

**M. Phil / Ph. D– BIOCHEMISTRY**  
**(Effective from the academic year 2021 - 2022 and onwards)**

**PREAMBLE**

- The degree of Master of Philosophy (M.Phil) /Doctor of Philosophy (Ph.D) is awarded to a candidate who has submitted a thesis based on original and independent research in any biochemistry field of research.
- This contributes to the advancement of knowledge, which can be useful to the society.

**PROGRAMME EDUCATIONAL OUTCOME (PEO)**

**PEO 1:** Awareness about the discipline major issues and will have an in-detail understanding of biochemistry, selected for research importance.

**PSO 2:** Ethical issue awareness in research and career options to gain expertise in continuing laboratory procedures for experimental animal handling and disposal.

**PSO 3:** Capable of planning and executing experiments safely and infer experimental data.

**PSO 4:** Develop skills to present their work via written, oral and visual presentations of an original research proposal.

**PSO 5:** Persistent production of good research findings for quality publication

**Programme Outcome (PO)**

**PO1: Literature review:** Elaborate survey on the particulars of research advancements and its methodologies.

**PO2: Subject knowledge:** In-depth knowledge in the respective field to find the solutions for the uncovered areas.

**PO3: Innovative ideas:** Agenda is to adopt a constructive idea to accomplish a unique goal

**PO4: Project/Model design:** Developing/promoting ideas using tools of biochemistry

**PO5: Science and Society:** Finding remedies which can solve problems oriented to the society.

**PO6: Ethics:** Research and career options to gain more expertise in continuing laboratory procedures for experimental animal handling and disposal.

**PO7: Product development:** At the outset the ultimate aim is to develop a product which can be later commercialized and utilized for the beneficiaries.

**PO8: Data interpretation:** Analyzing the outcome using statistical tools which can exhibit a complete picture of problem.

**PO9: Continuous quest:** Investigation on a particular topic to be an expert on it.

### **Programme Specific Objective (PSO)**

**PSO 1:** Exhibit in-depth mastery/scholarly of a wide range of knowledge biochemically that concern to the essentials of advanced biochemistry.

**PSO 2:** Be familiar in appropriate laboratory procedures and regulations in conduct and discarding of experimental animals with proper ethics.

**PSO 3:** Capable to associate biochemical model through theoretical view with laboratory skills to originate hypotheses, plan and execute experiments and then data collection, comparison and infer results to depict logical finale.

**PSO 4:** Data acquisition process using available software tools to analyze and further, can present their work through scientific publications and visual presentations.

**DEPARTMENT OF BIOCHEMISTRY**  
**FACULTY OF ARTS, SCIENCE AND HUMANITIES**  
**RESEARCH PROGRAM – M.Phil / PhD in Biochemistry**  
**(2021–2022 and onwards)**

<b>Course code</b>	<b>Name of the course</b>	<b>Instruction hours / week</b>	<b>Credits</b>	<b>Maximum Marks (100)</b>
21RBC101	Research Methodology and Pedagogy	4	4	100
21RBC201	Research and Publication Ethics	4	4	100
21RBC301	Enzyme and Enzyme technology	4	4	100
21RBC302	Cancer Biology and immunology			
21RBC303	Medicinal Plants and Plant therapeutics			
21RBC304	Clinical Biochemistry and Toxicology			
21RBC305	Plant Molecular Biotechnology			
21RBC306	Animal Tissue Culture			
21RBC307	Fish nutrition and tissue culture			
<b>Program Total</b>		<b>12</b>	<b>12</b>	<b>300</b>

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Instruction hours/week: L: 4 T: 0 P: 0

Marks: 100

End Semester Exam: 3 Hours

### Course Objectives

The course will help the scholars to

- Learn to collect, analyze and interpret research data and to identify appropriate research topics
- Inculcate technical writing and communication skills
- Gain a practical understanding of the various statistical tools used for scientific research
- Gain basic understanding of the usage of computer for data preparation and presentation

### Course Outcomes

On completion of the course, students will be able to

1. Gain practical knowledge of handling the instruments
2. Understand some basic concepts of research and its methodologies
3. Design their research and present their data
4. Write and prepare research papers and research proposals
5. Handle classes effectively since they know the pedagogical techniques

### UNIT I: Research Problem

Definition - Identification - Review of Literature – Lacunae identification-Research process - Research design –Experimental and non experimental designs- Exploratory – Diagnostic.

Sample selection Acceptance and rejection criteria- Serum, plasma, whole blood, urine CSF. Ethical consideration. Study conduct in human sample, animal sample. Experimental design. Sample collection- Order of draw

### UNIT II: Sampling methods

Sampling - Population –Census - Sample – Types – Probability – Non Probability sampling – Sampling size – Sampling process – Hypothesis and its formulation. Sampling distribution – Students t test. Experimental design – CRD, RBD. Analysis of experimental results – ANOVA and its interpretation. Duncan's Multiple Range Test. Interpretation.

Clinical research study measurement- Site selection, sample size, test evaluation.

### UNIT III: Data Processing

Data Collection Tools -Case studies - Interview – Questionnaire -Schedule - observation- Scaling techniques – Scale Construction – Rating scales. Hypothesis testing – Parametric and non parametric tests - Coding – Editing – Tabulation –Analysis – Correlation & regression.

#### **UNIT IV: Scientific writing and presentation**

Technical Writing: Scientific and technical subjects; formal and informal writings; formal writings/reports, handbooks, manuals, letters, memorandum, notices, agenda, minutes; common errors to be avoided. Microsoft Windows: Macintosh versions, Microsoft Word- Characteristics - Document statistics - Typical usage, Microsoft Excel - Basic operation – Charts - Using other Microsoft applications - Using external data, Microsoft Power Point –power point viewer – versions – uses, Microsoft Access –Uses – Features.

#### **UNIT- V: Pedagogical methods in higher education**

Objectives and role of higher education- Important characteristics of an effective lecture- Quality teaching and learning- lecture preparation- characteristics of instructional design- Methods of teaching and learning: Large group- Technique – lecture, seminar, symposium, team teaching, project, small group technique- simulation, role playing demonstration, Brain storing, Case discussion, and assignment, methods of evaluation- self evaluation, student evaluation, diagnostic testing and remedial teaching- question banking- electronic media in education:- ‘e’ learning researches- web based learning. **Risk management. Classification of medical devices. Risk- definition, identification, FMEA analysis**

#### **SUGGESTED READING**

1. B. Somekh & C. Lewin, (2005), Research methods in the social sciences, Vistaar Publications, New Delhi
2. Crotty, M. (1998), The Foundation of Social Research: Meaning and Perspective in the Research Process, Sage Publications, London
3. Blaikie, N. (2000), Beginning Social Research, Polity Press, Cambridge
4. V. Desai & R. B. Potter, (2006), Doing Development Research, Sage Publications, New Delhi.

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**Instruction hours/week: L: 4 T: 0 P: 0****Marks:100****End Semester Exam: 3 Hours****Course Objectives**

The main objectives of the course are

- To impart the knowledge on philosophy and ethics
- To apply the state of art knowledge for scientific conduct
- To become familiarize with publication ethics
- To understand the methods of publication misconduct
- To grasp knowledge on database and research metrics
- The students will learn overall open access publishing.

**Course Outcomes**

On completion of the course, students are able

1. To understand principles of philosophy and ethics
2. To explain research Intellectual honesty
3. To get insight into plagiarism
4. To develop the e-content
5. To access the Learning Management System
6. To understand publication misconduct

**Unit I Philosophy and Ethics**

Introduction to Philosophy: definition, nature, scope, concept, branches Ethics: definition, moral philosophy, nature of moral judgment and reactions.

**Unit II Scientific Conduct:**

Ethics with respect to science and research - Intellectual honesty and research integrity, copyright Scientific misconduct: falsification, fabrication and Plagiarism (FFP) Redundant Publication: duplication and overlapping publication, salami slicing. Selective reporting and misrepresentation of data.

**Unit III Publication Ethics**

Publication Ethics: definition, introduction and importance, Best practice/standard setting initiative and guidelines: COPE, WAME, etc. Conflict and interest - Publication misconduct: definition, concept, problems that leads to unethical behaviour and vice versa, type. Violation of

publication ethics, authorship and contributorship Identification of publication misconduct, complaint and appeals Predatory publisher and journals.

#### **UNIT IV Publication Misconduct**

Group Discussions: Subject Specific Ethical Issues FFP, authorship, Conflict interest, Complaints and appeals: examples and fraud, from India and abroad. Software tools: Use of plagiarism software like Turnitin, Urkund and other open-source software tools.

#### **UNIT V: Database and research metrics**

Database: Indexing database, Citation database: web of science, scopus, etc. Research metrics: Impact factor of Journal as per journal citation report, SNIP, SJR, IPP, Cite Score Metrics: h-index, g-index, i-10 index, altmetrics.

#### **UNIT VI: Development of e-content & IPR**

Integrated Library Management System (ILMS): e-journals, e-books, e-shodhsindushodhganga- Database – e content development – Learning Management System (LMS) – e-PG - Pathshala- CEC (UG) SWAYAM- MOOCs- NPTEL-NMEICT.

IPR: Patent – Copyrights- Trademarks- Geographical Indications.

### **PRACTICE**

#### **Open access publishing**

1. Open access publication and initiatives - SHERPA/RoMEOonline resource to check publisher copyright and self-archiving policies Software tool to identify predatory publication developed by SPPU - Journal finder/journal suggestion tools viz. JANE, Elsevier Journal finder, Springer, Journal Suggester, etc.

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**Instruction hours/week: L: 4 T: 0 P: 0****Marks:100****End Semester Exam: 3 Hours**

### Course Objectives

The course will help the scholars to

- Understand the structure of proteins and the catalytic mechanisms of enzymes.
- Develop expertise in the purification of enzymes and their analysis in various solvent systems.
- Learn the kinetics of enzyme catalyzed reactions.
- Learn the importance of enzyme immobilization and its wide applications in medicine and industries.
- Study the techniques for clinical analysis and also biochips and biocomputers.

### Course Outcomes

On completion of the course, students will be able to

- Understand the structure of proteins and mechanism of action of enzymes.
- Understand the catalytic mechanisms of enzymes.
- Apply the knowledge of enzyme immobilization to produce more products out of it.
- Understanding of enzyme purification by downstream processes and the efficiency testing of enzymes in various solvent systems.

### UNIT I: Protein and enzymes

Protein structure, functions, compositions and conformation of proteins. Enzyme catalysis-Acid base catalysis, covalent catalysis, an example, serine proteases. Enzyme kinetics – Michaelis menton equation, Line weaver Burk plot, Hills equation, Hans plot.

### UNIT II: Isolation and purification of enzymes

Sources of enzymes for industry, extraction of enzymes for scientific and industrial purposes. Downstream processing of enzymes, uses of soluble enzymes. Study of enzymes in aqueous biphasic systems. Factors affecting the enzyme activity -Substrate concentration, Enzyme concentration, pH, temperature etc.,



### **UNIT III: Enzyme immobilization and their applications**

Techniques employed for immobilizing enzymes, kinetics of immobilized enzymes. Advantages and disadvantages in the utilization of soluble enzymes, Immobilized enzymes and immobilized cells. Different types of reactors of immobilized enzymes and their applications.

### **UNITIV: Clinical analysis of enzymes**

Application of ELISA and EMIT in clinical analysis. Different types of Biosensors-potentiometric, amperometric, piezo - electric and immuno biosensors. Electro analytical applications of enzymes, Methods of coenzyme regeneration. Biochips and Biocomputers.

### **UNIT V: Enzymes in Biotechnology**

Enzyme catalysis in organic solvents, Restriction endonucleases, DNA ligases, DNA polymerase and their uses in Biotechnology. Site directed mutagenesis, artificial enzymes, ribozymes and Abzymes and their uses.

### **SUGGESTED READING**

1. Bommarius A.S., B.R. Riebel. 2004. Biocatalysis – Fundamentals and Applications, Wiley-VCH, Weinheim, Germany.
2. Buchholz K., V. Kasche, U.T. Bornscheuer. 2005. Biocatalysts and Enzyme Technology, Wiley-VCH, Weinheim, Germany.
3. Cook P. F., W.W. Cleland. 2007. Enzyme Kinetics and Mechanism, Garland Science Publishing, London, England and New York, USA.
4. Irwin Segel. 2004. Biochemical Calculations, John Wiley and Sons, California, USA.
5. Marangoni A.G. 2003, Enzyme Kinetics-A Modern Approach.

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Instruction hours/week: L: 4 T: 0 P: 0

Marks: 100

End Semester Exam: 3 Hours

### Course Objectives

The course will help the scholars to

- Understand the initiation and promotion pathways of cancer as a complex biological system.
- Educate on the etiological risks factors for cancer and methods to avoid such risks.
- Provide insight knowledge about the emerging themes and in depth analysis of cancer and its therapeutic approaches.

### Course Outcomes

On completion of the course, students will be able to

- Analyze, decipher and identify the complexity of cancer biology.
- Develop therapeutic approaches to circumvent cancer cell survival, multiplication and progression.

### UNIT I: Biology of cancer

Biology of cancer-Phenotype of a cancer cell causes of cancer-DNA tumor viruses, RNA tumor viruses, cell cycle and its control-role of protein kinases, checkpoints, kinase inhibitor and cellular response.

### UNIT II: Apoptosis

Programmed cell death (Apoptosis)-Intracellular proteolytic cascade, cascade of caspase proteins, adapter proteins, Bcl-2, IAP family proteins, extra cellular control of cell division, tumor necrosis factor and related death signals.

### UNIT III: Genetic basis of cancer

Genetic basis of cancer-oncogenes, tumor suppressor genes, aberrations in signaling pathways. oncogenic mutations in growth promoting proteins, Mutations causing loss of growth –inhibiting and cell cycle control, Role of carcinogens and DNA repair in cancer.

### UNIT IV: Immunology of cancer

Immunity- Active, passive, humoral and cell-mediated immunity. Therapeutic uses of cytokines and cytokine receptors. Test for lymphocyte function. B cell and T cell immuno deficiency disorder. Clinical laboratory methods for the detection of antigens and antibodies test for histocompatibility antigens, neoplasm of the immune system.

## UNIT V: Cancer Techniques

Techniques-FISH techniques, Real time PCR, Western blotting, ELISA assay, immunocytochemistry, immunohistochemistry, flow cytometry, fluorescent microscopy and confocal microscopy.

### SUGGESTED READING

1. Alberts, B. et al. (2008). Molecular Biology of the Cell. 5th Ed. Garland Publishing House. USA.
2. Benjamin Lewin (2007) Genes VIII, Prentice Hall. USA.
3. Brown T.A. (2010), Gene Cloning & DNA Analysis, 6nd Edition, Wiley-Blackwell, New York.
4. Karp G. (2012), Cell and Molecular Biology: Concept and Experiments. John Willy, New York.
5. Klug, W.S., Cummings, M.R, Spencer C.A and Palladino, M.A. (2012), Concept of Genetics, 10<sup>th</sup> Edition, Pearson Education, Singapore.
6. Lodish H., Berk A., Kaiser CA., Kriger M .,Scott M.P.,Bretscher A., Ploegh H., Matsudaira P.2008. Molecular Cell Biology, 6<sup>th</sup> edition, W.H. Freeman and Company, New York.
7. Janeway et al., 2012.Immunobiology, 8th Edition, Current Biology publications, USA.
8. Watson J.D. 2009, A Passion for DNA: Genes, Genomes & Society, Cold Spring Harbor Laboratory press (CSHL).

**Instruction hours/week: L: 4 T: 0 P: 0****Marks:100****End Semester Exam: 3 Hours****Course Objectives**

The course will help the scholars to

- Understand the basic knowledge of medicinal plants.
- Provide knowledge on the pharmacological studies using medicinal plants.
- Provide understanding on the principle and mechanism of different classes of phytoconstituents.
- Provide understanding of basic principles and methods in Plant tissue culture and animal tissue culture.

**Course Outcomes**

On completion of the course, students will be able to

- Bring basic knowledge of using medicinal plants in therapeutics.
- Bring new knowledge of using medicinal plants in alternative medicine.
- Develop advanced practical knowledge in plant and animal tissue culture techniques.

**UNIT I: Medicinal plants**

Medicinal plants-bioactive principles in medicinal plants methods of extraction, isolation, separation and screening, pharmacologically active plants-CNS, CVD, Hypoglycemic, Hepatoprotective, anti allergic, anticancer, immunoactive plants, plants protecting against oxidative stress, chemotherapeutic products.

**UNIT II: Free radicals**

Free radicals –types, sources, importance, production, free radicals induced damages, lipid peroxidation, measurement of free radicals, disease caused by radicals, reactive oxygen species, antioxidant defence system, enzymic and non-enzymic antioxidants, role of antioxidants in prevention of diseases, phytochemicals as antioxidants.

**UNIT III: Metabolites of Plant**

Alkaloids, flavonoids, terpenoids, phenols-Occurrence, distribution & functions, Production of secondary metabolite in plants, stages of secondary metabolite production, uses of tissue culture techniques, elicitation, biotransformation- production of pharmaceutical compounds.

#### **UNIT IV: Plant cell culture**

Principles-callus, meristem and organ culture, culture methods, culture media & preparations, plant regeneration, protoplast technology, micropropagation in plants, somatic embryogenesis, somoclonal selection.

#### **UNIT V: Therapeutic studies of medicinal plants using animal cell culture**

Animal cell culture: Culture media, Serum and protein free defined media and their application. Functions of different constituents of culture medium. Role of carbon dioxide, growth factors, glutamine in cell culture. Cell lines, primary culture and culture maintenance.

Experimental animals and Animal handling - Sacrification, collection of sample. Ethical issues for animal handling.

*In vivo* and *in vitro* assays for therapeutic studies.

#### **SUGGESTED READING**

1. Dubey R.C. (2009).Text book of Biotechnology, S. Chand & Company Ltd. New Delhi.
2. Freshney, R. I., & Freshney, M. G. (2010). In Freshney, R. I. (ed.), Animal cell culture: a practical approach, 2nd ed. IRL Press at Oxford University Press.USA.
3. Jain V. K. (2010). Fundamentals of plant physiology, C. Chand and Company Ltd, New Delhi.
4. Purohit. S.S. (2005). Agricultural Biotechnology, Dr.Updesh Purohit Publishers, Jodhpur.India
5. Singh. M.P and Panda. H (2005). Medicinal Herbs with their formulations, Daya Publishing House, New Delhi.

**Instruction hours/week: L: 4 T: 0 P: 0****Marks:100****End Semester Exam: 3 Hours****Course Objectives**

The course will help the scholars to

- Provide knowledge about the clinical enzymology, diagnosis and toxicological effects, which affects the daily activities in healthcare.
- Learn the clinical diagnostics for hematology, leukaemia and anaemia.
- Study the principles of pharmaceutical effects, metabolism in the body and the factors that influence these.
- Describe the principles of drug analyses, toxicological analyses and addiction analyses.

**Course Outcomes**

On completion of the course, students will be able to

- Identify the hematological changes in different diseases
- Describe the theoretical background of clinical diagnostics for the most common disorders in different organ systems.
- Explain the principle of pharmaceutical effects and metabolism in the body.
- Describe pre-analytical factors that are important for the results, interpretation and quality of the analytical result.

**UNIT I: Serology**

Blood collection, processing and transfusion process. Normal blood profile. C- reactive protein test, immunological test for pregnancy. Rheumatoid arthritis (RA) test, ESR. Coagulation test, prothrombin test. Haemoglobin Normal and abnormal Hb, separation of haemoglobin, Thalassemia, Hemoglobinopathies. Disorder of erythrocyte metabolic pathways, erythrocyte enzyme disorders. Porphyrins and disorder: porphyrias.

AIDS- Clinical diagnosis. Diagnosis of genetic diseases by molecular biology techniques (cystic fibrosis, Hemachromatosis, thalasseмииs, sickle cell diseases).

**UNIT II: Clinical Enzymology**

Clinical significance of Phosphatases, transaminases, 5'nucleotidase, Gamma -glutamyl transferase, Lactate Dehydrogenase, Creatine Phospho kinase.

Diagnostic enzymes in hepatobiliary disease, Atherosclerosis, Myocardial infarction, renal dysfunction. Cancer markers for oral, prostate, colorectal breast and GI tract cancer, oncofetal cancer markers.

### **UNIT III: Free radicals**

Formation of free radicals, autoxidation initiated by oxygen radicals, Influence of free radicals in metal toxicity. Free radicals and cancer .Oxidative process in tissue injury. Detection of free radicals and radical ions. Role of free radicals in diseases.

### **UNIT IV: Antioxidants**

**Enzymic antioxidants-** Chemistry, mechanism, antioxidant effect of SOD, catalase, Glutathione Peroxidase.

**Non Enzymic antioxidants-** source, chemistry, toxicity, biochemical functions, bioavailability, bioassays, Antioxidant effects of Vit A, Vit C, Vit E, glutathione and selenium.

**Trace elements** - Introduction, sources, biochemical functions of zinc, copper and magnesium and iron.

### **UNIT V: Toxicity**

Effects of physiochemical and biological factors on heavy metal toxicity, toxic mechanism- Carcinogenesis, teratogenesis and immunotoxicity. Bioassays for heavy metal toxicity, pathological, histopathological examinations for heavy metal toxicity.

### **SUGGESTED READING**

1. Chatterjee M.N. and Rana Sinde, (2006) Text Book of Medical Biochemistry, 6<sup>th</sup> Edition, Jaypee Brothers, Medical Publishers, New Delhi.
2. Harper's Illustrated Biochemistry (2009) 28<sup>th</sup> Edition McGraw Hill, Mumbai.
3. Nelson and Cox (2005). Principles of Biochemistry by, 4<sup>th</sup> Edition, Mumbai.
4. Devlin (2006). Biochemistry with Clinical Correlation, 6<sup>th</sup> Edition, John Wiley & Sons, USA.
5. Ramnik Sood (2009). Medical Laboratory Technology,; Jaypee Brothers Medical Publishers, New Delhi
6. Tietz. Fundamentals of Clinical Chemistry (2008). 6<sup>th</sup> Edition, Elsevier, USA.
7. Voet D.and Voet J (2008) .Biochemistry, 3<sup>rd</sup> Edition, J. Wiley & Sons, USA.

**Instruction hours/week: L: 4 T: 0 P: 0****Marks:100****End Semester Exam: 3 Hours****Course Objectives**

The course will help the scholars to

- Provide an advanced understanding of the core principles and topics of in plant biotechnology
- Enable students to acquire a specialized knowledge and understanding of advanced techniques in plant biotechnology.
- Develop students about better understanding of recent science areas such as plant genomics and transformation techniques.
- Acquire knowledge on gene expression and regulation, transgenic plants and production of secondary metabolites.

**Course Outcomes**

On completion of the course, students will be able to

- Students would get strong understanding of plant genome, advanced techniques in genomic studies.
- Students acquire knowledge on micropropagation techniques and using such techniques for the enhanced production of secondary metabolites.
- Acquire skills required to execute modern plant biotechnology and animal biotechnology experiments.

**UNIT I: Plant genome**

Plant genome organization, structural features of a representative plant gene. Organization of chloroplast genome and mitochondrial genome. Molecular markers (AFLP, ISSR and RAPD). Plant tissue culture media, plant hormones and growth regulators in tissue culture, preparation of suitable explants. Micropropagation of plants - somatic embryogenesis, protoplast culture, somatic hybridization and synthetic seeds.

**UNIT II: Cloning strategies**

Tools for cutting and joining of DNA; gene transfer techniques; Methods of selection and screening of recombinant DNA. Construction of genomic libraries and cDNA libraries - probe construction and labelling (radio and non-radio). Molecular mechanism of anti-sense technology - inhibition of splicing, disruption of RNA structure & capping - application of anti-sensing technology.



### **UNIT III: Gene regulation**

Inducible enzymes, regulatory mutations, repressor, operon, promotor, catabolic repression, repressible enzyme systems, control by attenuation, positive control, gene regulation in eukaryotes, transcriptional regulation, post transcriptional regulation, hormones & gene expression; viruses & gene expression, genetic control of pattern formation in plant development.

### **UNIT IV: Plant transformation technology**

Symbiotic nitrogen fixation in legumes by rhizobia - biochemistry and molecular biology. Binary vectors, Use of 35s & other promoters genetic markers methods of nuclear transformation viral vectors & their applications, Use of reporter gene, Particle bombardment, Electroporation, Microinjection, Chloroplast transformation, Transformation of monocots, Transgene stability & gene silencing in Plant transformation.

### **UNIT V: Plant manipulation and its applications**

Transgenic plants - for- biotic (weeds, insects, viruses, fungi and bacteria) and abiotic (drought, salt, temperature, poor soil quality and oxidative) stress tolerance. Production of secondary metabolites production. Molecular farming (improvement in protein, lipids, carbohydrates. Plant antibodies, vaccines, therapeutic proteins and active principles. Biofortification of important crops (rice and banana).

### **SUGGESTED READING**

1. Altman A, Hasegawa P M. 2012 “Plant Biotechnology and agriculture. Prospect for the 21<sup>st</sup> century” Academic Press, USA.
2. Brown T. A. 2010. Gene Cloning and DNA Analysis: an introduction, 6<sup>th</sup> edition, Wiley-Blackwell Publisher, UK.
3. Chawla H.C. 2009 Introduction to Plant Biotechnology 3<sup>rd</sup> Edition, Oxford & IBH publication Pvt .Ltd, New Delhi.
4. Davies K. 2004. Plant Pigments and their Manipulation – Annual plant reviews, vol 14 Blackwell Publication, UK.
5. Glick and Paster mark, 2002. Molecular Biotechnology - Principles and Applications in Recombinant DNA. Panima Publishing Co-operation, Bangalore.
6. Primrose S.B and R.M. Twyman. 2003. Principles of Genome Analysis. Blackwell Publishing, Oxford.
7. Slater A, Scott NW, Fowler MR. 2008 Plant Biotechnology: the genetic manipulation of plants, Oxford Press, UK.
8. Winnacker E. 2003. From Gene to Clones; Introduction to gene technology, 4<sup>th</sup> edition, Panima Publisher, India.

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**Instruction hours/week: L: 4 T: 0 P: 0****Marks:100****End Semester Exam: 3 Hours****Course Objectives**

The course will help the scholars to

- Equip scholars on the preparation of sterile culture media, aseptic methods to be used for the subculturing and passaging of cells.
- To avoid the risks during cell culture
- To explain the basis of primary cell cultures and cell lines, types of cell culture and methods to ascertain the structure and function of cells.

**Course Outcomes**

On completion of the course, students will be able to

- Learn the basis of cell culture techniques as an alternative method to use animal model to test the drugs.
- Learn the techniques behind cell based assays, which is required for pharmaceutical/research and development institutions.

**UNIT I: Introduction to animal cell culture**

Introduction, importance, history of cell culture development, different tissue culture techniques including primary and secondary culture, continuous cell lines, suspension culture, organ culture, advantages and limitations medical/pharmaceutical products of animal cell culture-genetic engineering of animal cells and their applications. Risks in a tissue culture laboratory and safety - biohazards.

**UNIT II: types of cell culture**

Different types of cell culture media, growth supplements, serum free media, balanced salt solution, other cell culture reagents, culture of different tissues and its application. Facilities for animal cell culture-infrastructure, equipment, culture vessels. Biology and characterization of cultured cells-cell adhesion, proliferation, differentiation, morphology of cells and identification.

**UNIT III: Types of Techniques**

Primary cell culture techniques - mechanical disaggregation, enzymatic disaggregation, separation of viable and non-viable cells. Mass culture of cells - manipulation of cell line selection - types of cell lines -maintenance of cell lines - immobilization of cells and its application - synchronization of cell cultures and cell division - production of secondary metabolites - biotransformation - Induction of cell line mutants and mutations - cryopreservation – germplasm conservation and establishment of gene banks.

#### **UNIT IV: Animal cell culture scale up**

Animal cell culture scale up: Scale up in suspension - stirrer culture, continuous flow culture, air-lift fermentor culture; Scale up in monolayer - Roller bottle culture, multi surface culture, multi array disks, spirals and tubes - monitoring of cell growth. Organ culture - whole embryo culture - specialized culture techniques - measurement of cell death.

#### **UNIT V: Tissue engineering**

Tissue engineering: Design and engineering of tissues - tissue modeling. Embryonic stem cell engineering - ES cell culture to produce differential cells - Human embryonic stem cell research. Transgenic animals-transgenic animals in xenotransplantation.

#### **SUGGESTED READING**

1. Butler. M. 2004. Animal Cell Culture and Technology, BIOS Scientific Publishers, Taylor and Francis Group. U. K.
2. Freshney, R. I., & Freshney, M. G. 2010. In Freshney, R. I. (ed.), Animal cell culture: a practical approach, 2nd ed. IRL Press at Oxford University Press.
3. Gupta P.K. (2010), Biotechnology & Genomics, 5th Reprint, Rastogi Publications Meerut.
4. Ranga M.M., Animal Biotechnology, (2007) Agrobios, India.
5. Satyanarayana, U., 2006. Biotechnology Books and Allied (P) Ltd. India.

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**Instruction hours/week: L: 4 T: 0 P: 0****Marks:100****End Semester Exam: 3 Hours****Course Objectives**

The course will help the scholars to

- Understand the principles and nutrition required for fish life.
- Learn the methods of standard feed formulations for fish with adequate nutritional requirements.
- Understand the fish breeding and tissue culture techniques.

**Course Outcomes**

On completion of the course, students will be able to

- Develop nutritional feed for fish life
- Develop quality food for larval growth and development
- Perform the quality test for confirmation the standard of feed for fish
- Perform fish breeding and tissue culture techniques

**UNIT – I: Fish Nutrition**

Fish nutrition: Principles of fish nutrition and terminologies, Role of nutrients: amino acids, fatty acids, proteins, lipids, carbohydrates, vitamins and minerals. Essential aminoacids, vitamins and minerals and their role in fish and shellfish nutrition.

**Unit – II: Energy nutrition**

Energy nutrition: Definition, energetics, expression of energy value of feed (gross energy, digestible energy, metabolizable energy, net energy), partitioning of energy and energy budget, protein energy ratio.

**UNIT- IV: Larval nutrition**

Larval nutrition: Nutritional requirements of fish and shellfish larvae, quality requirements of larval feeds (particle size, digestibility), natural food and its importance in aquaculture, nutritional quality of commonly used fish food organisms (bacterioplankton, phytoplankton and zooplankton) and their roles in larval nutrition.

**Unit -IV: Feed Formulations**

Feed Formulations and Feed Technology: Classification of feed ingredients. Antinutrients in fish feed ingredients. General principle of feed formulation, Methods of feed formulation: Pearson's method, quadratic equation linear programming, limitations. Types of feed. Hydro-stability of feed and their storage and prevention of spoilage from rancidity. Feed additives: - Classification, function, and specific use for economic and quality fish and shellfish production. Feed evaluation through the study of growth performance, FCR and PER analysis.

## **Unit V: Fish breeding and Tissue culture**

Fish breeding and Tissue Culture: Collection, selection and Nutritional management of brooder fishes. Methods of natural and artificial fertilization of fish reproduction. Induced breeding by synthetic hormones and its analogues. Genetic improvement of inheritance, inbreeding and cross breeding. General principles of cell and tissue culture. Culture of primary cell and secondary cell (sub-culture), Cryopreservation of cells, Cell viability and Karyotyping. Fish cell culture and development of fish cell lines and their application.

### **SUGGESTED READING**

1. Cyrino. J. E. P., Bureau, D. and Kapoor B. G. (2008) Feeding and Digestive Functions in Fishes. Edited by. xiii 575 pp. Published by Science Publishers, Enfield, New Hampshire. ISBN 978-1-57808-575-6.
2. Guillame J, Kaushik S, Bergot P & Metallier R. 2001. Nutrition and Feeding of Fish and Crustaceans. Springer Praxis Publication.
3. Heil, N. (2009). Nutritional Wild Fish Health Survey – Laboratory Procedures Manual 5<sup>th</sup> Edition. U.S. Fish and wildlife services, Warm Springs, GA, Washington, DC.
4. Goswami, M. and Lakra, W.S. (2012). Fish Cell and Tissue Culture: A Text Book. Published by Narendra Publishing House, Delhi. ISBN 10: 9380428642 / ISBN 13: 9789380428642.
5. Westerfield, M. Leonard Zon, H. and Detrich, W. (2009) Essential Zebrafish Methods: Cell and Developmental Biology. 1<sup>st</sup> Edition, Academic Press.