M. Sc., Biotechnology

Programme Structure
&
Syllabus

(For those who joined in July 2019 or after)

Department of Biotechnology

(UGC-SAP and DST-FIST & PURSE Sponsored Department)

Alagappa University

(A State University Accredited with 'A+' Grade by NAAC (CGPA: 3.64) in the Third Cycle and Graded as Category-I University by MHRD-UGC; 2019:
QS Asia Rank-216, QS BRICS Rank-104, QS India Rank 20; NIRF Ranking 28)

SCIENCE CAMPUS

Karaikudi 630 003

DEPARTMENT OF BIOTECHNOLOGY

(UGC-SAP and DST-FIST & PURSE Sponsored Department)

ALAGAPPA UNIVERSITY

(A State University Accredited with 'A+' Grade by NAAC (CGPA: 3.64) in the Third Cycle and Graded as Category-I University by MHRD-UGC; 2019: QS Asia Rank-216, QS BRICS Rank-104, QS India Rank 20; NIRF Ranking 28)

SCIENCE CAMPUS

Karaikudi 630 003

M. Sc., Biotechnology Programme

Choice Based Credit System (CBCS)

For those who joined in July 2019 or after

Biotechnology is a broad field which encompasses the study of life-based science and technology that helps to understand the cellular and molecular processes of biological system. Though many definitions exist for the term biotechnology, the most accepted definition proposed for biotechnology by The American Chemical Society is "The application of biological organisms, systems, or processes by various industries to learn about the science of life and the improvement of the value of materials and organisms such as pharmaceuticals, crops, and livestock". From this general definition, one can understand that biotechnology mainly deals with the development of novel methods and innovative strategies for the production of therapeutics, enzymes, vaccines, genetically modified plants and so on, which ultimately help to improve the quality of life. Recent advances in biotechnology also aid in developing tools and technologies to combat deadly diseases, to keep the environment healthier and to have efficient industrial manufacturing processes.

The curriculum of the Master's Programme in Biotechnology offered by the Department of Biotechnology has been designed to inculcate advanced biosciences based theoretical knowledge to the students as well as to impart extensive laboratory training to the students. Since the Programme provides a firm foundation on the principles underlying the modern biotechnology techniques and integrates theoretical understanding with intensive laboratory training, it will improve the likelihood of employment opportunities for the students upon graduation. Biotechnology being a multidisciplinary endeavor, the students

will be fundamentally educated in various scientific disciplines to create innovatively and to commercialize these developed technologies or products. All the faculty members are highly qualified and competent in providing International research environment to the students since they possess rich expertise in diverse fields of biotechnology including molecular biology, genetics, cell biology, biochemistry, microbiology, bioinformatics and so on. The faculty members have research collaboration with many renowned Research Institutes and Laboratories of International and National excellence. Hence, beyond being thorough teaching professionals, the faculty members also help the students to execute their innovative research ideas fruitfully. International and National level Seminars, Conferences and Workshops are organized periodically to expose the students to the global trends in Biotechnology.

PROGRAMME OBJECTIVES

- To enable the students to acquire knowledge on the fundamental aspects of Biotechnology such as Biochemistry, Cell Biology, Microbiology and Molecular Biology.
- To facilitate them to understand the advanced concepts of Biotechnology so that the students can take up any challenging career in this field.
- To inculcate knowledge to the students with recent advancements and developments in the fields of Genomics, Proteomics, Genetic Engineering, Bioinformatics, Gene therapy, Cell Culture, modern drug discovery and pharmacogenomics approaches.
- To impart knowledge on the importance of intellectual property rights, biosafety and bioethics, information technology for biologists, communication and management skills.
- Augmentation of problem-solving skills of students through industry-oriented

training programs at various levels.

- To supplement the academic input of students by periodically conducting seminars, conferences, guest lectures, workshops, publications of papers, books and so on.
- Moulding the graduates to effectively disseminate formal scientific written communications and deliver oral presentation. This Programme will in turn sculpt the students to fit into the expectation criteria i.e. strategies to achieve company goals and objectives of several biotech industries. In addition, this Programme will enlighten the students to pursue research as their profession.

PROGRAMME COMPONENTS

The Programme module is designed to impart basic knowledge in Cellular Molecular Biology, rDNA Technology, Immunobiology and Genetics. Apart from that, the Programme module also includes Biophysics and Instrumentation, Fermentation and Bioprocess Technology, IPR, Biosafety and Bioethics, Pharmacogenomics, Healthcare Biotechnology, Environmental Biotechnology and Inheritance Biology. In addition, students need to complete six months Project during the Fourth Semester as part of their curriculum which ultimately prepares them to enter into research field/industry.

PROGRAMME OUTCOME

Graduates of the Programme will be enriched with solid fundamentals of modern biology and advanced technologies and will enable them to employ the acquired theoretical knowledge as well as hands on skills in industry and/or institutes wherever necessary.

CAREER OPTIONS

Considering the prominence of biotechnology in various sectors such as pharmaceutical companies, chemical, agriculture and allied industries, there is a great scope for biotechnologists at the global forum. As the Biotechnologist acquires knowledge in

diverse field, they can be employed in the arena of planning, production, quality control and management of bio-processing industries. As there are plenty of opportunities available in biotechnology field, a Post Graduate in Biotechnology may decide to become an academician or a researcher or an entrepreneur, as per their desire. They also have the option to undertake task towards improvement and production of drugs, food stuffs, cosmetics and other value-added products. After completing their Doctoral studies, they also have the option of becoming an independent researcher in National/International Institutes/Universities. Overall, there are a wide range of career opportunities for the students and if the right career is explored and chosen by the students, it will provide them a life changing experience.

Regulations for M. Sc., Biotechnology Programme

1. Eligibility for admission:

The Bachelor's Degree under 10+2+3 pattern of education in Physical (Physics, Chemistry or equivalent) / Biological (Botany, Zoology, Biochemistry, Microbiology, Biotechnology or equivalent) / Agricultural / Veterinary / Fisheries Sciences / Pharmacy / Engineering / Technology with at least 55% marks.

2. Duration of the Programme:

The duration of the M.Sc. Programme shall be two years consisting of four semesters. All the core and elective courses need to be completed during the first three semesters and the Project Work needs to be completed during the fourth semester for the completion of the Course.

3. Programme Structure:

The two-year Programme is organized on Semester basis covering a total of four semesters under Choice Based Credit System (CBCS). CBCS is an innovative instructional package developed to suit the need of students keeping pace with the developments in higher education. One of the greatest merits of the system is the flexibility it offers to the students to choose elective courses according to their interest and aptitude. The student has to take core and elective courses that fulfills 90 credits of theory / laboratory courses and Project Work in four semesters in order to qualify for the P. G. degree. In order to augment the knowledge in interdisciplinary subjects, the student needs to carry out three Major Elective Courses (one each during the first three Semesters) from the Department of Biotechnology and other related Life Science Departments and two Non-Major Elective Courses (one each during the Second and Third Semester) from other Departments of Alagappa University.

Three types of courses are offered.

a) Core courses: 74 credits
b) Major Elective Courses: 12 credits
c) Non-Major Elective Courses: 4 credits

Total number of credits to be taken from Core and Elective Courses shall be 90 for the purpose of deciding CGPA, Class and Rank.

Summer Training is envisaged for the students of M. Sc., Biotechnology Course at the end of Second Semester in biotech / pharmaceuticals industries / academic / research institutions of national repute. The students will be trained extensively in the field of Biotechnology with modern equipment.

Major Criteria

Assessment & Evaluation

Student evaluation is based on exams, assignments, quizzes and class participation. The grade allocation is as follows:

Continuous Internal Assessment: 25 Marks		**End-Semester Exam: 75 Marks**
Two, 2-hour tests for 15 marks in all	Assignments, Seminars, Quizzes, etc. for 10 Marks	Three Hour examination on the whole syllabus for 75 Marks.

Attendance

Since regular attendance is important for gaining academic success, the students are expected to improve their class attendance. As per the norms of the University, the students are qualified to write their end-semester examinations only if they have a minimum attendance of 75% in all the courses.

Punctuality

The achievement of the students will be better only if they are punctual to the class and attend the class completely. It also creates a negative attitude and distracts the other students in the class. Hence students arriving late to the class by 10 minutes, without any valid reason, will be marked absent in the attendance record. However valid excuse including personal or medical emergency is acceptable, with prior approval by the Head of the Department.

Class Participation

Knowledge will be effectively imparted to the students only if they concentrate in the class and be more interactive. Also, providing an opportunity to the students to interact in the

class will enable the teacher to know the strength and weakness of the students. Hence the students are expected to get involved during the class hours and make the learning process interesting.

Presentation of Seminars

Each student is supposed to give an oral presentation in the class seminar, where the students discuss about the recent research findings and latest developments related to the topics assigned to them. This promotes the students to read more number of research articles and get acquainted with the scientific research undertaken around the world on a specified research theme. The other students attending the seminar are encouraged to actively participate in the seminar by asking valid questions.

Submission of Assignments

The students are allocated two assignments for the course, covering the entire topics included in the course. They are prompted to submit the assignment to the teacher by the deadline. Careful preparation of the assignment is requested, since assignment preparations will also aid the students for final exam preparation.

Preparedness

Prior-learning will help the students to understand better about the topic taken in the class. Hence the students are intimated about the topics to be covered in advance, so that it will also help them to clarify their doubts on the topic, when the class is taken.

Academic Dishonesty

Since many of the students don’t have proper knowledge about academic integrity, they commit academic dishonesty unintentionally. Hence the students will be first made to understand about what plagiarism is, avoid copying of others assignments, prevent violation of copyright laws and so on, so that academic dishonesty may be avoided.

Subject to change clause

Depending upon the requirement of the students, the contents mentioned in the syllabus and the course details are subject to minor changes, which will be informed to the students.

Question Paper Pattern (For both Theory and Practical)

Section	**Marks (Max : 75 Marks)**
Part A Answer all 10 questions (Two questions from each unit)	10 x 2 = 20 Marks
Part B Answer all 5 questions, choosing either (a) or (b) (Two questions from each unit)	5 x 5 = 25 Marks
Part C Answer any 3 questions out of 5 (One question from each unit)	3 x 10 = 30 Marks

I – IV SEMESTERS CURRICULUM AND SYLLABUS

Programme Structure

Semester	Course / Title	Course Code	Credit	Hours/ Week	Marks		Total
					Internal	External	
I	CC –I / Biochemistry	501101	4	4	25	75	100
	CC – II / Microbiology	501102	4	4	25	75	100
	CC – III / Cell Biology	501103	4	4	25	75	100
	CC – IV / Molecular Biology and Genetics	501104	4	4	25	75	100
	CC – V / Lab I: Analytical Biochemistry	501105	3	4	25	75	100
	CC – VI / Lab II: Microbiology	501106	3	4	25	75	100
	EC - I	-	4	4	25	75	100
	Library, Yoga and Career Guidance		-	2	-	-	-
	Total		**26**	**30**	**-**	**-**	**700**
II	CC- VII / Immunobiology	501201	4	4	25	75	100
	CC – VIII / Recombinant DNA Technology	501202	4	4	25	75	100
	CC-IX / Plant Molecular Biology	501203	4	4	25	75	100
	CC-X / Lab III: Molecular Biology and Genetic Engineering	501204	3	4	25	75	100
	CC-XI /Lab IV: Immunotechnology	501205	3	4	25	75	100
	EC- II	-	4	4	25	75	100
	NME-I	-	2	3	25	75	100
	SLC-I	MOOCs	**Extra Credit**	-	-	-	-
	Library, Yoga, Career Guidance and Seminar		-	3	-	-	-
	Total		**24+ Extra Credits**	**30**	-	-	**700**
III	CC-XII / Genomics and Proteomics	501301	4	4	25	75	100
	CC-XIII / Animal Biotechnology	501302	4	4	25	75	100
	CC-XIV / Bioinformatics	501303	4	4	25	75	100
	CC-XV / Lab V: Bioprocess Engineering and Bioinformatics	501304	3	4	25	75	100
	CC-XVI / Lab VI: Plant Biotechnology	501305	3	4	25	75	100
	EC- III	-	4	4	25	75	100
	NME-II	-	2	3	25	75	100
	SLC –II	MOOCs	**Extra Credit**	-	-	-	-
	Library, Yoga, Career Guidance and Seminar		-	3	-	-	-
	Total		**24+ Extra Credits**	**30**	-	-	**700**
IV	CC-XVII Project Work	501401	16	30	50	150	200
	Total		**16**	**30**	**-**	-	**200**
Grand Total			**90+ Extra Credits**	**-**	**-**	**-**	**2300**

CC- Core Course; EC- Elective Course; NME- Non-Major Elective; SLC- Self Learning Course

Major Elective Courses for the students from Department of Biotechnology (3 Credits)

501501 BIOPHYSICS AND INSTRUMENTATION

501502 MICROBIAL BIOTECHNOLOGY

501503 IPR, BIOSAFETY AND BIOETHICS

501504 DEVELOPMENTAL BIOLOGY

501505 HUMAN MOLECULAR GENETICS

501506 FERMENTATION AND BIOPROCESS TECHNOLOGY

501507 PHARMACOGENOMICS

501508 EMERGING TECHNOLOGIES IN BIOTECHNOLOGY

501509 INHERITANCE BIOLOGY

Non-Major Elective Courses (2 Credits)

501701 HEALTHCARE BIOTECHNOLOGY

501702 ENVIRONMENTAL BIOTECHNOLOGY

Semester: I

501101–BIOCHEMISTRY (Core – 4 credits)

COURSE DEPICTION

Program: M.Sc. Biotechnology	**Semester: I**
Course Title/ Code	**Biochemistry/501101**
Name of Course Teacher	**Dr. K. Pandima Devi**
Mobile: +91 9790358700	**Email: devikasi@yahoo.com**

Course Brief

Biochemistry is the science that deals with the study of various biomolecules that occur in living cells and organisms and also with the metabolic and chemical reactions occurring within them. It is also concerned with the entire range of life forms beginning from the obligate intracellular parasites such as viruses to simplest of prokaryotic organisms to complex human beings. Biochemistry has become the fundamental language for all the biological sciences as life depends on biochemical reactions and it is very much essential to know them for better living. The field of biochemistry and medicine are closely related. Health and disease of living organisms depend on the accustomed balance and abnormalities of biomolecules, biochemical reactions, or biochemical processes occurring in the body. Exploring these biochemical reactions with the recent advancement in biochemical knowledge have shed light on many areas of medicine. Biochemical approaches are often being considered as an important tool in identifying the causes of diseases and in designing appropriate therapies. Currently the smart use of various biochemical laboratory tests have become an integral part of disease diagnosis and monitoring the treatment. A high understanding of biochemistry and of other related basic disciplines such as cell biology, molecular biology and genetics is essential for the judicious practice of medicine and related other health sciences.

The principal aim of this course is to provide the students with the clear understanding of the molecular composition of living cells, their structure, organization and function. This course also focuses on the better understanding about the biological macromolecules like proteins, their different structural forms, polysaccharides, and nucleic acids. The course also shed knowledge to the students on the chemical structure, different intermolecular forces involved in the formation of molecules, their thermodynamics and kinetics, and functionality

to understand how biological molecules work. Biochemistry leads to a range of career preferences allowing students to grab various employment opportunities as chemical oceanographers, environmental scientists, pharmaceutical chemists, chemical engineers and chemical information specialists. Overall, the goal of this course is to impart fundamental working knowledge to the students on the biochemical perception and techniques which will be essential for their future job and scientific endeavors.

Course Objectives

The objectives of the course is to make the students

1. Understand the basic concepts of cellular structure, its organization and the functions and importance of various biomolecules.
2. Learn various energy production mechanisms in cells.
3. Describe the laws of thermodynamics and their importance in biological phenomenon
4. Describe the various metabolic pathways involved in cells for its normal functioning.

Course Outcomes

On successful completion of Analytical Biochemistry course, students will be able to:

1. Acquire knowledge on the building blocks of the macromolecules, their chemical properties and their modification and their importance in normal functioning of living organisms.
2. Understand the metabolic pathways and identify how the genetic abnormalities disturb the normal homeostasis and link with pathological conditions
3. Understand the applications of biochemistry in medicine, agriculture, and pharmaceuticals

Course outline

1. Basic concepts of cellular architecture
2. Structure and functions of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins)
3. Biological energy transducers- electron transport chain and oxidative phosphorylation
4. Energy production in living cells (glycolysis, TCA cycle)
5. Structure and functions of membrane and membrane proteins
6. Ion channels and pumps and their importance in transport of signaling molecules
7. Metabolism of carbohydrates, lipids, amino acids and nucleic acids
8. Genetic dysfunctions in metabolic pathways and metabolomics
9. Enzyme classification and their kinetics
10. Application of enzymes in agriculture, medicine and industries

Course Schedule: Core I: Biochemistry (4 credits)

Syllabus	Schedule
Unit 1: Chemical bonding in biological systems. Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction). Biological buffers, maintenance of blood pH and pH of gastric juice. Concepts of Bioenergetics: Thermodynamics- laws and quantities, biological oxidation-reduction reactions. Occurrence, structure and biological importance of mono, di and polysaccharide (starch, glycogen and cellulose).	**10 Days (1h/day)**
Unit 2: High energy phosphate compounds –phosphate group transfer, free energy of hydrolysis of ATP and sugar phosphates. Oxidative phosphorylation, mitochondrial respiratory complexes, organization of electron carriers, electrochemical gradient, chemiosmotic theory, F1-F0 ATP Synthase and mechanism of ATP synthesis. Photosynthesis – Light dependent and independent reactions.	**8 Days (1h/day)**
Unit 3: Structure, classification & functions of Lipids: triglycerides, phospholipids, sphingolipids and glycolipids. Biological significance of PUFA, cholesterol and its derivatives. Structure of model membrane: lipid bilayer, fluid mosaic model, electrical properties of membranes, membrane proteins (intrinsic, extrinsic, lipid-linked), transport mechanisms (mediated and non-mediated), ion channels and pumps.	**8 Days (1h/day)**
Unit 4: Metabolism of carbohydrates (glycolysis; gluconeogenesis; pentose phosphate pathway). Lipids (fatty acid oxidation and biosynthesis). Amino acids biosynthesis, nucleotides (de novo synthesis and salvage pathways). Disorders of lipid, carbohydrate, nucleic acid and amino acid metabolism. Significance of Metabolomics	**8 Days (1h/day)**

Unit 5: Enzyme nomenclature and classification; Principles and mechanism of enzyme catalysis; Catalytic power and specificity of enzymes. Enzyme kinetics and general properties of enzymes like effect of pH, temperature; Michaelis-Menten equation; Km and Vmax values and their significance. Enzyme inhibition - types of inhibitors - competitive, non-competitive and uncompetitive. Allosteric and feedback inhibition; Isolation and purification of enzymes. Applications of enzymes in agriculture, industry and therapy. Serum enzymes in health and disease.	**8 Days (1h/day)**
Days assigned for CIA Tests, Quizzes, Seminars, etc.	**8 Days (1h/day)**

Text Books

1. Biochemistry by Geoffrey L.Zubay,William W.Parson 4th edition (1998). W.M.C.Brow.
2. Biochemistry, 8th edition (2015) by Berg W H Freeman.
3. Biochemistry, 9th edition (2019) by Jeremy M. Berg, John L. Tymoczko, Gregory J. Gatto, Jr., Lubert Stryer. New York: WH Freeman.
4. Harpers Illustrated Biochemistry, 30th edition., (2015) by Victor W. Rodwell, David A. Bender, Kathleen M. Botham, Peter J. Kennelly,P. Anthony Weil Mcgraw hill
5. Lehninger Principles of Biochemistry 6th edition (2012) by Nelson DL and Cox MM Macmillan worth Publishers.
6. Textbook of Biochemistry, 6th edition. (2006) by M.Devlin Wiley-Liss.

Reference Books

1. Biochemistry, 4th edition, (2013) by Voet D and Voet JG John Wiley and Sons, USA
2. Enzymes-Biochemistry, Biotechnology and Clinical Chemistry, 2nd edition, (2007) by Palmer T., Affiliated East-West Press Pvt Ltd, India.

More books to Read and Refer

Author (s)	Title
Elliott & Elliot (4th ed.)	Biochemistry and molecular biology
Rodney F. Boyer	Modern Experimental Biochemistry
Nicholas C. Price, Lewis Stevens	Fundamental of Enzymology- Cell and Molecular Biology of Catalytic Proteins
Robert A. Copeland	Enzymes: A practical introduction to structure, mechanism and data analysis
Ashok Pandey, Colins Webb, Carlos Ricardo Soccol, Christian Larroche	Enzyme Technology
Miroslava Čuperlović-Culf	NMR Metabolomics in Cancer Research
Jeremy M. Berg, John L. Tymoczko, Lubert Stryer (9th ed.)	Biochemistry
Colleen Smith, Allan D. Marks, Michael Lieberman	Mark's Basic Medical Biochemistry- A Clinical approach
D.E. Vance and J.E Vance	Biochemistry of Lipids, Lipoproteins and Membranes

Assignment I- 501101–Biochemistry (Core – 4 credits)

1. Reversible interactions in biomolecules necessary for replication and protein folding.
2. Four orders of protein structure.
3. Structure and function of electron carrier complexes in mitochondrial respiratory chain.
4. CO_2 assimilation in the stroma of plants.
5. Architecture and composition of membranes.
6. Active and passive transport.
7. Stages of oxidation of unsaturated fatty acid.
8. Catabolism of purines and pyrimidines.
9. Types of reversible inhibition mechanisms and their kinetics.
10. Techniques involved in the purification of enzymes.

Assignment II - 501101–Biochemistry (Core – 4 credits)

1. Thermodynamics in the context of biochemical processes.
2. Different forms of DNA.
3. Synthesis of energy by the oxidation of acetyl residues.
4. Structure and functions of ATP.
5. Membrane proteins that make up the fluid mosaic model.
6. Role of ion selective channels in the movement of ions across membranes.
7. Genetic defects in the metabolic pathways of lipids and nucleic acids and their associated diseases.
8. Application of different techniques employed for metabolomic studies.
9. Classification of enzymes based on the reactions they catalyse.
10. Enzyme inhibition.

501102–MICROBIOLOGY (Core – 4 credits)

COURSE DEPICTION

Program: M.Sc. Biotechnology	**Semester: I**
Course Title/ Code	**Microbiology/501102**
Name of Course Teacher	**Dr. A. Veera Ravi**
Mobile: +91 9487149249	**Email: aveeraravi@rediffmail.com**

Course Brief

Microbiology is an essential part of various scientific studies such as biotechnology, genetics, immunology, molecular biology, medicine, biochemistry, ecology, agriculture, industrial processes, etc. These fields apply microbiology in their daily measures. Because of the broad range of its applications, understanding the basics of microbiology is vital to the completeness as biologists. This syllabus deals with the microorganisms' morphology, structure, classification, physiology, metabolism, reproduction and its economic importance. In other words, this syllabus distinguishes the beneficial as well as detrimental roles of microbes. This core course mainly covers the applications of microorganisms in human and animal health. It also deals with industrial applications of microorganisms such as vinegar, wine, sauerkraut, pickles, beer, green olives, soy sauce, buttermilk bread, cheese, and yoghurt productions. The main aim of this syllabus is to familiarize the students with understanding of basic concepts and advanced knowledge in microbiology.

Course Objectives

The objectives of the course is to make the students

1. To acquire knowledge about history of microbiology, classification, microbial anatomy, physiology, the basic principle of growth and metabolism and microbial diversity.
2. To understand the basic descriptions of different prokaryotic, eukaryotic and other life-forms and how they exploit these principles; the natural ecology of microorganisms; the human use of microorganisms; and how microorganisms'

function in disease.

3. To gain thorough knowledge about industrial applications of microorganisms.

   To understand the role of microorganisms in environment and their applications for the benefit of mankind.

Course Outcomes

On successful completion of Microbiology course, students will be able to:

1. Explain the historical perspectives of microbiology
2. Describe the use of Bergey's Manual of Systematic Bacteriology and its criteria for the taxonomy of prokaryotes
3. Understand and list the structural differences between eukaryotic and prokaryotic cells.
4. Understand the role of beneficial microorganisms in the environment and the application to benefit mankind.
5. List and describe the mechanisms of action of major chemotherapeutic agents that control microorganisms.
6. Explain about factors responsible for the virulence of different pathogenic microorganisms

Course Outline

1. Introduction to Historical perspectives of microbiology.
2. Landmark discoveries relevant to the field of microbiology.
3. Important criteria used for classification (morphological, ecological, biochemical, molecular and numerical criteria) of microorganisms.
4. Introduction to domain and kingdom concepts in classification of microorganisms
5. Introduction to classification of Bacteria according to Bergey's manual.
6. Introduction to diversity of prokaryotic microorganisms.
7. Background of microbial pathogens, epidemiology and their pathogenicity mechanisms.
8. The medically important aspects of microbiology in both basic and clinical aspects of bacteriology, virology and mycology.
9. Drug resistance mechanisms and sensitivity to antibiotics
10. The role of microorganisms on the earth (symbiosis, mutualism, commensalism and parasitism)

11. The importance of microorganisms in the production of useful human products such as antibiotics, enzymes, organic acids, wine, beer, cheese, yogurt and vitamins.
12. The nutraceuticals application of probiotics and gives an important background regarding biological control agents.
13. Introduction to biological causes of degradation and deterioration of oil, plastics and xenobiotics.

Course Schedule: Core: II: Microbiology (4 Credits)

Syllabus	Schedule
Unit-1: Historical perspectives and scope of microbiology: Landmark discoveries relevant to the field of microbiology. Important criteria used for classification (morphological, ecological, biochemical, molecular and numerical criteria) of microorganisms. Domain and Kingdom concepts in classification of microorganisms, Classification of Bacteria according to Bergey's manual. Diversity of prokaryotic microorganisms.	**8 Days (1h/day)**
Unit-2: Microbial Anatomy – Prokarya: Bacterial Cell structure & Organization. Bacterial endospores, Cyanobacteria, Archaea: halophiles, methanogens, hyperthermophilic archaea. Eukarya: Unicellular eukaryotes-fungi, yeast, slime molds and protozoa. Viruses, General properties of viruses, RNA & DNA Virus, Classification of virus– Baltimore, Virions & Prions. Microbial Physiology. Nutrition, Growth and Metabolism of microorganisms - Respiration, Fermentation, Photosynthesis.	**8 Days (1h/day)**
Unit-3: Microbial morphology, cultural characteristics, toxins, pathogenicity, prophylaxis & treatment: Bacterial pathogens- *Staphylococcus, Escherichia, Salmonella & Mycobacterium*; Viral pathogens- Hepatitis, HIV and Dengue; Fungal pathogens- Dermatophytes and Candida.	**7 Days (1h/day)**
Unit-4: Microbial Diseases and Host Pathogen Interaction: Normal microbiota; Ecological impact of microbes; Source/Reservoir of infection; Pathogen transmission & interaction, Infectious dose, Growth rate; Host susceptibility-nonspecific and specific defence mechanisms, nutrition, genetic predisposition, cleanliness and stress. Nosocomial infection, Emerging microbial diseases-mechanism of microbial pathogenicity. Virulence: Pathogenicity islands, Resisting host defenses, Invasion & Colonization, Toxins. Mechanisms of drug resistance.	**8 Days (1h/day)**
Unit-5: Microorganisms in the environment. Microbes from extreme environment. Industrial microbiology: Use of microbes in fermentation, production of antibiotics, enzymes, organic acids, wine, beer, cheese, yogurt and vitamins. Role of Microorganism on the earth - Symbiosis, mutalism, commensalism and parasitism, Probiotics and Prebiotics, Biological Control Agents (BCA), Biodegradation and biodeterioration of oil, plastics and xenobiotics. Quorum sensing and its inhibition mechanism.	**9 Days (1h/day)**
Days assigned for CIA Tests, Quizzes, Seminars, etc.	**8 Days (1h/day)**

Text Book

1. Prescott's Microbiology, 10th Edition, (2016), Joanne Willey, Linda Sherwood, McGraw-Hill Education.
2. Medical Microbiology (1997) by D. Greenwood, R. Slack and J. Peutherer, ELST with
   Churchill Livingstone, Hong Kong.

Reference Books

1. Bergey's Manual of Systematic Bacterial Vol.1, (2001) David R.Barne, Springer Verlag.
2. Microbial Biotechnology: Progress and trends, (2015), Harzevill, Farshed Darvishi. CRC Publication.
3. Microbiology, (2010). Pelczar, TMH Publishers.
4. Microbiology, (2013), Black, Jacquelyn G, John Wiley Publishers
5. Environmental Microbiology (2015), Third edition, I.L. Pepper, C.P. Gerba and Terry J. Gentry. Elseiver Publication, New Delhi, India.
6. Microbial Technology (2004) by H. J. Peppler and D. Perlman, second edition, Elsevier, academic press.
7. Molecular microbiology: Diagnostic principles and practice, (2016), Persing, David H, ASM Publishers.
8. Recent Trends in Microbiology Biotechnology, (2013), Singh, Padma, CBS Publishers.

More books to Read and Refer

Author (s)	Title
Gerard J. Tortora, Berdell R. Funke, Christine L. Case (12^{th} edition)	Microbiology: An Introduction (2014)
Jeffery C. Pommerville and I. Edward Alcoma. Chicago, Sudburg (15^{th} edition)	Alcamo's Fundamentals of Microbiology (2011)
Persing DH, Tenover FC, Hayden RT, Ieven M, Miller MB, Nolte FS, Tang YW, Belkum AV	Molecular microbiology: diagnostic principles and practice, (2016)
J.Zhou, D.K. Thomson. Y.Xu. J.M. Tiedje	Microbial Functional Genomics (2004)
R. M. Atlas and R. Bartha	Microbial Ecology. Fundamentals and Applications (2000)

Assignment I- 501102–Microbiology (Core – 4 credits)

1. Domain and kingdom concepts in classification of microorganisms.
2. Koch postulates.
3. Importance of Bergey's Manual in bacterial taxonomy.
4. Structure and organization of bacterial cells.
5. Microbial physiology.
6. Opportunistic pathogens.
7. Pathogenicity and diagnosis of bacterial diseases.
8. Bacterial toxins.
9. Reproduction and spore formation in fungi.
10. Mechanism of fungal pathogenesis.

Assignment II - 501102–Microbiology (Core – 4 credits)

1. Basic concepts of microbial commensalism, colonization, infection, and disease.
2. Biological control measures of microbial pathogenesis.
3. Antimicrobial drug resistance in pathogens causing nosocomial infections.
4. Types of symbiosis and symbiotic relationships.
5. Microbial fermentation.
6. Applications of probiotics in live feeds cultivation.
7. Biodegradation of xenobiotics.
8. Mode of actions and selection criteria of probiotic bacterial organisms.
9. Mode of action of various antibiotics.
10. Bacterial quorum sensing: its role in virulence and possibilities for its control.

501103–CELL BIOLOGY (Core – 4 credits)

COURSE DEPICTION

Program: M.Sc. Biotechnology	**Semester: I**
Course Title/ Code	**Cell Biology/501103**
Name of Course Teacher	**Dr. M. Ramesh**
Mobile: +91 7904270252	**Email: mrbiotech.alu@gmail.com**

Course Brief

Cell biology (formerly called cytology) is a branch of biology that covers aspects ranging from fundamentals of the structure and function of cells of higher organisms (both plants and animals) as the basic unit of living things and as the building blocks of multi-cellular organisms. The course integrates principles from many disciplines, including chemistry, physics, genetics, biochemistry and physiology, for a complete understanding of cell function. This important core course will focus on the key topics in cell biology and add details to various concepts that have been previously exposed to the students in their Undergraduate courses. Most of the recent advancements in plant and animal science are the result of a complete understanding of cellular components and their individual and coordinated functions. The curriculum is critically designed to provide a background in the basic cell biology that is essential for subsequent biology courses to be studied by the students in the second and third semester

Course Objectives

The objectives of the course is to make the students

1. Understand the basic concepts of prokaryotic and eukaryotic cell.
2. Get comprehensive and concise overview of basic cell biology aspects.
3. Understand the individual and coordinated functions of various cell organelles.
4. Apply cell biology concepts in plant and animal biotechnology.
5. Apply various assays in plant and animal biotechnology experiments.
6. Understand the role of cellular and environmental factors causing cancer and aging.

Course Outcomes

The students undergoing this important core course shall be able to:

1. Equip themselves with a basic knowledge of the structural and functional properties of cells.
2. Learn the basic concepts and theories of cell and become aware of the complexity (endomembrane system in eukaryotes) and harmony of the cell.
3. Describe important functions of the cell, its microscopic structure and the structure of the key cellular components including membranes, various membrane bound organelles, the cytoskeleton network, and the genetic material.
4. Get basic knowledge on practical techniques and approaches commonly used in molecular cell biology aspects such as protein sorting and aging studies.
5. Understand cellular components and their functions at a particular stage of development and differentiation.
6. Describe the mechanisms for cell growth, cell division, cell expansion and cell differentiation.
7. Learn the importance of necrosis and apoptosis.

Course outline

1. General organization of eukaryotic plant and animal cells
2. Architecture and function of intracellular organelles
3. Organization and packaging of chromatin
4. Structural organization and functions of cytoskeletons
5. Model membrane structure and functions
6. Mechanism and regulation of protein transport in semiautonomous organelles
7. Protein insertion and processing in Endoplasmic reticulum and protein trafficking
8. Cell cycle and its regulation
9. Basic process and mechanism of cell differentiation in higher plants
10. Nature, composition and organization of plant cell wall
11. Interdependent nuclear-cytoplasm interactions
12. Cell fusion and its applications, Structural organization and function of cell machines
13. Classification and cellular functions of chaperones
14. Necrosis and Apoptosis - Process and Mechanism.
15. Oncogenes, tumor suppressor genes, cancer and embryonic stem cells and cell cycle
16. Theories regarding tumor formation - Mutation, Virus, Metabolic and Hormonal disturbance theories of tumor. Cellular, Systemic Pace maker, Biological clock and Mutation theories of aging.

Course Schedule: Core: III: Cell Biology (4 credits)

Syllabus	Schedule
Unit-1: An overview of Plant and Animal Cells, Structure and Organization of Prokaryotic and Eukaryotic cells, Structural organization and function of intracellular organelles (Nucleus and its compartments, Endoplasmic Reticulum, Golgi complex, Mitochondria, Chloroplast, Lysosomes, Peroxisomes and vacuoles). Chromatin organization, heterochromatin and euchromatin, chromatin packaging. Three-dimensional organization and functions of Cytoskeletons (Microfilaments, Intermediate filaments, Microtubules and associated proteins).	**10 Days (1h/day)**
Unit-2: Structure of model membrane, lipid bilayer and membrane protein, Diffusion, osmosis, ion channels, active transport, and ion pumps. Intracellular protein sorting- Mechanism and regulation of intracellular transport in mitochondria, chloroplast, endoplasmic reticulum and nucleus. Protein insertion and processing in Endoplasmic reticulum and protein trafficking from Endoplasmic reticulum to Golgi bodies. Cell cycle and its regulation. Molecular events during cell cycle, Check points, Cyclins and protein kinases. Photophosphorylation. Cell receptors and trans-membrane signalling.	**10 Days (1h/day)**
Unit-3: Cellular differentiation in plants – Basic process and mechanism, specific role of hormones and regulation of cellular differentiation. Plant cell wall- Nature, composition and organization. Organization of shoot and root apical meristem; shoot, root and flower development. Cancer cells and Embryonic stem cells.	**8 Days (1h/day)**
Unit-4: Nuclear-Cytoplasm interactions. Isolation of cells and basics of cell culture. Cell fusion and its applications. Proteasome – structural organization and function. Chaperons-Classification and cellular Function. Necrosis and Apoptosis-Process and Mechanism.	**7 Days (1h/day)**
Unit-5: Oncogenes, tumor suppressor genes, cancer and the cell cycle. Theories regarding tumor formation - Mutation, Virus, Metabolic and Hormonal disturbance theory. Aging Theories– Cellular, Systemic, Pace maker, Biological clock and Mutation theory. Transpositions- transposable genetic elements in prokaryotes and eukaryotes, role of transposons in genome.	**8 Days (1h/day)**
Days assigned for CIA Tests, Quizzes, Seminars, etc.	**8 Days (1h/day)**

Text Books

1. Molecular Cell Biology (2016), Harvey Lodish et al., 8th Edition, W. H. Freeman and Company, New York. ISBN-10: 146418339
2. The Cell: A Molecular Approach (2019) 8th Edition, Geoffrey M.Cooper and Robert E.Hausman, New York : Sinauer Associates : Oxford University Press
3. Cell and Molecular Biology – Concepts and Experiments (2015), Gerald Karp, Harris, D, 8th Edition, John Wiley & Sons Inc, New York.
4. Genes XII (2018), 12th Edition, Benjamin Lewin, Jones and Barlett Publishers. ISBN: 0763740632.
5. Molecular Cell Biology (2007) James Darnell, 6th Edition, W. H. Freeman & Co. Cell Biology. Pollard, T.D. and Earnshaw. Publ. W.C. Saunders.
6. Becker's World of the Cells Boston (2018), 9th Edition, Hardin, J., Bertoni, G., Kleinsmith, L. J., & Becker, W. M. Benjamin Cummings

Reference Books

1. Essential Cell Biology (2014), 4th edition Bruce Alberts, Garland Science Pub, New York.
2. Introduction to Cell Biology (2014) Casper Barnes, Larsen and Keller Education (14 June 2017) ISBN – 10:1635490618

More books to Read and Refer

Author (s)	Title
B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts and P Walter (6th edition)	Molecular Biology of the Cell
DeRoberties, E.D.P. and DeRoberties, E.M.F. (8th edition)	Cell and Molecular Biology
Gerald Karp; James G Patton; John Wiley & Sons (7th edition)	Cell Biology
N. Chandar; S. Viselli (2nd edition)	Cell and molecular biology

Assignment I - 501103–Cell Biology (Core – 4 credits)

1. Coordinated functions of various compartments in a typical plant cell.
2. Structure and functions of Peroxisomes and vacuoles.
3. Salient features of chromatin packaging.
4. Significance of osmosis, ion channels, active transport, and ion pumps.
5. Cell receptors and trans-membrane signalling.
6. Importance of Photophosphorylation.

Assignment II - 501103–Cell Biology (Core – 4 credits)

1. Differences in the bacterial and plant cell wall.
2. Mechanism of necrosis.
3. Role of transposons in transgenic plant genome.
4. Role of SAM and RAM during differentiation.
5. Characteristic features of cancer cells and embryonic stem cells.
6. Significance of apoptosis process.

501104 – MOLECULAR BIOLOGY AND GENETICS (Core –4 credits)

COURSE DEPICTION

Program: M.Sc. Biotechnology	**Semester: I**
Course Title/ Code	**Molecular Biology and Genetics/ 501104**
Name of Course Teacher	**Prof. S. Karutha Pandian** **Dr. S. Gowrishankar**
Mobile: + 91 9442318144 **+ 91 9994933559**	**Email: sk_pandian@rediffmail.com** **gowrishankar.alu@gmail.com**

Course Brief

The course deals with the molecular level studies including DNA, RNA and protein; describes DNA as the genetic material, and the central dogma of life - replication, transcription and translation; demarcate the organization of genomes in prokaryotes and eukaryotes; explains the regulation of gene expressions and silencing; delineates the biology of bacteriophages and its lifecycles; delves into mutation, genetic recombination, genetic mapping, linkages and crossing over; scrutinize the causes of mutation, its types and the mechanisms to repair it; discriminate the methods of genetic transfers and decipher the mapping of genes; defines transposons and its mechanisms; discerns the human genetics and chromosomal aberrations.

Course Objectives

To make the students:

1. Understand the essentials of molecular biology: replication, transcription and translation; enzymes involved in the central dogma of life, proofreading, inhibitors and post modifications.
2. Thorough in prokaryotic and eukaryotic genome organization; lac & trp operon; regulation of transcription and translation in eukaryotes; lytic and lysogenic life cycle of bacteriophages; recombination in bacteriophage.
3. Knowledgeable in mutant and it types, genetic recombination, linkage, multifactor crosses; mutation: causative agents, types and the mechanism of repair; complementation and intragenic complementation.

4. Familiar with the methods of natural and artificial genetic transfer; mapping and structural analysis of genes; transposons.
5. Comprehend pedigree analysis, karyotypes, eugenics, epigenetics, chromosomal aberrations, phylogenetic inheritance and quantitative trait locus mapping.

Course Outcomes

The students shall be able to:

1. Understand the occurrence of central dogma of life in the cell and the machineries involved to initiate and inhibit.
2. Fathom the genome organization and control of gene expressions in prokaryotes and eukaryotes.
3. Decipher the types of mutant, isolation and characterization of mutant, types of genetic recombination, and the phenomenon of mutation, types, their causative agents, detection and repair mechanism.
4. Comprehend the genetic transfer methods and gene mapping, gene structure analysis, transposons types, nomenclature and their mechanism.
5. Aware of the genetic disorders in humans due to structural and numerical alterations in the chromosomes and its inheritance.

Course Outline

1. Structure and Types of DNA and RNA
2. Mechanism of DNA replication, Enzymes involved, replication origin, replication fork, fidelity of replication, Inhibitors of DNA replication
3. Replication in extra-chromosomal DNA
4. Transcription - initiation, elongation and termination, RNA processing, RNA transport and Transcription inhibitors.
5. Translation - formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination
6. Translational proof-reading, translational inhibitors, Post- translational modification of proteins.
7. Genome Organization in Prokaryotes, regulation of gene expression: lac & trp operon.
8. Genome Organization in eukaryotes, repetitive DNA and renaturation kinetics, Eukaryotic DNA Packaging, Regulation of transcription and translation
9. role of chromatin in gene expression and gene silencing
10. Bacteriophage: Lytic and lysogenic lifecycle
11. Types of mutants, Isolation and characterization of mutants and revertants; Genetic analysis of mutants
12. Genetic recombination, Genetic mapping, Linkage and multifactor crosses, Deletion

mapping, Complementation and Intragenic complementation

13. Mutation: causes, types, detection and repair
14. Methods of genetic transfers – transformation, conjugation and transduction
15. Mapping genes by interrupted mating, Fine structure analysis of genes-Linkage maps, tetrad analysis, mapping with molecular markers and by using somatic cell hybrids
16. Introduction to Transposable elements – Discovery, types, Nomenclature and mechanism
17. Human genetics - Pedigree analysis, Lod score for linkage testing, karyotypes, genetic disorders.
18. Eugenics. Epigenetics & Genome Imprinting.
19. Structural and numerical alterations of chromosomes - Deletion, duplication, inversion, translocation, ploidy and their genetic implications.
20. Polygenetic inheritance, heritability and its measurements, QTL Mapping

Course Schedule: Core: 501104: MOLECULAR BIOLOGY AND GENETICS (4 Credits)

Syllabus	Schedule
Unit 1: DNA as the genetic material, Structure and Types. Replication - Mechanism of DNA replication in Prokaryotic and eukaryotic systems, Enzymes involved, replication origin and replication fork, fidelity of replication, extra-chromosomal replicons, Inhibitors of DNA replication. Structure and functions of different types of RNA. Transcription - Transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, elongation and termination, RNA processing (capping, polyadenylation, RNA editing, and splicing), RNA transport and Transcription inhibitors. Genetic code. Translation - Prokaryotic and eukaryotic translation machinery, Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post- translational modification of proteins.	**9 Days (1h/day)**
Unit 2: Genome Organization in Prokaryotes, regulation of gene expression: The Operon concept - i) lac and ii) trp; stringent response. Genome Organization in eukaryotes, repetitive DNA and renaturation kinetics, Cot Curve analysis, Eukaryotic DNA Packaging, Regulation of transcription and translation in eukaryotes, role of chromatin in gene expression and gene silencing, Histone acetylation & deacetylation. Biology of bacteriophage λ. Lytic growth of phage λ: DNA replication and phage production, recombination in the λ life cycle. Lysogeny: Immunity and repression, Lysogeny and prophage integration, prophage excision. Decision between lysis and lysogeny.	**8 Days (1h/day)**

Unit 3: Genetic nomenclature- Types of mutants, Isolation and characterization of mutants and revertants. Genetic analysis of mutants, genetic recombination (Homologous, non-homologous and site specific recombination), Genetic mapping, Linkage and multifactor crosses, Deletion mapping, Complementation and Intragenic complementation; The need for isogenic strains for genetic analysis. Mutation - Causes (physical, chemical and biological) Types (lethal, conditional, biochemical, loss of function, gain of function) and detection. Mechanism of repair- photoreactivation, excision repair, recombinational repair. The SOS and adaptive responses and their regulation. Heat shock response.	**8 Days (1h/day)**
Unit 4: Methods of genetic transfers – transformation, conjugation- *(Hfr*, triparental mating, self-transmissible and mobilizable plasmids,) transduction (general and specialized), mapping genes by interrupted mating, Fine structure analysis of genes-Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids. Introduction to Transposable elements – Discovery and types, Nomenclature - Insertion sequences - Mechanism – Transposons of *E. coli*, Bacteriophage and Yeast.	**8 Days (1h/day)**
Unit 5: Human genetics **–** Various models to explain the structure of chromosomes, Special type of chromosomes: lamp brush, salivary and B chromosomes. Chromosomal DNA contents and Cvalue paradox. Pedigree analysis, Lod score for linkage testing, karyotypes, genetic disorders, Eugenics. Epigenetics & Genome Imprinting. Structural and numerical alterations of chromosomes - Deletion, duplication, inversion, translocation, ploidy and their genetic implications., Polygenetic inheritance, heritability and its measurements, QTL Mapping.	**7 Days (1h/day)**
Days assigned for CIA Tests, Quizzes, Seminars, etc.	**8 Days (1h/day)**

Text Books

1. Microbial Genetics (2006) by S.R. Maloy, J. E. Cronan Jr., and D. Freifelder, Jones and Bartlett Publishers, Sudbury, Massachusetts.
2. Modern Genetic Analysis, 2nd Edition (2002) by Anthony J.f.Griffiths, W.H.Freeman and Company.
3. Essentials of Molecular Biology, 2nd Edition (1993) by Freifielder, Jones and Bartlett Publication.
4. A Textbook of Human Genetics (2011) by Amita Sarkar, Wisdom
5. Molecular Biology of the Gene, 7th Edition (2014) by James D Watson, Tania A Baker, Stephen P Bell, Alexander Gann, Michael Levine and Richard Losick, Benjamin Cummings.

Reference Books

1. Academic Cell - Molecular Biology, 2nd Edition (2013) by David P Clark and Nanette J Pazdernik.
2. Essential Genetics, 6th Edition (2014) by Daniel L Hartl.

More books to Read and Refer

Author (s)	Title
Williams S Klug, Michael R Cummings, Charolette A Spencer and Michael A Palladino	Concepts of Genetics
Larry Snyder, Joseph E Peters, Tina M Henkin and Wendy Champness	Molecular Genetics of Bacteria,
Burton E Tropp	Molecular Biology – Genes to Proteins
S.R. Maloy, J. E. Cronan Jr., and D. Freifelder	Microbial Genetics
T. A. Brown	Genomes
S. B. Primrose and R. M. Twyman	Principles of Gene Manipulation and Genomics
David P Clark and Nanette J Pazdernik	Biotechnology
Lodish, Berk, Matsudaira, Kaiser, Krieger, Scott, Zipursky and Darnell	Molecular Cell Biology
R. M. Twyman	Advanced Molecular Biology
Gerald Karp	Cell and Molecular Biology
Robert Schleif	Genetics and Molecular Biology
Lizabeth A. Allison	Fundamental Molecular Biology
Alberts, Johnson, Lewis, Raff, Roberts and Walter	Molecular Biology of the cell
Lewis	Human Genetics Concept and Applications

Assignment I- 501104– Molecular Biology and Genetics (Core – 4 credits)

1. Different types of nucleic acids found inside the cell.
2. Role of enzymes involved in DNA Replication.
3. Formation of initiation complex of Transcription.
4. Post-transcriptional modifications and its significance.
5. Differentiate: Prokaryotic and Eukaryotic Translation.
6. Codons, anticodons and Wobble Hypothesis.
7. Importance of 16S rRNA.
8. Regulation of lac operon.
9. Cot curve analysis
10. Lytic and lysogenic cycle of phage λ.

Assignment II - 501104– Molecular Biology and Genetics (Core – 4 credits)

1. Homologous Recombination.
2. α-Complementation.
3. Different types of mutation.
4. Photoreactivation
5. DNA repair mechanisms.
6. Types of bacterial gene transfer.
7. F plasmid
8. Partial merozygotes
9. Transposons and its types
10. C-value paradox

501105–LAB I: ANALYTICAL BIOCHEMISTRY (Core – 3 credits)

COURSE DEPICTION

Program: M.Sc. Biotechnology	**Semester: I**
Course Title/ Code	**Lab I- Analytical Biochemistry/ 501105**
Name of Course Teacher	**Dr. K. Pandima Devi**
Mobile: +91 9790358700	**Email: devikasi@yahoo.com**

Course Brief

Analytical biochemistry is a subdivision of biochemistry which emphasizes on the experimental methods involved in biological sciences. The fast development and massive enlargement of every single phase of biochemistry has not only noticeably enhanced our knowledge about the nature of life but has also made biochemistry the right language of life itself. Realizing the dynamic importance of this discipline of science, degree courses in analytical biochemistry are now offered in postgraduate level. For certain degree programmes, depending upon the course, the students are also offered this subject at undergraduate level, since analytical biochemistry is not taught to them at the school level.

The syllabus of Analytical Biochemistry has been framed to meet the requirements of our students who will be performing various biological experiments by applying the modern tools of analytical biochemistry. Besides, the course might also support a suitable purpose for higher education in Biotechnology. The main goal of the course is to supply students with complete information on analytical biochemistry in the aspects of basic concepts, applications of the instruments used in biochemical analysis, separation techniques, clinical enzymology and so on. The course also highlights the application of analytical biochemistry concepts in the field of biotechnology to understand the regulation of protein signaling pathways, cell differentiation, cancer development and aging disorders. The syllabus for the course, which will be studied by the students in the first semester, is methodically designed to provide detailed information on the basic concepts of analytical biochemistry that is necessary for biotechnology course. It will also expose the students pursuing post graduation to the advanced research areas and will improve their analytical and practical abilities necessary for the current biotechnologists. Students experiencing the practical knowledge of this course will make themselves familiar with the basic knowledge of instruments used in biochemical analysis, which are progressively more essential in all forms of life sciences.

Course Objectives

The objectives of the course is to make the students

1. Learn the basic concepts and applications of instruments applied in biochemical analysis
2. Understand the clinical significance of enzymes
3. Describe the production techniques for extracellular enzymes and downstream processing methods
4. Describe the features of chromatography techniques and their biological applications.

Course Outcomes

1. On successful completion of Analytical Biochemistry course, students will be able to: Acquire basic knowledge on practical techniques and approaches commonly used in analytical biochemistry in the aspects of biochemical enzyme assays and separation techniques.
2. Realize the significance of electrophoretic techniques in molecular diagnosis
3. Understand about biostatistics and apply it for data analysis in the field of biological research.

Course outline

1. Basic concepts and applications of the instruments used in biochemical analysis
2. Spectroscopy techniques-principle and applications
3. Blood samples- Collection and preservation for enzyme assays
4. Enzymes- Derivation of Michaelis- Menten equation and significance of Vmax, Km and optimum pH
5. Clinical enzymes- assay and significance
6. pH Meter: buffer preparation and pI determination
7. Chromatography techniques-separation of plant pigments
8. Extracellular enzymes- production and purification
9. Proteins- separation by Native and SDS PAGE and identification by 2D gels
10. Radioactive labelling and measurement of radioactivity.

Course Schedule: Core: V- LAB I- Analytical Biochemistry (Core – 3 credits)

Syllabus	Schedule
Unit-1: Introduction to measurements: Weighing balance and pipetting. Preparing various stock solutions and working solutions. Basic concepts and applications of the instruments used in biochemical analysis: Colorimetry, spectrophotometry and spectroflorimetry. Colorimeter: Verification of Beer – Lambert's Law, complementary colour and wavelength of coloured solutions. Spectrophotometer-assay of DNA by diphenylamine method, assay of RNA by orcinol method, determination of carbohydrate by DNSA method, protein estimation by Lowry's and Bradford's method.	**5 Days (3h/day)**
Unit-2: Collection of samples for enzyme assays: whole blood, serum, plasma, tissue homogenate. Subcellular fractionation: mitochondria, cytosol, nuclei. Enzyme assays: Derivation of Michaelis- Menten equation and determination of Vmax, Km. Determination of optimum pH, optimum temperature and substrate concentration of enzymes. Clinical Enzymology: Clinical significance and assay of the enzymes- SGOT, SGPT, ALP, Amylase, ACP, Lipases. Estimation of blood glucose and determination of fasting, post-prandial and random blood sugar. Evaluation of risk of coronary heart disease-estimation of serum cholesterol.	**7 Days (3h/day)**
Unit-3: Determination of pH of Buffer Solution using Indicators and pH meter. Preparation of buffers of pH range 2 to 11 (Tris buffer, PBS buffer, citrate buffer, sodium phosphate buffer, potassium phosphate buffer, phosphate citrate buffer). Preparation of Sodium acetate buffer and validate the Henderson-Hasselbach equation. Determination of pI value of amino acids. Titration of Amino Acids and separation of aliphatic, aromatic and polar amino acids by TLC. Separation of sugars by – Paper chromatography and plant pigments by TLC and HPTLC.	**5 Days (3h/day)**
Unit-4: Production of extracellular enzymes from bacteria/fungus and downstream processing a) Ultrafiltration b) Ammonium sulphate precipitation c) Dialysis d) Ion exchange chromatography e) Gel permeation chromatography f) HPLC. Centrifugation and types of rotors (vertical, fixed angle, swinging bucket)	**5 Days (3h/day)**
Unit-5: Electrophoretic techniques- separation of proteins by Native and SDS PAGE. Identification of proteins by 2D gels. Principle, instrumentation and application of Atomic Absorption spectroscopy, Circular dichroism spectroscopy, Electron spin resonance spectroscopy. Radioactive labelling and measurement of radioactivity. Laboratory safety guidelines.	**6 Days (3h/day)**
Days assigned for CIA Tests, Quizzes, Seminars, etc.	**2 Days (3h/day)**

Text Books

1. Bioanalytical Chemistry 2nd edition (2016) by Susan R. Mikkelsen, Eduardo Cortón, Wiley, United States.
2. Biochemical Calculations and Biostatistics (2015) by Padmini. E, Books & Allied, Chennai, Tamil Nadu
3. Enzymes: Biochemistry Biotechnology, clinical chemistry (2007) by Trever Paltner, Harwood Publishing
4. Laboratory Manual in Biochemistry (2010) by Arun Rastogi, Anmol, Karnataka, India
5. Methods in Enzymology: Computer Methods for Macromolecular Sequence Analysis (1996) by Russell F. Doolittle, Vol.266. Academic Press, United States
6. Modern Experimental Biochemistry 3rd edition, (2002) by Boyer, Pearson Education, United Kingdom.
7. Practical Biochemistry: Principles & Techniques (2000) by Keith Wilson, Cambridge University Press, United Kingdom.

Reference Books

1. Lehninger Principles of Biochemistry 6th edition (2013) by David L.Nelson, Michael M. Cox MacMillan.
2. Principles and Practice of Bioanalysis (2000) by Richard F. Venn, Taylor Francis, United Kingdom.
3. Principles of Biochemistry (1995) by Geoffrey L. Zubay, William W. Parson, W.M.C.Brown
4. Textbook of Biochemistry with clinical correction (2010) by Thomas M. Devlin, wiley lions.

More books to Read and Refer

Author (s)	Title
R. Eisenthal and M.J.Danson	Enzyme assays
Monika Wakasmundzka-Hajnos, Joseph Sherma	High performance Liquid chromatography in Phytochemical Analysis
Hobart H. Willard, Lynne L. Merritt , John A, Dean, Frank A. Settle	Instrumental Methods Of Analysis
Ipsita Roy and Munishwarn Gupta	Downstream processing of enzymes/proteins
Susan R. Mikkelsen and Eduardo Corton	Bioanalytical Chemistry
Rodney and Royer	Modern Experimental Biochemistry
David Harvey	Modern Analytical Chemistry

Assignment I: 501105–LAB I- Analytical Biochemistry (Core – 3 credits)

1. Working principle and applications of atomic absorption spectroscopy and circular dichroism spectroscopy.
2. Safety guidelines to be followed in the laboratory.
3. Methods for determining the three-dimensional structure of a protein.
4. Relation between reaction velocity and substrate concentration by Michaelis-Menten Equation.
5. Determine a carbohydrate using DNSA method.
6. Chromatographic methods used in protein purification.
7. Basics of preparatory HPLC.
8. Principle and methodology of 2D gel electrophoresis.
9. Principle and application of Electron spin resonance spectroscopy.
10. Various types of rotors used in centrifugation.

Assignment II: 501105–LAB I- Analytical Biochemistry (Core – 3 credits)

1. a) Evaluation of beers law.
   b) Determination of protein by using Bradford's method.
2. a) Subcellular fractionation.
   b) Ammonium sulphate precipitation.
3. Principle and applications of NMR spectroscopy.
4. Radioactive labelling and measurement of radioactivity.
5. Production of extracellular enzymes through downstream processing methods.
6. Principle and application of FPLC.
7. Protein structure prediction software's.
8. Clinical significance of enzymes.
9. Methods for separation of sugars using paper chromatography
10. Aliphatic and aromatic amino acids.

501106–LAB II: MICROBIOLOGY (Core – 3 credits)

COURSE DEPICTION

Program: M.Sc. Biotechnology	**Semester: I**
Course Title/ Code	**Lab II: Microbiology/ 501106**
Name of Course Teacher	**Dr. A. Veera Ravi**
Mobile: +91 9487149249	**Email: aveeraravi@rediffmail.com**

Course Brief

This core course is planned for science majors who need a microbiology course for their professional preparation, usually in an area of clinical importance including pharmacy, nursing, physician's assistant, dental assistant, and others. In addition, this course deals with the basic microbial techniques required in the field of biotechnology. This important core course will focus on the lab uses that imply aseptic techniques and develop student's skills necessary to handle microbes in health care settings, including the isolation, identification and characterization of unknown microbes. Students will be exposed to hands on training relating to isolation, purification and identification of microorganisms from different sources. It also uncovers the general principles for microbial growth, evolution and classification and gives description of different prokaryotes and eukaryotes. Additionally, It will equip the students with basic bacterial and fungal laboratory techniques as well as factual and laboratory knowledge for specific microorganisms types. It will provide the students with understanding of microbial ecology and their practical uses, which is related to basic biological concepts. The main aim of this course is to develop an opportunity for the students to learn the skills necessary to understand concepts related to microbial life. This should permit the students to establish a strong foundation for future research in advanced biology field and give a good analytical power required to make reasoned choices in their everyday life. This syllabus is critically designed to provide the information regarding the survival of microorganisms and their relationship and interaction within them and us.

Course Objectives

The objectives of the course is to make the students

1. Learn the techniques relating to microscopy, culture handling and maintenance, microbial biochemistry and physiology and molecular biology.
2. Understand the safety precautions required in microbiology laboratories.
3. Employ the right staining methods and apply those methods to identify microorganisms
4. Perform and evaluate the use of different biochemical tests in the laboratory for characterization of bacteria.
5. Perform the serial dilution and the standard plate count techniques.

Course Outcomes

1. Familiarize with laboratory equipments used for working with microorganisms.
2. Develop expertise to use microscopes in the laboratory
3. Describe how microorganisms are collected, inoculated, cultured, incubated, and autoclaved
4. Perform and evaluate the use of water and food analyses
5. Understand the methods to characterize the unknown bacteria
6. Be proficient in writing scientific texts by accumulating information and results of each laboratory experiment in form of reports

Course outline

1. Safety measures in microbiology laboratory
2. Introduction to laboratory instruments & equipments and standard laboratory practices.
3. Microscopy- Bright field, Phase Contrast & Fluorescence microscopy
4. Sterilization methods and preparation of culture media.
5. Enumeration of bacteria and fungi from Soil, Water, Air and Marine environmental samples.
6. Techniques involved in isolation of pure bacterial culture.
7. Preservation methods and maintenance of microbial cultures
8. Staining methods- Simple staining, Negative staining & Differential staining techinques
9. Measurement of microbes using micrometry
10. Motility determination by hanging drop method
11. Measurement of growth- growth curve and generation time
12. Factors affecting the bacterial growth- pH, Temperature and Salinity
13. Screening and identification of Amylase, Protease, Lipase, Gelatinase, DNase enzymes and antibiotic producing microorganisms

14. Mass cultivation of commercially important compounds producing microorganisms using bioreactors
15. Water quality analysis - MPN method
16. Bacterial cell – cell communication system
17. Biochemical characterization: Carbohydrate fermentation, IMVIC tests, starch hydrolysis, cellulose, gelatin, casein, catalase test, oxidase test, urease test, nitrate reduction, TSI.
18. Molecular methods employed in identification of culture dependent and culture independent bacterial organism

Course Schedule: Core: VI - Lab II- Microbiology (Core – 3 credits)

Syllabus	Schedule
Unit-1: Safety measures in Microbiology laboratory. Introduction to laboratory instruments and equipment and standard laboratory practices. Microscopy: Bright field, Phase Contrast, Fluorescence, Confocal Laser scanning Microscope and Electron Microscopy (DEMO). Sterilization and disinfection- methods and Quality Control measures. Preparation of culture media. Enumeration of bacteria and fungi from environmental samples of Soil, Water, Air and Marine environments. Study of colony and growth characteristics of common microbes - Bacteria: *Bacillus, E. coli* and *Staphylococcus*; Fungi: *Aspergillus*, *Fusarium* and *Penicillium.*	**5 Days (3h/day)**
Unit-2: Techniques for isolation of pure bacterial culture. Preservation and maintenance of microbial cultures: slants, stabs and glycerol stock cultures. Stains and staining techniques, Simple staining, Negative staining, Differential staining, Flagella staining, Acid Fast staining and Endospore staining. Fungal staining method- Lacto Phenol cotton Blue. Motility determination – hanging drop method.	**5 Days (3h/day)**
Unit-3: Methods for measurement of cell mass and cell numbers. Measurement of size of microbes – micrometry method. Measurement of growth – Growth curve, determination of growth rate and generation time, factors affecting bacterial growth – pH, Temperature and Salinity. Screening and identification of Amylase, Protease, Lipase, Gelatinase, DNase enzymes and antibiotic producing microorganisms. Antimicrobial sensitivity test and demonstration of drug resistance. Determination of Minimum Inhibitory Concentration (MIC) - Broth dilution assay.	**6 Days (3h/day)**
Unit-4: Isolation of *E. coli* Bacteriophage from Raw Sewage. Culture methods for aerobes and anaerobes. Principle and methods of preservation of microbes. Water quality analysis - MPN method, Microbial analysis of food samples. Bacterial cell – cell communication system.	**5 Days (3h/day)**
Unit-5: The general principles of bacterial characterization. Biochemical tests: Carbohydrate fermentation, IMVIC tests, starch hydrolysis, cellulose, gelatin, casein, catalase test, oxidase test, coagulase test, urease test, nitrate reduction, TSI. Molecular methods employed in identification of culture dependent and culture independent bacterial organism.	**5 Days (3h/day)**
Days assigned for CIA Tests, Quizzes, Seminars, etc.	**4 Days (3h/day)**

Text Book

1. Microbiology (2013), Ninth edition by L.M. Prescott, J.P. Harley and D.A. Klein, McGraw Hill, Boston.

Reference Books

1. Laboratory Exercises in Microbiology, 4th Edition, (2011), Robert A. Pollack. John Wiley Publishers.
2. Laboratory Manual in General Microbiology (2002), N. Kannan. Panima Publishers.
3. Microbiological Methods (8th ed.) (2004). Collins, C. H., Lyne, P. M., Grange, J. M., & Falkinham III, J., Collins and Lyne's. Arnolds.
4. Microbiology: A Laboratory Manual, 11th Edition (2017), J.G. Cappuccino, SUNY and Chad T. Welsh, Pearson.
5. Diagnostic Microbiology. (2007). Betty Forbes, Daniel Sahm, Alice Weissfeld. Bailey & Scott's.
6. Practical hand book of microbiology (2015), Third edition, Emanvel Goldman and Lorrence H. Green, CRC Press

More books to Read and Refer

Author (s)	Title
D.H. Pershing	Diagnostic Molecular Microbiology: Principles and Applications (1993)
V. H. Talib	Handbook Medical Laboratory Technology (2014)
John Harley	Laboratory exercise in Microbiology (2010)
John Lammert	Techniques for Microbiology: A student handbook (2007)

Assignment I: 501106 - Lab II: Microbiology (Core – 3 credits)

1. Safety measures in Microbiology laboratory.
2. Different types of sterilization used in the laboratory.
3. Stains and staining principles involved in microbial staining.
4. Different types of media for microbial cultivation.
5. Preservation techniques of bacterial cultures.
6. Working principles and applications of Confocal Laser Scanning Microscopes.
7. Optical system of Dark field microscope.
8. Working principles and applications of Scanning Electron Microscope.
9. Bacterial population growth curve
10. Mechanism behind the microbial drug resistance.

Assignment II: 501106 - Lab II: Microbiology (Core – 3 credits)

1. Membrane Filtration technique and its advantages.
2. General principles of bacterial characterization
3. Screening of probiotic organism from environmental sample.
4. Screening of antibiotic producing organisms from environmental sample.
5. Isolation of industrially important bacterial organisms
6. Principle behind the production of DNase and Protease enzyme.
7. Principle behind the production of Amylase and Gelatinase enzyme.
8. Importance of biochemical tests of bacteria
9. Alternative strategies for the biochemical analysis in the identification of bacteria.
10. Molecular methods employed in identification of culture dependent and culture independent bacterial organism.

SEMESTER II

501201–IMMUNOBIOLOGY (Core – 4 credits)

COURSE DEPICTION

Program: M. Sc. Biotechnology	**Semester: II**
Course Title/ Code	**Immunobiology/ 501201**
Name of Course Teacher	**Dr. K. Pandima Devi**
Mobile: +91 9790358700	**Email: devikasi@yahoo.com**

Course Brief

The course on Immunobiology has been designed critically to study the basic concepts of immunity. The term immunity is basically used to explain about the defense of biological system against any disease or toxin or infection. The primary goal of this course is to make the students understand about the host immune system which consists of many biological structures and processes. Through the various mechanisms of immunity, the biological systems have the ability to protect against chronic diseases that might be caused by certain foreign substances. Immunity has been recognized as a protective agent as well as antagonistic to infectious diseases. The mechanism of immune reactions also deliberates the protection against some harmful substances. The course will also help the students to understand on how the immune system works in a specific and non-specific manner to defend the host against infections by microorganisms. The structure and functional features of the elements of immune system are explained in this core course which will enable the students to understand the protection mechanisms that can establish a state of immunity against infection, immune-related diseases and its responsiveness.

The course of the study is critically designed to provide a background on the basic concepts of immunity that is essential for understanding the causes, consequences, or treatments of diseases of the human system.

Course Objectives

1. Learn the basic principles of defense mechanism against infections.
2. Understand the structure and function of the molecules, cells, and organs involved in Immunity.
3. Explain the mechanism of how the immune system recognizes foreign antigen and the significance of self/non-self-discrimination
4. Describe how cell mediated and antibody-mediated immunity works to protect a host from pathogenic organisms and harmful substances

Course Outcomes

On successful completion of Immunobiology course, students will be able to:

1. Obtain knowledge on the basic concepts of immune system, mechanisms of immunity and the development and maturation process of immune competent cells
2. Recognize the structures and functions of immunoglobulin molecules
3. Understand the mechanism of immunodeficiency diseases and autoimmunity against infection.
4. Realize the methods for the treatment of immune related diseases
5. Know the interaction between antigen- antibody molecules

Course outline

1. Immune system – structure and function of the cells and types of immunity
2. Cytokines- Properties and functions
3. Immunoglobulins- Structure, function and its types
4. Organization and expression of Immunoglobulin Light and Heavy chain genes
5. Interactions of antigen-antibody reaction - affinity, avidity, valency
6. Immunogenicity- Immunogens, adjuvants, epitopes, haptens and carriers
7. The complement systems- classical and alternate pathway
8. Mechanisms of antigen processing and presentation of cells-cytosolic and endocytic pathways
9. Major histocompatibility complex (MHC)- structure and its interaction with peptide
10. Immune response to infectious diseases - bacterial, viral, protozoan and helminthes
11. Transplantation immunity - organ transplantation and HLA tissue typing
12. Hypersensitivity reactions- Type I, II, III and IV
13. Vaccine – Introduction and types of edible vaccines

Course Schedule: Core: VII IMMUNOBIOLOGY (Core – 4 credits)

Syllabus	Schedule
UNIT-1 Elements of immune system: Components of innate and acquired immunity. Organs (primary and secondary) and cells of the immune system. Lymphatic system. Mucosal, Cutaneous and Gut associated Lymphoid tissue (MALT, CALT, GALT). Antigens - immunogens, haptens, adjuvants and epitope.	**9 Days (1h/day)**
UNIT-2 Immunoglobulins-basic structure, classes & subclasses. Antibody genes and generation of diversity. Activation and Differentiation of B and T cells. B and T cell receptors. Humoral and cell-mediated immune responses. Mechanisms of antigen processing and presentation-cytosolic and endocytic pathways.	**8 Days (1h/day)**
UNIT-3 Major histocompatibility complex- structure and its interaction with peptide. Cytokines- properties, receptors and therapeutic uses. The complement systems: mode of activation, classical, alternate and lectin pathway. Immunization- active and passive. Immune response to infectious diseases – bacterial (tuberculosis), viral (HIV), protozoan and helminths. Antibody engineering.	**8 Days (1h/day)**
UNIT-4 Transplantation immunity - Organ transplantation and HLA tissue typing. Hypersensitivity-Type I-IV. Autoimmunity- organ specific (Type 1 Diabetes Mellitus, Myasthenia Gravis) and systemic (Multiple sclerosis, Rheumatoid Arthritis). Oncogenes and anti-oncogenes.	**7 Days (1h/day)**
UNIT- 5 Vaccinology: Active and passive immunization. Vaccines- live, killed, attenuated, subunit, recombinant DNA, protein based, peptide, plant-based and conjugate. Immunotherapy; Humanized antibody, Monoclonal antibodies- production and uses for cancer treatment. Applications of catalytic antibodies for treatment of diseases.	**8 Days (1h/day)**
Days assigned for CIA Tests, Quizzes, Seminars, etc.	**8 Days (1h/day)**

Text Book

1. Cellular and Molecular Immunology (2017) by A.K. Abbas, A.H. Lichtman and S. Pillai, Elsevier Health Sciences.
2. Essential of Clinical Immunology 5th edition (2006), Chapel, Helen, Haeney, Mansel, Misbah, Siraj, Snowden, Neil, Blackwell Publication.
3. Immunology of Infectious Diseases (2002) Edited by Stefan H. E. Kaufmann, Rafi Ahmedand Alan Sher. American Society for Microbiology Press.
4. Janeways Immunobiology, 9th edition (2016) by Kenneth Murphy, Casey Weaver, Garland Science, Taylor & Francis Group, LLC.
5. Kuby Immunology,8th edition (2018) Owen, Judith A; Punt, Jenni; Stranford, Sharon A; Jones, Patricia P. New York: W.H. Freeman, Macmillan Learning.
6. Roitt's Essential Immunology, 13th edition (2017) by Ivan M. Roitt and Pete J. Delves. Wiley-Blackwell

Reference Books

1. Antibodies: A laboratory Manual, 2nd Edition (2014) Edited by Edward A. Greenfield, *Dana-Farber*. Cold Spring Harbour Laboratory Press.
2. Immunology of Infectious Diseases (2002), by Stefan H. E. Kaufmann, Rafi Ahmed and Alan Sher. American Society for Microbiology Press.
3. Principles of Mucosal Immunology (2012) by Philip D. Smith, Thomas T MaDonald, Richard S. Blumberg, Garland Science, Taylor & Francis Group, LLC.

More books to Read and Refer

Author (s)	Title
Stanley Plotkin, Walter Orenstein, Paul Offit, Kathryn M. Edwards	Plotkin's Vaccines
Vaman Rao	Immunology
A.K. Abbas, A.H. Lichtman and S. Pillai	Cellular and Molecular Immunology
Charles A. Janeway, Paul Travers, Mark Walport and Mark Sholmchik	Immunobiology (The immune system in health and disease)
Peter Wood	Understanding Immunology
Ed Harlow and David Lane	Antibody Engineering
Noel R.Rose, Herman Friedman and John L. Fahey	Manual of Clinical Laboratory Immunology
R. Lanza, J. Gearhart, B. Hogan, D. Melton, R. Pedersen, E.D. Thomas, J.A. Thomson and M. West	Essentials of Stem Cell Biology

Assignment I- 501201- Immunobiology (Core – 4 credits)

1. Antigenic specificity and its function in developing immunity.
2. Participation of spleen and thymus in developing immunity.
3. Cells surface receptors in immune cells.
4. Complementation system in developing immunity against Epstein Barr virus
5. X-Linked agammaglobulinemic and the clinical symptoms associated to the disease
6. B cells activation by different viral factors and bacterial lipopolysaccharide
7. Lymphocyte level balance in human body.
8. Stain and FACS analysis of CD8 and CD4 cells.
9. Consequences of mutation in genes encoding NFkB, BCL-2 and caspases on regular cell death.
10. Mechanisms of processing and presentation of exogenous antigen.

Assignment II- 501201- Immunobiology (Core – 4 credits)

1. Role of complement system in immune system and the severity of complement disorders.
2. Conditions that can lead to lysis of own RBCs in complement system.
3. Antibody mediated hypersensitivity reaction.
4. Redundancies of expression of cell surface receptors in interleukins.
5. Effect of immunodeficiency in B and T cells.
6. Role of immune cells in organ transplantation.
7. Progress and problems encountered in the development of vaccines against malaria and cancers.
8. Immune cells found in Cerebrospinal Fluid and their place of origin.
9. Complicated health issues in HIV-AIDS patient.
10. Regulatory mechanisms involved in autoimmunity.

501202–RECOMBINANT DNA TECHNOLOGY (Core – 4 credits)

COURSE DEPICTION

Program: M.Sc. Biotechnology	**Semester: II**
Course Title/code	**Recombinant DNA Technology/ 501202**
Name of Course Teacher	**Prof. S. Karutha Pandian** **Prof. K. Balamurugan** **Dr. S. Gowrishankar**
Mobile: +91 9442318144 **+91 9486426931** **+ 91 9994933559**	**Email: sk_pandian@rediffmail.com** **bsuryar@yahoo.com** **gowrishankar.alu@gmail.com**

Course Brief

Recombinant DNA technology, also called "genetic engineering" is one of the main branches of biotechnology that deals with the manipulation of genetic material of any organism. This important course will enlighten the students to understand the mechanism of genetic modification, techniques used for genetic modifications. The course also highlights basic and advanced molecular techniques such as polymerase chain reaction (PCR), DNA sequencing-which covers conventional first-generation sequencing technology (Sanger Sequencing) to high throughput second (Pyrosequencing & Illumina) and third sequencing technologies (Nanopore, SMRT sequencing), blotting, chromosome walking, chromosome jumping, DNA profiling. The proposed course will cover topics starting from manipulation of organisms at genome level to use of that organism at various fields including agriculture, medical and pharmaceutical industries. The course also provides profound ideas on gene silencing, genome editing techniques and the concepts of synthetic biology.

Course Objectives

To make the students:

1. Understand the concepts, introduction of genetic engineering, introduction about restriction enzymes, ligases, polymerases, vectors, their types, sources and their roles in genetic engineering.
2. Knowledgeable in basic techniques of molecular biology and their applications in various aspects.
3. Versed in all application aspects of recombinant DNA technology like production of protein and enzyme from cloned genes, production of therapeutic products as well as

use of this subject in the diagnosis and treatment of inherited disorder and infectious disease.

4. Perceive the profound information on genome editing techniques, concepts and their applications and the concept of synthetic life.

Course Outcomes

After successful completion of the above discussed syllabus of Recombinant DNA technology course, students will be able to:

1. Understand and think about the basics of recombinant DNA technology
2. To understand the role, use and types of different DNA modifying enzymes viz. Polymerases, Nucleases, restriction endonuclease, ligases etc.
3. Acquire basic knowledge of DNA sequencing methods from conventional (Sanger sequencing) to High throughput Next generation sequencing technology, their principle, chemistry, theory and types.
4. Students will able to understand the strategies and steps involved in the construction of genomic and CDNA library, essential tools and the role of each and every constituent, DNA footprinting as well as description of industrial application of rDNA Technology, therapeutic and enzymatic products and deployment of rDNA Technology in diagnosis and disease.
5. The syllabus will also provide a plethora of information to students related to basic molecular biology techniques like blotting and its different types, genome editing techniques and synthetic biology.

Course Outline

1. Introduction and basics of genetic engineering, essential tools like DNA modifying enzymes-restriction endonuclease, ligases, Polymerases and thermostable enzymes like Taq polymerase.
2. Introduction of vector and host cells, uses and sources of vectors (including both prokaryotic and eukaryotic), bacteriophage vectors, artificial chromosome (YACs, BACs, PACs and MACs), specialized purpose vectors-expression vector and gene fusion vectors.
3. Introduction of cloning, cloning strategies, sticky and blunt ends, linker and adapters and their use in genetic engineering, steps involved in construction of genomic and cDNA libraries.
4. Screening strategies used for screening of recombinants-antibiotic resistance, blue-white selection, use of fluorescent markers.
5. Labeling of nucleic acid (DNA&RNA) using radiolabel and non radiolabel probes.
6. Theory and principles of different blotting techniques used to transfer biomolecules from gel to solid matrix for further analysis like Western blotting, Southern blotting, Northern blotting, Zoo blot and Dot blot.
7. Without cell cloning (polymerase chain reaction), basic theory, principle, terminology

and types of PCR-Hot start PCR, Touch-down PCR, Touch-up PCR, Nested PCR, Multiplex PCR, Reverse PCR, Asymmetric PCR and quantitative PCR.

8. Introduction and basics of DNA sequencing, different generations of sequencing methods starting from first generation (Sanger sequencing) to High throughput Next (Second) generation sequencing-Roche/454,Illumina (Solexa), SOLiD sequencing, Ion semiconductor sequencing method and different types of platform for Next-Next (third) generation sequencing- Single Molecule Real-Time (SMRT) sequencing.
9. Theory and principle of techniques: chromosome walking, chromosome jumping and DNA footprinting.
10. Application of rDNA technology at industrial level: Enzyme engineering, Synthesis and purification of native and fusion proteins from cloned genes, therapeutic products of rDNA technology for use in human health care- insulin, growth hormones, alpha interferon, Hepatitis B vaccine and Factor VIII.
11. Applications of rDNA technology in Medical and forensic science- DNA Profiling, Multiplex PCR, Diagnosis of inherited disorders and infectious diseases.
12. rDNA technology in treatment - introduction to gene therapy, gene therapy for ADA and cystic fibrosis.
13. Synthesis of nucleic acids and peptides, Gene silencing techniques, Recent trends in Genetic Engineering and concepts of synthetic biology.

Course Schedule: Core: VIII; Recombinant DNA technology (4 Credits)

Syllabus	Schedule
Unit 1: Tools of Recombinant DNA technology: DNA modifying enzymes and their uses in Molecular Biology a) Restriction enzymes b) DNA Polymerase i) Klenow ii) DNA polymerase I iii) T4/T7 DNA Polymerase c) Reverse Transcriptase d) Terminal Transferases e) T4 Polynucleotide kinases & Alkaline phosphatase f) DNA dependent RNA polymerases. g) DNA ligases h) Nucleases: - Bal 31, S1 nucleases, DNase I, Mungbean nucleases, Ribonucleases, EXO III. Thermostable DNA polymerases used in PCR.	**8 Days (1h/day)**
Unit 2: Introduction of vectors and types: Host cells and Vectors- Host Cell Types (Prokaryotic and eukaryotic). Plasmid vectors- pBR322, pUC18/19, pBluescript Phagevectors - Lambda and M13 vectors c) Cosmids d) Phagemidse) fosmid. Artificial chromosomes (YACs, PACs, BACs, MACs and HACs), Shuttle vectors. Specialized vectors & their uses a) Expression vectors for Prokaryotes & Eukaryotes - Inducible vectors; vectors with tags (Histidine tags, signalling peptides for exportation), b) Gene fusion vectors.	**8 Days (1h/day)**
Unit 3: Cloning strategies and recombinant screening: Cloning strategies: DNA cloning a) Sticky ends b) Blunt ends c) Homopolymeric tailing d) Use of adapters & linkers. Construction of genomic DNA libraries (shotgun cloning) and cDNA libraries. Screening of recombinants - Antibiotic resistance, lacZ complementation (Blue-white selection), fluorescent markers (e.g. GFP). Labelling of DNA- Preparation of radiolabelled/non-radiolabelled DNA & RNA probes, nick Translation, random priming. Southern/Northern/Western/southwestern/northwestern blot, dot blot Zoo blot, Fluorescence in situ hybridization (FISH). Screening of genomic	**9 Days (1h/day)**

libraries with oligo-probe. Immunological screening for expressed genes. *In-silico* analysis, manipulation and annotation of DNA sequences for experimental design and efficient management of cloning experiments.	
Unit 4: Without cell cloning and DNA sequencing: PCR – basic process and applications, Types- Nested PCR, Hot-start PCR, Touch-down PCR, Touch-up PCR, Colony PCR, Multiplex PCR, Asymmetric PCR, RACE-PCR, Inverse PCR, Reverse Transcriptase PCR, Quantitative PCR. First-Generation DNA Sequencing- Principle of chemical and enzymatic methods, Automated DNA sequencing. Second-Generation Sequencing – 454 Roche Pyrosequencing, Illumina sequencing, SOLiD sequencing, Ion semiconductor sequencing.Third-Generation Sequencing-Single Molecule Real-Time (SMRT) sequencing, Nanopore sequencing, RNA Sequencing. Site-directed mutagenesis (Single primer methods: Mis-incorporation of mismatched oligos, Over-lap extension, Whole plasmid single round PCR), mis-repair of mutant oligonucleotides, selection of mutant (dut/ung *E. coli* strains for SDM through uracil replacement), Ligase chain reaction. Detection of DNA polymorphisms and protein-DNA interactions -DNA footprinting, chromosome jumping, chromosome walking, electrophoretic mobility shift assay; methyl interference assay, chromatin immunoprecipitation (ChIP); protein-protein interactions using yeast two-hybrid system; phage display.Synthesis and purification of proteins from cloned genes- Native and fusion proteins. Yeast expression system.	**9 Days (1h/day)**
Unit 5: **Biotechnological applications of rDNA technology**: Enzyme Engineering: Production and purification of cloned enzymes, recombinant enzymes and engineered enymes and their applications. Therapeutic products for use in human health care- insulin, growth hormones, TPA, alpha interferon, recombinant vaccine and Factor VIII. Medical and forensic applications of rDNA technology-DNA Profiling, Diagnosis of inherited disorders and infectious diseases, Gene therapy. Synthesis of nucleic acids and peptides.Gene silencing techniques- introduction to RNAi; siRNA technology; Micro RNA; construction of siRNA vectors; principle and application of gene silencing; Recent trends in genetic engineering: CRISPRs - Golden Gate assembly, Overlapping PCR, Gibson assembly, ZFNs, TALENs. Gene Targeting: Knock - ins & Knock - outs. Synthetic biology: Basic concepts of synthetic biology and concepts of synthetic genome.	**7 Days (1h/day)**
Days assigned for CIA Tests, Quizzes, Seminars, etc.	**8 Days (1h/day)**

Text Book

1. Molecular cloning: A Laboratory Manual 4th Edition (2012) by Sambrook, j., Russel, D.W., Cold Spring Laboratory Press, Cold Spring, New York.

Reference Books

1. Gene Cloning and DNA Analysis. An introduction (2006) by T.A Brown, Blackwell Scientific Publications.
2. Principle of Gene Manipulation and Genomics, 8th edition (2006) by S.B. Primrose and R.M Twyman, Blackwell Scientific Publications.
3. Molecular Biology of the Gene, 6th edition (2008) by James D Watson, Tania A Baker, Stephen P Bell, Alexander Gann, Michael Levine and Richard Losick, Benjamin Cummings.
4. From Genes to Clones: Introduction to gene technology (1987) by Winnacker, E.L.
5. Next generation sequencing (2008) by Michael Janitz, Wiley-Blackwell Publications.
6. Selected papers from scientific journals, particularly Nature & Science.
7. Technical Literature from Stratagene, Promega, Novagen, New England Biolab etc.

More books to Read and Refer

Author (s)	Title
David P Clark and Nanette J Pazdernik	Academic Cell - Molecular Biology (2013)
Daniel L Hartl	Essential Genetics (2014)
Williams S Klug, Michael R Cummings, Charolette A Spencer and Michael A Palladino	Concepts of Genetics(2012)
Larry Snyder, Joseph E Peters, Tina M Henkin and Wendy Champness	Molecular Genetics of Bacteria(2013)
Jeremy W Dale, Malcolm Von Schantz and Nick Plant	From Genes to Genomes – Concepts and Applications of DNA technology (2012)

Assignment I- 501202- Recombinant DNA technology (Core-4 credits)

1. Milestones in history of molecular biology.
2. Basic theory and principle of DNA sequencing.
3. Generations of DNA sequencing
4. Sanger sequencing method for DNA.
5. Different approaches used in Next generation sequencing technologies.
6. Work flow used during normal next generation sequencing technologies.
7. Third generation sequencing (Next-Next generation sequencing) methods of DNA sequencing.
8. Types of blotting techniques.
9. Role of rDNA technology in following fields-
    a. Synthesis of commercially important enzymes and proteins
    b. Therapeutic product in Human health care
    c. Treatment of diseases
    d. Medical and forensic
10. Techniques involved to study the interaction of DNA-Proteins, RNA-protein and Protein-Protein.

Assignment II- 501202- Recombinant DNA technology (Core-4 credits)

1. Routinely used tools in genetic engineering.
2. Polymerase chain reaction (PCR), principle and application in various fields.
3. Types of PCR
    a. Nested PCR
    b. Hot start PCR
    c. Multiplex PCR
    d. Touch-down PCR
    e. Touch-up PCR and
    f. Reverse transcriptase PCR
4. Methods used to screen recombinant during cloning.
5. Strategies and steps involved in construction of cDNA and genomic DNA library.
6. Vectors and their types.
7. Different types, source and use of DNA modifying enzymes
8. Immunological screening of expressed genes.
9. Gene silencing techniques and genetic engineering tools, a. CRISPRs, b. ZFNs c. TALENs
10. Concepts of synthetic biology and synthetic genome.

501203–PLANT MOLECULAR BIOLOGY (Core – 4 credits)

COURSE DEPICTION

Program: M.Sc. Biotechnology	**Semester: II**
Course Title/Code	**Plant Molecular Biology/ 501203**
Name of Course Teacher	**Dr. M. Ramesh**
Mobile: +91 7904270252	**Email: mrbiotech.alu@gmail.com**

Course Brief

Molecular Biology is the branch of biology that studies the structure and function of macromolecules (DNA, RNA & Protein) that encode and regulate the flow of genetic information used by living organisms. Plant molecular biology is a highly specialized multidisciplinary science encompasses plant physiology, plant biochemistry and plant molecular biology and the aim of the course is to produce post graduates with knowledge of the structure and function of the whole plant at molecular level and the ability to apply both molecular and biochemical techniques to the manipulation of plants of agronomic importance. This highly specialized science course focuses on the scientific study of the structure and function of higher plant genes, cloning strategies, types of plant expression vectors, molecular markers, basis and principle of transformation through direct and indirect methods, generation of various types of genetically modified plants and their application to plants improvement. At the end of the course students will be able to differentiate between various transformations methods used for production of transgenic plants with their potential applications. Students undergoing this core course will equip themselves with an advanced knowledge of various types of transformation events and gain theoretical and technical skills that would empower them to assess and mitigate risks associated with transgenic plants. This course also gives students an exposure to the fundamentals of totipotency, tissue culture techniques for *in vitro* manipulations.

Course Objectives

The objectives of the course is to make the students

1. Understand the role of nuclear, chloroplast and mitochondrial genomes of higher plants
2. Familiarize with theoretical knowledge and also practical insights to understand the basic principles and application of plant tissue culture and recombinant DNA technology
3. Understand the use of molecular markers in assessing the genetic similarity and diversity of higher plants
4. Gain a deeper understanding of the specialized topics such as transplastomic plants, cryopreservation, phytoremediation, terminator seeds, and various recent advances in the field of plant molecular biology.
5. Understand the complexity of genome of higher plants and targeting of newly made proteins to different compartment of cell
6. Gain theoretical knowledge about cloning of genes in to binary vectors

Course Outcomes

The students undergoing this important core course shall be able to:

1. Narrate the architecture of nuclear, chloroplast and mitochondrial genomes of higher plants
2. Differentiate protein coding and RNA coding genes, its structure, expression, and regulation under particular development condition
3. Explain how gene function and regulation is used in modern plant biotechnology for plant improvement.
4. Gain knowledge Identify the basic methods and approaches used in molecular biology to utilize molecular markers.
5. Discuss the pros and cons of transgenic plants and to understand emerging technologies such as phytoremediation

Course outline

1. General organization of plant genome
2. Structure of protein coding and RNA coding genes & Organization of chloroplast genome in model crops
3. Import of nuclear encoded chloroplast proteins to stroma and thylakoids of chloroplast
4. Import of nuclear encoded mitochondrial proteins to matrix and inner membrane of mitochondria and Transplastomic plants and promiscuous DNA

5. Molecular markers for analyzing genetic diversity and crop improvement
6. Principle and methods involve in artificial seed preparation, Encapsulation and Low temperature storage
7. Cryopreservation of plant bioresources germplasm
8. *Agrobacterium tumefactions* and crown gall tumours and Mechanism of TDNA transfer and binary vectors. *Agrobacterium* - mediated transformation of food crops. Hairy root cultures
9. Molecular biology of plant stress response
10. Direct transformation of plants by physical methods, Transposon Tagging
11. Transgenic crops – Flavr Savr™, Bt Cotton, and Golden rice.
12. Functional Proteomic approaches in Grass species

Course Schedule: Core: IX– Plant Molecular Biology (Core – 4 credits)

Syllabus	Schedule
Unit – 1: Architecture of genome in higher plants. Plant gene structure (Protein coding and RNA coding). Arabidopsis Genome Initiative (AGI).Organization of chloroplast genome in tobacco and rice and coordinated expression. Targeting of nuclear encoded chloroplast proteins to different compartments of chloroplast. Organization of mitochondrial genome. Targeting of proteins to mitochondria. Genetic Engineering of Chloroplast genome and development of Transplastomic plants. Promiscuous DNA. Callus and suspension cultures. Protoplast isolation, culture and somatic hybridization. Plant cell cultures for secondary metabolite production.	**9 Days (1h/day)**
Unit – 2: Molecular markers - RAPD, ISSR, SCAR, STS, Microsatellites, AFLP and DNA Bar coding for analyzing genetic diversity and improvement. Artificial seeds – Introduction, Principle and Methods, applications of synseeds in commercial seed industry. Endangered germplasms, Encapsulation, Low temperature storage and Plant Conversion. Cryopreservation of plant bioresources through Encapsulation- Dehydration, Vitrification and Droplet vitrification methods, Plant regrowth and genetic fidelity analysis.	**9 Days (1h/day)**
Unit – 3: *Agrobacterium tumefaciens* and crown gall tumours. Basis of tumour formation, Mechanism of T- DNA transfer to plants, Co -integrate, binary and super binary Ti-plasmid based vectors for plant transformation. Agroinfection. *Agrobacterium* - mediated transformation of food crops. Hairy root cultures and elicitation for *in vitro* production of commercially important secondary metabolites. Marker Assisted Selection (MAS).	**8 Days (1h/day)**
Unit-4: Molecular biology of plant stress response - drought, salinity, dehydration, UV, and osmotic stress. Direct and Indirect methods of gene transfer into plant cells and development of transgenic plants. Direct transformation of plants by physical methods (Biolistic, Microlaser, Ultrasonication and Silicon carbide WHISKERTM method). Transposon	**9 Days**

Tagging. Molecular Farming – Concepts, Production of industrial enzymes and pharmaceutically important compounds (PHB, Polyfructons and Cyclodextrans). Transgenic crops – Flavr Savr, Bt Cotton, and Golden rice.	**(1h/day)**
Unit-5: Genetic engineering in plants - selectable and screenable markers in plant gene expression vectors. Genetic engineering of plants for virus resistance, pest resistance, herbicide tolerance, abiotic stress tolerance, and delays of fruit ripening. Production of antibodies, viral antigens and peptide hormones in plants. Terminator seed technology. Phytoremediation – types and methods. Multiple omics approaches - Gene mining, expression profiling and functional validation.	**8 Days (1h/day)**
Days assigned for CIA Tests, Quizzes, Seminars, etc.	**8 Days (1h/day)**

Text Books

1. Plant Genetic Engineering (2012), John H. Dodds, Cambridge University Press, Cambridge, London, ISBN:9781107404571.
2. Plant Biotechnology: The Genetic Manipulation of Plants (2008), 2nd Edition, Adrian Slater, Nigel W. Scott and Mark R. Fowler, Oxford University Press.
3. Recent advances in Plant Biotechnology (2009), 1st Edition, Ara. Kirakosyan and Peter B Kaufman, Springer Dordrecht Heidelberg, London.
4. Genetic modification of plants: Methods and Applications (2009) Edwin B. Herman, (Ed.), USA: Agritech Consultants,Inc.
5. Phytoremediation: Methods and Reviews (2007), 1st Edition, Neil Wille, Humana Press, New York.
6. Plant Molecular Genetics (1996) Monica A. Hughes. Harlow, England: Addison Wesley Longman.

Reference Books

1. Biochemistry and Molecular Biology of Plants (2015) 2nd Edition, Edited by Bob B. Buchanan, Wilhelm Gruissem, Russell L. Jones, American Society of Plant Biologists. Berkeley, USA.
2. Introduction to Plant Biotechnology (2017), 3rd Edition, H.S. Chawla, Enfield, N.H. : Science Publishers

More books to Read and Refer

Author (s)	Title
C. Neal Stewart, 2nd edition, 2016	Plant Biotechnology and Genetics: Principles Techniques and Applications
J. Hammond, P. McGarvey & V. Yusibov, 2nd edition, 2004	Plant Biotechnology-New Products & Applications
Peter J.Lea, Richard C.Leegood, John Wiley & Sons (2nd Edition)	Plant Biochemistry & Molecular Biology
Maarten J. Chrispeels and David E.Sadava, Sudbury, MA (2nd Edition)	Plants, Genes and Crop Biotechnology
Stanton B Gelvin; Robbert A Schilperoort; Desh Pal S Verma, 1993	Plant Molecular biology
Bishun Deo Prasad, 2nd edition, 2018	Plant Biotechnology-Vol.1, principles, techniques and applications

Assignment I- 501203– Plant Molecular Biology (Core – 4 credits)

1. Importance of Arabidopsis Genome project
2. Phenolics in plant cell cultures for secondary metabolite production.
3. Role of various membrane receptors in mitochondrial protein import.
4. Merit and demerits of RAPD and ISSR.
5. Principle of Encapsulation- Dehydration and Vitrification.
6. Importance of hairy root culture in phytoremediation.

Assignment II - 501203– Plant Molecular Biology (Core – 4 credits)

1. Physiological and molecular changes exhibited by plants under drought stress.
2. Principle of Ultra sonication and Silicon carbide WHISKER™ methods.
3. Golden rice is safe for human consumption – Discuss.
4. Differentiate selection and screening markers.
5. Terminator seeds are not safe- Discuss.
6. Good and bad herbicides.

501204–LAB III: MOLECULAR BIOLOGY AND GENETIC ENGINEERING
(Core – 3 credits)

COURSE DEPICTION

Program: M. Sc. Biotechnology	**Semester: II**
Course Title/ Code	**Lab III: Molecular Biology and Genetic Engineering/ 501204**
Name of Course Teacher	**Prof. S. Karutha Pandian** **Prof. K. Balamurugan** **Dr. S. Gowrishankar**
Mobile: +91 9442318144 **+91 9486426931** **+ 91 9994933559**	**Email: sk_pandian@rediffmail.com** **bsuryar@yahoo.com** **gowrishankar.alu@gmail.com**

Course Brief

Molecular Biology and Genetic Engineering is a field of study that deals with structure and function of genes at molecular level. This course is very fundamental and form the basis for all the advancements happened in the biotechnology era. It will augment the existing knowledge about genetic material isolation from various biological sources, mutagenesis, target specific gene amplification, genetic mapping and molecular cloning. It will also extend the knowledge on application-oriented view of Genetic Engineering such as mutations and gene therapy, genetic models of disease and development, molecular medicine and human genetics, molecular microbiology and infectious diseases, functional genomics and proteomics. It clearly explains the importance of genome structure and integrity, gene expression and function, gene sequencing and mapping.

Course Objectives

To make the students:

1. Understand the basic techniques involved in the maintenance of microbial cultures.
2. Knowledgeable in mutagenesis, mutagen and its impact on phenotypic traits of an organism and also in isolating antibiotic-resistant and auxotrophic mutants using various techniques.
3. Well-equipped in carrying out transformation such as Chemical mediated transformation, Competent cell preparation, Microinjection, Electroporation, Tri-parental mating and various ways to visualize the transformed colonies.
4. Understand and perform Generalized and Specialized Transduction, Genetic mapping by P1 transduction.
5. Perform the genomic DNA library construction.

Course Outcomes

The students shall be able to:

1. Isolate single colony of bacteria and to describe various stages of growth by measuring the rate of growth and plotting growth curve.
2. Describe wide applications of bacteriophages in molecular genetics.
3. Demonstrate mutagenesis, its types and techniques involved in isolation of mutants.
4. Acquire knowledge to implement transduction in laboratory level and use transduction as a mode to perform genetic mapping.
5. Illustrate transposons, transposon mediated mutagenesis and applications of transposons in molecular biology.
6. Perform PCR based amplification of molecular marker genes for identification and phylogenetic allocation of prokaryotes and eukaryotes.

Course Outline: Core: Lab III: Molecular Biology and Genetic Engineering (3 Credits)

1. Fundamental Concepts of structure and function of genes at molecular level.
2. Single colony isolation and checking for genetic markers.
3. Measurement of growth rate and one step growth curve using a T even phage.
4. Amplification and sequencing of 16S rRNA gene for molecular identification of bacteria.
5. Titration of phage to analyze the infective capacity of phage.
6. Mutagenesis, types of mutagenesis and mutagens.
7. Isolation of antibiotic-resistant and auxotrophic mutants, Enrichment methods for isolation of auxotrophic and antibiotic-resistant mutants and Ames test.
8. Isolation of plasmid DNA from bacteria.
9. Polymerase chain reaction-based amplification of target genes.
10. Transformation and various techniques of transformation like Chemical mediated transformation; competent cell preparation, Microinjection, Electroporation and Tri-parental mating.
11. Conjugation and Hfr Conjugation, Transduction-Generalized and Specialized Transduction
12. Isolation of specialized transducing phage.
13. Applications of bacteriophages.
14. Genetic mapping by conjugation and P1 transduction.
15. Transposons, Transposition and Types of transposons,
16. Transposon mutagenesis of chromosomal and plasmid DNA.
17. Insertional inactivation.
18. Applications of Transposons in molecular biology.
19. Growth and maintenance of *C. elegans.*
20. Expression of GFP-tagged proteins on live *C. elegans* model.

Course Schedule: Core: X - Lab III: Molecular Biology and Genetic Engineering (3 Credits)

Syllabus	Schedule
Unit-1: Revival of culture from glycerol stock and isolation of pure colonies. Screening of isolates for antibiotic-resistance/sensitivity. Isolation of auxotrophic mutants, Screening of carcinogen, Ames test. UV-induced mutagenesis and photo-reactivation.	**5 Days (3h/day)**
Unit-2: Isolation of nucleic acid- Genomic DNA isolation from bacteria, plant and animal sources. Plasmid DNA and RNA isolation from bacteria. Qualitative and quantitative analysis of DNA and RNA by UV Spectrophotometer, Nano Spectrophotometer and Agarose gel electrophoresis.	**5 Days (3h/day)**
Unit-3: Amplification of specific gene: Polymerase Chain Reaction, Types - Gradient PCR, Touchdown PCR, Nested PCR, Hotstart PCR and Colony PCR. PCR for Molecular identification of microbes - 16S rRNA gene amplification, ITS gene amplification. Microbial profiling techniques-RFLP, ARDRA and DGGE.	**5 Days (3h/day)**
Unit-4: Partial digestion of chromosomal DNA with restriction enzymes. Construction of genomic DNA Library - Ligation of DNA fragments to a plasmid vector, competent cell preparation, Transformation, Screening of Library, Blue White Selection. Restriction analysis of plasmid DNA. Conjugation- Hfr Conjugation, Genetic mapping by conjugation. Transduction – Infection of donor cells with bacteriophage, measure of Plaque-Forming Units (PFU), Phage retrieval and Phage lysate preparation, Infection of recipient cells.	**6 Days (3h/day)**
Unit-5: Growth and maintenance of *C. elegans*. Identification of wild-type and mutant *C. elegans*. Isolation of nucleic acids from *C. elegans*. Single worm PCR. Studies on expression of antimicrobial genes. Expression of GFP-tagged proteins on live *C. elegans* model. Reverse Transcriptase PCR and Real Time PCR. Expression of recombinant protein, concept of soluble proteins and inclusion body formation in *E.coli*, Purification of His-Tagged protein on Ni-NTA columns.	**5 Days (3h/day)**
Days assigned for CIA Tests, Quizzes, Seminars, etc.	**4 Days (3h/day)**

Text Book

1. Molecular Biology of the Gene 6th edition (2008). Watson, Baker, Bell, Gann, Levine and Losick.

Reference Books

1. Academic Cell - Molecular Biology, 4nd Edition (2014) by Clark, D.P. and Pazdernik, N.J.
2. Brown T.A. (2005). Genetics: A Molecular Approach. Bios Scientific Publishers Ltd.
3. Brown T.A. (2006). Gene Cloning and DNA Analysis (5th Edition).Blackwell Publishers.
4. Green, M. R., &Sambrook, J. (2012). Molecular Cloning: a Laboratory Manual (4th Edition). Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
5. Griffiths (2015). An Introduction to Genetic Analysis (11th Edition). Freeman Publishers.
6. McPherson. M. J. & Moller S. G. (2006). PCR - The Basics (Garland Science, 2nd Edition). Taylor & Francis.
7. Michell Y. Walkar (2005). Advanced Genetic Analysis. Blackwell Publishers.
8. Molecular Genetics of Bacteria 4th edition (2013). Snyder, L., Peters, J.E., Henkin, T.M. and Champness,W.
9. Smita Rastogi (2009). Genetic Engineering. Oxford University Press.
10. Stanly R. Maby (2006). Microbial Genetics (2nd Edition). Narosa Publishing House.

More books to Read and Refer

Author (s)	Title
Daniel L Hartl.	Essential Genetics, 6th Edition (2014)
Williams S Klug, Michael R Cummings, Charolette A Spencer and Michael A [illegible]	Concepts of Genetics, 10th Edition (2012)
S. B. Primrose and R. M. Twyman	Principles of Gene Manipulation and Genomics, 8th Edition (2016)
Burton E Tropp	Molecular Biology – Genes to Proteins, 4th Edition (2012)
S.R. Maloy, J. E. Cronan Jr., and D. Freifelder, Jones and Bartlett Publishers, Sudbury, Massachusetts.	Microbial Genetics (2006)

Assignment I – 501204- Lab III: Molecular Biology and Genetic Engineering

(Core – 3 credits)

1. Genetic markers.
2. Different stages of growth and the growth rate
3. One step growth curve using a T even phage and phage titration.
4. Mutagenesis and its types.
5. Mutagens and its types.

6. Ames test- its significance and applications.
7. Enrichment methods available for antibiotic resistant and auxotrophic mutants.
8. Different conformations of plasmid DNA and different techniques available to isolate plasmid DNA from bacteria.
9. Transformation and methods of transformation.
10. Hfr conjugation.
11. Genetic mapping - its applications and significance.
12. Genetic mapping by conjugation.
13. Transduction and stages of transduction.
14. Generalized and Specialized transduction.
15. Steps involved in performing Genetic mapping using transduction.

Assignment II – 501204- Lab III: Molecular Biology and Genetic Engineering

(Core – 3 credits)

1. Applications of bacteriophages.
2. Specialized transducing phage
3. Transposons and its types.
4. Transposon mutagenesis of chromosomal and plasmid DNA and insertional inactivation.
5. Applications of Transposons in molecular biology
6. Various blotting techniques
7. Phylogenetic analysis of bacteria and fungi.
8. DNA fingerprinting techniques.
9. Labelling and detection of nucleic acid sequences.
10. Different stages in the life cycle of *C. elegans.*
11. Growth, maintenance and identification of wild-type and mutant *C. elegans.*
12. PCR from single worm.
13. Expression of GFP-tagged proteins on live *C. elegans* model.
14. Expression of recombinant protein, concept of soluble proteins and inclusion body formation in *E. coli*.
15. Purification of His-Tagged protein on Ni-NTA columns.

501205–LAB IV: IMMUNOTECHNOLOGY (Core – 3 credits)

COURSE DEPICTION

Program: M.Sc. Biotechnology	**Semester: II**
Course Title/Code:	**Lab IV- Immunotechnology/ 501205**
Name of Course Teacher	**Dr. K. Pandima Devi**
Mobile: +91 9790358700	**Email: devikasi@yahoo.com**

Course Brief

Immunotechnology is a branch of biomedicine which comprise of various techniques and experiments that range from basic to recent advancement in Immunology. The main focus of this course is to provide the opportunity to the students to learn the basic and advanced techniques which are currently utilized in immunological research. This course also encourages the students to learn about the research areas like oncology and infectious diseases. This laboratory course explains about a wide range of basic immunology concepts in a practical manner including immunity, immunization, antigen-antibody interaction, infection, antibody production, blood cell counting, cell culture and diagnostic techniques for infectious diseases. In addition, this course provides exposure to students of the recent advanced techniques applied in immunology research like fluorescent microscopy, B and T lymphocytes identification and enumeration, FACS, cell culture, RT-PCR, RIA, ELISA, ELISPOT, Western and Eastern blotting, indirect fluorescent antibody test, pregnancy test, FISH and GISH. Many of the human incurable diseases like cancer, autoimmune diseases, and neurodegenerative diseases have been strongly linked with the imbalance in the human immune system. Hence, learning about these techniques will encourage the students to do research in the field of human immunology involved in the incurable diseases.

Course Objectives

The objectives of the course is to make the students

1. Understand the basic concepts in immunology by practical approach
2. Learn the various human hematological techniques
3. Understand human and animal cell culture methods
4. Study about the recent advancement in immunology and know about the diagnostic methods for human infectious diseases

Course Outcomes

On successful completion of Immunotechnology course, students will be able to:

1. Independently perform the experiments involved in human immunology research
2. Understand about the human immune system and infectious diseases
3. Acquire knowledge in recent advancement in human immunology.

Course outline

1. Antibody generating methods
2. Monoclonal antibody production and hybridoma technology
3. Agglutination and precipitation test
4. Immunodiffusion and immunoelectrophoresis
5. Blood cell counts and PBMC isolation
6. B and T lymphocytes identification and enumeration
7. Cell culture media-preparation, cell lines-subculturing and disaggregation methods
8. Transient and stable transfection using epithelial cell lines
9. Immunodiagnostic methods
10. Diagnostic protocol for identification of infectious diseases

Course Schedule: Core: XI- LAB IV- Immunotechnology (3 credits)

Syllabus	Schedule
Unit 1: Techniques to raise antibodies in animal models: selection of animals (rats, rabbits, mice), preparation and purification of antigens, route of injection and dosage, protocol of immunization, methods of bleeding and serum collection, conventional antibody preparation.	**4 Days (3h/day)**
Unit 2: Immunological assays - Detection of antigen-antibody reactions- Agglutination reactions- Haemagglutination, passive HA. Precipitation reactions- precipitin ring test, immunodiffusion immunoelectrophoresis. Immunohistochemical staining. Separation of serum proteins by electrophoresis. Immuno fluorescence microscopy.	**5 Days (3h/day)**
Unit 3: Immunohematology: Blood cell counts (Total RBC, WBC and differential count of WBC), blood grouping (ABO system and Rh grouping). Peripheral blood mononuclear cell separation and enumeration of live, dead cells by MTT and Trypan blue methods. Apoptosis detection – DAPI,	**6 Days (3h/day)**

Annexin V staining in a fluorescent microscope. Lymphocyte subset (B and T lymphocytes) identification and enumeration by FACS (Demonstration).	
Unit 4: Cell culture media-Types and preparation. Primary cultures (different sources, mechanical and enzymatic disaggregation) and established cell lines (sub-culturing, maintenance, large-scale cultures using bioreactors, microcarriers). Common cell lines and its applications. Detection and prevention of contamination of cell culture. Cell synchronization - preservation and revival of cells. Transient and stable transfection methods. Evaluation of host-pathogen interaction using C. elegans as model organism and monitoring the expression of Immunoglobulin genes by RT-PCR.	**6 Days (3h/day)**
Unit 5: Immunodiagnostic techniques: RIA, ELISA, ELISPOT assay, Western blotting, Eastern blotting, IFAT (indirect fluorescent antibody test). Diagnostic kits for identifying infectious agents: HIV, malaria, tuberculosis, hepatitis B surface antigen and detection of VDRL and pregnancy test.	**6 Days (3h/day)**
Days assigned for CIA Tests, Quizzes, Seminars, etc.	**3 Days (3h/day)**

Text Books

1. Textbook of Immunology, (2015) Including immunotechnology and immunotherapy,by Books & Allied.
2. Immunology, 5th edition, (2001).by Charles, A. Janeway, Jr. et al Garland Publishing,
3. Kuby immunology, 8th edition (2018) by Owen, Judith A; Punt, Jenni; Stranford, Sharon A; Jones, Patricia P. New York: W.H. Freeman, Macmillan Learning.
4. Immunology 5th edition (2012), by Joshi, K.R. Osama, N.O. Agrobios.

Reference Books

1. Cellular and Molecular Immunology (2017) by Abul K. Abbas, Andrew H Lichtman, Shiv Pillai, Elsevier Health Sciences.
2. Diagnostic Immunohistochemistry 2nd Edition (2006), by David J. Dabbs MD Churchill Living stone, Elsevier.
3. Essentials of Stem Cell Biology (2005) by R. Lanza, J. Gearhart, B. Hogan, D. Melton, R. Pedersen, E.D. Thomas, J.A. Thomson and M. West, Academic Press.
4. Fundamental Immunology, (2012) by Paul, W. E. New York, Raven Press.
5. Plotkin's Vaccines, 7th edition (2017), by Stanley Plotkin Walter Orenstein Paul Offit Kathryn M. Edwards, Elsevier Publication.
6. Manual of Clinical laboratory Immunology, 6th edition (2002) Rose et al., ASM Publications.

More books to Read and Refer

Author (s)	Title
John. R. W. Masters	Animal cell culture
Mor Gil, Alvero, Ayesha	Apoptosis and Cancer. Methods and Protocols
J.M.Davis	Basic Cell Culture
Brostoff, J. Seaddin, J. K. Male, D. & Roitt, I. M.	Clinical Immunology
Annadurai,B. Chand,S Publishing	A Textbook of Immunology & Immuno Technology
Noel R.Rose, Herman Friedman and John L. Fahey	Manual of Clinical Laboratory Immunology

Assignment I -501205–LAB IV- IMMUNOTECHNOLOGY (Core – 3 credits)

1. Current threatening human infectious diseases and their global and Indian status.
2. Recent advancement in monoclonal antibody productions and hybridoma technology.
3. Applications of monoclonal antibody in cancer research and drug discovery.
4. Animals used in antibody production How are hybrid cells selected in HAT medium?
5. Leukoagglutination and haemoagglutination
6. Advantages of PBMC cells as model system in toxicological studies.
7. Recent advancement in FACS and their applications in cancer research.

Assignment II -501205–LAB IV- IMMUNOTECHNOLOGY (Core – 3 credits)

1. Current statistics scenario of immune disorders and mortality rates in India and worldwide.
2. Immunological disorders and its treatment methods.
3. Applications of immunohistochemical staining in protein identification and localization.
4. Mycoplasma contamination in cell culture and
5. Cell lines used in cancer research and its application in drug developmental process.
6. Adherent and suspension cells.
7. Major discoveries in immunology research achieved by applying the *C. elegans* as model system.
8. Detection of inflammatory cytokines using ELISA and Western blot.
9. FISH and GISH for protein detection.

SEMESTER III

501301–GENOMICS AND PROTEOMICS (Core – 4 credits)

COURSE DEPICTION

Program: M. Sc. Biotechnology	**Semester: III**
Course Title/Code	**Genomics and Proteomics/ 501301**
Course Teacher	**Prof. K. Balamurugan** **Prof. S. Karutha Pandian**
Mobile: +91 9486426931 **+91 9442318144**	**E-mail: bsuryar@yahoo.com** **sk_pandian@rediffmail.com**

Course Brief

The subject Genomics and Proteomics deals with the combination of Genomics and Proteomics to study the complex nature of life. It provides a molecular level analysis of biological molecules such as nucleic acids and proteins. This subject provides a clear picture of the molecular mechanisms that takes place inside the multicellular host system. Moreover, this subject outlines the importance and emergence of new technologies in the genomics and proteomics.

Course Objectives

1. To provide a brief introduction about human genome project and other genome projects, a precise note on the transcript analysis techniques such as DNA chip and microarray for gene screening, DGE (Differential gene expression) RNA sequencing and Real-Time PCR.
2. To provide good knowledge on microbial functional genomics of bacterial pathogens and environmentally significant microbes, using animal models such as *C. elegans*, mice and techniques such as gene knockout, cell culture.
3. To provide basic knowledge of system biology which includes proteomics and different techniques, or approaches involved. It explains the protocols in sample preparation, extraction, solubilization of different proteins for proteomic analysis and the challenges associated with the analysis like sample pre-fractionation, liquid phase IEF, molecular weight cut off, IgG depletion.
4. To explain the principle and working methodology of the proteome techniques such as 2-D electrophoresis, 2-D NMR, Mass spectrometry, LC-MS, DIGE, gel free mass spectrometry with their merits and demerits.
5. To introduce the interactomics to the students to gain the knowledge on advanced techniques for example co-immunoprecipitation, protein microarray and computational tools of protein - protein interactions.

Course Outcome

Each unit is designed to accommodate students from multiple disciplines; therefore the students are expected to understand the basics concepts of Genomics & Proteomics and its involvement in biological processes that can be utilized as a parameter for the analysis of biological expression. The student also will study in depth the expression analysis of a protein. The student will be equipped with knowledge of various proteomic techniques required to measure the expression level of proteins which could be used in future. The understanding of interactomics with analysing the expression of protein with reporter gene and GFP can equip the student for future career perspective. The student will study the introduction of emerging fields such as proteogenomics, metabolomics, lipidomics, etc. which will show the importance of their existence in growing translational research.

Course Outline

The subject content includes interdisciplinary concepts that provide a wide berth to serve students from various fields such as Botany, Zoology, Biochemistry, Microbiology, Veterinary Science, Biotechnology, Nanotechnology, Molecular Biology, Structural Biology, Bioinformatics and Bioengineering. The understanding of basic biology is important to comprehend the use of advanced technology to aid the analysis of biomolecules. The subject has been divided into five units from basic concepts to use of advanced technology in analyzing the building blocks of life (DNA ,RNA and Proteins,).

Course Schedule: Core: XII: Genomics and Proteomics (4 credits)

Syllabus	Schedule
Unit-1: Brief introduction to Human and other genome projects. Transcript analysis: DNA chips and microarray gene screen technology, RNA sequencing, Differential gene expression and Real-Time PCR.	**8 Days (1h/day)**
Unit – 2: Microbial Functional genomics- Functional Genomic analysis of bacterial pathogens and environmentally significant microorganisms. Studies on human microbial pathogens using model systems (Cell lines, Mice and *C. elegans*), Transgenic animals and genome editing techniques (RNAi, CRISPR-CAS). Virus-induced cell transformation, pathogen-induced diseases in animals, cell-cell fusion in both normal and abnormal cells.	**8 Days (1h/day)**
Unit – 3: Introduction to Systems Biology approach- Proteome and Proteomics- Extraction and solubilisation of proteins from cytoplasm, membrane, extracellular, sub-cellular organelles and biological fluids. Challenges associated with low- and high- abundant proteins- sample pre-fractionation techniques - Liquid phase IEF, Molecular Weight Cut Off and chromatographic techniques	**7 Days (1h/day)**
Unit – 4: Protein analysis: Protein micro array. Analysis of proteins by 2-D gel electrophoresis, 2-D Fluorescence Difference Gel Electrophoresis (DIGE) and Introduction to Mass Spectrometry (MS): Separation techniques - Liquid Chromatography (UPLC and Nano), Ionization sources/techniques -MALDI, ESI and SELDI, Mass analyzers - ToF, Quadrupole, Ion traps and Fourier Transform Ion Cyclotron Resonance, Quantitative Proteomics - gel- based and gel-free quantitative proteomic techniques. Applications of gel based and gel-free quantitative proteomic techniques. MudPIT Technology and De novo (peptide) sequencing.	**8 Days (1h/day)**
Unit – 5: Interactomics - Yeast Two Hybrid- Immunoprecipitation- Computational tools for Protein-protein interactions- Pros and cons using various Interactomics techniques. Differential display proteomics Protein engineering; Protein chips; experimental and computational methods, databases. Functional characterisation of proteins, Use of reporter gene GFP to visualize proteins in live-culture; Clinical and biomedical applications of proteomics. Post Translational Modifications (PTMs) of proteins. Reversible and Irreversible PTMs- techniques for identification and characterisation of PTMs- gel electrophoresis, staining procedures, MS and PTM specific immunoblotting. Public protein databases and interfaces for PTMs- challenges in PTMs for Proteomics and Bioinformatics. Introduction to Proteogenomics, Metabolomics, Lipidomics, and Metagenomics.	**9 Days (1h/day)**
Days assigned for CIA Tests, Quizzes, Seminars, etc.	**8 Days (1h/day)**

Text Books

1. Introducing proteomics (2011) Josip lovric. John Wiley Publication
2. Principles of proteomics (2013). R. M Twyman. Taylor and Francis publishers.

Reference Books

1. Expression Genetics: accelerated and High Throughput Methods (1999). Edited by M. McClelland and A. Pardee, Eaton Publishing, MA.
2. Microbial Functional Genomics (2004). J. Zhou, D.K. Thomson, Y. Xu and J.M. Tiedje, Wiley Liss.
3. Reviews and articles from Journals such as Nature, Science, PNAS (USA), Nucleic Acids Research, Trends and Current Opinion Series.
4. Principles of Gene Manipulation and Genomics (2013) Sandy B. Primrose, Richard Twyman – Blackwell Publishing
5. An Introduction to Genetic Engineering 3rd Edition DesmondS. T. Nicholl Cambridge University Press
6. Molecular Biotechnology: Principles and Applications of Recombinant DNA 4th Edition Bernard R. Glick, Jack J. Pasternak, Cheryl L. Patten ASM Press
7. Post-translational modifications in host cells during bacterial infection, D. Ribert, P. Cossart, FEBS letters, 2010.
8. Proteomics in practice: a laboratory manual of proteome analysis (2002). Westermeier, R., & Naven, T. John Wiley & Sons, Inc.
9. Proteomics for biological discovery. Veenstra, (2006). Timothy D. and John R. Yates John Wiley & Sons,
10. Plant proteomics: methods and protocols. (2007). Thiellement, H., Zivy, M., Damerval, C. and Méchin, V. eds. Totowa (NJ): Humana Press.

More Books to Read and Refer

Author (s)	Title
Devarajan Thangadurai, Jeyabalan Sangeetha	Genomics and Proteomics: Principles, Technologies, and Applications (2015)
Ferenc Darvas, Andras Guttman, Gyorgy Dorman	Chemical Genomics and Proteomics (2016)
Yu Liu	Omics in Clinical Practice: Genomics, Pharmacogenomics, Proteomics, and Transcriptomics in Clinical Research (2014)
John Parrington, Kevin Coward	Comparative Genomics and Proteomics in Drug Discovery (2006)

Seminars on Invention

1. James Watson & Francis Crick and DNA double helices
2. Rosalind Franklin and molecular structures of DNA
3. Stephen Fodor and micro array

4. Kary Mullis and PCR
5. Dick Haugland and fluorescent dyes
6. Eric Kandel and model systems in biology
7. Rudolf Jaenisch and transgenic animal
8. Andrew Fire & Craig Mello and gene silencing
9. Osamu Shimomura and GFP
10. Jennifer Doudna and CRISPR-CAS9 system
11. O'Farrell & Klose and 2D-Gel electrophoresis
12. Hand Dehmelt & Wolfgang Paul and Iontrap techniques
13. John Bennett Fenn and ESI
14. Koichi Tanaka and Soft Laser Desorption (SLD)

Assignment- I- 501301–Genomics and Proteomics (Core – 4 credits)

1. Human and other genome projects.
2. DNA chips and microarray gene screen technology in Transcript analysis.
3. Functional genomic analysis of bacterial pathogens and environmentally significant microorganisms.
4. Studies on human microbial pathogens using model systems.
5. Systems biology approach in Proteome and Proteomics.
6. Extraction and solubilisation of proteins from organelles and biological fluids.
7. Protein micro array.
8. Mass Spectrometry and types of mass analyzers.
9. Computational tools for protein-protein.
10. Use of reporter gene GFP to visualize proteins in live-culture.

Assignment- II- 501301–Genomics and Proteomics (Core – 4 credits)

1. RNA sequencing and its processing.
2. Differential gene expression and Real-Time PCR.
3. Transgenic animals and genome editing techniques by using RNAi, CRISPR-CAS techniques.
4. Virus-induced cell transformation.
5. Challenges associated with low and high abundant proteins and sample pre-fractionation techniques.
6. Liquid phase IEF, Molecular Weight Cut Off and chromatographic techniques.
7. Ionization sources/techniques by MALDI, ESI and SELDI and its Mass analyzers
8. Gel- based and gel-free quantitative proteomic techniques of Quantitative Proteomics
9. Clinical and biomedical applications of proteomics.
10. Public protein databases and interfaces for PTMs.

501302–ANIMAL BIOTECHNOLOGY (Core – 4 credits)

COURSE DEPICTION

Program: M.Sc. Biotechnology	**Semester: III**
Course Title/Code	**Animal Biotechnology/501302**
Name of Course Teacher	**Dr. K. Pandima Devi**
Mobile: +91 9790358700	**Email: devikasi@yahoo.com**

Course Brief

Animal biotechnology is one of the modern branches of Biotechnology which deals with the use of science and engineering to modify living organisms in order to improve their suitability for pharmaceutical and agricultural applications. This field has gained enormous popularity because of its huge applications in our day-to-day life, starting from probiotics to vaccines. Consequently, it has become indispensable to have a thorough idea on this current subject. Therefore this course has been designed to introduce the basic features of animal biotechnology to the students such as animal cell culture techniques, conventional and advanced methods for genetic manipulation to create transgenic animals, using gene knock out technology to make animals with a specific inactivated gene, producing nearly identical animals by somatic cell nuclear transfer (or cloning) and so on. This course is a primary source for the beginners which will help them to understand the complex phenomena during their higher studies. Special features of the course include preliminary idea on various new topics such as stem cells and cancer cells. Also this course throws light on the pathways of gene regulation, function, gene transfer, gene therapy etc. The course also focuses on the application of these concepts to create recombinant animal viral vectors to produce vaccines, regulatory proteins etc. The set of courses is critically intended to afford background knowledge on diverse techniques associated with animal biotechnology that are necessary for a student to prosper by realizing the multifaceted issues related to this area for socio-economical and environmental benefit.

This course deals with how the central units of life (i.e. a cell) can be manipulated on laboratory bench according to the need of a biotechnologist and how the outcome can be used for various applications like production of large scale of desired proteins and other food supplements, and to combat diseased conditions. Moreover, this course will provide a beginning to understand various technical approaches related to animal biotechnology and thus will help the students to become well versed in the subject in the subsequent years.

Course Objectives

The objectives of the course is to make the students

1. Realize the basic concepts of animal cell culture.
2. Understand the basic properties of cancer cells.
3. Describe the principle and application of gene manipulation.
4. Illustrate how transgenic animals can be produced with a specific gene of interest and their clinical advantages.

Course Outcomes

On successful completion of Animal Biotechnology course, students will be able to:

1. Describe the mechanism of gene therapy and its uses.
2. Illustrate how different blood products like antibodies, hormones and vaccines are produced industrially.
3. Describe the features of stem cell and their application.
4. Differentiate between the different methods adopted for generating transgenic animals

Course outline

1. Physical, chemical and biological methods for gene transfer and their respective application for creating transgenic animals.
2. Artificial insemination and embryo transfer.
3. Construction of various recombinant animal vectors.
4. Production of vaccines and hormones using eukaryotic expression vectors.
5. *Ex-vivo* and *in-vivo* gene therapy for HIV, Cancer treatment and organ transplantation.
6. Stem cell therapy and its advantages over conventional therapeutics.
7. Ethical issues related to stem cell research.

Course Schedule: Core: XIII: Animal Biotechnology (4 credits)

Syllabus	Schedule
Unit 1: Transgenesis; Methods of gene transfer- physical, chemical and biological methods. Methods for the construction of recombinant animal viral vectors for gene transfer into cell lines. Transgenic animals (Mice, Cows, Pigs, Sheep, Goat, Birds, fish and Insects). Applications of transgenic animals as disease models (neurodegenerative disorders, carcinogenesis and hypertension) and production of therapeutic proteins. Cloning for conservation of endangered species; ethical issues in cloning.	**9 Days (1h/day)**
Unit 2: Gene Knock out and mouse as model system for human genetic disorders; Different lab strains of mice. Artificial insemination, super ovulation, embryo recovery and *in vitro* fertilization. Embryo culture, cryopreservation of embryos, embryo transfer technology. Biology of Animal viral vectors - SV40, Adeno virus, Retro virus, Vaccinia virus, herpes virus, Adeno associated virus and Baculovirus. Baculovirus in biocontrol. Applications of yeast system to study eukaryotic genome.	**8 Days (1h/day)**
Unit 3: Application of animal cell culture for virus isolation, *in vitro* testing of drugs, testing of toxicity of environmental pollutants, production of human and animal viral vaccines and pharmaceutical proteins. 3D cultures and tissue engineering. Cellular models for diseases (cancer).	**7 Days (1h/day)**
Unit 4: Gene therapy - *Ex vivo* and *in vivo*, viral and non- viral; Biotechnological applications for HIV diagnostics and therapy; DNA based diagnosis of genetic diseases. Phage display technology and its applications.	**8 Days (1h/day)**
Unit 5: History of stem cells; Types (embryonic, adult , umbilical cord blood and induced pluripotent stem cells), applications in treatment of diseases (Cancer and Diabetes mellitus); Hematopoietic stem cell transplantation, cloning and stem cell research; Ethical limits of stem cell research. Cell signaling (Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, and regulation of signaling pathways).	**9 Days (1h/day)**
Days assigned for CIA Tests, Quizzes, Seminars, etc.	**8 Days (1h/day)**

Text Books

1. Animal Cell Culture Methods, 1st edition, (2006) by Jennie P. Mather, Elsevier.
2. Cell Signaling, 3rd Edition, (2010) John T Hancock, O U P.
3. Cloning, Genetics and Stem Cell Technology, (2010) by Ruchi Dhawan, Axis Publications
4. Gene Transfer: Delivery and Expression of DNA and RNA, (2007), by Friedmann. T, Cold Spring Harbor Lab.
5. Principles of Gene Manipulation and Genomics 7th edition (2006). Sandy Primrose, Richard Twyman and Bob Old. Blackwell Science.
6. Transgenic Animal Technology, 3rd edition, (2014), by Pinkertl, Academic.

Reference Books

1. Animal Cell Biotechnology, (2005) by Jenkins, Humana Press.
2. Contemporary Issues in Bioethics, 8th edition (2013) by Tom L. Beauchamp, LeRoy Walters, Jeffrey P. Kahn, Anna C. Mastroianni, Thomson Wads Worth.
3. Gene Cloning and DNA Analysis 7th edition, (2016). Brown TA, Brown T. Blackwell Science Ltd
4. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th edition, (2010), GlickBR., and PasternackJJ., ASM Press, Washington, DC.
5. RNA Viruses: A Practical Approach (2000). Cann AJ. Oxford University Press

More books to Read and Refer

Author (s)	Title
JM Fernandes and JP Hoeffler	Gene Expression Systems
SS Purohit	Biotechnology: Fundamentals and Applications
J Lodge, PA Lund, S Minchin	Gene Cloning: Principles and Applications
AJ Holland, A Johnson	Animal Biotechnology and Ethics
I. Gordon,	Reproductive Techniques in Farm Animals
M. M.Levine,	Concepts in Biotechnology
H.D. Kumar	New Generation Vaccines
R.I.Freshney	Animal cell culture A practical approach
J.S.F.Barrer, K.Hammond and A.E.McClintock	Future Developments in the Genetic Improvements of Animals

Assignment I: 501302-Animal Biotechnology (Core – 4 credits)

1. Xenotransplantation- its advantages and disadvantages in health care arena.
2. NAGRP.
3. Pathway for production of transgenic poultry with these specific genes.
4. Methods for long term storage of sperms and embryos.
5. Artificial insemination in cow and its advantages in diary industry.
6. Methodologies for creating transgenic animals.
7. Animal models recently being used in neurodegenerative studies.
8. Special features of animal models.

9. Potent animal models used for carcinogenic studies.
10. Significance of viruses in animal gene transfer technology.
11. Hypertension and its clinical symptoms.

Assignment II: 501302-Animal Biotechnology (Core – 4 credits)

1. Diagnosis of disease using DNA fingerprinting method.
2. 3D tissue cultures.
3. Gene therapy.
4. Use of stem cells for treatment of diseases
5. Biological insecticides.
6. Live and attenuated vaccines.

501303–BIOINFORMATICS (Core – 4 credits)

COURSE DEPICTION

Program: M. Sc.	**Semester: III**
Course Title/Code	**Bioinformatics/ 501303**
Name of Course Teacher	**Prof. S. Karutha Pandian** **Dr. S. Gowrishankar**
Mobile: +91 9442318144 **+ 91 9994933559**	**Email: sk_pandian@rediffmail.com** **gowrishankar.alu@gmail.com**

Course Brief

This course contains fully revised and updated topics of bioinformatics which includes recent advancements in computer application. This course will give complete overview about the tools and softwares used to analyze the biological data. This course also highlights the application of softwares and algorithms used to analyze the biological data. The topics of this course work covers the biological database retrieval, open and proprietary databases, sequence alignment, phylogentic analysis, nucleic acid sequence and structure analysis, protein structure prediction, computing in proteomics, interaction between biomolecules, visualization of macromolecules, virtual screening, molecular docking and drug designing. The complete course gives thorough knowledge about different database retrieval, algorithms involved in alignment of sequences, software used in biomolecules structure, prediction and interaction, tools used to analyze the genomics and proteomics data and drug designing concepts.

Course Objectives

To make the students:

1. Understand basics of bioinformatics which includes recent advancements in computer application
2. Analyze the biological data using bioinformatics tools and softwares
3. Know about specific application of softwares and algorithms used for the clear understanding of biological data.
4. Knowledge about softwares used in biomolecules structure, prediction and interaction, tools used to analyze the genomics and proteomics data and drug designing concepts.

Course Outcomes

The students shall be able to:

1. Understand biological databases and how to retrieve the information from the databases
2. Differentiate open and proprietary source software
3. Learn about algorithms and matrices in global and local alignment
4. Construct phylogentic tree using multiple sequence alignment
5. Analyze DNA sequencing data using electropherogram viewer, contig assembly software.
6. Find vector contamination in DNA sequences and how to annotate and submit DNA sequences in public domain
7. Understand gene prediction, RNA structure analysis, protein secondary and tertiary structure prediction and motifs with suitable example.
8. Analyze proteome data using MASCOT, X!Tandom, SPC tools.
9. Describe about protein interaction with DNA and RNA by interaction databsases
10. Knowledge about virtual screening. Molecular modelling and dynamics

Course Outline

1. Biological databases – Protein and nucleotide sequence and structure databases
2. Retrieve the information from open access databases, Proprietary and Open Source software
3. BLAST tool and its types
4. Global and local alignment – alignment methods, algorithms, matrices, etc
5. Phylogenetic tree construction using MEGA software
6. DNA sequencing data analysis
7. Software used for electropherogram viewer and finding vector contamination in DNA sequencing results.
8. Submission of DNA sequencing data in public databases
9. Gene expression data analysis using qPCR
10. DNA, RNA, Protein sequence and structure prediction
11. Proteomics data analysis by MASCOT, X!Tandem, and SPC.
12. Software used for Interaction databases - Protein-protein interaction, Protein-RNA interaction, Protein-DNA interaction
13. Application of Rasmol and Swiss PDB viewer
14. Screening of small compounds by molecular docking
15. Molecular modeling, dynamics and simulation
16. Drug development process
17. Pharmacogenomics, pharmacodynamics properties
18. Softwares to find ADMET properties of drug.

Course Schedule: Core: XIV: BIOINFORMATICS: (4 Credits)

Syllabus	Schedule
Unit 1: Biological data types, Major Biological databases and its classification- Generalized and Specialized databases**,** Retrieving information and sequences from databases. Proprietary and Open Source software: Bioinformatics analysis packages available – EMBOSS	**8 Days (1h/day)**
Unit 2: Computational Analysis of Sequences - BLAST-Basic and Specialized. Methods of Sequence alignment –Pair wise alignment Global, local, dot plot and its applications. Multiple sequence alignment, Alignment viewers, Formatting and editing multiple sequence alignments. HMM analysis – HMMSCAN and HMMER. Molecular Phylogeny- Concepts of Trees- Distance matrix methods, Character based methods. Principles and tools- MEGA, Applications of Phylogenetics.	**8 Days (1h/day)**
Unit 3: DNA Sequencing and gene prediction - Analysis of electropherogram; Contig assembly; Checking for vector contamination and chimeras; Sequence annotation and submission in public databases. Restriction mapping and Primer design using programs from public domain. Prediction of Genes and Regulatory regions in DNA; Gene Annotation; Prediction of gene using homology. RNA structure analysis, Protein secondary and tertiary structure prediction - and motifs.	**9 Days (1h/day)**
Unit 4: Proteomic, interactomic data analysis and databases- Introduction to proteomics, Computing in Proteomics- Databases and search tools; MASCOT, X!Tandem, and SPC. Commercial software analysis of raw data spectrum. Interaction databases and tools: Protein-protein interaction, Protein-RNA interaction, Protein-DNA interaction. Visualisation of macromolecules – Rasmol, Swiss PDB Viewer.	**10 Days (1h/day)**
Unit 5: Molecular docking and Drug designing - Virtual screening, Molecular modeling and docking. Molecular dynamics and simulation. Drug designing concepts – Structure based and Ligand based drug development, Pharmacogenetics and Pharmacogenomics, Pharmacokinetics- High throughput screening for Discovery and identification of drugs. Cheminformatics usage in drug discovery. Drug absorption, bioavailability, distribution, and excretion. Software tools (ADMET).	**8 Days (1h/day)**
Days assigned for CIA Tests, Quizzes, Seminars, etc.	**8 Days (1h/day)**

Text Books

1. Bioinformatics. Sequence and Genome Analysis - David W. Mount
2. Bioinformatics – A Student's Companion (2017) by Ibrahim KS, Gurusubramanian G, Zothansanga, Yadav RP, Kumar NS, Pandian SK, Borah P and Mohan S, Springer Singapore Private Ltd.,
3. Practical Bioinformatic (2013) by Michael J Agostino,Garland Science, Taylor & Francis Group, LLC.

Reference Books

1. Bioinformatics (2006) N. Gautham, Narosa Publications
2. Bioinformatics. Sequence and Genome Analysis (2001) by David W. Mount, Cold Spring Harbor Laboratory Press.
3. Bioinformatics - A Practical Guide to the Analysis of Genes and Proteins (2005) by A.D. Baxevanis and B.F. Francis Ouellette (3rd Ed.) Wiley Student Ed
4. Introduction to Bioinformatics (2006) by Arthur M. Lesk, Oxford University Press.
5. Introduction to Bioinformatics (2006) by T.K. Attwood and D.J. Parry-Smith, Pearson Education Asia.
6. Bioinformatics for Dummies (2003) by J-M Claverie and C. Notredame, Wiley Publishing, Inc.

More books to Read and Refer

Author (s)	Title
A.D. Baxevanis and B.F. Francis Ouellette	Bioinformatics - A Practical Guide to the Analysis of Genes and Proteins
Arthur M. Lesk	Introduction to Bioinformatics
Ziwei Huang	Drug Discovery Research
Claude Cohen	Guidebook on Molecular Modeling in Drug Design
Andrew Leach	Molecular Modeling - Principles and Applications
J-M Claverie and C. Notredame	Bioinformatics for Dummies
Michael J. Brownstein, Arkady B. Khodursky	Functional Genomics –Methods and Protocols
Michael J. Korenberg	Microarray Data Analysis –Methods and Applications
Bryan M. Ham John	Proteomics of Biological Systems (Protein Phosphorylation Using Mass Spectrometry Techniques)
Ziwei Huang	Drug Discovery Research
Claude Cohen	Guidebook on Molecular Modeling in Drug Design
Andrew Leach	Molecular Modeling - Principles and Applications

Mini Project

Mini Project relevant to the course may be given as an assignment. Based on the project, the student needs to prepare their project report and submit in time. The following things should be followed by the students in executing their project work: a. Introduce the project stating its nature, scope, importance, etc. b. Formulate the objectives and hypotheses; c. Design the methodology (sampling, data collection, tools, designs, tool validation, chapterisation etc); d. Data: Collect Edit, tabulate data and analyze the same; make your findings. E. Write up the Project: Report starting from (a) to (e) describing each step in your project report meaningfully, logically with evidences supporting your findings and suitable divided into chapters as per chapterisation given already.

501304- LAB V: BIOPROCESS ENGINEERING AND BIOINFORMATICS
(Core – 3 credits)

COURSE DEPICTION

Program: M.Sc. Biotechnology	**Semester: III**
Course Title/ Code	**Lab V- Bioprocess engineering and Bioinformatics/ 501304**
Name of Course Teacher	**Dr. A. Veera Ravi** **Prof. S. Karutha Pandian**

Course Brief

The fundamental objective of the course is to provide students with an extensive and concise knowledge about bioprocess principles and strategies to optimize the production of byproducts from industrial important microbial strains. The laboratory component provides the hands-on experience benefitting the students with right skills required for industrial, academic and research career. Further, this course also provides exposure to understand the basic concepts and fundamental principles of the fermentor. Though this course, students will understand the fundamental concepts of fermentation; aerobic and anaerobic fermentation, production of biotechnologically important products and steps involved in upstream and downstream processes.

This course will also provide knowledge on bioinformatics and recent advancements in computer application. This course will give complete overview about the tools and softwares used to analyze the biological data. The complete course gives thorough knowledge about

different database retrieval, algorithms involved in alignment of sequences, software used in biomolecules structure, prediction and interaction, tools used to analyze the genomics and proteomics data and drug designing concepts.

Course Objectives

Furnish themselves with thorough knowledge of the fundamental science and methodologies in the various concepts of fermentation. This area is increasingly important in all forms of biotechnology.

1. To impart in-depth knowledge on the cutting-edge techniques and glimpse on various experimental approaches such as sterilization, fermentation, agitation and Computer application in control of bioprocess.

2. Impart practical skills to the students to immobilize industrially important enzymes for fermentation processes.

Understand basics of bioinformatics which includes recent advancements in computer Application,

1. Analyze the biological data using bioinformatics tools and softwares
2. Know about specific application of softwares and algorithms used for the clear understanding of biological data.
3. Knowledge about softwares used in biomolecules structure, prediction and interaction, tools used to analyze the genomics and proteomics data and drug designing concepts.

Couse Outcomes

The students shall be able to:

1. Describe the basic concepts and theories of the growth kinetics of microbial cells
2. Recognize the fundamentals of fermentation technology.
3. Assess power requirements in bioreactors, modeling of bioprocesses, traditional and new concepts in bioprocess monitoring, and the biological basis for industrial fermentations and cell cultures.
4. Use the most common equipment, materials and methods related to fermentation processes, microbial growth and cultivation and sterilization.
5. Understand biological databases and how to retrieve the information from the Databases
6. Differentiate open and proprietary source software
7. Learn about algorithms and matrices in global and local alignment
8. Construct phylogentic tree using multiple sequence alignment
9. Analyze DNA sequencing data using electropherogram viewer, contig assembly software.
10. Find vector contamination in DNA sequences and how to annotate and submit DNA sequences in public domain
11. Understand gene prediction, RNA structure analysis, protein secondary and tertiary structure prediction and motifs with suitable example.
12. Analyze proteome data using MASCOT, X!Tandom, SPC tools.
13. Describe about protein interaction with DNA and RNA by interaction databsases
14. Knowledge about virtual screening. Molecular modelling and dynamics

Course Schedule: Core: XV- LAB V – Bioprocess Engineering and Bioinformatics

(3 credits)

Syllabus	Schedule
Unit-1: Basic Microbiology techniques: Scale up from frozen vial to agar plate to shake flask culture. Instrumentation: Microplate reader, spectrophotometer, microscopy. Experimental set-up: Assembly of bioreactor and sterilization. Growth kinetics, Development of enzyme assays and quantification of enzyme activity and specific activity. Enzyme kinetics. Effect of pH and temperature on enzyme activity.	**5 Days (3h/day)**
Unit -2: Fermentation: Batch, Fed-batch, Continuous. Unit operations: Microfiltrations: Separation of cells from broth, Bioseparations: Various chromatographic techniques and extractions, Bioanalytics: Fraction analytical techniques such as HPLC, FPLC, GC-MS, SDS-PAGE, Western Blot and/or ELISA for measurement of amounts of products/substrates.	**5 Days (3h/day)**
Unit -3: Introduction and Use of biological databases: NCBI, EMBL, Genbank, Entrez, Swissprot/TrEMBL, UniProt. Retrieval of Sequence information: Retrieval of gene sequence in FASTA format, determining the function of a sequence by searching secondary and specialized databases.	**5 Days (3h/day)**
Unit -4: Similarity searches: Database sequence similarity searches, Pairwise sequence alignment, Multiple sequence alignment, Hidden Markov Model Construction and searches, Protein motif searches, DNA motif searches. Phylogenetic Analysis- Construction and Refining a Multiple Sequence Alignment, Constructing a Distance-Based Phylogenetic Tree, Constructing a Maximum Parsimony Tree, Constructing a Maximum Likelihood Tree, Constructing a Phylogenetic Tree Using Bayesian Inference.	**5 Days (3h/day)**
Unit -5: Molecular Imputations- Gene, Promoter and Operon Prediction- Gene Ontology. Primer Designing: Principle and Applications, Databases and Tools- Primer3, GenScript, Primer BLAST, Restriction site prediction tools- NEB Cutter, Removal of Vector Contamination- VecScreen, Sequence Massager, Contig Sequence Assembly- CAP3. Protein Structure Prediction- Secondary and Tertiary Structure, Protein Homology Modelling-SWISS modelling. Visualization of Protein -Rasmol, SPDB Viewer, Protein Explorer.	**6 Days (3h/day)**
Days assigned for CIA Tests, Quizzes, Seminars, etc.	**4 Days (3h/day)**

Text Book

1. Bioinformatics. Sequence and Genome Analysis - David W. Mount

Reference Books

1. Athel Cornish-Bowden (2013). Fundamentals of Enzyme Kinetics 4th Edition, Wiley-Blackwel.
2. Bailey, J. E., & Ollis, D. F. (1986). Biochemical Engineering Fundamentals. New York: McGraw-Hill.
3. Blanch, H. W., & Clark, D. S. (1997). Biochemical Engineering. New York: M. Dekker.
4. El-Mansi, M., & Bryce, C. F. (2007). Fermentation Microbiology and Biotechnology. Boca Raton: CRC/Taylor & Francis.
5. Shuler, M. L., & Kargi, F. (2002). Bioprocess Engineering: Basic Concepts. Upper Saddle River, NJ: Prentice Hall.
6. Ashok Kumar Sharma (2012). Practical Bioinformatics. Oxford University Press.
7. Cynthia Gibas, Per Jambeck (2001). Developing Bioinformatics Computer Skills, O'Reilly Media,Inc.,
8. David Edwards, Jason Eric Stajich, David Hansen, (2009). Bioinformatics: Tools and Applications, Springer.
9. David W Mount (2004). Bioinformatics: Sequence and genome analysis, Cold spring harbor laboratory press, 2nd edition,
10. Stanbury, P. F., & Whitaker, A. (2010). Principles of Fermentation Technology. Oxford: Pergamon Press.
11. Practical Bioinformatic (2013) by Michael J Agostino,Garland Science, Taylor & Francis Group, LLC

More books to Read and Refer

Author (s)	Title
Rosenberg	Protein Analysis and Purification (2005)
Doyle	High through put protein expression and purification (2009)
Baxevanis	Bioinformatics (2006)
Bosu	Bioinformatics, Databases, Tools And Algorithms(2007)
Stephen Misener	Bioinformatics Methods and Protocols(2000)
A.D. Baxevanis and B.F. Francis Ouellette	Bioinformatics - A Practical Guide to the analysis of Genes and Proteins

Assignment I- 501304- LAB V – Bioprocess Engineering and Bioinformatics (3 credits)

1. Bio-process engineering and its advantages.
2. Various types of bioreactors.
3. Fed batch cultivation/fermentation and its advantages.
4. Kinetics of cell cycle cultivation.
5. Basic design and operation of different types of fermenters.

Assignment II- 501304- LAB V – Bioprocess Engineering and Bioinformatics (3 credits)

1. Scale up criteria for bioreactors bared on oxygen transfer and power consumption.
2. Various factors for scaling up process in the bioreactor.
3. Various chromatographic techniques.
4. Scale up and scale down processing.

Mini Project for Bioinformatics

Mini Project relevant to the course may be given as an assignment. Based on the project, the student needs to prepare their project report and submit in time. The following things should be followed by the students in executing their project work: a. **Introduce** the project stating its nature, scope, importance, etc. b. **Formulate** the objectives and hypotheses; c. **Design** the methodology (sampling, data collection, tools, designs, tool validation, chapterisation etc); d. **Data:** Collect Edit, tabulate data and analyze the same; make your findings. E. **Write up the Project:** Report starting from **(a) to (e)** describing each step in your project report meaningfully, logically with evidences supporting your findings and suitable divided into chapters as per chapterisation given already.

501305- LAB VI - PLANT BIOTECHNOLOGY (Core – 3 credits)

COURSE DEPICTION

Program: M.Sc. Biotechnology	**Semester: III**
Course Title/Code	**Lab VI- Plant Biotechnology/501305**
Name of Course Teacher	**Dr. M. Ramesh**
Mobile: +91 7904270252	**Email: mrbiotech.alu@gmail.com**

Course Brief

Plant biotechnology is an integration of several sciences including genetics, biochemistry, microbiology, agriculture, plant breeding, medicine, pharmacology, environmental sciences and so on. So, it is clearly an interdisciplinary science surrounding not only biology, but also other subjects, including physics, chemistry, mathematics and engineering. Plant biotechnology course emerged as an exciting area of plant sciences by creating several new opportunities for the manipulations of plants *in vitro*. The tools of biotechnology can be applied to any living system such as plants, animals or microorganisms to obtain products or processes that are directly or indirectly useful to mankind. Lab in Plant Biotechnology course provides an elaborate and complete education in which the students (with plant molecular biology knowledge gained in the second semester) learn underlying principles of various experiments, concepts, theories, key methodologies, practical exposure and equip themselves with a wide range of skills and knowledge base employed in plant biotechnology research. Plant tissue culture has contributed greatly to understanding the factors responsible for growth, development, differentiation and other vital processes of plant cells, tissues & organs *in vitro*. The collection of techniques contributed immensely towards plant improvement, plant protection and also for large-scale production of industrially important compounds by gene manipulation and elicitation. More than that laboratory course in Plant Biotechnology is a multidisciplinary area of specialization with wide applications in Research & Development of pharmaceutical and agriculture-based industries. Emphasis will be placed on developing Good Laboratory Practices, including novel and innovative thinking, proper utilization of technique, record-keeping, and scientific writing.

Course Objectives

The objectives of the course is to make the students

1. Understand the principles, practices and application of plant tissue culture techniques.
2. Obtain practical skills (in basic plant tissue culture and advanced molecular biology techniques) and to enhance students' understanding of the knowledge learned from the theory lectures in the second semester.
3. Have hands-on experience and training in genetic engineering techniques.
4. Learn preparation of nutrient media, sterilization techniques, and development of axenic cultures through in vitro culture, cryopreservation, and genetic modification through transformation.
5. Analyze transgenic plants with biochemical assays and molecular analysis.

Course Outcomes

The students undergoing this important core course shall be able to:

1. Explain the various components of major plant tissue culture media, e.g. macro and micronutrients, growth factors, vitamins, hormones, and other choice of components.
2. Explain the various steps taken to establish and optimize media for particular purposes in particular species.
3. Familiar with sterile techniques, media preparation, DNA extraction methods, and isolation of particular gene.
4. Apply tissue culture techniques for the large scale production of food crops and medicinal plants with economically useful traits
5. Apply knowledge of molecular markers for the identification of traits in various genomes
6. Apply genetic engineering concepts to induce biotic and abiotic stresses in plants
7. Perform a variety of molecular biology techniques, including restriction digestion, polymerase chain reaction, and Biolistic TM transformation

Course outline

1. Preparation of stock solutions and nutrient media
2. Processing of explants (mature seed, leaf base, shoot tip and node) for aseptic culture condition
3. Sterilization of nutrient media and surface sterilization of explants collected from field for aseptic culture initiation
4. Establishment and maintenance of callus and suspension culture
5. Subculture and regeneration of shoots and roots
6. Molecular marker analysis of conserved and wild type medicinal plants for genetic stability and diversity
7. Micropropagation of endangered medicinal plants
8. Acclimatization and hardening of micropropagated plants

9. Synthetic seed preparation through gel entrapment and plant conversion
10. Low temperature storage and Cryopreservation of plant genetic resources from endangered medicinal plants
11. Introduction of binary plasmids into Agrobacterium cells by triparental mating
12. Isolation and purification of Ti-plasmid DNA
13. Cloning of abiotic responsive genes into binary vector
14. *Agrobacterium tumefaciens* - mediated transformation of plants
15. Transient gus gene expression by histochemical method
16. PCR analysis of putatively transformed plants.

Course Schedule: Core: XVI: Lab VI - Plant Biotechnology (3 credits)

Syllabus	Schedule
Unit-1: Preparation of stock solutions and nutrient media for callus culture initiation and plant regeneration. Processing of various explants (mature seed, leaf base, shoot tip and node) for culture initiation. Aseptic techniques- Sterilization of nutrient media. Pretreatment and surface sterilization of various explants collected from field for aseptic culture initiation.	**4 Days (3h/day)**
Unit -2: Establishment and maintenance of callus and suspension culture. Subculture and regeneration of shoots and roots from callus cultures through organogenesis and somatic embryogenesis. Shoot tip culture. RAPD and ISSR analysis of in vitro conserved and wild type medicinal plants for genetic stability and diversity. Acclimatization and hardening of micropropagated plants.	**5 Days (3h/day)**
Unit -3: Micropropagation of endangered and threatened medicinal plants. Synthetic seed preparation from intact regenerable explants of medicinal plants through gel entrapment. Plant conversion from synthetic seeds. Low temperature storage. Cryopreservation of plant genetic resources through Encapsulation dehydration and vitrification.	**5 Days (3h/day)**
Unit -4: Genomic DNA extraction and purification – Principle and methods. Isolation and purification of Ti-plasmid DNA. Introduction of binary plasmids into Agrobacterium cells by Triparental mating. Cloning of abiotic responsive genes into binary vector.	**6 Days (3h/day)**
Unit -5: Agrobacterium tumefaciens - mediated transformation of plants - Culture initiation, explant preparation, preincubation, co-cultivation, selection, and regeneration. PCR analysis of putatively transformed plants. Transient ß-glucuronidase (GUS) gene expression assays in transformed intact explants and callus tissues by histochemical method. Agrobacterium rhizogenes- mediated transformation of medicinal plans and enhancement of secondary metabolite through elicitation. Biolistic transformation of food crops (Demo).	**6 Days (3h/day)**
Days assigned for CIA Tests, Quizzes, Seminars, etc.	**4 Days (3h/day)**

Text and Reference Books

1. Plant Cell Culture Protocols (2012), Vol- 877, 3rd Edition, Loyola-Vargas, Víctor M.; OchoaAlejo, Neftalí(Eds.)
2. Introduction to Plant Biotechnology (2010), 3rd Edition. H.S. Chawla, Oxford & IBH Publishing Co. Pvt.Ltd.
3. Plant Cell Culture-A - Practical Approach (2006), 2nd Edition, R.A. Dixon, IRL Press, Oxford.
4. Methods in Plant Molecular Biology. A Laboratory Course Manual (1995) Pal Maliga Cold Spring Harbor LaboratoryPress.
5. Plant Tissue Culture: Theory and Practice, Revised Edition - 2004, S.S. Bhojwani and M.K. Razdan, Elsevier Science Publications, The Netherlands.
6. Plant Biotechnology-Laboratory manual for Plant Biotechnology (2008), H.S. Chawla, Oxford & IBH Publishing Co. Pvt. Ltd.

More books to Read and Refer

Author (s)	Title
Amla Batra (2nd edition)	Fundamentals of Plant Biotechnology
Hamish A Collin, Sue Edwards (1998)	Plant Cell Culture
John H Dodds; Lorin W Roberts,3rd edition, 2004	Experiments in Plant tissue Culture
Robert H Smith, 3rd edition	Plant Tissue Culture: Techniques and Experiments
H E Street, 2nd edition	Plant Tissue and Cell Culture

Assignment I- 501305–- Lab VI - Plant Biotechnology (Core – 3 credits)

1. Principle and methodology of aseptic culture initiation.
2. Shoot tip explants for culture initiation.
3. Various steps involved in acclimatization.
4. Organogenesis and somatic embryogenesis.
5. Conditions for RAPD and ISSR fingerprinting technique.
6. Principle of gel entrapment.

Assignment II - 501305–- Lab VI - Plant Biotechnology (Core – 3 credits)

1. Natural and artificial seeds.
2. Low temperature storage.
3. Cryopreservation as ideal alternative to preserve to endangered germplasm.
4. Principle of triparental mating.
5. Principle of gus assay.

SEMESTER IV

501401 PROJECT WORK (Core – 16 Credits)

SYLLABUS FOR MAJOR ELECTIVE COURSES

501501–BIOPHYSICS AND INSTRUMENTATION (Core – 4 credits)

COURSE DEPICTION

Program	**M. Sc. Biotechnology**
Course Title/ Code	**Biophysics and Instrumentation/501501**
Course Teacher	**Dr. K. Balamurugan**
Contact email	**bsuryar@yahoo.com**

Course Brief

The subject Biophysics deals with the combination of biology and approaches of physics to study the complex nature of life. It provides a qualitative analysis of biological experiments regarding proteins, lipids, nucleic acid and carbohydrate. This subject provides a clear picture of the physical phenomenon such as the response of an organism to the food, prey, external and internal stimulus during the normal conditions. These observable facts are due to the regulation of various events that deals with cell to cell interaction, which is a consequence of interactions between RNA, DNA and biosynthesis of Proteins, Lipids and Carbohydrates. The qualitative and quantitative analysis of these events can be done by using various sophisticated techniques (instrumentation) which has been included in the syllabus

Course Objectives

1. To provide basic principles of important biomolecules.
2. To provide basic information about biological and biophysical instrumentation and measurement techniques commonly used in biology.
3. To provide thorough knowledge of the various principles in biophysical concepts and the understanding of technologically advanced instrumentation which can be used by the students in their future career.
4. To establish the relationship between the importance of structure and function at the molecular level of biomolecules.
5. To prepare students for competitive exams for higher studies/courses in molecular and medical biophysics by incorporating the outcome of latest genomics and proteomics tools.

Course Outcome

Each unit is designed to accommodate students from multiple disciplines, therefore the students are expected to understand the basic concepts of biophysics and its involvement in biological processes that can be utilized as a parameter for the analysis of biomolecular samples. The student also will study in depth the structure and molecular function of the important biomolecules such as Proteins, Lipids, Carbohydrates, DNA and RNA along with their interaction between each other. The student will be equipped with knowledge of various separation techniques required for different biomolecules which could be used in future. The understanding of various detection methods for different biomolecular structures through advanced techniques can give an overall perception of the use of these instruments which can equip the student for future career perspective.

Course Outline

The subject content includes interdisciplinary concepts that provide a wide berth to serve students from various fields such as Botany, Zoology, Biochemistry, Microbiology, Veterinary Science, Biotechnology, Nanotechnology, Molecular Biology, Structural Biology, Bioinformatics and Bioengineering. The understanding of basic biology is important to comprehend the use of advanced technology to aid in biomolecule analysis. The subject has been divided into five units from basic concepts to use advanced technology in analyzing the building blocks of life (Lipids, Carbohydrates, Proteins, DNA and RNA). For better understanding, provided below the topics included in each unit.

Course Schedule: Major Elective: I –Biophysics and Instrumentation (4 Credits)

Syllabus	Schedule
Unit-1: Basic concepts of Biophysics: Bonding: Strong (covalent, ionic, peptide and coordinate bonds) and Weak interactions (Hydrogen bonding and Van der Waals forces) in macromolecules. Structure and properties of water: Hydrophobic and hydrophilic interactions. Principles of biophysical chemistry (pH, buffers, reaction kinetics, thermodynamics, Colligative properties).	**8 Days (1h/day)**
Unit -2 : Organization of proteins at different levels - primary, secondary, tertiary and quaternary structure of protein; forces stabilizing structure of protein; protein folding, Ramachandran plot; Structure- Function relationships; Structural polymorphisms of DNA, tRNA and micro-RNA	**7 Days (1h/day)**
Unit -3: Radiation Biophysics or Radioisotope techniques: Stable and radio-isotopes. Measurement of radioactivity in biological samples: Gas ionization	**7 Days (1h/day)**

(GM counter), Scintillation counter, autoradiography and dosimeter. Radiation units; Safety aspects in handling radioactive isotope; Application of radioactive isotopes in biological studies. Molecular imaging of radioactive materials. Concentration - Lyophilization and rotatory vacuum concentration; Diffusion techniques - Dialysis, Electrodialysis, Osmosis and Reverse osmosis	
Unit -4: Separation techniques: Centrifugation - Basic principles of sedimentation, types of centrifuges and rotors. Preparative ultracentrifugation - differential and density gradient; Chromatography: General principles and definitions, Rf value. Methods based on polarity - Partition chromatography, adsorption chromatography, TLC, HPTLC, gas, liquid chromatography, and reverse phase liquid chromatography. Methods based on partition - Gel filtration and Affinity chromatography. HPLC, Nano-LC and FPLC. Ion-exchange chromatography. Electrophoresis - basic principles, PAGE - Native-PAGE, SDS-PAGE, Isoelectricfocusing and 2Dimensional gel electrophoresis. Capillary electrophoresis. Principle and application of Agarose gel electrophoresis, denaturing agarose gel electrophoresis, Pulse-field gel electrophoresis, Mobility shift electrophoresis.	**9 Days (1h/day)**
Unit -5: Basic principles of biophysical methods used for analysis of biopolymer structure, X-ray diffraction, fluorescence, ORD\CD, NMR, IR, MS and ESR spectroscopy, X-ray photoelectron spectroscopy (XPS) Surface Plasmon Resonance (SPR) and Electron Paramagnetic Resonance (EPR) - . Symmetry, space group crystal lattices, Bragg's law in real & reciprocal space. Use of analytical microscopy in elucidating the structure function relationship in prokaryotes: Light Microscopy: Microscopic optics, components of microscope: lenses and microscopes, resolution: Rayleigh's Approach, Basic principles and methods of Bright-field, Dark-field, Phase contrast, interference contrast, Fluorescence Microscopy, Confocal Scanning Laser Microscopy, Transmission Electron Microscopy, Scanning Electron Microscope (SEM), Field Emission SEM (FESEM), Atomic Force Microscopy. Image processing methods in microscopy. Different fixation and staining techniques for EM, freeze-etch and freeze- fracture methods for EM, image processing methods in microscopy.	**9 Days (1h/day)**
Days assigned for CIA Tests, Quizzes, Seminars, etc.	**8 Days (1h/day)**

Text and Reference Books

1. Biophysical Chemistry Part I, II and III (2004) by Charles R. cantor & Paul R. Schimmel, W.H. Freeman and Company, USA
2. Biochemistry (2004) by Donald Voet & Judith G. Voet, John Wiley and Sons, USA
3. Lehninger's Biochemistry (2006) by Nelson, D.L. & Cox, M.M. W.H. Freeman and company, USA.
4. Principles and practice of bioanalysis (2004) by Richard F. Venn, Taylor & Francis, London, New York.
5. Basic methods in microscopy: Protocols and concepts from cells: A laboratory manual (2006) by David L. spector & Robert D. Goldman, Cold Spring Harbor Laboratory Press, New York.
6. Instrumental Methods of Analysis (1986) by Willard, Herrit, Dean and Settle, CBS Publishers and Distributors.
7. Biophysics: an introduction (2012) by Glaser, R. Springer Science & Business Media.
8. Principles of Physical Pharmacy & Biophysical Chemistry. (2007) by Sadhan Kumar Dutta. Books & Allied Ltd.

More Books to Read and Refer

Author (s)	Title
Zane Bradley	Biophysics: An Introduction (2017)
Misra & Gauri	Introduction to biomolecular structure and biophysics: basics of biophysics (2017)
Pranav Kumar	Fundamentals and Techniques of Biophysics and Molecular Biology (2014)

Seminars on Invention

1. American chemist G. N. Lewis and covalent bonding
2. Max Perutz & Sir John Cowdery Kendrew and hemoglobin and myoglobin
3. Marie Curie and radiation
4. Jean Antoine Nollet and osmosis
5. Benjamin Robins and centrifugation
6. Mikhail Tsvet and chromatography
7. Arne Tiselius and electrophoresis
8. Robert Wilhelm Bunsen and spectroscopy
9. Ernst Ruska & Max Knoll and electron microscope
10. Manfred von Ardenne and SEM

Assignment I- 501501- Biophysics and Instrumentation (Major Elective -4 credits)

1. Basic concepts of strong bonding in macro molecules.
2. Basic concepts of weak interactions in macromolecules.
3. Structure of the protein.
4. Forces stabilizing structure of protein.
5. Stable and radio-isotopes in Radiation Biophysics or Radioisotope techniques.
6. Measurement of radioactivity in biological samples by using different techniques.
7. Basic principles of sedimentation and centrifugation.
8. Basic principles of biophysical methods used for analysis of biopolymer structure.
9. Use of analytical microscopy in elucidating the structure function relationship in prokaryotes.

Assignment II- 501501- Biophysics and Instrumentation (Major Elective -4 credits)

1. Structure and properties of hydrophobic and hydrophilic interactions of the water.
2. Principles of pH, buffers, reaction kinetics, thermodynamics and colligative properties in biophysical chemistry.
3. Protein folding and Ramachandran plot and its structure and function relationships.
4. Structural polymorphisms of DNA, tRNA and micro-RNA.
5. Handling radioactive isotope in the safety aspects and its application of radioactive isotopes in biological studies.
6. Lyophilization and rotatory vacuum concentration
7. Methods based on partition of the Gel filtration and Affinity chromatography
8. Basic principles of Electrophoresis.
9. Rayleigh's Approach.
10. Different fixation and staining techniques and image processing methods in microscopy.

501502– MICROBIAL BIOTECHNOLOGY (Major Elective - 4 Credits)

COURSE DEPICTION

Program	**M. Sc. Biotechnology**
Course Title/ Code	**Microbial Biotechnology/ 501502**
Name of Course Teacher	**Dr. A. Veera Ravi** **Dr. S. Gowrishankar**

Course Brief

The subject 'Microbial Biotechnology' focuses on microbes of environmental, industrial or clinical relevance. This study provides an overview of how microbes (e.g., bacteria, viruses and yeast) are manipulated to solve practical problems through biotechnology. The major objectives of this course are basics in microbial life, ecology and metabolism, methods used in microbial technology, industrial microbiology, microbes in drug development, interactions between microbes, plants and animals, food microbiology, metagenomics and others. This course will take an in-depth look at how microbes and their metabolic pathways and products can be used in biotechnology, but the study will also allow students to develop their own interests in other aspects of biotechnology. The advent of genome sequencing, proteomics and metabolomics now allow comprehensive insights into microbial physiology and their ability to synthesize long stretches of DNA, enables genome engineering on a grand scale, with many new possibilities. This elective course should help the students at post graduate level to understand the fundamentals of bacterial genetics and techniques for genetic engineering as well as the role of microbiology in medicine, agriculture and environment.

Course Objectives

The course is intended to make the students

1. To introduce the new era of biotechnology.
2. To learn industrial application of microorganism such as enzymes, antibiotics production, bioremediation etc.
3. To understand the fundamentals of bacterial genetics and techniques for genetic engineering as well as the role of microbiology in medicine, agriculture, and the environment.
4. To develop interest in the research areas and to understand the advanced genome and epigenome editing tools such as engineered zinc finger proteins, TALEs/TALENs, and CRISPR/Cas9 system.

5. To learn the metagenomics and metatranscriptomics analysis for develop the microbes facilitated animal and plant health, environmental clean-up, global nutrient cycles & global sustainability.

Course Outcomes

The students shall be able to:

1. Acquire the basic concepts and theories of microbial biotechnology and understand the industrial applications of microorganisms.
2. Acquire basic information on practical techniques and approaches commonly used in molecular biology for manipulation of useful microbes/strains and their applications through advanced genome and epigenome editing tools such as engineered zinc finger proteins, TALEs/TALENs, and CRISPR/Cas9 system.
3. Understand the application of microbes and microbial processes in food and healthcare industries (e.g. food processing and food preservation, antibiotics and enzymes production).
4. Explicate and know the importance of genetically modified organisms in environment, food and pharmaceuticals.
5. Construct metagenomic library and functional screening in suitable hosts – tools and techniques for discovery/identification of novel enzymes, drugs.

Course Outline

1. Applications of industrially important microorganism
2. Genome editing techniques- TALEs/TALENs, and the CRISPR/Cas9 system
3. Microbial environmental applications – biodegradation, bioremediation, etc.
4. Introduction of desirable properties in industrially important microbes
5. Metagenomic library construction
6. Genetically modified microorganism for develop the food and pharmaceutical products

Course Schedule: Major Elective: II– Microbial Biotechnology (4 Credits)

Syllabus	Schedule
Unit-1: Microbial biotechnology in human welfare; Isolation and screening of microbes important for industry – advances in methodology and its application; Advanced genome and epigenome editing tools (*e.g.*, engineered zinc finger proteins, TALEs/TALENs, and the CRISPR/Cas9 system as nucleases for genome editing, transcription factors for epigenome editing, and other emerging tools) for manipulation of useful microbes/strains and their applications; Strain improvement to increase yield of selected molecules, *e.g.*, antibiotics, enzymes, biofuels.	**9 Days (1h/day)**
Unit-2: Environmental application of microbes; Ore leaching; Biodegradation - biomass recycle and removal; Bioremediation - toxic waste removal and soil remediation; Global Biogeochemical cycles; Environment sensing (sensor organisms/ biological sensors); International and National guidelines regarding use of genetically modified organisms in environment, food and pharmaceuticals.	**7 Days (1h/day)**
Unit-3: Recombinant protein and pharmaceuticals production in microbes – common bottlenecks and issues (technical/operational, commercial and ethical); Attributes required in industrial microbes (*Streptomyces* sp., Yeast) to be used as efficient cloning and expression hosts (biologicals production); Generating diversity and introduction of desirable properties in industrially important microbes (*Streptomyces*/Yeast); Microbial cell factories; Downstream processing approaches used in industrial production process (*Streptomyces* sp., Yeast).	**7 Days (1h/day)**
Unit-4: Application of microbes and microbial processes in food and healthcare industries - food processing and food preservation, antibiotics and enzymes production, microbes in targeted delivery application – drugs and vaccines (bacterial and viral vectors); Non-recombinant ways of introducing desirable properties in Generally recognized as safe (GRAS) microbes to be used in food (*e.g.*, Yeast) - exploiting the existing natural diversity or the artificially introduced diversity through conventional acceptable techniques (mutagenesis, protoplast fusion, breeding, genome shuffling, directed evolution *etc.*).	**9 Days (1h/day)**
Unit-5: Microbial genomics for discovery of novel enzymes, drugs/ antibiotics; Limits of microbial genomics with respect to use in human welfare; Metagenomics and metatranscriptomics – their potential, methods to study and applications/use (animal and plant health, environmental clean-up, global nutrient cycles & global sustainability, understanding evolution), Global metagenomics initiative - surveys/projects and outcome, metagenomic library construction and functional screening in suitable hosts – tools and techniques for discovery/identification of novel enzymes, drugs (*e.g.*, protease, antibiotic) *etc.*	**9 Days (1h/day)**
Days assigned for CIA Tests, Quizzes, Seminars, etc.	**8 Days (1h/day)**

Text and Reference Books

1. Lee, Y. K. (2013). Microbial Biotechnology: Principles and Applications. Hackensack, NJ: World Scientific.
2. Moo-Young, M. (2011). Comprehensive Biotechnology. Amsterdam: Elsevier.
3. Nelson, K. E. (2015). Encyclopedia of Metagenomics. Genes, Genomes and Metagenomes: Basics, Methods, Databases and Tools. Boston, MA: Springer US.
4. The New Science of Metagenomics Revealing the Secrets of Our Microbial Planet. (2007). Washington, D.C.: National Academies Press.
5. Industrial Microbiology. (2006). Prescott. Agrobios.
6. Website: http://jgi.doe.gov/our-science/
7. H. J. Peppler and D. Perlman, (2004), Microbial Technology second edition, Elsevier, academic press.

More books to Read and Refer

Author(s)	Title
H.B Singh, Vijai G. Gupta, Sudisha	New and Future Developments in Microbial Biotechnology and Bioengineering (2018)
Alexander N. Glazer, Hiroshi Nikaido	Microbial Biotechnology: Fundamentals of Applied Microbiology (2007)
Farshad D. Harzevili, H. Chen	Microbial Biotechnology: Progress and Trends (2017)
Alexander N. Glazer, Hiroshi Nikaido	Microbial Biotechnology: Fundamentals of Applied Microbiology (2007)

Assignment I- 501502– Microbial Biotechnology (Major Elective -4 Credits)

1. Industrially important microorganisms.
2. Techniques of advanced genome and epigenome editing tools for manipulation of beneficial microorganisms.
3. Application of genetically engineered microorganisms in environment.
4. Role of genetically modified organism in food and pharmaceutical industries.
5. Biodegradation, Bioremediation and Ore leaching.

Assignment II- 501502– Microbial Biotechnology (Major Elective -4 Credits)

1. Recombinant protein and microbial pharmaceutical production.
2. Advances of industrially important *Streptomyces* sp., and Yeast for cloning and expression hosts (biologicals production).
3. Downstream processing approaches used in industrial production process.
4. Application of microbes and microbial processes in food and healthcare industries.
5. Genetically modified yeast and its industrial applications.
6. Limits of microbial genomics with respect to use in human welfare.
7. Applications of metagenomics and metatranscriptomics in animal and plant health, environmental clean-up, global nutrient cycles & sustainability.
8. Metagenomic library construction.

501503– IPR, BIOSAFETY AND BIOETHICS (Major-Elective-4 credits)

COURSE DEPICTION

Program	**M.Sc. Biotechnology**
Course Title	**IPR, Biosafety and Bioethics/ 501503**
Name of Course Teacher	**Dr. M. Ramesh**
Mobile: +91 7904270252	**Email : mrbiotech.alu@gmail.com**

Course Brief

IPR, Biosafety and Bioethics is one of the interesting general elective courses designed for the aspiring students to understand the rules and regulations governing various types of IPR. This elective course is an advance level course and students must have an understanding of introductory undergraduate level course such as chemistry, biology, microbiology, plant and animal biology and molecular biology. Overall the course explain the basic concepts of Intellectual Property Rights, Biosafety, Bioethics and their relevance for science and technology and develop basic understanding of national and international IPR regime. During the last two decades, considerable number of advances has been made in application of biotechnology for the benefit of human being in field of agriculture, medicine, and industrial production. In order to approve those new technologies, intellectual property i.e. legally enforceable rights resulting from intellectual activity in the industrial and scientific fields is very important. In this course, safety concerns and ethical issues on application of biotechnology will be discussed under the current issues associated with the benefits and risk concerns on biotechnology. Biotechnology students supposed to understand the basic concepts of patent rights and follow the regulatory framework important for the product safety and benefit for the society. Thorough understanding of this course will creates awareness on the patenting of biotechnological processes and products and makes students aware about the regulation of bioethics and the biosafety rules and understands the laws governing biotechnology and related field at national and international level. The course also helps them to gain knowledge about precautions (for example basic and Good Laboratory Practices (GLP), Standard Operating Procedures (SOP) necessary during biotechnological work and to understand the ethical perspective of handling potentially harmful biomaterials. In this course, safety concerns and ethical issues on application of biotechnology will be discussed under the current issues associated with the benefits and risk concerns on biotechnology.

Course Objectives

The objectives of the course is to make the students

1. Be aware / understand the laws governing patents, trade secrets, copy rights and trademarks with special emphasis to biotechnology at national and international level.
2. Familiarize with various criteria of patents
3. Sort out the requirements of patent and trade secret
4. Get acquainted with principles of biosafety and gain knowledge about basic and advanced laboratory practices and safety precautions followed during biotechnological work
5. Understand the ethical perspective of handling biomaterials including transgenic plants and animals
6. Be aware of the general guidelines for research in microorganisms, animals and plants
7. Follow Good Laboratory Practices during practical's and dissertation works
8. Gain Ethical, Legal and Social Implications of Human Genome Project

Course Outcomes

On successful completion of IPR elective course, students should be able to:

1. Understand the concepts, criteria, and importance of IPR
2. Analyze the basic principles and legal framework of intellectual property rights and its application to biotechnology
3. Understood the basic issues of IPR Biosafety and Bioethics. It is expected that they will be more confidant to practice and implement all these policies in their future endeavour.
4. Create awareness on the Biosafety, Bioethics and patenting of biotechnological processes and products.
5. Define biosafety and bioethics in the context of modern biotechnology, demonstrate good laboratory procedures and practices, describe the standard operating procedures for biotechnology research
6. Follow Biosafety practices in appropriate Biosafety labs

Course outline

1. Role of international agencies such as GATT, WTO and WIPO and National agencies- RCGM, GEAC and IBSC
2. Salient features of physical and intellectual Property, tangible and intangible property
3. Different types of IPR - Patents, Trade mark, Trade secret, Copy right and Geographical Indications and their requirement
4. Biotechnological examples of patent, trade mark, trade secret, and copy right
5. Rules governing patents
6. Case studies on Basmati rice, Turmeric, and Neem patents
7. Indian Patent Act 1970 and amendments
8. Levels of Biosafety

9. Guidelines for rDNA research activities in microbes, plants and animals
10. Assessment of risks associated with GMO
11. Bioethics and animal rights
12. General issues related to the release of transgenic plants, animals and microorganisms.
13. Embryonic stem cell cloning and its ethics
14. ELSI of Human Genome Project.

Course Schedule: Major Elective: III-IPR, Biosafety and Bioethics (4 Credits)

Syllabus	Schedule
Unit-1: Introduction. Definitions. General Agreement on Trade and Tariff (GATT) and World Trade Organization (WTO). Establishment and functions of GATT, WTO and WIPO. WTO Guidelines and Summits. Physical and Intellectual Property. Tangible and Intangible properties. Roles of IBSC, RCGM and GEAC.	**9 Days (1h/day)**
Unit-2: TRIPS. Different types of intellectual property rights (IPR) - Patents, Trade mark, Trade secret, Copy right and Geographical Indications. Requirement of patentability. Compulsory licences. Biotechnological examples of patent, trademark, trade secret, copy right. Traditional Knowledge.	**7 Days (1h/day)**
Unit -3 : Indian, US and European Patent application, Basics and types of patent, Disclosure and non-disclosure, Filing of a patent. Rules governing patents. Patent procedures and cost, patent infringement. Budapest Treaty, Patent Cooperation Treaty (PCT) and implications. Patent related cases. Licensing - Flavr Savr™ tomato as a model case. Biopiracy and case studies on patents (Basmati rice, Turmeric, and Neem). Indian Patent Act, 1970 and recent amendments	**9 Days (1h/day)**
Unit -4: Biosafety-Introduction. Different levels of Biosafety. GRAS organisms. Guidelines for rDNA research activities. General guidelines for research in transgenic plants, Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP). Containments- Types. Basic Laboratory and Maximum Containment Laboratory. The Cartagena Biosafety protocol (CAB). Assessment of risks associated with GMO.	**8 Days (1h/day)**
Unit -5 : Bioethics-Introduction. Animal Rights/welfare. General issues related to environmental release of transgenic plants, animals and microorganisms. Ethical issues related to research in embryonic stem cell cloning. Ethical, Legal and Social Implications (ELSI) of Human Genome Project. Plagiarism.	**8 Days (1h/day)**
Days assigned for CIA Tests, Quizzes, Seminars, etc.	**8 Days (1h/day)**

Text Books

1. Recombinant DNA safety guidelines (January 1990), Department of Biotechnology, Ministry of Science & Technology, Government of India, New Delhi.
2. Revised guidelines for research in Transgenic plants (August 1998), Department of Biotechnology, Ministry of Science & Technology, Government of India, New Delhi.
3. Patents (2003), N.Subbaram, Pharma Book Syndicate, Hyderabad.
4. Bioethics and Biosafety (2013) M.K.Sateesh, I.K.International Pvt. Ltd, New Delhi, India, ISBN 8190675702,9788190675703
5. Intellectual Property Rights (2008) Prabuddha Ganguly, Tata McGraw Hill Publishing Company, India. ISBN: 9780070077171 9. http://www.patentoffice.com/index.php.
6. Office of the Controller General of Patents, Design & Trademarks; Department of Industrial Policy & Promotion; Ministry of Commerce & Industry; Government of India. http://www.ipindia.nic.in/
7. World Trade Organisation. http://www.wto.org
8. World Intellectual Property Organisation. http://www.wipo.int
9. Craig, W., Tepfer, M., Degrassi, G., & Ripandelli, D. (2008). An Overview of General Features of Risk Assessments of Genetically Modified Crops. Euphytica, 164(3), 853-880. doi:10.1007/s10681-007-9643-8

Reference Books

1. IPR, Biosafety and Bioethics. Shomini Parashar, Deepa Goel, Pearson India (2013) ISBN: 9788131774700
2. Molecular Biotechnology: Principles and Applications of Recombinant DNA (2010), 4th Edition, Glick, B.R., and Pasternack, J.J., ASM Press, Washington, DC.

More books to Read and Refer

Author (s)	Title
V. Sree Krishna (2007)	Bioethics and Biosafety in Biotechnology
H.S.Chawla (3rd Edition)	Introduction to Plant Biotechnology
Deepa Goel and Shomini Parashar (2013)	IPR, Biosafety and Bioethics
Anupam Singh and Ashwani Kumar Singh, 1st edition	Intellectual property rights and biotechnology: Biosafety and Bioethics
Padma Nambisan, 2017	An introduction to Ethical, Safety and Intellectual Property Rights Issues in Biotechnology
Sylvia Engdahl, 2010	Intellectual Property Rights

Assignment I - 501503– IPR, Biosafety and Bioethics (Major Elective -4 Credits)

1. Organizational structure of WTO.
2. Physical and Intellectual Property.
3. Requirements of patentability.
4. Requirements of Patent and Trade secret.
5. Implications of Patent Cooperation Treaty.
6. Flavr Savr™ tomato is ethically safe- Discuss.

Assignment II - 501503– IPR, Biosafety and Bioethics (Major Elective -4 Credits)

1. Various steps involved in filing of a patent.
2. Good Laboratory Practices.
3. Importance of Cartagena Biosafety protocol.
4. General issues related to environmental release of transgenic animals.
5. Different types of Containments
6. Legal and Social Implications of Human Genome Project.

501504- DEVELOPMENTAL BIOLOGY (Major Elective-4 credits)

COURSE DEPICTION

Program	**M.Sc. Biotechnology**
Course Title/ Code	**Developmental Biology/ 501504**
Name of Course Teacher	**Prof. S. Karutha Pandian**
Mobile: +91 9442318144	**Email : sk_pandian@rediffmail.com**

Course Brief

Developmental biology deals with the basic concept of cell growth and development. It describes the process of how a single cell become a multicellular organism and end up with many different cell types organized into the tissues and organs of the body. It provides a detailed view of how these are regulated genetically during the cell growth, differentiation, and morphogenesis. It addresses the mechanism underlying the developments in plants, animals and insect and how these developments changes during the evolution. In addition, it also deals with the embryology which covers from the production of gametes, fertilization, zygote formation and development of embryo to the senescence and death. The stem cell represents an exciting area in medicine because they are capable of developing into any type of specific cell that serve numerous functions in different parts of the body. Tissue regeneration is the most important application of the stem cell research. Besides, it is used in cardiovascular disease treatment, brain diseases such as Parkinson's and Alzheimer and blood related treatments such as leukemia and sickle cell anemia. Developmental biology is one of the fastest growing and most exciting fields in biology, creating a framework that integrates molecular biology, physiology, cell biology, anatomy, and cancer research.

Course Objectives

The objectives of the course is to make the students

1. Understand the concepts of cell development and their organization into tissues in different organisms
2. To better understand the molecular mechanisms regulating the cell development, morphogenesis, programmed cell death and senescence.
3. learn gametogenesis, fertilization, and embryo development in plants and animals
4. learn morphogenesis and organogenesis in model organisms

Course Outcomes

On successful completion of Developmental Biology course, students will be able to:

1. Acquire in-depth knowledge on the mechanisms of development, differentiation and growth in animals and plants at molecular, cellular and genetic level
2. Understand the advances in stem cell research and therapeutic development
3. Learn the tools of developmental biology in recent drug discovery efforts and its utilization in the treatment of human diseases

Course Outline

1. Basics concepts in the cell development
2. Transgenics in analysis of development
3. Gametogenesis, fertilization and early development
4. Embryo sac development and double fertilization in plants
5. Establishment of symmetry in plants and animals
6. Cell differentiation in model organisms such as *Dictyostelium, Drosophila,* chick and *Caenorhabditis elegans*
7. Organ development in plants
8. Floral meristems and floral development in *Arabidopsis* and *Antirrhinum*
9. Aging and apoptosis

Course Schedule: Major Elective: IV - Developmental Biology (4 Credits)

Syllabus	Schedule
Unit 1: Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development	**8 Days (1h/day)**
Unit 2: Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination.	**7 Days (1h/day)**
Unit 3: Morphogenesis and organogenesis in animals : Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in Drosophila, amphibia and chick; organogenesis – vulva formation in *Caenorhabditis elegans*, eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons, post embryonic development- larval formation, metamorphosis; environmental regulation of normal development; sex determination.	**10 Days (1h/day)**

Unit 4: Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in Arabidopsis and Antirrhinum	**8 Days (1h/day)**
Unit 5: Programmed cell death, aging and senescence.	**7 Days (1h/day)**
Days assigned for CIA Tests, Quizzes, Seminars, etc.	**8 Days (1h/day)**

Reference Books

1. Developmental Biology 9th Edition. (2010) by Gilbert FS, Sinauer Associates, Inc.
2. Principles of Development 4th Edition. (2011) by Lewis Wolpert and Cheryll Tickle, Oxford University Publication.
3. Essential Developmental Biology 3rd Edition (2012) by Jonathan M. W. Slack, Wiley-Blackwell.
4. Developmental Biology: A Very Short Introduction 1st Edition (Very Short Introductions) (2011) by Lewis Wolpert , Oxford University Publication
5. Current Topics in Developmental Biology (2004) by Gerald P. Schatten Academic Press

Assignment I: 501504 – Developmental Biology (Major Elective -4 Credits)

1. Basic concepts in Developmental Biology
2. Cell fate and cell lineages.
3. Genomic equivalence
4. Morphogenesis of the *C. elegans* vulva.
5. Gametogenesis.
6. Development of symmetry in plants
7. Different stages of plant embryogenesis.
8. Process of seed germination in plants.
9. Dictyostelium life cycle.
10. Importance of dictyostelium

Assignment II: 501504 – Developmental Biology (Major Elective -4 Credits)

1. Drosophila embryogenesis.
2. Development and axis formation in amphibians.
3. Organogenesis in chick.
4. Development of the vertebrate Eye.
5. Neuronal differentiation
6. Metamorphosis.
7. Genetic mechanisms of sex determination.
8. Morphogenesis of Arabidopsis.
9. Organogenesis of Antirrhinum.
10. Programmed cell death in aging.

501505- HUMAN MOLECULAR GENETICS (Major Elective-4 credits)

COURSE DEPICTION

Program	**M. Sc. Biotechnology**
Course Title/ Code	**Human Molecular Genetics/501505**
Name of Course Teacher	**Prof. S. Karutha Pandian**
Mobile: +91 9442318144	**Email: sk_pandian@rediffmail.com**

Course Brief

Human Molecular Genetics is the area of study principally deals with biomedical research, medicine, genetic counseling and clinical genetics. This course is expected to introduce current advancement in our understanding about the role of human genome in various diseases and human health. The course will enlarge the existing knowledge on basic concepts of chromosome organization, human inheritance, pedigree analsyis, chromosal and extra-chromosal genetic defects and their detection by chromose analysis. The course will clearly explain the molecular basis of various genetic diseases and their correlation with human genome and environment.

Course Objectives

To make the students:

1. To understand the structure and chemical nature of human chromosome
2. Knowledgeable in Mendelian disorders: autosomal dominant and autosomal recessive and also genetic and physical mapping
3. Know about the X and Y-linked inheritance
4. Understand the chromosomal analysis through karyotyping and its role in determining chromosomal abnormalities-associated disorders
5. Familiar with the techniques used in detection of known and unknown mutations

Course Outcomes

On successful completion of Human Molecular Genetics course, the students shall be able to:

1. Understand the importance of Genome Organization in Human Disease and Health.
2. Describe wide applications of karyotyping in human disease and inheritance.
3. Explain various types of Autosomal and Sex-linked inheritance.
4. Understand the arrangement of chromosomes in normal and various disease conditions.
5. Illustrate role of epigenetics in Human Diseases.
6. Understand the molecular basis of various inheritance and metabolic diseases such as Phenylketoneurea, Duchene Muscular Dystrophy, Sickle cell anemia, β-Thalassemia, retinoblastoma, cystic fibrosis, Alzheimer's disease, diabetes,

Course Outline

1. Fundamental concepts of chromosomal organization.
2. Chromosome aberrations and abnormalities.
3. Autosomal and Sex-linked inheritance.
4. Pedigree construction using molecular genetic data and family history.
5. Genetic susceptibility in complex traits.
6. Various metabolic and genetic disorders.
7. Extrachromosomal inheritance and Mitochondrial syndromes.
8. DNA testing for mutation detection.
9. Cytogenetics techniques to determine developmental disabilities in children.

Course Schedule: Major Elective: V Human Molecular Genetics (4 Credits)

Syllabus	Schedule
Unit -1: Human Chromosomes: Structure and Chemical nature, Heterochromatin and euchromatin, Linkage and crossing over, Chromosome aberrations and abnormalities, Autosomal inheritance- dominant, recessive; Sex-linked inheritance- X-linked recessive, dominant; Y–linked; Sex-limited and sex-influenced traits; Mitochondrial inheritance; MIM number, Pedigrees- gathering family history; Pedigree symbols; Construction of pedigrees; Presentation of molecular genetic data in pedigrees; Pedigree analysis of monogenic traits Complications to the basic pedigree patterns I: Non-penetrance, variable expressivity, pleiotropy, onset, dominance problem; Anticipation;Compound heterozygosity.	**8 Days (1h/day)**
Unit -2: Complications to the basic pedigree patterns II: Genomic imprinting and uniparental disomy; Spontaneous mutations; Mosaicism and chimerism; Male lethality; X-inactivation; Consanguinity and its effects in the pedigree pattern; Allele frequency in population; Complex	**9 Days (1h/day)**

traits-polygenic and multifactorial: Approaches to analysis of complex traits- 'Nature *vs* nurture'; Role of family and shared environment; Monozygotic and dizygotic twins and adoption studies; Polygenic inheritance of continuous (quantitative) traits, normal growth charts, Dysmorphology; Polygenic inheritance of discontinuous (dichotomous) traits – threshold model, liability and recurrence risk; Genetic susceptibility in complex traits; Alcoholism, cardiovascular disease, diabetes mellitus, obesity & epilepsy; Estimation of genetic components of multifactorial traits: empiric risk; Heritability; Coefficient of relationship; Application of Bayes' theorem.	
Unit -3: Detection of genetic defects, Gene polymorphism, Metabolic and genetic disorders, Phenylketoneurea, Duchene Muscular Dystrophy, Sickle cell anemia, β-Thalassemia, retinoblastoma, cystic fibrosis, Alzheimer's disease, diabetes, X-linked CGD, Mitochondrial syndromes, management of genetic disorders.	**7 Days (1h/day)**
Unit -4: DNA Fingerprinting, Prenatal molecular diagnostics-CVS and amniocentesis, pre-implantation test-Medico, legal, social, ethical and legal aspects of molecular diagnostics, Paternity dispute-Personal identification and identity of descent by molecular methods, Human disease gene detection-SNP detection, hybridization based assays (Allele specific probes), polymerization based assays (Allele specific nucleotide incorporation, allele-specific PCR), Ligand based assay (Allele specific oligonucleotide ligation).	**8 Days (1h/day)**
Unit-5: DNA Testing-Direct testing-Screening for unknown mutations, detection of known mutations, Indirect testing-gene tracking, Mutational screening, loss of function and gain of function, Molecular Pathology-from genes to disease and from disease to genes, Epigenetics, Comparative genomics for human disease identification-Proteome tools in human disease diagnosis, Identification of diseased gene/locus, Chromosome analysis, karyotyping and chromosome banding, molecular cytogenetics, Nucleic acid hybridization assays, FISH, Fiber FISH, m-FISH	**8 Days (1h/day)**
Days assigned for CIA Tests, Quizzes, Seminars, etc.	**8 Days (1h/day)**

Text Book

1. Lewis, Human Genetics, 7th Edition, WCB & McGraw, 2007.

Reference Books

1. Amita Sarkar, Human Genetics, Vol.1&2, Dominant Publishers, 2001.
2. Amita Sarkar, A Textbook of Human Genetics, Wisdom, 2011.
3. Daniel L.Hartl, Genetics: Analysis of Genes & Genomes, Deep & Deep Publication, 1998.
4. Tom Strachan of Andrew P.Read, Human Molecular Genetics, John Wiley & Sons, 1999.
5. Robert, Principles of Genetics, T M H, 2002.
6. Pastemak, An Introduction to Molecular Human Genetics, 2nd Edition, Fritzgarald, 2005.
7. Mange and Mange, Basic Human Genetics, 2nd Edition, Sinauer Assoc, 1999.
8. Vogel and Motulsky, Human Genetics, 3rd Edition, Springer Verlag, 1997.
9. Strachen and Read, Human Molecular Genetics, 3rd Edition, Garland Sci. Publishing, 2004.
10. Maroni, Molecular and Genetic Analysis of Human Traits, 1st Edition, Wiley-Blackwell, 2001.
11. How1ey and Mori, The Human Genome, Academic Press, 1999.

More Books to Read and Refer

Author (s)	Title
Daniel L Hartl.	Essential Genetics, 6th Edition (2014)
Williams S Klug, Michael R Cummings, Charolette A Spencer and Michael A Palladino	Concepts of Genetics, 10th Edition (2012)
S. B. Primrose and R. M. Twyman	Principles of Gene Manipulation and Genomics, 8th Edition (2016)
Susan Elrod	Genetics, T M H (2009)
Ajoy Paul	Textbook of Genetics-From Genes to Genomes, Books & Allied (2012)

Assignment I: 501505 – Human Molecular Genetics (Major Elective -4 Credits)

1. Structural organization of human chromosome.
2. Chromosome aberrations and its types.
3. Record of human genome in disease prediction and prevention.
4. Autosomal and Sex-linked inheritance.
5. Pedigree analysis and the symbols that used to construct pedigree.
6. Application of Bayes' theorem.

Assignment II: 501505 – Human Molecular Genetics (Major Elective -4 Credits)

1. Inherited metabolic disorders, their symptoms and causes.
2. Numerical and structural chromosomal abnormalities.
3. Karyotype and the role of Karyotyping in human health.
4. Genetic variations in Human Disease: Methods for human disease gene detection.
5. Detection of known and unknown mutation by DNA testing.
6. Key role of epigenetics in Human Diseases and Disease prevention.

501506- FERMENTATION AND BIOPROCESS TECHNOLOGY
(Major Elective- 4 Credits)
COURSE DEPICTION

Program	**M. Sc. Biotechnology**
Course Title/Code	**Fermentation and Bioprocess Technology/501506**
Name of Course Teacher	**Dr. A. Veera Ravi** **Dr. S. Gowrishankar**

Course Brief

The fundamental objective of the course is to provide students with an extensive and concise knowledge about bioprocess principles and strategies to optimize the production of byproducts from industrial important microbial strains. Students will learn the concepts of bioprocessing and its application in industries, media design, cultivation, fermentation technology, bioreactor design and optimization of cellular behavior. The laboratory component provides the hands-on experience benefitting the students with right skills required for industrial, academic and research career. Further, this course also provides exposure to understand the basic concepts and fundamental principles of the fermentor.

Through this course, students will understand the fundamental concepts of fermentation; aerobic and anaerobic fermentation, production of biotechnologically important products, exopolymers and steps involved in upstream and downstream processes.

Course Objectives

Furnish themselves with thorough knowledge of the fundamental science and methodologies in the various concepts of fermentation. This area is increasingly important in all forms of biotechnology.

1. Understanding of strain improvement and knowing the isolation and screening of industrially important microbes.
2. To impart in-depth knowledge on the cutting-edge techniques and glimpse on various experimental approaches such as sterilization, fermentation, agitation and Computer application in control of bioprocess.
3. Impart practical skills to the students to immobilize industrially important enzymes for fermentation processes.

Course Outcomes

The students shall be able to

1. Describe the basic concepts and theories of the growth kinetics of microbial cells
2. Recognize the fundamentals of fermentation technology.
3. Assess power requirements in bioreactors, modeling of bioprocesses, traditional and new concepts in bioprocess monitoring, and the biological basis for industrial fermentations and cell cultures.
4. Understand the differences between aerobic and anaerobic fermentation and the classification of microorganisms based on their respiratory action.
5. Use the most common equipment, materials and methods related to fermentation processes, microbial growth and cultivation and sterilization.
6. Produce, analyze and interpret data from bioprocesses.

Course Outline

Concepts on basic principles of Biochemical Engineering. Isolation and screening of industrially important microbes etc.,

1. Medium Design and kinetics of microbial cell cultivation.
2. Basic knowledge on bioprocess principles and strategies to optimize the industrial cellular strains.
3. The significant features of improvement of strains for increased yield and other desirable characteristics.
4. The cutting-edge techniques and experimental approaches of various fermentation technologies, Bioreactor design principles and operating mode.
5. Instrumentation and control of bioprocesses, Demonstration of various parts with the Laboratory Fermenter.
6. Basic principles of Cell Separation: Filtration and Centrifugation etc. and Cell disruption – Mechanical & Non-mechanical methods.
7. Experimental approach on Bioprocess for the production of biomass, primary and secondary metabolites.
8. Fundamentals of Cell and Filtrate Processing: Precipitation, Centrifugation, Filtration, Dialysis, Reverse osmosis, Chromatography, Drying, Crystallization and Product Formulation
9. Biotechnologically important Antibiotics (β-lactum), Solvents (acetone) Amino acid (Lysine), Organic acids (Citric acid), Alcohols (Ethanol), Ind. Enzymes (Protease/Amylase) and Biopharmaceuticals (Insulin/Interferon etc.)

Course Schedule: Major Elective: VI - Fermentation and Bioprocess Technology (4 Credits)

Syllabus	Schedule
Unit -1: Basic principles of Biochemical Engineering. Isolation and screening of industrially important microbes. Improvement of strains for increased yield and other desirable characteristics.	**7 Days (1h/day)**
Unit -2: Concepts of basic modes of fermentation - Batch, Fed batch and Continuous fermentation. Bioreactor designs. Air and media sterilization, Aeration & agitation in bioprocess. Scale up fermentation processes. Instrumentation & control bioprocess. Computer application in control of bioprocess.	**10 Days (1h/day)**
Unit -3: Fermentation economics of large-scale fermentation.	**10 Days (1h/day)**
Unit -4: Downstream processing. Bioprocess for the production of biomass, 5 Days primary and secondary metabolites, extracellular enzymes, biotechnologically important intracellular products and exopolymers.	**7 Days (1h/day)**
Unit-5: Immobilization of enzymes and microbial cells, Secondary metabolites.	**8 Days (1h/day)**
Days assigned for CIA Tests, Quizzes, Seminars, etc.	**8 Days (1h/day)**

Text Book

1. Principles of Fermentation Technology (2003), P.F. Stanbury, A.Whitaker and S.J.Hall, Butterworth Heinemann.
2. Bioprocess Engineering Principles. 2nd Edition (2013), P. M. Doran, Academic Press, Harcourt Brace and Company, Publishers.

Reference Books

1. Comprehensive Biotechnology. The Principles, Applications and Regulations of Biotechnology in Industry, Agriculture and Medicine, Vol 1, 2, 3 and 4 (2004). Edited by M. M. Young, Reed Elsevier India Private Ltd, India.
2. Fermentation Microbiology and Biotechnology (2002) by E.M.T.EL. Mansi and C.F.A. Bryle, Taylor & Francis Ltd, UK.
3. Biotechnology: A Textbook of Industrial Microbiology (2000), Wulf Cruege and Anneliese Crueger, Punima Publishing Corporation, India.
4. Bioprocess Engineering Principles (2012), Doran, P.M, Academic Press.

More books to Read and Refer

Author(s)	Title
W. Crueger & A. Crueger	Biotechnology: A Text Book of Industrial Microbiology
M. Shuler and F. Kargi	Bioprocess Engineering
Wei-Shou Hu	Cell Culture Bioprocess Engineering
Moser, A	Bioprocess technology, kinetics and reactors

Assignment I: 501506 – Fermentation and Bioprocess Technology (Major Elective -4 Credits)

1. History and types of fermentation.
2. Microbial Growth Kinetics: Growth, substrate utilization and product formation.
3. Fermentation Media: Formulation, carbon, nitrogen, oxygen, minerals sources, etc.
4. Sterilization: Sterilization of air and medium; sterilization of fermentor, thermal death kinetics of microorganisms.
5. Bioreactor Design

Assignment II: 501506 – Fermentation and Bioprocess Technology (Major Elective -4 Credits)

1. Physical Processes in Fermentation System: fluid flow and mixing, mass and heat transfer.
2. Bioreactor Operation Systems: stirred tank reactor (batch, semi-batch, continuous), bubble column, airlift and packed bed.
3. Specialty products and industrial chemicals.
4. Current Bioprocess Technology, Products, and Opportunities.
5. Strategies for the improvement of secondary metabolite production in microbial cell cultures.

501507–PHARMACOGENOMICS (Major Elective-4 credits)

COURSE DEPICTION

Program	**M. Sc. Biotechnology**
Course Title/ Code	**Pharmacogenomics/501507**
Course Teacher	**Dr. K. Balamurugan**
Contact email	**bsuryar@yahoo.com**

Course Brief

Pharmacogenomics is the study which analyses the response of genetic makeup of an individual against a particular drug. The main aim of pharmacogenomics is to optimise personalized drug therapy with relevance to the patient's genotype. This could ensure maximum efficiency of the drug with minimum side effects. The paper has all the basic and necessary tools required for understanding the pharmacogenomics related developments in the future. Computer aided drug designing and analysis of latest data on human transcriptomics play a critical role in pharmacogenomics.

Course Objectives

1. To understand the basic concept and tools used in computational analysis
2. To learn the principle and application of docking and to use it to design the 3D structure of ligands binding to molecules
3. To explore the applications in the field of pharmacy (Toxicity analysis, drug development, etc.)
4. To equip the students with necessary hands on skill which will help them to pursue a career in this field

Course Outline

The subject content includes interdisciplinary concepts that provide a wide berth to serve students from various fields such as Botany, Zoology, Biochemistry, Microbiology, Veterinary Science, Biotechnology, Nanotechnology, Molecular Biology, Structural Biology, Bioinformatics and Bioengineering. The understanding of basic biology along with basic knowledge in computer operation is important to comprehend the use of advanced technology to aid the analysis of pharmacogenomics. The subject has been divided into five units covering basic concepts to computer tools used for applications in the field of Pharmacy and to provide a better idea of the concept dealt.

Course Schedule: Major Elective: VII - Pharmacogenomics (4 Credits)

Syllabus	Schedule
Unit-1: Computational Chemistry: Concepts of computational chemistry, Born-Oppenheimer approximations, Application of Hartree- Fock equations to molecular systems, approximate Molecular orbital theories, semi-emperical methods	**8 Days (1h/day)**
Unit -2: Docking and Drug Design: DOCK algorithm, Discovery and design of new drugs, computer representation of molecules, 3D database searching, scoring functions, Pharmacophore keys, Structure-based De Novo Ligand design, Quantitative Structure Activity Relationship QSAR, Combinatorial libraries	**9 Days (1h/day)**
Unit-3: Clinical Applications of Pharmacogenetics/Pharmacogenomics in HIV, Pharmacogenomic based therapeutic applications	**8 Days (1h/day)**
Unit -4: Genetics effects to predict efficacy of toxicity, ADMET, Virtual screening, Combinatorial library designing	**8 Days (1h/day)**
Unit-5: Pharmocogenomics related curated Databases. Pharmacogenomics and the Future of Pharmaceuticals	**7 Days (1h/day)**
Days assigned for CIA Tests, Quizzes, Seminars, etc.	**8 Days (1h/day)**

Text and Reference Books

1. Molecular Modelling, Principles and Applications, II Edition, A.R. Leach, 2001, Prentice Hall
2. Pharmocogenomics and Proteomic enabling the practice of personalized medicine, Steven H. Y. Wong, 2006, American Association for Clinical Chemistry
3. Pharmocogenomics applications to patient care ACCP, 2004, American College of Clinical Pharmacy
4. Drug Discovery Research- New frontiers in the Post- Genomic Era (2007), by Ziwei Huang, Wiley- Interscience.
5. Guidebook on Molecular Modeling in Drug Design (1996), Edited by N. Claude Cohen Academic Press.

More Books to Read and Refer

Author (s)	Title
Yui-Wing Francis Lam and Stuart Scott	Pharmacogenomics (2018)
Yui-Wing Francis Lam and Larisa H. Cavallari	Pharmacogenomics - Challenges and Opportunities in Therapeutic Implementation (2013)
Xiaodong Feng and Hong-Guang Xie	Applying Pharmacogenomics in Therapeutics (2016)

Assignment I: 501507 – Pharmacogenomics (Major Elective -4 Credits)

1. Concepts of computational chemistry briefly.
2. Born-Oppenheimer approximations in Computational Chemistry.
3. DOCK algorithm, Discovery and design of new drugs in Docking and Drug Design.
4. Computer representation of molecules, 3D database searching and scoring functions in Docking and Drug Design.
5. Clinical Pharmacogenetics/Pharmacogenomics in HIV.
6. Genetics effects to predict efficacy of toxicity.
7. Genetics effects to predict efficacy of ADMET.
8. Pharmocogenomics related curated Databases.
9. Current studies of Pharmacogenomics.

Assignment II: 501507 – Pharmacogenomics (Major Elective -4 Credits)

1. Hartree-Fock equations to molecular systems, approximate Molecular orbital theories and semi-emperical methods.
2. Application of Hartree-Fock equations to molecular systems.
3. Pharmacophore keys and structure of based on *De Novo* Ligand design.
4. Quantitative Structure Activity Relationship (QSAR) and Combinatorial libraries.
5. Pharmacogenomic based therapeutic applications.
6. Genetics effects to predict efficacy of the Virtual screening.
7. Genetics effects to predict efficacy of the Combinatorial library designing.
8. Early stage studies of Pharmaceuticals.
9. Future of Pharmaceuticals.

501508– EMERGING TECHNOLOGIES IN BIOTECHNOLOGY

(Major Elective-4 credits)

COURSE DEPICTION

Program	**M. Sc Biotechnology**
Course Title/ Code	**Emerging Technologies in Biotechnology/ 501508**
Course Teacher	**Dr. K. Balamurugan**
Contact email	**bsuryar@yahoo.com**

Course Brief

In the past decades, there was a need for advanced technologies to study and understand the underlying molecular mechanisms of cellular systems at different conditions. This course includes the highly significant technologies (starting from advanced microscopic technologies to genome editing technologies) that are frequently used in Biotechnology. This subject is aimed to impart the basic knowledge of widely used technologies to the students to make them study about their applications in various fields of biotechnology.

Course Objectives

This course is a broad-based in nature encompassing several new technologies that current experimental researchers are employing to probe complex system biology questions in life-sciences. The objectives of this course are to teach basics of the new principles to students so as to appreciate current-day research tool-kit better.

Course Outline

UNIT 1: This unit will make the students to understand the basic concepts of advanced microscopic techniques along with the working principles. Many of the mentioned microscopic techniques are widely used by the researchers in a number of fields to study the molecular events in deeper.

UNIT 2: This unit deals with the basics of mass spectrometric techniques in order to study the dynamic changes in the proteins and peptides with more attention to post translational modifications of amino acid residues. Meanwhile, a part of the unit is designed to study about the basics of advanced 3D imaging techniques using the mass spectrometric technologies.

UNIT 3: The students will study the basics of OMICS in this unit. A part of this unit covers the importance of bioinformatics to predict the structures and models. Vaccine technology is one of the important technologies whereas the basics, principles and the applications of several vaccines are covered in this unit.

UNIT 4: Structural biology and Nanobodies will be elaborately studied in this unit with special reference to characterization techniques such as XRD, AFM, NMR, etc.

UNIT 5: Genome editing (CRISPR-CAS technology) is a one of the few technologies that can able to change an organism's DNA. CRISPR-CAS allows a genetic material to be added, removed, or altered at specific locations in the target genome. This unit will impart a clear knowledge to the students in respect of utilizing the genome editing technology.

Course Outcome

Students will learn history, theoretical basis and basic understanding of latest technologies in the area of biotechnology. They will be able to learn about various applications of these emerging technologies. The students may also learn the applications in depth through assignments and/or seminars.

Course Schedule: Major Elective: VIII - Emerging Technologies in Biotechnology (4 Credits)

Syllabus	Schedule
Unit-1: Advances in optical microscopy Microscopy: Confocal microscope: scanning optical microscope, confocal principle, resolution and point spread function, light source: gas lasers & solid-state, primary beam splitter; beam scanning, pinhole and signal channel configurations, detectors; pixels and voxels; contrast, spatial sampling: temporal sampling: signal-to-noise ratio, multichannel images. nonlinear microscopy: multiphoton microscopy; principles of two-photon fluorescence, advantages of two-photon excitation, tandem scanning (spinning disk) microscopes, deconvolving confocal images; image processing, three-dimensional reconstruction; advanced fluorescence techniques: Fluorescence Lifetime, Fluorescence Resonant Energy Transfer (FRET), Fluorescence Correlation Spectroscopy (FCS), Evanescent Wave Microscopy; Near-Field and Evanescent Waves, Total Internal Reflection Microscopy; Near-Field Microscopy; Beyond the Diffraction Limit: Stimulated Emission Depletion (STED), Super-Resolution Summary, Super-Resolution Imaging with Stochastic Optical Reconstruction Microscopy (STORM) and Photoactivated Localization Microscopy (PALM).	**9 Days (1h/day)**
Unit-2: Mass spectrometry Ionization techniques; mass analyzers/overview MS; FT-ICR and Orbitrap, fragmentation of peptides; proteomics, Metabolomics and metabolic pathways databases, nano-LC-MS; Phospho proteomics; interaction proteomics, mass spectroscopy in structural biology; imaging mass spectrometry.	**8 Days (1h/day)**
Unit- 3: Systems biology & Vaccine technology High throughput screens in cellular systems, target identification, validation of experimental methods to generate the OMICS data, bioinformatics analyses, mathematical modelling and designing testable predictions. Vaccines: Principle & types of vaccines, drawbacks of existing vaccines, criteria for successful vaccine, peptide vaccine, minicells as vaccines, impact of genetic engineering on vaccine production, viral vector vaccines	**7 Days (1h/day)**

and AIDS vaccine chiral technology: Principle and applications, Recent advances in vaccination	
Unit-4: Structural biology and Nanobodies X-ray diffraction methods, solution & solid-state NMR, cryo-electron microscopy, small-angle X-ray scattering, Atomic force microscopy. Introduction to nanobodies, combining nanobody with phage-display method for development of antibody against native proteins, nanobody as a tool for protein structure-function studies, use of nanobodies for molecular imaging, catabolic antibodies using nanobodies.	**7 Days (1h/day)**
Unit- 5: CRISPR-CAS History of its discovery, elucidation of the mechanism including introduction to all the molecular players, development of applications for *in vivo* genome engineering for genetic studies, promise of the technology as a next generation therapeutic method.	**10 Days (1h/day)**
Days assigned for CIA Tests, Quizzes, Seminars, etc.	**8 Days (1h/day)**

Text and Reference Books

1. Spector, D. L., & Goldman, R. D. (2006). Basic methods in microscopy: protocols and concepts from cells: a laboratory manual (No. Sirsi) i9780879697471).
2. Cavanagh, J., Fairbrother, W. J., Palmer III, A. G., & Skelton, N. J. (1995). Protein NMR spectroscopy: principles and practice. Elsevier.
3. Voit, E. (2017). A first course in systems biology. Garland Science.
4. Malsch, N. H. (Ed.). (2005). Biomedical nanotechnology. Crc Press.
5. Grandi et al., Genomics, Proteomics and Vaccines. Wiley publication, 2003.
6. Baschieri, S. (2012). Innovation in Vaccinology: from design, through to delivery and testing. Springer Science & Business Media.
7. Kurstak, E. (2013). Modern vaccinology. Springer Science & Business Media.
8. Campbell, I. D. (2012). Biophysical Techniques. Oxford: Oxford University Press.
9. Serdyuk, I. N., Zaccai, N. R., & Zaccai, G. (2007). Methods in Molecular Biophysics: Structure, Dynamics, Function. Cambridge: Cambridge University Press.
10. Huang, B., Bates, M., & Zhuang, X. (2009). Super-Resolution Fluorescence Microscopy. Annual Review of Biochemistry, 78(1), 993-1016. doi:10.1146/annurev.biochem.77.061906.092014.
11. Mohanraju, P., Makarova, K. S., Zetsche, B., Zhang, F., Koonin, E. V., & Oost, J. V. (2016). Diverse Evolutionary Roots and Mechanistic Variations of the CRISPR-Cas Systems. Science, 353(6299). doi:10.1126/science.aad5147.
12. Lander, E. (2016). The Heroes of CRISPR. Cell, 164(1-2), 18-28. doi:10.1016/j.cell.2015.12.041.
13. Ledford, H. (2016). The Unsung Heroes of CRISPR. Nature, 535(7612), 342-344. doi:10.1038/535342a.
14. Jinek, M., Chylinski, K., Fonfara, I., Hauer, M., Doudna, J. A., & Charpentier, E. (2012). A Programmable Dual-RNA-Guided DNA Endonuclease in Adaptive Bacterial Immunity. Science, 337(6096), 816-821. doi:10.1126/science.1225829.

15. Sidhu, S. S., & Koide, S. (2007). Phage Display for Engineering and Analyzing Protein Interaction Interfaces. Current Opinion in Structural Biology, 17(4), 481-487. doi:10.1016/j.sbi.2007.08.007.
16. Steyaert, J., & Kobilka, B. K. (2011). Nanobody Stabilization of G Protein-Coupled Receptor Conformational States. Current Opinion in Structural Biology, 21(4), 567-572. doi:10.1016/j.sbi.2011.06.011.
17. Verheesen, P., & Laeremans, T. (2012). Selection by Phage Display of Single Domain Antibodies Specific to Antigens in their Native Conformation. Single Domain Antibodies, 81-104. doi:10.1007/978-1-61779-968-6_6.
18. Chakravarty, R., Goel, S., & Cai, W. (2014). Nanobody: The "Magic Bullet" for Molecular Imaging? Theranostics, 4(4), 386-398. doi:10.7150/thno.8006.

Seminars on inventions

1. Sir George G. Stokes and fluorescence
2. Zacharias Janssen and microscope
3. F. W. Aston and mass spectrometer
4. Edward Jenner and vaccine
5. Paulien Hogeweg and bioinformatics
6. Richard Feynman and nano
7. Wilhelm Conrad Roentgen and X-ray
8. Isidor Rabi and NMR
9. Calvin Quate and AFM
10. Jennifer Doudna and CRISPR-CAS9 system

Assignment I: 501508 – Emerging Technologies in Biotechnology (Major Elective -4 Credits)

1. Scanning optical microscope – its principle and resolution
2. Temporal sampling of spatial sampling, signal-to-noise ratio, multichannel images and principles of two-photon fluorescence.
3. Ionization techniques.
4. Metabolomics and metabolic pathways databases.
5. High throughput screens in cellular systems, target identification.
6. Validation of experimental methods to generate the OMICS data.
7. X-ray diffraction methods, solution & solid-state NMR.
8. Cryo-electron microscopy, small-angle X-ray scattering, and Atomic force microscopy.
9. History and discovery of CRISPR-CAS.
10. Mechanisms involved in the molecular players of the CRISPR-CAS.

Assignment II: 501508 – Emerging Technologies in Biotechnology
(Major Elective -4 Credits)

1. Deconvolving confocal images and its processing.
2. Evanescent Wave Microscopy.
3. Phospho proteomics and interaction proteomics.
4. Mass spectroscopy in structural biology.
5. Principle and types of vaccines.
6. Impact of genetic engineering on vaccine production.
7. Nanobodies.
8. Nanobody as a tool for protein structure and function studies.
9. *In vivo* genome engineering and genetic studies using CRISPR-CAS.
10. Next generation therapeutic methods of CRISPR-CAS.

501509 - INHERITANCE BIOLOGY (Major-Elective – 4 credits)

COURSE DEPICTION

Program	**M. Sc. Biotechnology**
Course Title/code	**Inheritance Biology/ 501509**
Name of Course Teacher	**Prof. S. Karutha Pandian**
Mobile: + 91 9442318144	**Email : sk_pandian@rediffmail.com**

Course Brief

Inheritance biology is a science that deals with heredity and the process by which characters are passed from parent to progeny. It is a fundamental body that clarified the purpose of genetic material and function of a gene. The principles of unit factors that represent the genetic basis of inheritance, understanding the structural basis of genotype and phenotype, bacterial genetics, chromosomal mapping and human genetics is essential for the basic understanding of molecular biology. This course initiates with the concept of heredity factor-gene, discusses the principles of Mendelian inheritance and its associated inheritance laws, delineate the gene mapping tools, explains extra chromosomal inheritance, defines microbial genetics and concepts of mutations and finally demarcates the human genetics of inherited diseases and disorders.

Course Objectives

To make the students:

1. Understand the units of inheritance, its transmission from generation to generation and rules that govern the inheritance and the relationship between genes and chromosomes.
2. Distinguish the position of loci on chromosome and various methods of recombination involved in the occurrence of new alleles.
3. Perceive the knowledge about the extra-chromosomal inheritance and how specifically the offspring acquires specific traits from maternal or paternal gamete.
4. Learn microbial inheritance and horizontal gene transfer methods such as conjugation, transformation and transduction.
5. Understand the heritable changes in DNA by various mutations & recombinations and these changes lead to hereditary disorders & genetic diseases.

Course Outcomes

After successful completion of the above discussed syllabus of Inheritance Biology course, students will be able to:

1. Understand the Mendalian laws of inheritance such as law of segregation and independent assortment and the importance of allele interaction in inheritance and phenotypic effects.
2. Acquire the tactics in genetic mapping analysis and the method to determine the order of loci on a chromosome and to learn process involved in new combination of alleles emerging through recombination.
3. Gain knowledge on the effects of genes outside the nucleus from organelles such as plastids and mitochondria and role of extra-chromosomal heredity in phenotypic traits acquired by the offspring.
4. Understand the various kinds of genetic mutation and their effect such as loss of function and gain of function that leads to genetic disorders.
5. Interpret the inheritance pattern of a rare mutant phenotype, sex limited and sex influenced disorders in humans.

Course Outline

1. Mendelian principles and laws of inheritance
2. Concept of genes and alleles
3. Chromosomal inheritance and sex influenced characters
4. Gene mapping tools and methods
5. Concept and recombination and its types
6. Extra chromosomal inheritance from chloroplast and mitochondria
7. Methods of gene transfer in bacteria
8. Gene structure and analysis
9. Mutation; types, causes and detection
10. Chromosomal alterations and genetic implications
11. Human genetics, inherited diseases and pedigree analysis
12. Polygenic inheritance, heritability measurements and QTL mapping.

Course Schedule: Major Elective: IX -Inheritance Biology (4 Credits)

Syllabus	Schedule
Unit-1: 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.	**8 Days (1h/day)**
Unit -2: Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development	**9 Days (1h/day)**

of mapping population in plants. Recombination: Homologous and non-homologous recombination, including transposition, site-specific recombination.	
Unit -3: Extra chromosomal inheritance: Inheritance of mitochondrial and chloroplast genes, maternal inheritance. Microbial genetics: Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes.	**8 Days (1h/day)**
Unit -4: Mutation: Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis. Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, ploidy and their genetic implications.	**8 Days (1h/day)**
Unit -5: Human genetics: Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders. Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTL mapping.	**8 Days (1h/day)**
Days assigned for CIA Tests, Quizzes, Seminars, etc.	**8 Days (1h/day)**

Text Book

1. Essential genetics: A genomic perspective. 6th edition (2014) by Hartl DL, Library of congress, USA.

Reference Books

1. Concepts of Genetics. 10th edition (2012) by Klug WS, Cummings MR, Spencer CA and Palladino MA, Pearson Education, Inc., San Francisco.
2. Lewin's Genes XI. 1st Indian Edition (2014) by Krebs JE, Goldstein ES and Kilpatrick ST, Jones and Bartlett India Pvt. Ltd., New Delhi.
3. Molecular Biology of the Gene. 6th edition (2008) by Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R, Pearson Education, Inc., San Francisco.
4. Molecular Genetics of Bacteria. 4th edition (2013) by Snyder L, Peters JE, Henkin TM and Champness W, ASM press, USA.
5. Modern Genetic Analysis: Integrating Genes and Genomes. 2nd edition (2002) by Griffiths AJF, Gelbart WM, Lewontin RC and Miller JH, W.H. Freeman and company, USA.

More books to Read and Refer

Author (s)	Title
Williams S Klug, Michael R Cummings, Charolette A Spencer and Michael A Palladino	Concepts of Genetics
Larry Snyder, Joseph E Peters, Tina M Henkin and Wendy Champness	Molecular Genetics of Bacteria,
S.R. Maloy, J. E. Cronan Jr., and D. Freifelder	Microbial Genetics
T. A. Brown	Genomes
S. B. Primrose and R. M. Twyman	Principles of Gene Manipulation and Genomics
Lodish, Berk, Matsudaira, Kaiser, Krieger, Scott, Zipursky and Darnell	Molecular Cell Biology
R. M. Twyman	Advanced Molecular Biology
Lewis	Human Genetics Concept and Applications

Assignment I: 501509 – Inheritance Biology (Major Elective -4 Credits)

1. Advantages of selecting pea plant for experiment by Mendel.
2. Mention and differentiate sex influenced and sex limited characters.
3. Test-cross.
4. Molecular markers, its types and applications.
6. Recombination - homologous and non-homologous recombination.

Assignment II: 501509 – Inheritance Biology (Major Elective – 4 Credits)

1. Extra chromosomal inheritance methods.
2. Mapping genes by interrupted mating.
3. DNA changes that leads to genetic diseases.
4. Genetic screening to detect genetic diseases.
5. QTL mapping.

SYLLABUS FOR NON-MAJOR ELECTIVE COURSES

501701–HEALTHCARE BIOTECHNOLOGY (Non-Major Elective –2 credits)

COURSE DEPICTION

Course Title	**Healthcare Biotechnology/501701**
Course Teacher	**Dr. K. Balamurugan**
Contact email	**bsuryar@yahoo.com**

Course Brief

The Healthcare Biotechnology, which includes Genetics, Clinical diagnostic systems and innovative therapies, constitutes the latest research area leading to generation of many biotechnological industries on an international level. In the last decades, the use of biotech in medicine has led to a series of important developments in several fields. This subject is designed for the students intending to develop their careers in scientific-research institutions, clinical and diagnostic laboratories, analytical services, pharmacological and pharmaceutical companies, etc. Specifically, the human healthcare, biotechnology is enabling the development and manufacturing of therapies for a number of rare diseases with a genetic origin. Students will be provided with basic information associated with human diseases due to genetic abnormalities and pathogen induced changes in the field of Healthcare biotechnology. Research and experimental design will be highlighted as students develop and conduct industry appropriate investigations.

Course Objective

1. To provide basic concepts on Molecular genetics and the dynamic nature of modern genetics, chromosomal abnormalities and related inherited diseases.
2. To provide basic idea on testing how to detect and diagnose genetic conditions in human population.
3. To impart knowledge on human infectious diseases and their causative agents. Furthermore, prevention, control and cure of those diseases by vaccination, chemotherapeutic agents and other alternate strategies (quorum sensing inhibition)
4. To provide insight on innovative medicines as well as many diagnostic and agricultural products made by applying modern biotechnology, their development and manufacturing processes.
5. To provide basic knowledge on cancer, its types, causative agents and its several modern therapeutic strategies.

Course Outcome

This course will provide basic knowledge and research developments at the interface of molecular biology and genetic engineering with special reference to human health care. This course provides students with an interdisciplinary understanding of the fundamental scientific principles, analysis techniques, and research design methodologies that are required for both practice and advanced study in the field of health care biological sciences. This course is expected to impart fundamental knowledge and human health care updates necessary for successful careers in industrial or academic roles.

Future Career Opportunities

This program will be attractive to students interested in moving directly into industry or the public sector or continuing on to a Ph.D. program in biological science. On successful completion of the course, the candidate can take up jobs in industry as Scientific Officer (Quality Assurance/ Quality Control), biological Science Project Manager, able to run the genetic diagnostic lab and also in academics as Junior Research Fellow in the National Laboratories, Assistant Professor in the Department of biological Science in various Universities in India and abroad.

Course Outline

Unit-1: This kind of study will make students understand the basic concept of DNA's structure and function**.** The effect of DNA on scientific and medical progress has been enormous. This unit will enlighten students in identifying human genes that trigger major inherited diseases. In fact, the identification of these genes and their subsequent analysis in terms of therapeutics has ultimately influenced science and will continue to do so in future.

Unit-2: This is detection techniques-based unit which will provide students about use of several diagnostics techniques in detail. A diagnosis of a genetic disorder can be made anytime during life, from before birth to old age, depending on when the symptoms of the condition appear and the availability for testing. A genetic diagnosis can also suggest whether other family members may be affected by or at risk of a specific disorder. While many genetic diseases are still incurable, understanding what causes them is the first step to successfully treating them, and hopefully a cure. In doing so may pave the pathway to formulate brand new drugs to treat these diseases.

Unit-3: Several pathogens like bacteria, fungi, viruses and parasites use to establish an infection in a susceptible host. This unit will provide important concepts about host immunity to selected infectious diseases caused by the pathogens and will impart important knowledge about pathogen strategies and pathways to cause a disease. Although both innate

immunity and adaptive immunity responses to pathogen and provides critical defense to human, they still cause death of million each year. However, wide spread use of vaccines and drug therapy has drastically reduced mortality from infectious diseases. This unit will impart several targets to design a future drug or new vaccine.

Unit-4: Application of healthcare biotechnology will provide knowledge on how to diagnose an infectious disease and cure that by referring several diagnostic products or a vaccine that consists of or has been produced in living organisms and may be manufactured by combining DNA sequences that would not naturally occur together (recombinant DNA). Today, the majority of innovative medicines like antibiotics, insulin, growth hormones, interferon's etc and as well as many diagnostic products are made by applying modern biotechnology in their development and manufacturing processes and led to a series of important developments in several fields. About 50% of all new drugs and therapies in development for the foreseeable future will originate from biotechnology, and the proportion is growing in the most innovative treatments such as vaccines, monoclonal antibodies for the treatment of cancer and inflammatory diseases/infectious diseases, cell therapy, gene therapy and regenerative medicine. This unit also provides a brief account on the Biotechnology technique, DNA fingerprinting, which has revolutionized the criminal investigations, and is an incredibly important tool for identifying the guilty, as well as liberating the innocent. DNA testing can also identify siblings, grandparents, aunts, uncles, and more. This type of testing plays an important role in legal proceedings, particularly in immigration or child custody cases; DNA testing can be used to confirm the pedigree.

Unit-5: This unit will impart important knowledge about most dreadful disease called cancer. Cancer is the name given to a collection of related diseases. This unit provides information about three main drivers of Cancer, proto-oncogenes, changes of given genes will cause the cancer. This unit will cover about many treatment options for cancer, the primary ones include surgery, chemotherapy, radiation therapy, hormonal therapy, targeted therapy and palliative care.

Course Schedule: NME: I -Healthcare Biotechnology (2 Credits)

Syllabus	Schedule
Unit- 1: DNA as genetic material: DNA structure, central dogma. Genome structure and function - Chromosome theory, Chromosome number, Abnormalities of chromosome number- ploidy. Concept of gene, Mutation, Mutagens-physical, chemical and biological agents. Inherited diseases	**8 Days (1h/day)**
Unit- 2: Diagnosis of inherited diseases- Karyotyping, DNA based diagnosis- PCR, protein and enzyme markers. Prenatal diagnosis of genetic diseases - Amniocentesis, Chorionic villus sampling, Fetoscopy, Percutaneous umbilical cord blood sampling. Population screening, carrier detection and genetic counseling, consanguinity in human population.	**8 Days (1h/day)**
Unit- 3: Infectious diseases: causative agents- Bacteria, virus, fungi, parasites; disease transmission. Prophylactic measures- General hygiene, Vaccines-	

principle, types- inactivated, attenuated, toxoid, subunit, conjugate. Control of microorganisms - antibiotics and chemotherapeutic agents, proper usage of antibiotic. Alternate strategies to control infection- quorum sensing inhibition	**8 Days (1h/day)**
Unit- 4: Application of biotechnology in healthcare: Diagnosis of infectious diseases, Production of therapeutic products- antibiotics, insulin, growth hormones, TPA, alpha interferon, Hepatitis B vaccine and Factor VIII, Forensic application- DNA Profiling, Paternity dispute, Agriculture Genetically modified foods, Medicine-Gene therapy.	**9 Days (1h/day)**
Unit- 5: Cancer- Benign and malignant, Hallmarks of cancer, Grades and stages of cancer, Causative agents- Physical, chemical and biological, therapeutic strategies- Chemotherapy, radiotherapy, stem cell therapy	**8 Days (1h/day)**
Days assigned for CIA Tests, Quizzes, Seminars, etc.	**8 Days (1h/day)**

Text and Reference Books

1. Microbiology, (2005), Sixth edition by L.M. Prescott, J.P. Harley and D.A. Klein, McGraw Hill, Boston.
2. Molecular Microbiology – Diagnostic Principles and Practice, (2004), D.H. Persing, ASM Press, Washington, USA.
3. Genetics – A Molecular Approach, 2nd Edition (2006) by Peter J. Russel
4. Laboratory Manual for Analytical Biochemistry and Separation techniques (2009). P. Palanivelu, Madurai Kamaraj University.
5. Kuby Immunology 4th Edition by Thomas J. Kindt, Richard A. Goldsby and Barbara A. Osborne. W.H.Freeman and Company
6. From Genes to Genomes – Concepts and Applications of DNA technology. 3rd Edition (2012) by Jeremy W Dale, Malcolm Von Schantz and Nick Plant.
7. Genetic modification of plants: Methods and Applications (2009) Edwin B. Herman, (Ed.), USA: Agritech Consultants, Inc.
8. Biotechnology, Academic cell update (2012) by David P. Clark, Nanette J. Pazdernik, Academic Press.
9. Essential genetics: A genomic perspective. 6th edition (2014) by Hartl DL, Library of congress, USA.
10. Concepts of Genetics. 10thedition (2012) by Klug WS, Cummings MR, Spencer CA and Palladino MA, Pearson Education, Inc., San Francisco.

More Books to Read and Refer

Author (s)	Title
Jeyabalan Sangeetha, Devarajan Thangadurai, Somboon Tanasupawat, Pradnya Pralhad Kanekar	Biotechnology of Microorganisms: Diversity, Improvement, and Application of Microbes for Food Processing, Healthcare, Environmental Safety, and Agriculture (2019)

Assignment I: 501701 - Healthcare Biotechnology (NME -2 Credits)

1. DNA structure and central dogma.
2. DNA as genetic material.
3. Chromosome theory and Chromosome number in Genome structure and function.
4. Diagnosis of inherited diseases using various molecular techniques.
5. Prenatal diagnosis of genetic diseases: Amniocentesis and Chorionic villus sampling.
6. Causative agents of bacteria, virus, fungi, parasites in the infectious diseases and disease transmission.
7. General hygiene of prophylactic measures.
8. Principles of Vaccines and its types.
9. Application of biotechnology in healthcare and diagnosis of infectious diseases.
10. Benign and malignant cancer.
11. Grades and stages of cancer.
12. Hallmarks of cancer.

Assignment II: 501701 - Healthcare Biotechnology (NME -2 Credits)

1. Ploidy in abnormalities of chromosome number.
2. Physical, chemical and biological agents of Mutagens and Inherited diseases.
3. Prenatal diagnosis of genetic diseases.
4. Genetic counseling.
5. Antibiotics and chemotherapeutic agents.
6. Quorum sensing inhibition as an alternate strategy to control infection.
7. Hepatitis B vaccine and Factor VIII.
8. DNA Profiling and paternity dispute in Forensic application
9. Chemotherapy, radiotherapy and stem cell therapy.

501702 – ENVIRONMENTAL BIOTECHNOLOGY (Non-major Elective- 2 Credits)

COURSE DEPICTION

Course Title/Code	**Environmental Biotechnology/ 501702**
Name of Course Teacher	**Dr. A. Veera Ravi**

Course Brief

The theme Environmental biotechnology is historic and also eminently modern. Although, the microbiological treatment technologies developed at the beginning of the 20th century, such as filtration techniques, pollution control measures, and waste water treatment, bioremediation remain the mainstays today. In recent years, new technologies are constantly introduced on bioremediation and air pollution control and solid waste management that address very contemporary problems such as detoxification, detoxification of hazardous chemicals, environmental biomonitoring and microbial genetic engineering for bioremediation of air, water, and soil. This course aims to provide in-depth knowledge on the environmental issues, ways to control them for the sustainable development through biotechnological approaches.

Course Objectives

1. To provide basic concepts on environmental biotechnology and its components.
2. To provide basic idea on environmental ethics and policies.
3. To provide awareness of emerging concerns such as water, Air, Soil and Thermal pollutions
4. To explain advanced skills in understanding engineered bioremediation
5. To appreciate ethical and social issues associated with environmental issues and applications for alleviating the environmental concerns.
6. To impart knowledge on biotechnological techniques required for clean environment.

Course Outcomes

The students shall be able to

1. Explain the importance of environmental protection, diversity in environmental systems, processes and biotechnology.
2. Understand and explain the importance of molecular approaches and control measures to protect environmental insults.
3. Understand existing and emerging technologies that are important in the area of

environmental biotechnology in controlling various types of pollution and hazardous materials;

4. Explore the biotechnological solutions to address environmental issues including ethical problems associated with environment, pollution management, microbial technology for mining, waste water treatment, renewable energy and bioremediation, and solid waste management;
5. Understand and develop specific case-studies for targeting key areas of environmental Biotechnology;
6. Undertake a range of practical approaches relevant to environmental biotechnology and
7. Bioremediation for clean environment and be able to record, report and discuss data

Course Outline

1. Issues and scopes of environmental biotechnology.
2. Pollution- types of pollution, methods for measurement of pollution, Environmental management-problem solving approaches- its limitations.
3. Principles and aims of biological wastewater treatment processes
4. Biodegradation of organic pollutants: Mechanisms and factors affecting biodegradation.
5. Bioremediation: Bio stimulation and bioaugmentation. Bioremediation of oil spills and heavy metal pollution.
6. Biogeotechnology: Bioleaching of metals, microbially enhanced oil recovery.
7. Solid waste management: Anaerobic digestion, Composting and Toxicity testing in waste water treatment plants.

Course Schedule: NME: II -Environmental Biotechnology (2 Credits)

Syllabus	Schedule
Unit -1: Basic concepts of Environment and Environmental components. Status, Scope and Role of Biotechnology in Environmental protection. Environment protection Act: Environmental laws, Environmental policies, Environmental ethics - need for public awareness	**10 Days (1h/day)**
Unit -2: Environmental pollution and its types: Definition – causes, effects, control measures and Biotechnological methods for management of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Noise pollution (e) Thermal pollution (f) Nuclear hazards.	**8 Days (1h/day)**
Unit -3: Sewage and waste water treatment and solid waste management, chemical measure of water pollution, conventional	**7 Days**

biological treatment. Recent approaches to biological waste water treatment, composting process and techniques, use of composted materials.	**(1h/day)**
Unit -4: Concept of bioremediation (in-situ, ex-situ, intrinsic & engineered bioremediation). Bioremediation of toxic metal ions-biosorption and bioaccumulation principles. Concepts of phytoremediation. Microbial leaching mechanism. Mining: use of microbial technology for mining.	**7 Days (1h/day)**
Unit-5: Bioremediation- Biotechnology for clean environment. Bioindicators and biosensors for detection of pollution. Biotechnology for Hazardous Waste Management, Persistent organic pollutants, Xenobiotics, Biological Detoxification of PAH, Biotechniques for Air Pollution Control. Solid Waste Management-Bio-toilets.	**8 Days (1h/day)**
Days assigned for CIA Tests, Quizzes, Seminars, etc.	**8 Days (1h/day)**

Text and Reference Books

1. Biotechnology for Wastewater Treatment (2001), P Nicholas Cheremisin off. Prentice Hal.
2. Biotechnological Methods of Pollution Control (1999), S. A. Abbasi and E Ramaswami. Un Press.
3. Environmental Biotechnology, Concepts and Applications (2005), Hans-Joachin Jordenin Winter. Winter-VCH.
4. R.K. Trivedi, "Handbook of Environmental Laws, Rules, Guidelines, Compliances Standards", Vol. I and II, Enviro Media.
5. Biology of wastewater Treatment (2004), N F Gray. Mc Graw Hill.
6. Environmental Biotechnology (1999), S. K. Agarwal 8. Biodegradation & Bioremediation, Martin Alexander, Academic press.

More books to Read and Refer

Author (s)	Title
Manahan, S.E.	Environmental Science and Technology (1997)
Evans, G.M. and Furlong J.C.	Environmental Biotechnology: Theory and Application (2003)
S.K.Agarwal	Environmental Microbiology (2009)
A.K.Chatterji	Introduction to Environmental biotechnology (2011)
R.M Maier, I.L. Pepper and C.P.Gerba	Environmental Microbiology (2000).

Assignment I: 501702 - Environmental Biotechnology (NME -2 Credits)

1. Pollution- types of pollution and methods for measurement of pollution,
2. Biological wastewater treatment.
3. Inorganic constituents, solids, biological components.
4. Principles and aims of biological wastewater treatment processes.
5. Biochemistry and microbiology of inorganic phosphorus and nitrogen removal.
6. Suspended growth technologies.

Assignment II: 501702 - Environmental Biotechnology (NME -2 Credits)

1. Environmental problems and treatment of industrial waste waters.
2. Toxicity testing in waste water treatment plants.
3. Solid waste management: Anaerobic digestion, Composting.
4. Biodegradation of organic pollutants.
5. Bioremediation: *in situ* and *ex situ* bioremediation technologies for various pollutants and sites.
6. Biogeotechnology.