

# **SCHEME OF INSTRUCTION & SYLLABUS**

**FOR**

**DOCTOR OF PHILOSOPHY  
(Ph. D.)**

**IN**

## **BIOTECHNOLOGY**

(Academic Session: 2014)

**DEPARTMENT OF BIOTECHNOLOGY**  
**INVERTIS UNIVERSITY, NH24, BAREILLY - 243 123**

**DOCTOR OF PHILOSOPHY (Ph.D.)  
IN  
BIOTECHNOLOGY**

**COURSE STRUCTURE**

(EFFECTIVE FROM THE ACADEMIC SESSION: 2014)

1. Duration of the Pre-Ph.D. course: Six Months
2. Qualifying Marks: 50% (in each paper)

S. No.	CODE	SUBJECT	MARKS DISTRIBUTION			CREDIT
			IAM*	SM	TOTAL	
1.	DRM-101	RESEARCH METHODOLOGY	30	70	100	4
2.	PBT-102	INSTRUMENTATION IN BIOTECHNOLOGY	30	70	100	4
<b>ELECTIVE PAPER (ANY ONE)</b>						
3.	PBT-103	ADVANCES IN BIOTECHNOLOGY	30	70	100	4
4.	PBT-104	MOLECULAR & STRUCTURAL BIOLOGY				
5.	PBT-105	IMMUNOLOGY & VACCINE TECHNOLOGY				
6.	PBT-106	BIOLOGICAL ENGINEERING				
<b>TOTAL</b>			<b>90</b>	<b>210</b>	<b>300</b>	<b>12</b>

\* TWO ASSIGNMENTS OF 10 MARKS EACH AND SEMINAR OF THE CONCERNED PAPER 10 MARK.

## DRM-101 RESEARCH METHODOLOGY

### UNIT I

Research Topic: selection of problems, stages in the execution of research, preparation of manuscript and report writing. Search engines: google, pubmed, google scholar, EMBL, etc. Publication of Report in Journals: Standard of research journals, impact factor, citation index, H index, and more. Proof reading, reading journals and review.

### UNIT II

Introduction of computer science- Database management systems, presentation graphics, management of biological data by office applications: MS-office, MS-Word, MS-Excel, and MS-PowerPoint.

### UNIT III

Measures of dispersion: sampling methods: random sampling - types of variables: qualitative and quantitative variables - continuous and discontinuous variables - scaling method – mean - standard deviation- standard error - coefficient of variation. Comparison of means: chi square test, students t test and ANOVA.

### UNIT IV

Spectrophotometer: principle and applications, Ultra violet, Infra Red, Nuclear magnetic resonance (NMR), fundamental and procedure of chromatography: Paper Chromatography, TLC, Gas Chromatography, etc., Generation and evaluation of data.

### UNIT V

Principle and application of microscopy, Light and electron microscope - scanning electron microscopy, transmission electron microscopy; X-ray diffraction, generation and analysis of data, basic of softwares: Matlab and Labview.

### Text/Reference Books:

- Statistical methods, Snedecor, G. W. and W.G. Cochran, 1978. Oxford and IBH publishing CO Pvt. Ltd.
- Biometry, Sokal, R.R. and F.J.Rohlf, 1981. W.H. Freeman, NewYork.
- Authoring a PhD, thesis: how to plan, draft, write and finish a doctoral dissertation, Duncary, P. 2003. Macmillan, pp 256.
- Biostatistical analysis, Zar, J.H., 1996. Prentice Hall, Uppar Saddle River, newjersey, USA.
- Scientific courses and presentations, Martha Davis, 2005. Academic press, Tokyo.pp.356

## PBT-102 INSTRUMENTATION IN BIOTECHNOLOGY

### UNIT I

Microscopic Techniques: Dark field and bright field microscope; Phase contrast microscopy; Confocal microscope; Brief introduction of EM (TEM, SEM and STEM). Chromatographic Techniques: Affinity, mobile phase and stationary phase. Types of advance chromatography: ion-exchange chromatography, affinity chromatography, gel filtration, HPLC and their MS combination.

### UNIT II

Centrifugation techniques: Basic principles of sedimentation. Types of centrifuge: refrigerated high-speed preparative centrifuges, analytical ultracentrifuges, density gradient centrifugation etc. Safety aspects of centrifugation.

### UNIT III

Introduction of Molecular techniques: Polymerase Chain Reaction and its modification. Restriction fragment length polymorphism, RAPD. Electrophoresis: Principal and procedure of agarose Gel electrophoresis. Introduction of genetic engineering: vectors, restriction enzymes, transformation.

### UNIT IV

Biomolecules: Estimation and separation techniques: Qualitative and quantitative estimation of Protein, carbohydrate and nucleic acids. Sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE), Basics of Isoelectric focusing (IF) and Two-dimensional (2D) electrophoresis.

### UNIT V

Advanced techniques: Enzyme Linked Immunosorbant Assay (ELISA) and Radioimmuno Assay (RIA), Western blotting. UV and visible spectroscopy, Mass Spectrometry: MALDI-TOF. Mass precision, mass measurement accuracy, mass resolution, ionization energy and appearance energy.

### Text/Reference Books:

- Principles of Physical Biochemistry, K.E. Van Holde, Prentice Hall.
- Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes, J.F. Van Impe, Kluwer Academic
- Modern Spectroscopy, J.M. Hollas, John Wiley and Son Ltd.
- Principles and techniques in biochemistry and molecular biology by Wilson and Walker.
- Introduction to instrumental analysis : Robert. D. Braun (1987). McGraw Hill International Edition, Chemistry Series.
- Principles and techniques of Practical Biochemistry: K.Wilson and J.Walker (1994), Cambridge University Press, Cambridge

## PBT-103 ADVANCES IN BIOTECHNOLOGY

### UNIT I

Molecular medicine: Gene mutation, point mutation, allele specific oligonucleotides, disease diagnosis with linked genetic markers, fluorescently labeled DNA sequencing. Micro RNA, Gene silencing and siRNA.

### UNIT II

Nano-biotechnology: Introduction, definition, hybrid nanopracticles, smart drug delivery, gene sensors, biomolecule control, microfluidics, nanofluidics, nanotechnology in medicine.

### UNIT III

Genetically modified organisms: Genetically modified food crops, food animals, Biosafety and ethical issues. Future goals in GM food crops and animals, legal requirements in production of GMO. Pros and Cons of GMOs. Genetically modified commercial products: Golden rice and BT Cotton.

### UNIT IV

Industrial Biotechnology: Upstream and downstream processing in brief. Introduction and types of bioreactors, enzyme immobilization, continuous and Feb-batch fermentation techniques. Control of physical and chemical parameters during fermentation. Production of biofuels / industrially important enzymes.

### UNIT V

Brief introduction of stem cells technology: Definition, properties, proliferation, culture of stem cells, medical applications of stem cells.

### Text/Reference Books:

- Plants, Genes and Crop Biotechnology (2003) 2nd Edition by Chrispeels, M.J. & Sadava D.E. American Society of Plant Biologists, Jones and Bartlett Publishers, USA.
- David W. Mount. Bioinformatics: Sequence and Genome Analysis 2nd Edition, CSHL Press, 2004.
- A. Baxevanis and F. B. F. Ouellette, Bioinformatics: a practical guide to the analysis of genes and proteins, 2nd Edition, John Wiley, 2001.
- Molecular Biology and Biotechnology, 4th Edn, J.M Walker and R. Rapley, Panima Books
- Cell Biology, David. E. Sadava, Panima Books, Stem Cell Biology, Daniel Marshak, Richard L. Gardener and David Gottlieb, Cold Spring Harbour Laboratory Press
- Environmental Microbiology, 2nd Edition, Ian L .Pepper and Charles P. Gerba, Elsevier Pub.
- Environmental Biotechnology – Concepts and Application, Hans – Joachim Jordening and Jesefwinter – Wiley – VCH.

**PBT-104 MOLECULAR AND STRUCTURAL BIOLOGY****UNIT I**

Molecular Basis of Gene, Biological Repair Mechanisms, Repair Defects and Diseases, DNA Replication: Replication Machinery in Prokaryotes and Eukaryotes. Transcription in prokaryotes: Initiation, elongation and termination. Attenuation and anti termination

**UNIT II**

Regulation of gene expression in prokaryotes: Operon concept (lac, ara & trp), induction and repression. Initiation of transcription, Transcription factors, repressor, activator and enhancer.

**UNIT III**

DNA structure and types, base pairing, hydrogen bonding, DNA melting and annealing, difference between AT and GC pairing, Watson Crick model; Crystal structure of B-DNA, major and minor grooves, telomeric sequences and structure

**UNIT IV**

Amino acids and peptides: Side chain structure and function in protein folding and functionality: Secondary structure of proteins -helices, sheets, loops and turns; Structural and functional proteins. Tertiary structure of proteins, homo and hetero-dimers, trimers and tetramers

**UNIT V**

Interaction of biomolecules: Protein-protein, Protein-DNA and Protein-ligand, drug-DNA interactions. Databases of sequences and structure for protein and DNA, public domain softwares for visualizing and modeling biomolecules.

**Text/Reference Books:**

- Biochemistry, R.H. Abeles, P.A. Frey and W.A. Jencks, Jones and Bartlett.
- Essentials of Molecular Biology, D. Freifelder, Jones and Bartlett Publications.
- Genes VII, B. Lewin, Oxford University Press.
- Introduction to Protein Structure, C. Branden and J Tooze, Garland Publishing Company.
- Proteins (Structures and Molecular Properties), T.E. Creighton, W.H. Freeman and Company.
- Database Annotation in Molecular Biology, Arthur M. Lesk.
- Genes & Genomes, M.S. Paul Berg.
- Structure and Mechanism in Protein Science, Alan Fersht.

**PBT-105 IMMUNOLOGY AND VACCINE TECHNOLOGY****UNIT I**

Immune response: Innate and adaptive immune system, Antigen presenting cells, Antigens, Antigenic specificity, Diversity, Immunologic memory, Self / nonself recognition, Antigens and epitopes: immunogenicity, antigenicity and haptens; factors affecting immunogenicity. adjuvants, epitopes, properties of b-cell epitopes and t-cell epitopes.

**UNIT II**

Antigen-Antibody Interactions: Cross-Reactivity, Precipitation Reactions, Agglutination Reactions, Radioimmunoassay, Enzyme-Linked Immunosorbent Assay, Western, Blotting, Immunoprecipitation. Production and application of monoclonal antibody: hybridoma technology.

**UNIT III**

Major histocompatibility complex: Structure of MHC I and II molecule, Association of MHC with disease. Recognition of antigens by T and B Cells: Antigen processing, role of MHC molecules in antigen presentation. T-cell receptor complex, B-cell receptor complex.

**UNIT IV**

Introduction to vaccines, fundamental concepts in vaccination, types of vaccines, traditional methods of vaccine production, production of DPT and Rabies vaccine, Production of Modern Vaccines - production of Hepatitis vaccine; DNA vaccine.

**UNIT V**

B-cell epitope and T-cell epitope prediction methods, reverse vaccinology and immunoinformatics Databases. Production of peptide based vaccine in detail

**Text/Reference Books:**

- Kuby Immunology 4e by Richard A. Goldsby, Thomas J. Kindt and Barbara A. Osborne
- Immunoinformatics: Predicting Immunogenicity in Silico By Darren R Flower Publisher: Humana Press
- Immunoinformatics (Immunomics Reviews:) By Shoba Ranganathan ,Vladimir Brusic, Christian Schonbach. Publisher: Springer

## PBT-106 BIOLOGICAL ENGINEERING

### UNIT I

Introduction and tools for Genetic Engineering: Introduction of RDT, Restriction enzymes, Modifying enzymes, DNA ligase, Polymerase. Cloning Vectors: Plasmids, Lambda phage, Phagemids, Cosmids, Artificial chromosomes (BACs, YACs), virus based vectors

### UNIT II

Polymerase Chain reaction (PCR) and applications: Basic principles, PCR modifications and their applications. Gene libraries: cDNA synthesis, Genomic DNA libraries.

### UNIT III

Gene Transfer Technology: Isolation of gene, methods of gene transfer: Transformation, transduction, Particle gun, Electroporation, liposome mediated, microinjection, Agro-bacterium mediated gene transfer.

### UNIT IV

Introduction and scope of metabolic engineering, engineering of biosynthetic pathways for production of artemisinin, microbial synthesis of chemicals, bioethanol, butanol, hydrogen and biodiesel.

### UNIT V

Introduction and scope of synthetic biology, Biobrick, iGEM, designing a small gene network, building standards in biology, making artificial gene, codon optimization methods, promoter, plasmid, cell free systems, toggle switch, logic gates, oscillators, time delay circuits, riboregulator, riboswitch.

### Text/Reference Books:

- Microbial Biotechnology (1995) Alexander n. Glazer Hiroshi Nikaido W.H.Freeman and Company
- Molecular Biotechnology: Principles and Applications of Recombinant DNA –Bernaral R.
- Glick and Jack J. Pastemak ASM Press. Washington, D.C (1994).
- Fungal Ecology and Biotechnology (1993) Rastogi Publicaions, Meerut.
- Sprinzak D. Elowitz MB. Reconstruction of genetic circuits. Nature 438, 443-448
- Drew Endy. Foundations for engineering biology. Nature 438, 449-453
- Arkin, A.P., Synthetic cell biology. Curr Opin Biotechnol, 2001. 12(6): 638–644.
- Designing Human Practices: An Experiment with Synthetic Biology by Paul Rabinow and Gaymon Bennett University Of Chicago Press, 2012