank You
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