

**VIJAYANAGARA SRI KRISHNADEVARAYA  
UNIVERSITY, BALLARI-583 105**



**SYLLABUS  
FOR  
Ph.D. COURSE WORK IN  
BIOTECHNOLOGY**

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# DEPARTMENT OF P.G. STUDIES AND RESEARCH IN BIOTECHNOLOGY

## SYLLABUS FOR Ph.D. COURSEWORK

(APPROVED IN BOS-PG MEETING HELD ON 19.01.2019)

Sl. No	Name of the Course	Contact Hours per week	Maximum marks			Examination Hours
			Continuous assessment	Course-end examination	Total	
1	Course-I: Research Methodology	03	25	75	100	03
2	Course-II: Core subject (Biotechnology)	03	25	75	100	03
3	Course-III: Field of Specialization (Recent Advances in Biotechnology)	03	25	75	100	03
<b>Total</b>			75	225	300	
<b>Viva-voce</b>					<b>50</b>	

\*The student should obtain a minimum of 55% marks in order to be declared successful at the Pre-Ph.D. examination.

**COURSE-I: RESEARCH METHODOLOGY****[48 hrs]****Unit 1: Research Methods****[10 hrs]**

- Introduction to research; Definitions and characteristics of research; Types of research; Main components of any research work.
- Topic Selection: Learning Objectives; Problem identification; Criteria for prioritizing problems for research.
- Analysis and Statement of the problem: Learning Objectives; analyzing the problem; formulating the problem statement.
- Literature review: Uses of literature review; Source of information; Organization of information on index cards.
- Objectives: Learning Objectives; Definitions; Formulation of the research objectives.
- Research methodologies: Study population; Variables; Sampling; Sample size determination; Plan for data collection; Methods of data collection; Plan for data processing and analysis; Ethical considerations.
- Work Plan; Major components and outline of the different phases in a research process; Summary of the major components of a research proposal; Fieldwork; Writing a research report.

**Unit 2: Quantitative Methods:****[08 hrs]**

- Statistics: Probability & Sampling distribution; Estimation, Hypothesis testing & application; Correlation & regression analysis.
- Types of study designs/ Experiment design – Orthogonal array, ANOVA, interaction, Signal-to-Noise ratio, replication.

**Unit 3: Computer Applications****[08 hrs]**

- Spreadsheet tool: Introduction to spread-sheet applications, features & functions, using formulae & functions, data storing, features for statistical data analysis, generating charts/graphs & other features. [*Tools: Microsoft Excel, Open office and similar or other advanced tools*]
- Presentation tool: Introduction to presentation tool, features & functions, creating presentations, customising presentation. [*Tools used: Microsoft Powerpoint, Open Office or any other tool*]
- Web Search: introduction to internet, Use of Internet & www, using search engines using advanced search tools.
- Thesis writing & Scientific editing tools.

**Unit 4: Bioinformatics****[12 hrs]**

- **Databases and search tools:** Database browsing and Data retrieval; Searching of databases similar sequence; The NCBI; Publicly available tools; Resources at EBI; Resources on the web; Database mining tools. Sequence database and genome database; Data Structures and Databases; Databases such as GeneBank; EMBL; DDBJ; Swissprot; PIR; MIPS; TIGR; Hovergen; TAIR; PlasmODB; ECDC; Searching for sequence database like FASTA and Blast algorithm. Biological back ground for sequence analysis; Identification of protein sequence from DNA sequence.
- **DNA sequence analysis:** The gene bank sequence database; Submitting DNA sequence to the databases and database searching; Sequence alignment; Pair wise alignment techniques; Multiple sequence analysis; Multiple sequence alignment; Flexible sequence similarity

searching with the FAST3 program package; Use of CLUSTAL W and CLUSTAL X for the multiple sequence alignment; Submitting DNA, protein sequence to databases: Where and how to submit, SEQUIN, genome centre; Submitting aligned set of sequences, updates and internet resources, Phylogenetic analysis, Primer designing and DNA microarray or Biochips.

### Unit 5: Bioethical Issues IPR and Patents

[10 hrs]

- **Ethical Issues:** Ethical, legal, social and scientific issues in Biological Research. A brief idea about the funding agencies such as DST, DBT, ICMR, CSIR and UGC. Role of IPR in Research and Development.
- **Introduction to Intellectual Property :**Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of GMOs IP as a factor in R&D; IPs of relevance to Biotechnology and few Case Studies
- **Patent filing procedures :**National & PCT filing procedure; Time frame and cost; Status of the patent applications filed; Precautions while patenting –disclosure/non-disclosure; Financial assistance for patenting -introduction to existing schemes Patent licensing and agreement Patent infringement- meaning, scope, litigation, case studies

### REFERENCES:

1. Montgomery, Douglas C. (2007) 5/e, Design and Analysis of Experiments (Wiley India)
2. Montgomery, Douglas C. & Runger, George C. (2007) 3/e, Applied Statistics & probability for Engineers (Wiley India)
3. Kothari C.K. (2004) 2/e, Research Methodology – Methods and Techniques (New Age International, New Delhi)
4. Krishnswamy, K.N., Shivkumar, Appa Iyer and Mathiranjana M. (2006) Management Research Methodology; Integration of Principles, Methods and Techniques (Pearson Education, New Delhi)
5. The Complete reference Office Xp- (2001) Stephan L. Nelson, Gujulia Kelly (TMH)
6. Basic Computer Science and Communication Engineering (2000)– R. Rajaram (SCITECH).
7. Design of Experiments: Statistical Principles of Research Design and Analysis, by Robert O. Kuehl Brooks/Cole (1999).
8. Study and Communication Skills for the Biosciences by Stuart Johnson and Jon Scott, Oxford University Press (2014) .
9. Write and Publish a Scientific Paper by Robert A. Day Oryx Press Scientific Easy when you know how by Jennifer Peat BMJ Books .
10. Research Projects and Research Proposals A Guide for Scientists Seeking Funding by Paul G. Chapin Cambridge University Press (2004).
11. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007.
12. Kankanala C., Genetic Patent Law & Strategy, 1<sup>st</sup> Edition, Manupatra Information Solution Pvt. Ltd., 2007 .
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**COURSE-II: CORE SUBJECT: BIOTECHNOLOGY****[48 hrs]****Unit 1****[10 hrs]**

**Biophysical Techniques:** Over view of spectroscopy, Electromagnetic and quantum theory of radiation, Wave – particle duality, Photons, Interaction of light with matter , Transition dipole moment, Jablonsky diagram, Beer – Lamberts law; UV – visible absorption spectroscopy: applications of UV – visible for estimation of protein. DNA and RNA, enzyme kinetics: protein – ligand interaction.

Fluorescence spectroscopy of Biomolecules: quantum yield, static and dynamic quenching of fluorescence, energy transfer, polarization , anisotropy, time resolved fluorescence, application to biomolecule structure and dynamics, Protein- ligand interaction. Circular dichroism spectroscopy and its application for studying the secondary and tertiary structure of proteins;

Diffraction of x-rays and Braggs law, Surface Plasmon spectroscopy, Electron Microscopy of Biomolecules.

**Unit 2****[10 hrs]**

**Gene Technology:** Enzymes: DNA polymerase, restriction endonucleases, topoisomerase I and DNA ligase, reverse transcriptase, kinase, alkaline phosphatase, nuclease, RNase H. Vectors: plasmids;(Ti/Ri), Cosmids, bacteriophage, M13 vectors, BAC, YAC and synthetic plasmids. DNA sequencing dideoxy chain termination and Sanger's +/- method. cDNA library – screening by oligonucleotide probe, nick translation, site directed mutagenesis, linkage analysis. Gene cloning- General strategy for gene cloning, transformation. Application of gene technology, Gene Silencing, Geneknock out and gene therapy.

**Unit 3****[08 hrs]**

**Immunology:** Complement fixation, structure and classes of antibodies, genetic basis of antibody diversity. MHC I and II: structure and antigen presentation. T and B lymphocytes activation and role in humoral and cell mediated immunity. Vaccines live and attenuated, killed, multi-subunit and DNA vaccines. Hypersensitivity and auto immune diseases. ELISA, RIA, Hybridoma Technology.

**Unit 4****[10 hrs]****Tissue culture Techniques:**

a) Animal Culture: Media requirements and sterilization techniques, primary and established cell lines. Culture methods: hanging drop, monolayer and suspension. Advantages and disadvantages. Scale up methods. Roux tubes roller bottles. Stem cells: adult and embryonic, applications to tissue engineering. Applications of animal cells.

b) Plant tissue culture: Cell and callus culture, anther culture. Micropropagation, somatic cell hybridization, protoplast fusion, cybrids, artificial seeds, Agrobacterium mediated gene transfer and use of Ti plasmid. Applications of plant tissue culture engineering, pathogen resistance (BT gene), herbicide tolerance, salt tolerance, production of secondary metabolites and transgenic plants.

**Unit 5****[10 hrs]**

**Biofertilizers:** Symbiotic free nitrogen fixers, asymbiotic free nitrogen fixers, algal, phosphate solublizing, mycorrhizae and green manure.

a. Recent advances in Bacterial Taxonomy –

i. Identification of Prokaryotes

ii. A phylogenetic backbone and taxonomic framework for prokaryotic systems

iii. A road map to the use of the current Bergey's Manual

iv. Computer taxonomy

- v. 16s rRNA fingerprinting and lipid profile by GLC
- b. Microbial sources of pharmaceutically important compounds.
- c. Quorum sensing and microbial hormones – intercellular signaling.
- d. Biosensors – living biosensors for the management and manipulation of microbial consortia

## REFERENCES:

1. Culture of Animal Cell by R. Ian Freshney. 5th Edition., Wiley-Liss (2005).
2. Biotechnology by U. Satyanarayana, Books and Allied (P) Ltd, Kolkata (2005).
3. Gene Transfer to Animal Cells - R.M.Twyman, Publisher : Garland Science/BIOS Scientific Publishers, (2005), ISBN 0-203-48923-3
4. Animal Biotechnology 2nd edition. - M. M. Ranga, Publisher: Agrobios India, ISBN: 81-7754-155-2, (2009)
5. Practical Application of Plant Molecular Biology by .R.J. Henry: Chapman and Hall. 1997
6. Maarten J. Chrispeels and David E. Sadava. Jones (2002) Plants, genes and agriculture Bartlett Publishers, 1 Exeter Plaza, Boston, USA.
7. Harvinder Singh Chawla (1998) Biotechnology in Crop Improvement IBD Publishers.
8. Razdan MK (2003). Introduction to Plant Tissue Culture, Oxford-IBH Publishers
9. Mantel, Mathews and Mickee (1985). An introduction to genetic engineering in plants. Blackwell Publishers.
10. Molecular Farming: Plant made pharmaceuticals and technical proteins.Eds. Rainer Fischer and Stefan Schillberg (2004).
11. Manual of Environmental Microbiology, 3rd Edition 2007, Editors: Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, Linda D. Stetzenbach, ASM Press Title: Manual of Environmental Microbiology, 3rd Edition
12. Methods for General and Molecular Microbiology, 3rd Edition, 2007 , Editors: C. A. Reddy, Terry J. Beveridge, John A. Breznak, George Marzluf, Thomas M. Schmidt, Loren R. Snyder, ASM Press 3
13. Lehninger Principles of Biochemistry 5th Ed 2009, Dave Nelson and Mike Cox Publisher WH Freeman.
14. Genes IX, Lewin, Benjamin 2007, CBS Publishers and Distributors Molecular Biology of the Gene 6th Edition 2008 Ed James Watson, Tania Baker, Stephen Bell, Alexander Gann, Michael Levine, Richard Losick Pearson Education.
15. Electron Microscopy: Principles and Techniques for Biologists By John J. Bozzola, Jones & Bartlett Learning, 2011.

**COURSE-III: FIELD OF SPECILIZATION: RECENT ADVANCES IN BIOTECHNOLOGY****[48 hrs]****Unit 1: [08 hrs]**

- Introduction to Stem Cells (Stem cells - definition, classification and sources: embryonic stem cells, adult stem cells and mesenchymal stem cells; stem cells differentiation; Stem cells cryopreservation; clinical applications of stem cells).
- Reprogramming of Somatic Cells to induced pluripotent Stem cells (iPS), Application of iPS technology to Regenerative Medicine.
- Developmental hematopoiesis, Epigenetic regulation of stem cell fate, Niche biology: regulation of hematopoiesis by the nice- mediated signaling mechanisms.
- Cryopreservation of cells (general), Cord blood banking and long- term storage of stem cells, FACS and its application in stem cell research. Neural stem cells and differentiation. Embryonic stem cells, Cancer stem cells.
- Mammalian Nuclear Transfer Technology; Stem cell based therapies and ethical considerations.

**Unit 2: [04 hrs]**

- Cancer gene regulation and epigenetics. Cellular signalling in Cancer. Cancer stem cell; Molecular classification of biomarkers; Cancer therapeutics; Cancer Immunotherapy; Animal models in cancer; Histopathology in cancer diagnosis and prognosis.
- Eukaryotic cell cycle, regulators of cell cycle progression, oncogenes, DNA repair defects and genomic instability in cancer cells.
- Cell line based evaluation of anticancer agents, apoptosis and therapeutic aspects.

**Unit 3: [07 hrs]**

- Biologics and molecular medicine in immunology (cytokines, chemokines, cell-adhesion molecules, co-stimulatory molecules and surface receptor and ligands as therapeutic targets). Role of non-coding RNA in immune regulation.
- Advanced immunological techniques: Flow cytometry, Magnetic sorting, MHC tetramer technology, multiplex assays. Antibody purification and protein conjugations, spectratyping, surface plasmon resonance (SPR). Animal model of immunological diseases (Transgenic and knockout animals).
- Generation of bone-marrow chimeras, humanized mice, parabiosis.

**Unit 4: [07 hrs]**

- Nanobiotechnology: Introduction, Definitions and historical evolution (colloids etc.) and current practice.
- Types of nanomaterials and their classifications (1D, 2D and 3D etc). Nanocrystal, Nanoparticle, Quantum dot, Quantum Wire and Quantum Well etc.
- Physical and Chemical Fundamentals of Nanomaterials, Overview of synthetic methods, Surfactants, polymers, emulsions. Micelles/reverse micelles and colloids
- Biological Methods, Properties and Characterizations, Applications of Nano-Materials in Biosystems
- Proteins - Lipids - RNA and DNA, Protein Targeting - Small Molecule/Nanomaterial - Protein Interactions
- Nanomaterial-Cell interactions-Manifestations of Surface Modification, Nanomaterials and Diagnostics/Drug Delivery and Therapeutics, Nanomaterials and Toxicity Evaluation.

**Unit 5:** [07 hrs]

- Fermentation Microbial Growth and Death Kinetics; Media for Industrial Fermentation; media optimization; Air and Media Sterilization.
- Types of fermentation processes - Analysis of batch, Fed-batch and continuous bioreactions, bioreactors, specialized bioreactors (pulsed, fluidized, photobioreactors etc. Concept of SSF, downstream processing, product recovery.
- Phases of cell growth in batch cultures, Simple unstructured kinetic models for microbial growth, Monod model, Growth of filamentous organisms. Growth associated (primary) and non-growth associated (secondary) product formation Kinetics. Leudeking-Piret models.
- History of molecular modeling, physical and computer models, different representations of computer models, Generation of 3D coordinates—using x-ray crystallographic databases, compilation of fragment libraries with standard geometrics, drawing of 2D structures using sketch.

**Unit 6:** [07 hrs]

- Totipotency, Media, types of media used, media composition, nutritional variations, cell nutrition, cytodifferentiation, invitro growth parameters, contamination and recalcitrance, invitro cultivation methods, molecular farming.
- New approaches to scientific research with computers, Information and communication technologies (ICT model systems), genomics (functional and structural), proteomics, molecular bioinformatics, chemi-informatics and their applications in Plant improvement.
- Protoplast isolation, culture and fusion technique, protoplast induced transformation, Target cells for transformation, methods of gene transfer, selectable marker genes, reporter genes, screenable genes, *Agrobacterium* mediated transformation, histochemical assay, transgenic plants, Plant DNA finger printing, RAPD, RFLP, PCR studies in plants with a focus on molecular assisted selection.

**Unit 7:** [08 hrs]

- Protein crystallization; Theory and methods; API-electrospray and MALDI-TOF; Massspectrometry; Enzyme and cell immobilization techniques; DNA & Peptide Synthesis and sequencing.
- Chromatographic methods for macromolecule separation – Gel permeation, Ion exchange, Hydrophobic, Reverse-phase and Affinity chromatography; HPLC and FPLC; Criteria of protein purity; Ultrafiltration and other membrane techniques UV, Visible and Raman Spectroscopy; Theory and application of Circular Dichroism; Fluorescence; MS, NMR, PMR, ESR and Plasma Emission spectroscopy.



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15. Razdan MK (2003). Introduction to Plant Tissue Culture, Oxford-IBH Publishers
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17. Vogel's text book of quantitative chemical analysis by G.H.Jeffery, J.Bassett, J.Mendhan, R.C.Denny.