

Exploring the Dynamics and Diversity of Chemical Reactions

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Perspective

Received: 01-Jun-2022,
Manuscript No. JOMC-22-56014;
Editor assigned: 03-Jun2022,
Pre QC No. JOMC-22-
56014(PQ); **Reviewed:** 17-Jun-
2022, QC No. JOMC-22-56014;
Revised: 24-Jun-2022,
Manuscript No. JOMC-22-
56014(R); **Published:** 30-Jun-
2022, DOI: 10.4172/J
Med.Orgnichem.09.S1.004
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DESCRIPTION

Organic reactions are chemical reactions involving organic compounds. The basic organic chemistry reaction types are addition reactions, elimination reactions, substitution reactions, pericyclic reactions, rearrangement reactions, photochemical reactions and redox reactions. In organic synthesis, organic reactions are used in the construction of new organic molecules. The production of many man-made chemicals such as drugs, plastics, food additives, fabrics depend on organic reactions.

The oldest organic reactions are combustion of organic fuels and saponification of fats to make soap. Modern organic chemistry starts with the Wöhler synthesis in 1828. In the history of the Nobel Prize in Chemistry awards have been given for the invention of specific organic reactions such as the Grignard reaction in 1912, the Diels-Alder reaction in 1950, the Wittig reaction in 1979 and olefin metathesis in 2005.

Organic chemistry has a strong tradition of naming a specific reaction to its inventor or inventors and a long list of so-called named reactions exists, conservatively estimated at 1000. A very old named reaction is the Claisen rearrangement (1912) and a recent named reaction is the Bingel reaction (1993). When the named reaction is difficult to pronounce or very long as in the Corey-House-Posner-Whitesides reaction it helps to use the abbreviation as in the CBS reduction. The number of reactions hinting at the actual process taking place is much smaller, for example the ene reaction or aldol reaction.

Another approach to organic reactions is by type of organic reagent, many of them inorganic, required in a specific transformation. The major types are oxidizing agents such as osmium tetroxide, reducing agents such as lithium aluminium hydride, bases such as lithium diisopropylamide and acids such as sulfuric acid.

Finally, reactions are also classified by mechanistic class. Commonly these classes are (1) polar, (2) radical, and (3) pericyclic. Polar reactions are characterized by the movement of electron pairs from a well-defined source (a nucleophilic

bond or lone pair) to a well-defined sink (an electrophilic center with a low-lying antibonding orbital). Participating atoms undergo changes in charge, both in the formal sense as well as in terms of the actual electron density. The vast majority of organic reactions fall under this category. Radical reactions are characterized by species with unpaired electrons (radicals) and the movement of single electrons. Radical reactions are further divided into chain and nonchain processes. Finally, pericyclic reactions involve the redistribution of chemical bonds along a cyclic transition state. Although electron pairs are formally involved, they move around in a cycle without a true source or sink. These reactions require the continuous overlap of participating orbitals and are governed by orbital symmetry considerations. Of course, some chemical processes may involve steps from two (or even all three) of these categories, so this classification scheme is not necessarily straightforward or clear in all cases. Beyond these classes, transition-metal mediated reactions are often considered to form a fourth category of reactions, although this category encompasses a broad range of elementary organometallic processes, many of which have little in common.