FUNDAMENTALS OF BIOCATALYSIS (PBT-905) **Credit Hrs 3(3-0)**

Educational Objectives:

1. This course is designed to introduce participants to the fundamentals of enzyme-catalyzed reactions, especially as they apply to large-scale production of small molecules. We will cover the EC system for enzyme classification and key reaction classes demonstrated in commercial processes. Fundamentals of enzyme mechanisms will be presented. Considerations for the use of purified enzymes over whole cell catalysts will be discussed, as well as procedures for cloning enzymes of interest. Case studies will be used to illustrate the concepts presented. Advanced topics include the design of multi-step biosynthetic pathways. Approximately 30-40% of the course will be dedicated to a hands-on laboratory component. In the lab sections, student will translate the basics of gene cloning into practice, with exercises for design of primers for gene amplification, cloning of genes into expression vectors, verification of protein expression, enzyme purification, and determination of enzyme kinetics.

Course Outcomes:

2. This course will give the basic classes of enzymes and industrially useful enzyme reactions. Students will be able to understand considerations for the use of purified enzymes versus whole cell catalysts. Students will be capable of considering opportunities for the design of multi-step biocatalytic routes. Students will be able to gain hands-on experience in cloning and expression of recombinant enzymes.

3. **Course Contents:**

a. Enzyme catalysts

(1) Overview/review of protein chemistry
(2) The Enzyme Commission (EC) nomenclature
(3) Enzyme kinetics
(4) Enzyme inhibition and toxicity

b. Whole cell catalysts

(1) Considerations for applications of whole cell catalysts
(2) Decoupling growth and conversion
(3) Control of protein expression
(4) Toxicity and inhibition
(5) By-product formation

c. Process design for Biocatalytic processes

(1) Typical problems encountered in industrial biocatalysis
(2) Engineering (process design) solutions
(3) Biological (protein/cellular engineering) solutions

d. Laboratory concepts

(1) Participants will gain hands-on laboratory experience in the following methods relevant to bioconversions:
(2) Design of primers for gene amplification
(3) Polymerase Chain Reaction (PCR)-based amplification of genes
(4) Sub-cloning of amplified genes into expression vectors
(5) Transformation of microbial strains
(6) Protein expression and purification
(7) Enzyme assays and determination of kinetic parameters

Recommended books

1. **Biocatalysis:** Biochemical Fundamentals and Applications by Peter Grunwald
2. **Biocatalysis:** Fundamentals and Applications by Andreas S. Bommarius, Bettina R. Riebel-Bommarius