1. 1. Overview of Bioorganic Chemistry

1.1.1. What is Biological Chemistry? Chemical Biology? And Bio-Organic Chemistry?

Definition of Biological Chemistry:

Biological Chemistry is the understanding how biological processes are controlled by underlying chemical principles.

Definition of Chemical Biology:

Chemical Biology is defined as the development and use of techniques of chemistry for the study of biological phenomena.

Definition of Bioorganic Chemistry:

Bioorganic Chemistry can be defined as a branch of chemistry or broadly speaking a branch of science which utilizes the principles, tools and techniques of organic chemistry to the understanding of biochemical/biophysical process.

As for example, the classical chemistry of natural products with its characteristic triad of isolation, structural proof and total synthesis is an evident, but purely organic ancestor. Likewise, inquiry into the biosynthetic pathways for the same natural products is plain biochemistry. But when the total synthesis of a neutral product explicitly is based upon the known route of biosynthesis or if the biosynthesis has been translated into structural and mechanistic organic chemical language, one is clearly dealing with bioorganic chemistry.

Organic chemistry deals with:-Structure Design, synthesis, and kinetics (physical organic).

1. **Structure Design**: It guides us of how potential the interaction between structures and the biological partners.
2. **Synthesis**: Synthesis provides us with compounds which might be the analogue or the mimic of natural species and may not have created in sufficient quantity for investigation by nature.
3. **Kinetics**: Physical organic chemistry and analytical methodology provide quantitative measures and intimate details of reaction pathways.

Biochemistry deals with study of life processes by means of biochemical methodology.

1.1.2. What's the Difference between Biological Chemistry and Bio-Organic Chemistry?

All deal with interface of biology and chemistry, exchange of knowledge and solution of problems.

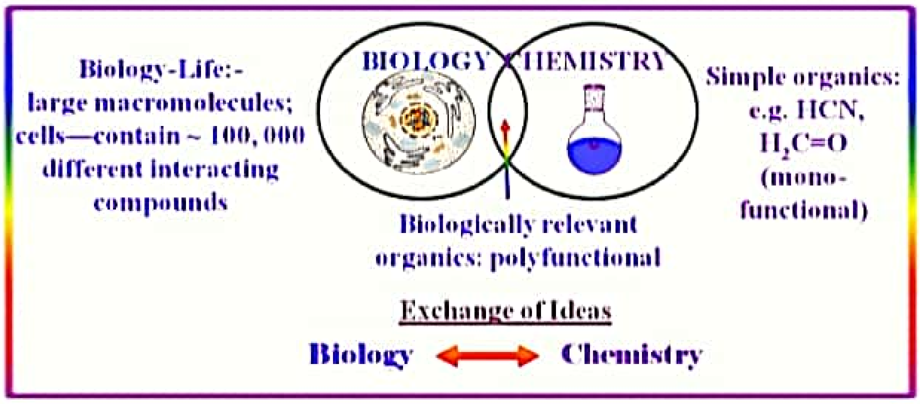

Figure 1.1: Representation of ideas exchange between chemistry and biology.

<u>Organic Chemistry:</u>

- **Explains the events of biology:-** mechanisms, rationalization, kinetics

<u>Biological Chemistry:</u>

- **Provides challenges to chemistry:-** Design, synthesis, structure determination
- **Inspires chemists:** ***Biomimetics*** → improved chemistry by understanding of biology.

1.1.3. Why the term Bio-organic Chemistry

As we discussed earlier, that the organic chemistry is related to the development of methodology to synthesize organic molecules of biological importance/analogues. However, not all the analogues are potent to have response to/or with biological molecules. So, modification of synthesis is necessary which is only possible from a thorough study of biological process, a part of biochemistry.

On the other hand, knowledge of biochemistry gives the idea of what would be useful to synthesis for a fruitful response which can only be possible via organic chemistry.

Therefore, the need for the multidisciplinary approach become obvious and there must have to have two laboratories-i) one for the synthesis and ii) another for the biological study. Thus, knowledge of organic chemistry give rise to the concept of building of organic models chemically synthesized in the laboratory to study the complex biological processes.

Bioorganic chemistry is thus, a young and rapidly growing science arising from the overlap of biochemistry and organic chemistry.

1.1.4. Bio-organic Chemistry-A Borderline Science-Its Multiple Origin:

1. **Enzyme Chemistry:** For some hydrolytic enzymes the catalyzed reaction has been translated already into a series of normal organic reaction steps. At the same time organic chemists are mimicking the characteristics of enzyme catalysis in model organic reactions dealing with both the rate of reaction and specificity.

   Investigations, involving metalloenzymes and cofactors, the contiguous areas of bioorganic and bioinorganic chemistry also merge.

2. **Nutritional Research:** Knowledge of biochemistry enables us to recognize the factors essential in the human diet, and their structures and syntheses with the help of organic chemistry led to the recognition of the modes of action of the so-called vitamins and related cofactors, or coenzymes.

3. **Hormone Research:** Secreted factors that exert a stimulatory effect on cellular activity, the hormones, could be better understood at the molecular level once their structure determinations and syntheses made them available in reasonable amounts with the help of organic chemists.

4. **Natural Products Chemistry:** Concepts of the biogenesis of natural products played, and continues to play, a major role in the development of bioorganic chemistry. The classical chemistry of natural products with its characteristic triad of isolation, structural proof and total synthesis is an evident, but is a purely organic ancestor. Likewise, inquiry into the biosynthetic pathways for the same natural products is plain biochemistry. But when the total synthesis of a natural product explicitly is based upon the known route of biosynthesis or if the biosynthesis has been translated into structural and mechanistic organic chemical language, one is clearly dealing with bioorganic chemistry.

5. **Molecular Recognition:** The term molecular recognition refers to the specific interaction between two or more molecules through non-covalent bonding such as hydrogen bonding, metal coordination, hydrophobic forces, van deer Waals forces, pi-pi interactions, electrostatic and/or electromagnetic effects and is purely physical organic chemistry origin. The host and guest involved in molecular recognition exhibit molecular complementarities. Molecular recognition plays an important role in biological systems and is observed in between receptor-ligand, antigen-antibody, DNA-protein, sugar-lectin, RNA-ribosome, etc. An important example of molecular recognition is the antibiotic vancomycin that selectively binds with the peptides with terminal D-alanyl-D-alanine in