# SYLLABUS

# Post Graduate Diploma in Applied Microbiology - Cell and Molecular Biology

## (Semester I-II)

### Choice Based Credit System (CBCS)

## Effective from June 2016

Accredited **Grade A** by NAAC

**(CGPA 3.05)**

## Department of Biochemistry

## Saurashtra University

## Rajkot

## POSTGRADUATE DIPLOMA IN APPLIED MICROBIOLOGY

## - CELL AND MOLECULAR BIOLOGY

| Name of Program | Sem. | Course Group | Credits | Hours / Week | Internal marks | External Marks | Practical/ Viva Marks | Total Marks | 16 digit Number |
|---|---|---|---|---|---|---|---|---|---|
| | | **Core** | | | | | | | |
| PG Diploma in Applied Microbiology – Cell and Molecular Biology | 1 | CCMB 101: Advanced Cell Biology | 04 | 04 | 30 | 70 | | 100 | 1603120105010400 |
| | | CCMB 102: Molecular Biology And Methodologies | 04 | 04 | 30 | 70 | | 100 | 1603120105010500 |
| | | CCMB 103: Developmental Biology | 04 | 04 | 30 | 70 | | 100 | 1603120105010600 |
| | | **Interdisciplinary** | | | | | | | |
| | | ICMB 101: Analytical Techniques | 04 | 04 | 30 | 70 | | 100 | 1603120205010200 |
| | | **Seminar** | | | | | | | |
| | | CCMB 104: Class presentations | 02 | 02 | - | 50 | | 50 | 1603120305010200 |
| | | **Practical** | | | | | | | |
| | | CCMB 105: Practicals | 06 | 12 | - | - | 150 | 150 | 1603120405010200 |
| | | | | | | | | | |
| | 2 | **Elective** (Any one) | 04 | 04 | 30 | 70 | | 100 | |
| | | ECMB 101: Animal Cell Tissue Culture | | | | | | | 1603120505020300 |
| | | ECMB 102: Bioinformatics And Biostatistics | | | | | | | 1603120505020400 |
| | | **Project Work** | | | | | | | |
| | | CCMB 106: Dissertation Research Thesis Work | 12 | 26 | - | 300 | | 300 | 1603120605020200 |

# Examination Marks Distribution

| Subject | External Marks | | Internal Marks | | Total Marks | |
|---|---|---|---|---|---|---|
| | **Max** | **Min** | **Max** | **Min** | **Max** | **Min** |
| All Theory Papers (Core, Interdisciplinary & Elective) | 070 | 028 | 030 | 012 | 100 | 040 |
| Practicals | 150 | 060 | - | - | 150 | 060 |
| Seminar | 050 | 020 | - | - | 050 | 020 |
| Dissertation | 300 | 120 | - | - | 300 | 120 |

# SEMESTER-I

## CCMB-101 ADVANCED CELL BIOLOGY

### UNIT 1: Cells, Cell Organelles & Membrane Biochemistry

Evolution and Introduction of Cell Types including Cellular Specialization and Differentiation, Differences in Plant and Animal Cells, Eukaryotic Cell Organelle's Structure, Functions and Biochemistry, Structure and Biochemical Aspects of Specialized Plant Cell Organelles, Cell Plate, Primary and Secondary Cell Walls, Plasmodesmeta, Importance of Vacuoles, Chemical Composition and function of Biomembranes, Model of Lipid Membranes, Differences between Biomembranes and Artificial Phospholipids Membranes, Models of Plasma membranes and techniques to study fluidity

### UNIT 2: Tissue Organization and Cytoskeleton:

Cell Differentiation, Organogenesis, Morphological, Functional and Biochemical Maturation of Tissues, Cytoskeleton: Microtubules Polymerization, Dynamic, and Functions, Microtubules in Cell Division, Role of Cytoskeleton Filaments in Cancer

### UNIT 3: Cell Cycle

Phases of Cell Cycle, Functional Importance of each Phase, Molecular Events during Cell Cycle, Check Points, Cyclins and Protein kinases, MPF (maturation promoting factor), Regulation of Cell Cycle. Apoptotic Pathway and Cell Death.

### UNIT 4: Signaling Pathway

Signal transduction, G proteins, cyclic nucleotide and kinase signaling, phospholipid and Ca++ signaling, growth factor and cytokine signaling, MAP kinase cascades, signaling via regulated proteolysis

## CCMB-101 ADVANCED CELL BIOLOGY

Objectives

- To equip students with a basic knowledge of the structural and functional properties of cells.
- To examine properties of differentiated cell systems and tissues.
- Aspect of cell cycle and cell death.
- To introduce the fascinating mechanism of cell signaling along with brief overview on developmental biology.
- To provide thorough knowledge on classical genetics.

Outcomes

Students will understand the structures and purposes of basic components of cell, especially membranes and organelles. Appreciate the cellular components underlying cell division along with a deep insight to cell division, cell death and uncontrolled cell division. Students will learn the basic principles of inheritance and patterns of heredity. Students will test and deepen their mastery of genetics by applying this knowledge in a variety of problem-solving situations.

## CCMB-102 MOLECULAR BIOLOGY AND METHODOLOGIES

**Unit-1: Basic genetics**

Mendelian principles: Dominance, segregation, independent assortment, deviation from Mendelian inheritance. Concept of gene: Allele, multiple alleles, pseudoallele, complementation tests, Extensions of Mendelian principles, Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters.

**Unit-2: Advanced genetics**

Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants. Extra chromosomal inheritance: Inheritance of mitochondrial and chloroplast genes, maternal inheritance. Microbial genetics: Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, Lambda Genetics mapping genes by interrupted mating, fine structure analysis of genes. Human genetics, Mutation, Structural and numerical alterations of chromosomes, Recombination.

**Unit-3: Molecular dogma**

DNA replication, repair and recombination, RNA synthesis and processing, Protein synthesis and processing, Control of gene expression at transcription and translation level

**Unit-4: Methods in Molecular biology**

Cloning, Cloning vectors, Selection and expression of suitable vectors, cDNA libraries and Genomic libraries, DNA sequencing, Site directed mutagenesis, Hybridization techniques, PCR techniques, Molecular markers, Transgenic animals and Plants, Applications of recombinant technology

## CCMB-102 MOLECULAR BIOLOGY AND METHODOLOGIES

Objectives:

- Detailed understanding of prokaryotic and eukaryotic replication, types of DNA polymerases and inhibitors of DNA replication
- To gain detail on prokaryotic and eukaryotic transcription, translation and gene expression regulation
- In depth study of various types of vectors, hybridization technique and its application
- To develop an understating of advanced technologies like RFLP, Sequencing, SSR, REMAP, SCAR and various types of PCR

Outcome:

Students will choose appropriate experimental strategy for research in basic and molecular biology. To perform laboratory techniques in basic biology, molecular biology, and advanced techniques. Explanation and integration of biological principles, as applied to basic and molecular biology. Development of strong diversified background in modern biology, appropriate to the individual student goals. Develop critical-thinking, and problem based learning skills. This paper will open an understanding of current trends in molecular and genetic research, and critically appraise published work. Students will be prepared to demonstrate an ability to design, undertake, and interpret, a research project, presented in the form of a dissertation.

## CCMB-103 DEVELOPMENTAL BIOLOGY

**Unit-1 Introduction and overview of animal development**

Developmental control of gene expression, Cell signaling, Determining cell fate and cell commitment, Fertilization and cleavage, Gastrulation and Neurulation

**Unit-2 Examples of induction and cell fate determination**

Early inductive events in Xenopus: Axis formation, Early inductive events in Xenopus: the Nieuwkoop center and the Organizer, Early inductive events in Xenopus, continued (neural fate), Examples of determination of cell fate in the nervous system: the cerebral cortex, Examples of determination of cell fate in the nervous system: the retina, Consequences of molecular evolution

**Unit-3 Developmental Genetics**

Introduction to developmental genetics: approaches and techniques, introduction to C. elegans, Developmental genetics in practice: studying events controlled by maternal transcripts as well as later signaling events using C. elegans, Developmental genetics in practice continued: using epistasis and mosaic analysis to determine how genes products interact, Developmental genetics in practice: studying early events in Drosophila development, Drosophila axis formation and embryonic patterning, Drosophila segmentation and segment identity (Hox genes), Developmental genetics in practice: Mouse transgenics: techniques and applications

**Unit-4 Patterning: genes, environment and plasticity**

Organizing the limb, Pattern formation in the nervous system: Axon guidance, Neuronal plasticity, Sex determination, Dosage compensation, Epigenetics: Imprinting, Stem cells and medical applications for humans

**CCMB-103 DEVELOPMENTAL BIOLOGY**

Objectives:

- Detailed understanding of prokaryotic and eukaryotic replication, types of DNA polymerases and inhibitors of DNA replication
- To gain detail on prokaryotic and eukaryotic transcription, translation and gene expression regulation
- In depth study of various types of vectors, hybridization technique and its application
- To develop an understating of advanced technologies like RFLP, Sequencing, SSR, REMAP, SCAR and various types of PCR

Outcome:

This paper captivates student interest, opening minds to the wonder of developmental biology, whilst covering required material with scientific rigour. The present paper reflects the exciting new age of genomics, genetic regulatory networks and digital visualization techniques while keeping focus on the major questions of animal development.

## ICMB - 101: ANALYTICAL TECHNIQUES

**UNIT 1: Microscopy and Autoradiography**

Theories of Tissue Fixation and Staining Techniques. Principles of Transmission and Scanning Electron Microscopy. Principles of Phase Contrast and Fluorescence Microscopy. Principle and Applications of Autoradiography

**UNIT 2: Spectroscopy**

Basic Principles of Spectroscopy, UV, IR, Raman, ESR, ORD. CD and Structure of Proteins using NMR and ESR. Neutron and X-Ray Diffraction for Elucidation of 3D Structure. Molecular Modelling, Mass Spectrometry

**UNIT 3: Chromatographic Techniques**

Basic Principle and types of Chromatography. Gas Chromatography, GC-MS, LC – MS / MS. Ion Exchange Chromatography, Gel permeation, Affinity and Reverse Phase Chromatography. HPLC and FPLC

**UNIT 4: Centrifugation and Electrophoretic Techniques**

Principle and Applications of Centrifugation Techniques. Basic Principles of Electrophoresis, Agarose Gel, Native and SDS-PAGE. Isoelectric Focusing, 2D-PAGE and their uses in Protein Research. Fractionation and Blotting Techniques

**CMB-104 Class presentations**

**CMB-105 Practicals**

# SEMESTER – II

## ECMB-101: ANIMAL CELL TISSUE CULTURE

**UNIT 1: Introduction**

History, Biology of cell culture, Laboratory design and layout, equipments, aseptic condition, safety, bioethics and validation

**UNIT 2: Media**

Culture vessels, substrates, defined media supplements, serum free media, media preparation and sterilization

**UNIT 3: Various Cell Culture**

Primary culture, subculture and cell lines, cloning and selection, cell separation, characterization, differentiation, transformation and immortalization

**UNIT 4: Techniques and Media**

Contamination, cryopreservation, quantification, cytotoxicity, special cell type culture, culture of tumor cells, organotypic culture, scale up and specialized techniques

**ECMB-101: ANIMAL CELL TISSUE CULTURE**

Objectives:

- Understating the basics of animal tissue culture i.e. laboratory design and requirements
- To acquire a knowledge of various types of media and methodologies
- An understanding of the various types of cell cultures and separation techniques
- In-depth knowledge and understanding of cell preservation, scale up and special cell cultures

Outcome:

The expected learning outcomes of this course is to attain a working knowledge of discrimination between the different types of cell culture technologies. Detailed criteria for consideration for scale up of cell culture and media composition. Students will gain knowledge in identifying the appropriate cell model for a large scale process and explaining recent developments in cell and tissue engineering.

## ECMB-102: BIOINFORMATICS AND BIOSTATISTICS

### UNIT 1: Basics of Bioinformatics

Introduction to Bioinformatics: Definition and History of Bioinformatics, Internet and Bioinformatics, Introduction to Data Mining, Applications of Data Mining to Bioinformatics Problems and Applications of Bioinformatics

### UNIT 2: Biocomputing and Softwares in Bioinformatics

Introduction to String Matching Algorithms, Database Search Techniques, Sequence Comparison and Alignment Techniques, Use of Biochemical Scoring Matrices, Introduction to Graph Matching Algorithms, Automated Genome Comparison and its Implication, Automated Gene Prediction, Automated Identification of Bacterial Operons and Pathways Bioinformatics Softwares: Clustal V, Clustal W, RasMol, Oligo, Molscript, Treeview, Alscript, Genetic Analysis Software, Phylip

### UNIT 3: Biological Databases & Protein Engineering

Nucleic acid sequence databases: GenBank, EMBL, DDBJ, Protein sequence databases: SWISS-PROT, TrEMBL, PIR_PSD, Genome Databases at NCBI, EBI, TIGR, SANGER, PDB, NDB, CCSD, Prosite, PRODOM, Pfam, PRINTS, CATH, SCOP, DSSP, FSSP, DALI, Site directed mutagenesis, Role of Bioinformatics in Protein Engineering.

### UNIT 4: Statistical Tests in Biology

Mean, Median, Mode, Student's t Test, Meaning of Significance and Significance Levels Analysis of Variance. Analysis of Covariance, Regression and Correlation Analysis, Qui square test, Confidence limits

## ECMB-102: BIOINFORMATICS AND BIOSTATISTICS

Objectives:

- Detailed understanding of genome projects, related disciplines of Bioinformatics use of Databases and Tools in Biological Discovery, Major Bioinformatics Resources
- To gain detail on biological databases like primary sequence databases, protein three dimensional databases, Protein Structure Mathematical model databases, PCR and quantitative PCR primer databases, Chemical Databases, Drug & Drug Target / Therapeutic Target Databases, Disease databases, Immunological database.
- In depth study of various types of tools including sequence submission tools, Chemical molecule designing software, Protein & Chemical molecule visualization tools, Docking software, Molecular dynamics software; QSAR, ADME Toxicity prediction, Allergen prediction, Venomics & Antivenomics.
- To develop an understating of statistical methods and calculations

Outcome:

Students will choose appropriate experimental strategy for research in basic and applied biology. Explanation and integration of bioinformatics principles and its applications to basic and applied biology. Students will gain *in silico* training on data mining, database searching, software application, quantitative analysis and interpretation, molecular modeling, QSAR and various DNA, RNA and Protein analytical tools. Moreover, this paper enables students to acquire the knowledge of statistical analysis and its principles.

**CCMB-106: Dissertation Thesis work / Research Project Work include thesis work and viva voce examination**

Dissertation research work is offered to students of Semester II to carry out research according to the provision of objectives and teacher guide. Students are eligible to apply in other national and international level research institutes, Universities and industries of high repute to pursue six month dissertation research project for the partial fulfillment of PG Diploma degree.

## REFERENCE BOOKS


1. Analytical Biochemistry by Holme, D. J. & Peck, H.
2. Biochemical calculation by Segel
3. Laboratory Manual in Biochemistry by Jayraman
4. Biochemistry and Molecular Biology of Antimicrobial Drug Action by Franklin, T. J. & Snow, J. A.
5. Biochemistry by Champe
6. Biochemistry by Todd, W. B., Mason, M., Bruggen, R. V. & Macmillan.
7. Biochemistry by Voet & Voet
8. Lehninger Principles of Biochemistry by Nelson, D. L. & Cox, M. M.
9. Biochemistry by Mathews
10. Biochemistry by Satyanarayana, U.
11. Biochemistry by Zubay, J.
12. Biochemistry by Stryer
13. Cell Biology Protocols by Harris, R., Graham, J. & Rickwood, D.
14. Color Atlas of Biochemistry by Koolman, J. & Roehm, K. H.
15. Current Protocols in Protein Science (All Vol) John Wiley & Sons
16. Dynamics of Proteins and Nucleic Acids by Mccammon, J. A. & Harvey, S. C.
17. Fundamentals of Biostatistics by Bernard Rosner
18. Fundamentals of Protein Structure and Function by Buxbaum, E.
19. Instant Notes in Biochemistry by Hames, B. D. & Hooper, N. M.
20. Introduction to Molecular Biology by Paolella, P.
21. Introduction to Protein Architecture: The structural biology of proteins by Lesk, A. M.
22. Introductory Biostatistics by Chap T. Le
23. Modern Experimental Biochemistry by Boyer, R.
24. Molecular Biology of The Cell - Bruce Alberts
25. Molecular Cell Biology by Lodish, H.
26. Molecular biology of the gene by Watson.
27. Genes IX by Lewin, B.
28. Essential Molecular Biology by T. A. Brown
29. Principles Of Gene Manipulation And Genomics by Primarose
30. Molecular Cloning by Russell Sambrook

31. Analytical chemistry by Skoog
32. Nutritional Biochemistry by Tom Brody
33. Plant Biochemistry by Heldt, H-W.
34. Plant Physiology By Taiz and Zeiger
35. Principles of Biochemistry by Zubay, J.
36. Protein Biochemistry and Proteomics: Experimental series by Rehm, H
37. Proteins: structure and function by Whitford, D.
38. Culture of Animal Cells by Freshney R. I.
39. Animal Cell Culture by Masters
40. Bioinformatics Methods and Applications by Rastogi, S.C.
41. Bioinformatics for Dummies by Jean-Michel Claverie
42. Textbook of bioinformatics by Subramaniam, C.
43. Review & Research papers from Bioinformatics & related Journals
44. Arthur M. Lesk, Introduction to Bioinformatics, Oxford University Press, 2008.
45. David W. Mount, Bioinformatics – Sequence and Genome analysis, 2004.
46. G. Gibson & S.V.Muse, A Primer of Genome Science, 2009.
47. A. Baxevanis and B.F. Ouellette. Bioinformatics: A practical Guide to the Analysis of Genes and Proteins, Wiley- Interscience, Hoboken, NJ, 2005.
48. A. M.Campbell & L. J. Heyer, Discovering Genomics, Proteomics & Bioinformatics, CSHL Press, 2006.
49. S.R. Pennington & M.J. Dunn, Proteomics – from protein sequence to function, BIOS Scientific Publishers, 2002.
50. Fundamentals of Biostatistics by Bernard Rosner $5^{th}$ Ed.