

## ORGANIC REACTIONS

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**Keywords:** Organic reactions, ecology, types of reactions, alkynes, nucleophilic, aldehydes

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### 1. Introduction

Organic reactions are chemical reactions of the formation and the transformation of organic compounds. The majority of such reactions occur with the participation of organic compounds only. However, quite a few transformations are known, in which organic compounds are formed by an interaction between organic and inorganic compounds as well as between inorganic compounds only.

The latter type is exemplified by the synthesis of a mixture of natural amino acids from carbon dioxide, ammonia, and water carried out in laboratory by the action of radiation, electric discharges, and other sources of energy. Similar processes could possibly take place in the primordial atmosphere of the Earth.

Amino acids formed in such a way could possibly be able to transform into polypeptides thus creating favorable conditions for the origin of the simplest living organisms. Transformations with the participation of hydrogen (hydrogenation), halogens (halogenation), water (hydration), and mineral acids as nitric acid (nitration), and sulphuric acid (sulphonation) are widely practiced in organic reactions.

As a rule, organic reactions occur via several stages following each other. These are accompanied by the formation of different intermediates such as carbocations ( $R^+$ ), carbanions ( $R^-$ ), free radicals ( $R\cdot$ ), cation radicals ( $R^{+\cdot}$ ), anion radicals ( $R^{-\cdot}$ ), carbenes ( $R^1R^2C:$ ), nitrenes ( $R-N:$ ), and other unstable short-lived (parts of a second) particles.

The most recent achievement in this direction is the study of chemical transformations, which last up to  $10^{-15}$  sec (femtochemistry). It looks as if scientists have mastered a super-high-speed survey of chemical processes.

The existence of super-short-lived transition states, i.e. complexes containing substrates and reagents was thus established (which was considered essentially impossible, up to

recently). Alongside that, unstable intermediates and their structures were determined (A. Zewall, Nobel Prize 1999).

Several approaches to classifying organic reactions have been supposed. The simplest one common for both organic and inorganic reactions, takes into account only formal external signs and does not depend on their mechanism.

It includes the addition reactions, i.e. the formation of one compound from several initial ones, the substitution reactions, when another one substitutes one fragment of a molecule, and isomerization reactions, i.e., bond redistribution (including variations in stereochemistry) without qualitative and quantitative variation of composition.

More frequently used classification of organic reactions is based on the reaction mechanism and its characteristic factors. The nature of reagents and intermediates (vide supra), bond breaking and formation, and method of excitation are taken into account as well.

The nature of reagents makes it possible to distinguish between electrophilic and nucleophilic reactions. The former ones occur with the participation of lone electron pair acceptors – electrophilic reagents, and include electrophilic substitution,  $S_E$ , and electrophilic addition,  $Ad_E$ .

Nucleophilic reactions occur with the participation of lone electron pair donors – nucleophilic reagents, which provide for nucleophilic substitution,  $S_N$ , and nucleophilic addition,  $Ad_N$ .

Organic reactions may be classified as homolytic or heterolytic, based on the mode of bond rupture in organic molecules. The former transformations consist in a symmetric rupture of two-electron, two-centered bond followed by the formation of free radicals.

The latter transformations consist in an asymmetric rupture of the above-mentioned bond with the formation of two charged particles with opposite signs – cation and anion.

Taking into account the nature of intermediates they distinguish between radical reactions (intermediates have unpaired electrons), ionic reactions (intermediates are charged particles, including cation radicals and anion radicals) as well as carbenic and nitrenic ones.

According to the method of excitation, organic reactions are subdivided into catalytic (including enzymic) reactions, photoreactions, radiation reactions, and electrochemical reactions.

Specific interactions are also very important. These occur with a simultaneous rupture of former bonds and formation of new bonds.

They cover such important transformations as pericyclic reactions, cyclo-addition and cyclo-elimination reactions as well as sigmatropic rearrangements.

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