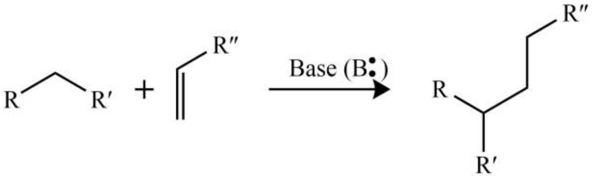
❖ Michael Reaction

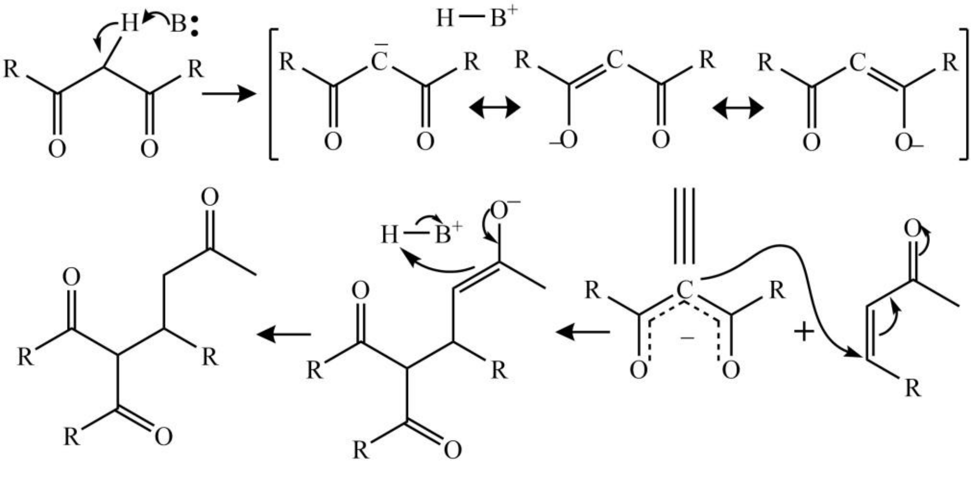
The Michael addition (or Michael reaction) may simply be defined as the addition of a nucleophile like a carbanion to an α, β-unsaturated carbonyl compound with an electron-withdrawing group. It is a type of conjugated addition, and this process is one of the most practical approaches for the formation of C-C bonds.

Illustrative Reaction: The typical organic reaction showing this type of addition is shown below.

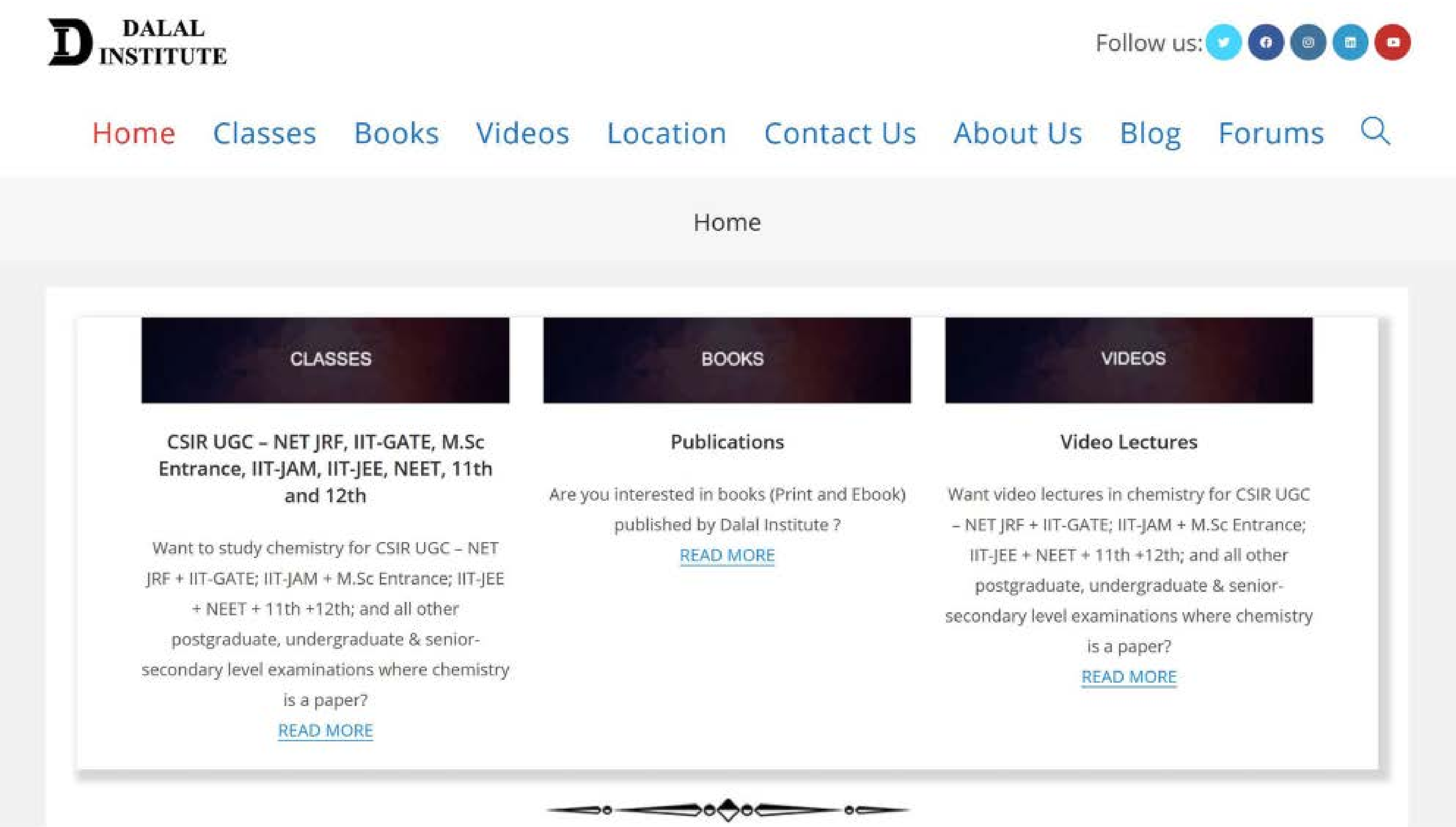


Where R and R' on the nucleophile symbolize the electron-withdrawing groups such as cyano and acyl, making the nearby methylene H enough acidic to give rise to a carbanion when treated with a base (B). The R" group on the activated olefin (Michael acceptor) is generally a ketone to makes the molecule an enone; nevertheless, it can also be a sulfonyl fluoride or nitro group.

Mechanism Involved: In the first step, the carbanion is formed due to the deprotonation of the substates, which is stabilized by electron-withdrawing groups. Three resonating structures (2A, 2B, and 2C) can be drawn for this hybrid species with two enolate ion types. The electrophilic alkene reacts with this nucleophile via conjugated addition mode. Finally, the abstraction of a proton by the enolate from solvent (or protonated base) gives rise to the final product.



It is also worthy to note that the Michael addition is primarily dominated by the orbital picture rather than the electrostatic interactions. The lowest unoccupied molecular orbital (LUMO) of α-, β- unsaturated carbonyl systems have a hefty magnitude of the coefficient for β-carbon, whereas the HOMO of resonance stabilized enolates have a large magnitude of the coefficient for carbon. Therefore, owing to the similar-energy polarized frontier orbitals and softens, they are suitable for generating a good C–C bond.



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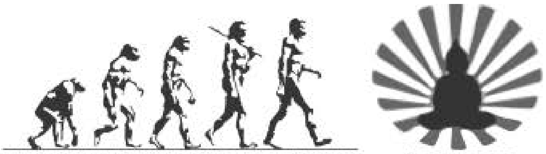

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Mandeep Dalal
(M.Sc, Ph.D, CSIR UGC – NET JRF, IIT-GATE)
Founder & Educator, Dalal Institute
E-Mail: dr.mandeep.dalal@gmail.com
www.mandeepdalal.com

Mandeep Dalal is an Indian research scholar who is primarily working in the field of Science and Philosophy. He received his Ph.D in Chemistry from Maharshi Dayanand University, Rohtak, in 2018. He is also the Founder of "Dalal Institute" (India's best coaching centre for academic and competitive chemistry exams), the organization that is committed to revolutionize the field of school-level and higher education in Chemistry across the globe. He has published more than 40 research papers in various international scientific journals, including mostly from Elsevier (USA), IOP (UK), and Springer (Netherlands).

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