Development of novel carbon–carbon and carbon–heteroatom bond forming reaction for the synthesis of complex bioactive natural and synthetic products has been foremost area of research in synthetic organic chemistry. Present dissertation describes our studies towards the development of novel carbon–carbon and carbon–heteroatom bond forming reactions with the cyclic anhydride derivatives, and their applications for the facile synthesis of structurally interesting bioactive natural and synthetic products along with the concise account of the chemistry of homophthalic anhydrides and their derivatives. Homophthalic anhydrides/acids are a versatile synths in organic synthesis. This small molecule with multiple functionalities has been efficiently utilized for building the backbones of many structurally complex and medicinally important molecules in a convergent manner.

Since many years, our research group is using cyclic anhydrides as the starting materials for the natural product synthesis; the considerable attempts have been made by us using homophthalic anhydrides for the synthesis of natural and synthetic products. We have attempted for the structure revision of the proposed natural product gusanlung D by using a general approach developed earlier in our group starting from homophthalic anhydride to synthesize claimed gusanlung D. The synthesis of isogusanlung D and dehydroisogusanlung D have been completed by taking the advantage of intramolecular radical induced cyclizations and Heck-coupling reaction, respectively. Unfortunately, the analytical and spectral data obtained for our proposed berberine analogues did not concur with the reported data of the natural product.

We have demonstrated the applications of serendipitously observed air-oxidation of homophthalimide for the synthesis of different natural and synthetic products. We have achieved a noteworthy total synthesis of nuevamine by using the facile air-oxidation of homophthalimide. We could isolate the reactive intermediate trione under neutral condition, which is responsible for the formation of final product isoindole from homophthalimide. The second application of air-oxidation propensity of homophthalimide was the stereoselective synthesis of (+)-isoindolo-β-carboline with high enantiomeric excess. Geometry-dependent demethoxycarbonylation, gain in the diastereoselectivity during the intramolecular dehydrative cyclization step and preservation of high enantiomeric excess at high temperature have been worth mentioning in this approach. Third application of the air-oxidation propensity was the five steps total synthesis of berberis natural products chilenine and deoxychilenine in decent overall yields. The use of
Parham cyclization for the construction of seven membered ring was the key feature of this approach.

We have also completed an efficient one-pot two-step synthesis of nuevamine and isonuevamine by taking the advantage of highly regioselective electronically and thermodynamically favored sodium borohydride reductions and sterically favored DIBAL-H reduction reactions. This provides a short access to these architectures using simple starting material over the all earlier approaches including our approach.

A short four steps access to (±)-erythrina skeleton has been described by taking the advantage of two sequential Wittig reactions. The developed protocol for the synthesis of this skeleton will be utilized for the synthesis of natural product (±)-erysotramidine. The work is in active progress towards the target molecule by taking in account the oxygenation pattern in A-ring of natural product. The developed strategy after the optimization of the non-classical Wittig reaction would be highly useful to develop natural and synthetic analogs as well as other natural products of erythrina family.