

SCH 511: Chemistry of Primary and Secondary Metabolites

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Course outline

- 1. Introduction (Primary and Secondary metabolites. Enzymes and Cofactors).**
- 2. Biosynthesis of Fatty Acids and Polyketides**
 - 2.1 Fatty acids**
 - Occurrence and Function of Fatty Acids
 - Semi-systematic nomenclature of Fatty acids
 - Biosynthesis of Saturated Straight-Chain Fatty Acids;
 - Biosynthesis of Saturated Branched Fatty Acids;
 - Mono-unsaturated Fatty Acids
 - Poly-unsaturated Fatty Acid; Oxygenated Fatty Acids.
 - Modification of Fatty acids
 - Prostaglandins: Definition; occurrence; function; biosynthesis
 - 2.2 Polyketides**
 - What are Polyketides?
 - The Chemistry of 1,3-Dicarbonyls:
 - Keto-Enol Tautomerism
 - Condensation Reactions
 - Polyketide Cyclizations
 - Formation of Unsaturated Products
 - Secondary Structural Modifications During Polyketide Cyclizations (Alkylation, Reduction, Oxidation, Decarboxylation)
- 3 Biosynthesis of Terpenoids**
 - Definition
 - Biosynthesis of Mevalonic Acid
 - The Nonmevalonate Pathway (the Methylerythritol Phosphate (MEP) pathway)
 - Carbocations as Intermediates in Terpene Biosynthesis [Rearrangement of carbocations (Hydride Shifts; Alkyl Shifts)]
 - Termination of Carbocations (Loss of a Proton; Addition of Water)
 - Biosynthesis of Terpenes (Hemiterpenes, Monoterpenes, Sesquiterpenes, Diterpenes and Triterpenes)
- 4 Secondary metabolites derived from Shikimic acid (Phenyl propanoids).**
 - Biosynthesis of Shikimic acid, Chorismic acid, Prephenic acid and Cinnamic acid
 - Biosynthesis of Coumarins
 - Biosynthesis of Lignans

- 5 Secondary metabolites derived from mixed biosynthetic origin (The flavonoids).**
- Introduction
 - Classification of flavonoids
 - Nomenclature of flavonoids
 - Biosynthesis of flavonoids (Chalcones, Flavanones, Isoflavones, Pterocarpanes, Rotenoids and Anthocyanin)
- 6 Secondary metabolites derived from amino acids (The alkaloids).**
- What are alkaloids?
 - Biosynthetic Origin of Alkaloids
 - Alkaloids derived from ornithine and lysine (aliphatic alkaloids);
 - Alkaloids derived from tryptophan
 - Alkaloids derived from tyrosine
 - Alkaloids derived from phenylalanine;
 - Alkaloids derived from Nicotinic acid
 - Alkaloids derived from Anthranilic acid

Objectives

General Course Objectives: To give the learner an understanding of the biosynthesis and ecological role of secondary metabolites.

Specific objectives

- To understand the general differences between primary and secondary metabolism.
- To appreciate the origins of secondary metabolites.
- Recognize the major building blocks that are used by nature to synthesize secondary metabolites.
- To understand the ecological roles played by secondary metabolites.
- To understand the molecular mechanisms of the most important enzyme catalyzed reactions in secondary metabolism, and associated coenzyme.
- To appreciate the similarities and differences between chemical reaction in the cell and the test tube
- Recognize the source, structure and function of fatty acids in biological systems
- Identify the roles of acetyl coenzyme A and malonyl coenzyme A in biosynthesis of acetate derived secondary metabolites.
- To understand how even-numbered, odd-numbered and branched fatty acids are biosynthesized
- Describe how unsaturated fatty acids are produced from saturated fatty acids
- Describe how fatty acids can undergo further modification.
- To understand the role of essential fatty acids in animals.
- Recognise the structure of natural products derived from the polyketide pathway.
- Describe the primary process in which polyketides are biosynthesised.
- Recognise the various cyclisation pathways encountered in the formation of polyketides.
- Describe how secondary processes give further structural diversification.
- Recognize the role of carbocations in terpene biosynthesis
- Describe how carbocations are formed from pyrophosphate precursors
- Describe important reactions of carbocations in terpene biosynthesis
- Propose reasonable biosynthetic pathways to a variety of terpenes.

- Recognize the role of shikimic acid, chorismic acid and prephenic acid in biosynthesis.
- Recognize that cinnamic acid derivatives are precursors to other natural products like lignans and coumarines.
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- Recognize that cinnamic acid derivatives are precursors to other natural products like lignans and coumarines
- Understand the biosynthesis of the different classes of flavonoids
- Propose a biosynthetic route for the major classes of alkaloids

Course Evaluation:

- CAT (30 MARKS)
- Final Exam (70 MARKS)

Recommended Text Books

1. Medicinal Natural Product-A Biosynthetic Approach, Dewick, 3rd Edition, 2009
2. Natural Product Chemistry at a glance, Stanforth
3. Natural Products- The Secondary Metabolites, Hanson