Biocatalysts are turned out to be versatile catalysts for carbon-carbon bond forming and reduction reactions in organic synthesis.

Carbon-carbon bond formation belongs to the heart of organic synthesis. The biocatalyzed route provides effective tool for the construction of carbon-carbon with excellent enantioselectivity.

11.2.1 Hydrocyanation of Aldehydes

The biocatalytic hydrocyanation of aldehydes is one of the oldest methods in organic synthesis. One of the well-established technologies for the large-scale hydrocyanation of aldehydes is the oxynitrilase (Griengl process) catalyzed production of (S)-phenoxybenzaldehyde cyanohydrins, which is an important intermediate for the industrial pyrethroid manufacture (Scheme \(\PageIndex{1}\)). This method is turned out to be useful for the reactions of numerous aldehydes.

Scheme \(\PageIndex{1}\)

11.2.2 Benzoin Condensation

The development of an asymmetric cross-benzoin condensation via enzymatic cross-coupling reactions is a synthetically useful process. Highly enantiomerically enriched mixed benzoins can be obtained from two different substituted benzaldehydes using benzaldehyde lyase as a catalyst (Scheme \(\PageIndex{2}\)). One of the aldehydes acts as acceptor, whereas the other one acts as donor.

Scheme \(\PageIndex{2}\)

11.2.3 Aldol Reaction

The biocatalytic aldol reactions are highly specific with respect to donor component, whereas a broad substrate scope is observed for the acceptor molecules. One of the examples is the reaction of glycine (donor) with substituted benzaldehyde (acceptor) employing threonine aldolases to give \(\alpha\)-amino \(\beta\)-hydroxy acids with excellent enantioselectivity (Scheme \(\PageIndex{3}\)).
11.2.4 Nitroaldol Reaction

Enzymes are also useful for the non-natural reactions. For example, using (S)-oxynitrilase the reaction of nitromethane with a broad range of aldehydes can be accomplished with excellent enantioselectivity (Scheme (4)). Nitroalkane acts donor, whereas the aldehydes are acceptors.