



Editorial

Pharmaceutical organic chemistry: Actual teaching aesthetics

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ABSTRACT

The most difficult subject for students of Pharmacy or Pharmaceutical Sciences undergraduates and postgraduates is Pharmaceutical Organic Chemistry. The professor teaching this subject should be well versed with basic concepts of the Organic Chemistry belonging to the specialization of Chemical Sciences. The Pharmaceutical Organic Chemistry specialization has vast scope, and the teaching professor needs to clear the basics concepts of the subject. In this connection the actual teaching aesthetics of Pharmaceutical Organic Chemistry (POC) has been described. The review is an attempt to summarize the importance of the POC and make aware the teachers of Indian and Foreign Universities for the new direction and aesthetics of the teaching of the same.

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1. Introduction

Pharmacy and Pharmaceutical Sciences has vast and correlation and connection with medicine or basic medical Sciences and applied medical sciences. Both programs and course works have very similar subjects and studied at the same depth of the knowledge throughout worldwide. The surgery course in Medicine or Medical Science graduates is replaced with Pharmaceutical Organic Chemistry for Pharmacy and Pharmaceutical Sciences graduates. Rest of the subjects of the program and course work such as Clinical Pharmacology, Toxicology, Microbiology, Biochemistry, Medicine and its chemistry remain same for both medicine and pharmacy graduates. Both modern medicine and modern clinical pharmacology is core part of therapeutics and similar and at same level of study for both medicine and pharmaceutical science or pharmacy graduates. Further Pharmacy graduates can study 17 or 18 specializations and

interdisciplinary programs for practice of allopathy and research or pharmaceutical development in industry in India and worldwide.

2. Definition

Pharmaceutical Organic Chemistry (POC) is defined as the Organic Chemistry with specific applications to the Pharmaceutical Sciences. Pharmaceutical Chemistry is the broad term and includes Medicinal Chemistry, Biochemistry, Pharmaceutical Inorganic Chemistry and Pharmaceutical Analysis. A post graduate in Pharmacy or Pharmaceutical Sciences in Pharmaceutical Chemistry may write his specialization based on the thesis submitted and award of the degree abbreviated as M. Pharm (Medi Chem) or M.Pharm (Pharmaceutical Analysis) and as exemplified for the other subject of thesis for the thesis in Pharmaceutical Chemistry.

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2.1. How different is POC from medicinal chemistry

To define as Medicinal Chemistry is POC and part of this specialization but all Pharmaceutical Organic Chemistry is not always Medicinal Chemistry. The POC as defined here may also include process development and purely organic synthesis without pharmacological screenings and considered as POC only or specialized for the postgraduate as Pharmaceutical Organic Chemistry. Whereas Medicinal Chemistry being integrated study of human and veterinary medicine Clinical Biochemistry, Pathophysiology, Clinical Pharmacology, toxicology and pharmacotherapeutics in general at biological interface.

3. Basics Concepts in POC

1. *Functional Groups*: The basic teaching of POC starts with making the learner understand the functional groups in Organic Chemistry. Without this approach a learner is always surprised till the end of the course that what is exactly happening in the reaction. Further a list of functional groups should be made available at the end of teaching that class. Some functional group make a great difference but vary only in spelling such as Benzyl and Benzoyl.
2. *Molecular Basis for reactions*: The charge theory, that all the molecules are made up of two charges being positive and negative and in reactions the opposite charge come together to form a molecule that is the product. In this universe, at present the molecules are made of two charges only as stated above. Further neutral molecule concept should also be explained.
3. *Exothermic and Endothermic Solvents*: This is important from laboratory course work or practical point of view. Exothermic solvents are thermodynamically unstable and fuming in nature always give reactions at cold conditions whereas endothermic solvents are cold in nature and from thermodynamic point of view needs to be heated for the reaction. Both concepts need to be explained to the students, by these concepts the students also gain the insight for the corrosive and non-corrosive nature of the solvents.
4. *Charges and Valences*: Charges on the molecules are the basis for valencies and vice versa. The same should be explained to the students in detailed.
5. *Types of Organic Reactions*: There are main 4-5 types of organic reactions such as substitution, addition, replacement, etc the same should be explained to the students in detail.
6. *Arrows and Reaction sequence*: The arrows move from electron rich to the electron deficient, the reaction sequence should be given, and learner should understand the concept of the which reactant should be written first, last and by product how are the written.

7. *Electron Rich and Electron Deficient*: The concept of electron rich and electron deficient should be explained properly and based on which the directors in chemistry of Benzene and heterocyclics affect the course of the reaction.
8. *Illustrating Resonance Structures*: The position at which charge is delocalised on the benzene ring should be remembered and the resonance occurs at those positions only.
9. *Major and Minor Products*: The by product and its percentage yield determines the major and minor product in the reaction. Based on this understanding the orientation of the reaction can be studied.
10. *Mechanisms*: Here, to study the mechanisms, cleaving molecules, expelling molecules and reaction arrows should be taken care while teaching the basic concepts in POC for mechanisms.
11. *Stereochemistry*: Deeper understanding should be developed for E-Z, Cis Trans, Syn and Anti, R and S nomenclature by the teacher (Professor).
12. *Heterocyclic Chemistry*: It is part of POC and mostly the similar reactions at same positions of the heterocyclic ring should be taught, the unsimilar reactions where substitution occurs differently should be remembered for better understanding.

4. Relevance to Pharmaceutical Chemistry

The preservatives, certain additives to injectables, formulations and many more of the chemical compounds that does not fall in the category of medicine or drug and organic in nature is included in Pharmaceutical Chemistry and majorly a part of POC. The other things are medicinal chemistry.

5. Relevance to Pharmaceutical Engineering

Based on the type of the reactions in the POC the basis to set the large reactions on bulk scale through technology transfer are developed for Pharmaceuticals and Bulk Drugs.

6. Applications of POC

These are the speciality applications of POC and should be taught at UG, PG and PhD level of Pharmacy or Pharmaceutical Science graduates and M.Sc in Pharmaceutical Chemistry graduates.

1. *Chirality*: Chiral approach and Chiral or asymmetric synthesis should be included in syllabi for the chemical interface of POC and chemical interface of M.Pharm (Pharm Chem) specialization.
2. *Metabolic Reactions*: POC has great role in studying metabolic reactions and metabolic reactions should also be included in the part of Indian Pharmacy syllabi.

3. *Resonance and Drug Action (Mechanism of Action):* This is Bio-organic application of the POC and Medicinal Chemistry, still this application is missing from the Indian Pharmacy Syllabi.
4. *Technology Transfer:* The POC graduates should be taught with equations and mathematical calculation involved in the bulk synthesis at industry level as usual this application is missing from Indian Pharmacy syllabi.
5. *Pharmaceutical Preservatives:* Monographs of the preservatives / additives are least studied in any pharmacy curriculum, and one may find this useful lifelong if included in syllabi.

7. Pharmaceutical Analysis

1. *Pka and HPLC:* POC finds application in Pharmaceutical Analysis also with the help of Pka of the given organic compound, the HPLC method can be developed for the same. This correlation should be taught by pharmacy teacher to the students.
2. *Spectroscopy:* All spectroscopies depend on the POC and should be taught in detail, whether its Mass, ¹³C, H-NMR, HETCOR, COSY etc.
3. *Role in Pharmacological Screenings:* The toxicological screenings depend on the POC the correlation should be made understand to the students.


4. *Chemistry of Natural Products or Phytochemistry:* Elucidation of structures depends on the basic concepts of the reaction of POC.
5. *New Drug Discovery and NCE Research:* This process is part of medicinal chemistry application of POC. The 90% of the drug molecules being organic in nature this application should be included in syllabi at PG level of pharmaceutical chemistry students. The process chemistry for synthesis also should be taught in detail.

The author does not intend to criticize any system of medicine or any syllabi but there are lot of changes required in current syllabi and one should take this article as opportunity for the changes and for positive advancements for betterment of Indian Pharmacy and Pharmaceutical Science graduates and ultimately the nation.

8. Conflict of Interest

None.

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