MANGALORE UNIVERSITY
Department of Biosciences

PhD course work in Biotechnology*

Scheme of Examination

Paper	Details	Hours of instruction per week	Hours of Examination	Marks			Credits
				Internal assessment**	Theory	Total	
Paper 1	Research Methodology	4	3	30	70	100	4
Paper 2	Theoretical Foundations	4	3	30	70	100	4
Paper 3 (one paper has to be chosen)	Recent Developments: 3.1. Enzymology and Immunology 3.2. Genetic Engineering 3.3. Bioprocess Technology 3.4. Environmental Biotechnology	4	3	30	70	100	4
Paper 4	Review of literature, work plan of the proposed research with tentative title	16				200	8
		Total				500	20

* The full-time candidates are required to undertake the course work in one semester immediately after the enrollment

* The part-time candidates shall complete papers 1, 2 and 3 in the first semester and the paper 4 in second semester

** Internal assessment marks will be awarded based on one seminar and one assignment

PAPER 1 - RESEARCH METHODOLOGY

Unit 1: Research prerequisites **60 hr (15 hr/unit)**

a) Testing hypothesis – refinement of experiment
b) Field/Lab techniques- design, sample size
c) Collection, compilation, analysis, interpretation of data and drawing conclusions
d) Literature retrieval, citation methods and bibliography
e) Format of writing research paper/dissertation
a) Types of research/study (e.g. Cohort study)
b) Design of questionnaire
f) Safety standards, safety measures, safety regulations and good laboratory practices

Unit 2: Principles of instrumental analysis

a) Photomicrography; Tissue preparation for microscopic analysis
c) Light microscopy, Fluorescent microscopy, Transmission and scanning electron microscopic techniques (TEM and SEM) - Preparation of samples and their applications; confocal microscopy and atomic force microscopy
d) Autoradiography and X-ray diffraction techniques
e) IR-analysis, Scintillation counting, Gel documentation, NMR, HPLC, ELISA, GCMS, MALDI and PCR

Unit 3: Analytical techniques

a) Ultra centrifugation (tissue fractionation)
b) Chromatographic techniques
c) Electrophoresis and Spectrophotometry
d) Photometry and related techniques, Luminometer
e) Staining techniques –cytological and histochemical
f) Lyophilization
g) Isolation of cellular and subcellular components

Unit 4: Biostatistical and mathematical methods

c) Sampling - Design, concepts, types, techniques and scaling, choosing sample size and z-score
d) Statistical design (e.g. Random block design and Latin square design)
a) Standard deviation
b) Theory of probability
c) Student t-test
d) Analysis of variance
e) Graphical representation
f) Computer applications in biological sciences
g) Statistical packages
h) Hardy-Weinberg equilibrium
i) Techniques of remote sensing in bioresource mapping
j) Databases

References

Baily and Ollis. Biochemical Engineering Fundamentals. McGraw-Hill. .
Banwell, C.N. 1972. Fundamentals of Molecular Spectroscopy. McGraw Hill, London.
Buerges, M.J. 1942. X-Ray Crystallography, John Wiley, New York.
Carr and Casherine, E. 1982. Cell Structure: An Introduction to Biomedical Electron Microscopy. Churchill, Edinburgh.
Chaplin, M.F. and Bruke. Enzyme Technology. Cambridge University Press.
Da Skooge Holt 1985. Principles of Instrumental Analysis. Saunders.
Dennis, P. 1977. Kinetics of Chemical and Energy Catalyzed Reactions. Oxford University Press, New York.
Hayet, M.A. 1978. Principles and Techniques of Electron Microscopy. Van Nostrand Reinhold, New York.
Ian Freshney, R. 2000. Culture of Animal Cells: A Manual of Basic Technique. IV Edition, Wiley-Liss.
Karp, G. 1999. Cell and Molecular Biology – Concepts and Experiments. (Ed. John Harris, D), Wiley & Sons, New York.
Khan and Irfan 1994. Fundamentals of Biostatistics, Ukaae Publication, Hyderabad.
Khopkar, S.N. 1988. Basic Concepts of Analytical Chemistry. II Edition, New Age Publishers.
Newbury Dale, E. 1988. Advanced Electron Microscopy and x-Ray Microanalysis. Plenum Publishers, New York.
Rastogi, V.B. 2006. Fundamentals of Biostatistics. Ane Book India, New Delhi

PAPER 2 - THEORETICAL FOUNDATION

60 hr (15 hr/unit)

Unit 1: Enzymology and Immunology

Principles of Enzymology, Purification of Enzymes, Determination of structure of enzymes, Principles of the kinetics of enzyme catalyzed reaction, Mechanism of Enzyme action, Regulation of enzyme activity, Enzymes in organized systems, Enzymes in the cell, Enzyme turnover, Clinical and industrial aspects of Enzymology, Enzyme technology.

Principles of Immunology, Cells and the organs of the immune system, Types of immunity, Immunization and vaccines. Effector response and its mechanism, Immune system in health and disease, Experimental immunology

Unit 2: Molecular Genetics

Recombinant DNA technology, Restriction Digestion and Ligation, Enzymes in genetic engineering (DNA modifying enzymes), Techniques of gene expression and manipulations: Fusion Proteins Gene introduction techniques- Construction of vectors and gene probes, Identification and the selection of the right clones, Southern blotting, Northern blotting and Western blotting, Gene library and c-DNA library, Analysis of gene expression, PCR, RT- PCR, Nested PCR, Gene and Genome sequencing, DNA finger printing and analysis of phylogeny.

Gene expression assessment using microarray system. Genomics and proteomics.

Unit 3: Bioprocess Technology

Basic principles of Bioprocess technology, Design of fermentation media and the fermentors, Types of fermentation, Kinetics of the fermentation process, Bioprocess control and monitoring, Downstream processing of biomolecules, Cell separation techniques (small scale and large scale), Methods of cell lysis, Isolation of the products and preservation techniques, Biosensors and bioreactors

Unit 4: Environmental Biotechnology

Principles of Environmental biotechnology, Bioindicators and the pathogens, Biogeochemical cycles, Degradation of organic and the toxic compounds by microbes, Microbes in mining, microbes in biogas production, Microbial corrosion, Biofouling, Biofilms, Bioaccumulation and the Biomagnification, Bioremediation, Sewage treatment, Pollution control policies.

References

Baily and Ollis. Biochemical Engineering Fundamentals, McGraw-Hill.
Bernard, G. and Pasternack, 1998. Molecular biotechnology. ASM Press, Washington
Brayce, C.F., El-Mansi, E.M.T. 2002. Fermentation Microbiology and Biotechnology. Taylor and Francis, London.
Cassida. Industrial microbiology.
Charles, E.D. 1973. Outlines of Chemical Technology. Affiliated, New Delhi.
Costa, M.S. 1989. Microbiology of External Environments and its Potential for Biotechnology. EAS Publications, London.
Coulson, J.M. Chemical Engineering. Pergamon Press.
Devlin, T.M. 2005. Text Book of Biochemistry with Clinical Correlation. Wiley Liss Inc., New York.
Elgert, J. 1997. Immunology - Understanding the Immune System. Wiley Liss Inc., New York.
Faust, Samuel D. 1983. Chemistry of Water Treatment, Butterworths, London.
Helm, K. and Adriance, M. 1996. Recombinant DNA and Biotechnology, ASM Publication, Washington.
Hudson and others 1986. Practical Immunology. Blackwell scientific.
Kindt, T.T.J., Goldsby, R.A., Osborne,.B.A. 2007. Immunology. VI Edition, W.H. Freeman and Co., New York.
Kuby, J. 1997. Immunology. III edition .W.H. Freeman and Co., New York.
Lewin, B. 2000. Genes VII. Oxford University Press, New York.
Mathew, S.K. and Purohit, S.S. 1976. Biotechnology: Fundamentals and its Applications. Agro Botanical Publications, Bikaner.
Mitchell and Ralph, E. 1978. Water Pollution Microbiology. John Wiley Publishers, New York.
Old and Primrose 1994. Principles of Gene Manipulation. Blackwell Scientific Publishers.
Page, M.I. and Williams, A.. 1993. Enzyme Mechanisms. The Royal Society of Cambridge, Cambridge.
Price, C.N and Stevens, L. 2006. Fundamentals of Enzymology. Oxford University Press, New York.
Riott, I.M., Brostoff, J. and Male, D.K. 1993. Immunology. Mostby-Year Book Europe Ltd., London
Rosevear, A. and others. Immobilised Enzymes and Cells. IOP Publishers.
Stanburry, P.F. and Whitaker. Principles of Fermentation Technology. Pergamon Press.
Stryer, L. 1983. Principles of Biochemistry. W.H Freeman and Co., San Francisco
Tali and Robert. 1995. Soil Microbiology. John Wiley, New York.
Wilson, K. and Walker, J.M. 1995. Principles and the Techniques of Practical Biochemistry. Cambridge University Press.
Zuby, G. 1983. Principles of Biochemistry: General Aspects. McGraw Hill Book Co., Kogakusha
Watson, J.D. *et al.*1992. Recombinant DNA Technology. Scientific American Books, New York

PAPER 3 – RECENT DEVELOPMENTS

Enzymology and Immunology **60 hr (15 hr/unit)**

Unit 1

Enzyme Isolation: Salt precipitation, Solvent precipitation, Isoionic precipitation.
Enzyme Purification: Objectives and strategy, Choice of source, Methods of homogenization and Separation: Dialysis, Size exclusion chromatography, Affinity chromatography, Ion exchange resins, Isotachophoresis. Determination of the specific activity, Visualization of purified enzymes: SDS-PAGE and native PAGE, Preservation techniques: Lyophilization

Unit 2

Enzyme Crystallization, Determination of amino acid composition, Quaternary structure, and the molecular weight, Application of bioinformatics in Enzymology, Unfolding and folding of enzymes, Analyses of Kinetic data, Mechanism of enzyme action- experimental approach, Application of enzyme inhibitors, Multienzyme polypeptides, Enzyme turnover, Active site residues, The structural analysis of enzymes- NMR and X ray crystallography, Enzyme engineering, Enzyme immobilization and their applications.

Unit 3

Historical preview of immunology, Overview of the immune system and general properties of immune response, Cells and the organs of Immune System, Innate and adaptive immunity, Principles of antigen and antibody interaction and its applications, Organization and Hematopoiesis, Expression of immunoglobulin genes, Complement system, MHC and antigen presentation, TCRs, Proliferation and the differentiation of B cell, T cells, and NK cells.
Fine structure of Immunoglobulins, Immunoglobulin super family. Monoclonal and polyclonal antibodies

Unit 4

Effector response: Cytokines, Leukocyte activation and migration, Cell mediated cytotoxicity, Hypersensitivity reactions, Tolerance and autoimmunity, Transplantation immunology, Immune response to infectious disease, AIDS and other Immunodificiencies, Tumor immunology and immunotherapy for tumors and tumor vaccines.
Experimental immunology: Hybridoma technology, monoclonal antibody production and applications, diagnostic applications of immunology. Animal models, Cell culture system, Protein biochemistry, Recombinant DNA technology, Analysis of DNA regulatory sequences, Gene Transfer into mammalian cells, Advanced micro array approach to analyze the gene expression.

References

Devlin, T.M. 2005. Text Book of Biochemistry with Clinical Correlation. Wiley Liss Inc., New York.
Elgert, J. 1997. Immunology - Understanding the Immune System. Wiley Liss Inc., New York.
Hudson and others 1986. Practical Immunology. Blackwell scientific.
Kindt, T.T.J., Goldsby, R.A. and Osborne, B.A. 2007. Immunology. W.H. Freeman and Co., New York.
Kuby, J. 1997. Immunology. III edition .W.H. Freeman and Co., New York.
Page, M.I. and Williams, A.. 1993. Enzyme Mechanisms. The Royal Society of Cambridge, Cambridge.
Price, C.N and Stevens, L. 2006. Fundamentals of Enzymology. Oxford University Press, New York.
Riott, I.M., Brostoff, J. and Male, D.K. 1993. Immunology. Mosby-Year Book Europe Ltd., London
Rosevear, A. and others. Immobilized Enzymes and Cells. IOP Publishers.
Stryer, L. 1983. Principles of Biochemistry. W.H Freeman and Co., San Francisco
Wilson, K. and Walker, J.M. 1995. Principles and the Techniques of Practical Biochemistry. Cambridge University Press, Cambridge.
Zuby, G. 1983. Principles of Biochemistry: General Aspects. McGraw Hill Book Co., Kogakusha

PAPER 3 - RECENT DEVELOPMENTS

Genetic Engineering

60 hr (15 hr/unit)

Unit 1

Principles of recombinant DNA technology, restriction enzymes and their applications, DNA polymerase and Klenow fragment. Design of Genome library and cDNA library, Analysis of products through PCR and RT- PCR, Cloning of PCR products, Applications of genetic engineering. Cell signaling.

Unit 2

Vectors – Construction of artificial vectors, Features of expression vectors, Role of vectors in transformation, Gene introduction techniques, Methods of identifying the right clones, Construction of gene probes, Radioactive labeling of nucleic acids and autoradiography; Chemical tagging with biotin or diogoxigenin.
In vitro fertilization and embryo transfer. Cryopreservation of gametes and embryos.
Principles of chromosome walking and chromosome jumping.

Unit 3

Gene mapping: Restriction mapping, DNA foot printing, Somatic cell hybridization and Application of transposons in gene mapping, Gene and genome sequencing,
DNA sequencing methods: Maxum and Gilbert method, Sanger and Coulson method, Messing shot gun method, Automated analyzers.
Analysis of genetic variations: Single nucleotide polymorphism, Conserved and variable domains**,** RFLP, AFLP and DNA fingerprinting
Cell lines, stem cells and their applications
Phylogeny and evolutionary genetics.
Overview and strategies of genome sequencing, Human genome project

Unit 4

Manipulation of gene expression: Transcriptional fusions, Translational fusions, *in vitro* mutagenesis, site directed mutagenesis
Analysis of gene expression: Northern blot, RNase protection assay, Primer extension assay, *in situ* hybridization.
Types of gene therapy, mechanism, somatic and germline gene therapy and immunotherapy
Model organisms for genetic modification and genetically modified organisms (GMOs)
Human and animal ethics in animal experiments and human subjects

References

Bernard, G. and Pasternack, 1998. Molecular biotechnology. ASM Press, Washington
Lewin, B. 2000. Genes VII. Oxford University Press, New York
Old and Primrose 1994. Principles of Gene Manipulation. Blackwell Scientific Publishers.
Watson, J.D. and others 1992. Recombinant DNA Technology. Scientific American Books, New York
Winnaker. From Genes to Clones. Panima Educational Book Agency.

PAPER 3 - RECENT DEVELOPMENTS
Bioprocess Technology

60 hr (15 hr/unit)

Unit 1
Bioprocess vs. chemical Process, Isolation and improvements of industrially important strains, Requisites for fermentation, Design of fermentation media, Methods of inoculation and sterilization, Applications of bioprocess technology in food quality improvement.

Unit 2
Principles of fermentation, Design and Criteria for ideal fermentor, Types of fermentors, Animal cell culture, Micro carriers, cell encapsulation and immobilization techniques, Physicochemical basis of bioseparation, Foam separation, Flocculation, Filtration, Centrifugation, Methods of cell lysis.
Types and working principles of biosensors.
Non-conventional energy sources and biomass energy utilization.

Unit 3
Methods employed in solid substrate and submerged fermentation. Kinetics of fermentation process, Transport phenomenon in bioprocesses- mass transfer, mass transfer coefficient for gases and liquids, Oxygen transfer coefficients, Biological heat transfer and heat transfer coefficients, Online acquisition, Control and monitoring of bioprocess, Use of computers in Bioprocess technology.

Unit 4
Large scale separation techniques: Distillation, Solvent extraction, Liquid- liquid extraction, Adsorption and evaporation, Membrane filtration, Ultra filtration, Reverse osmosis
Preservation techniques: Crystallization, Spray drying, Drum drying, Freeze drying, Whole broth processing.
Secondary metabolites and biosynthesis of secondary metabolites in microorganisms. Probiotics. Mushroom cultivation. Chitin and chitin derivatives. Phosphate solubilizers.

References

Baily and Ollis. Biochemical Engineering Fundamentals, McGraw-Hill.
Cassida. Industrial microbiology,
Chirikilan, Jack G. 1995. Biotechnology – Theory and Techniques. Jones and Bartlett, Salisburry.
Coulson, J.M. Chemical Engineering. Pergamon Press.
Ignacimuthu, S. 1996. Applied Plant Biotechnology. Tata McGraw Hill, New Delhi.
Kalaichelvan, P.T., Pandi, I. and Anil, J. 2007. Bioprocess Technology, MJP Publishers, Chennai.
Murray, M.Y. Comprehensive Biotechnology. Volume 1,2,3 and 4, Pergamon Press.
Prave, P. and others. Fundamentals of Biotechnology. WCH Weinhein.
Smith, J.E. 1996. Biotechnology. CUP Publication, Cambridge.
Stanburry, P.F. and Whitaker. Principles of Fermentation Technology. Pergamon Press.

PAPER 3 - RECENT DEVELOPMENTS

Environmental Biotechnology

60 hr (15 hr/unit)

Unit 1

Socioeconomic relevance of environmental biotechnology, Cycling of nitrogen, phosphorus and heavy metals, Environmental pollutions and its impact on biological systems, Bioindicators and human pathogens. Mycotoxins.

Unit 2

Bioremediation technology, Phytoremediation and Microbial remediation, Biosorbents.
Microbial metabolites, toxins and their applications (bacteria, cyanobacteria, fungi). Biofouling.
Degradation of organic and toxic elements by microbes, Bioaccumulation and microbial deterioration of the textiles, papers, leather wood and biomaterials.
Microbes in mining industry (bioleaching). Microbes in waste water and sewage treatment.

Unit 3

Agricultural microbiology: Microbial degradation of structural components (carbohydrates, proteins and fats).
Production of energy from biomass (biogas), biofuels, energy plantations, optimum utilization of biomass in energy generation.
Biofertilizers, composting and bioprotectants.
Biopesticides.

Unit 4

Transgenic crops, terminator gene technology, Transgenic animals.
Benefits and controversies of transgenic crops (e.g. BT cotton, BT brinjal and golden rice).
Environmental release and monitoring of GMOs.
Biopiracy, Patenting and Intellectual property rights.

References

Alexander, G. Microbial Biotechnology. WH Freeman and Co.
Bajaj, Y.P.S. 1986. Biotechnology in Agriculture and Forestry. Springer Verlag.
Jogdanand, Environmental Biotechnology. Himalaya Publishing House, India
John Arundel. Sewage and Industrial Effluent Treatment, Blackwell Science Publishers.
Metcalf and Eddy. Waste Water Engineering. McGraw-Hill.
Subba Rao, N.S. Soil Microbiology. Oxford & IBH, New Delhi.

Model Question Paper
(Papers 1, 2 and 3)

PhD Course Work - Biotechnology
Paper Number and Paper Title

Time: 3 hr Max Marks: 70

1. Write short notes on **any five** of the following (not exceeding 10 pages) (5 × 3 = 15)

   a)
   b)
   c)
   d)
   e)
   f)
   g)
   h)

2. Explain **any five** of the following (not exceeding 15 pages) (5 × 5 = 25)

   a)
   b)
   c)
   d)
   e)
   f)
   g)
   h)

Answer **any three** of the following (not exceeding 15 pages) (3× 10 = 30)

3.

4.

5.

6.

7.
