Mody University of Science & Technology

Master of Science (Microbiology)

(Effective from Academic Year 2020-21)

M.Sc. (Microbiology)

Vision:

To provide quality education in Microbiology contributing to make student's career bright as well as making them competent.

Mission

To provide an environment to foster continuous improvement, innovation and become vanguard in the field of Microbiology.

Programme Educational Objectives (PEO's)

PEO1: Graduates are grounded with practical knowledge and hands-on microbiological techniques and project experience to meet the industrial needs.

PEO2: Graduates are well indoctrinated to be employed in the field of education, research, food and pharma industries.

PEO3: Graduates are prepared and motivated to adapt themselves for life-long learning through professional activities to become universal figurehead.

Program Outcomes (POs)

At the end of the M.Sc. Microbiology Programme, graduates will be able to

PO1: Acquire knowledge of various domains including Bacteriology, Phycology, Virology, Mycology, Physiology, Food/Medical/Industrial and Environmental Microbiology and many others.

PO2: Gain expertise in handling and working of microbiological tools, equipment and instruments.

PO3: Prepare for NET/SET examinations.

PO4: Gain insight into research and research methodologies.

Programme Specific Outcome (PSOs)

At the end of the M.Sc Programme, Post-graduates will be able to

PSO1: Can implement their knowledge and skills in a wide range of careers in industry (marketing, technical support and regulatory affairs) education (teaching, museums and science centres), business (patent attorney or accountant) and communications (public relations, journalism and publishing).

PSO2: Student will demonstrate high level proficiency in emerging research areas.

PSO3: Devise and fabricate new inventions and share their work through publications.

Session 2020-2021 onwards

The proposed programme shall be governed by the Department of - Biosciences, SLAS, MUST, Laxshmangarh.

Programme Level: Post Graduate **Duration:** Two Years (Four Semesters)

No. of Seats: 10

Introduction:

Master of Science is a graduate level degree course in the field of science for 2 years (four semesters). This course contains a deeper insight into microbiology which includes the study of all living organisms that are too small to be visible to the naked eye such as bacteria and fungi which are collectively known as microbes. The subject of microbiology is a vast subject, including numerous sub-disciplines like virology, parasitology, mycology and bacteriology. These microscopic organisms are known as microbes which play crucial roles in nutrient cycling, biodegradation/biodeterioration, climate change, food spoilage, the cause and control of disease, and biotechnology. Microbes are also useful in making life-saving drugs, manufacturing of biofuels, cleaning up pollution and producing/processing food and drink. The job opportunities for a graduate of M.Sc course are plenty in the public and private sectors.

Input Qualification:

Candidate should have passed bachelor's degree from a recognized university with Microbiology/ Biotechnology/ Botany/ Zoology as a subject for three years or six semesters.

Programmed and Teaching Methodology

The teaching methods include lectures, practical's, field visits, workshops, seminars, field visits, guest lectures etc.

Evaluation Procedure

Evaluation Procedure:

All the Rules and Regulations as provided in the Ordinances and Regulations of the Mody University shall be followed. No student shall be admitted as a candidate for the examination for any of the Parts/Semesters after the lapse of [4] years from the date of admission to the Part-I/Semester-I of the Programme.

Minimum Credits (Excluding Proficiency credits) required for year up-gradation: Year up-gradation of the student will be as per the University ordinance.

Name of the Programme: M.Sc. Microbiology								Year: First		
	Course Code	Course Title	Contact Hours per Week			Credits	ETE Duration Hours	Weightage (%)		
			L	T	P			CW[$]	MTE	ETE
	Core Courses									
Autumn Semester	MB20.501	Microbial Physiology and Metabolism	4	-	-	4	3	25	25	50
	MB20.503	Bacteriology and Phycology	3	-	-	3	3	25	25	50
	MB20.505	Microbial Physiology and Instrumentation Laboratory	-	-	6	3	8	25	25	50
	MB20.507	Microbiology Laboratory-I	-	-	6	3	8	25	25	50
	BT20.507	Cell and Molecular Biology	3	-	-	3	3	25	25	50
	MS20.501	Math and Statistics for Biology	2	-	-	2	3	25	25	50
	RM20.501	Research Methodology and Scientific Communication Skills	2	-	-	2	3	25	25	50
	BT20.513	IPR and Biosafety and Bioethics	2	-	-	2	3	25	25	50
	FL-I	Foreign Language-I	3	-	-	3	3	25	25	50
		Sub Total	**19**		**12**	**25**				
	SF 101 (Non credit)	Personal Grooming, Fine Dining				1				

	Course Code	Course Title	Contact Hours per Week			Credits	ETE Duration Hours	Weightage (%)		
			L	T	P			CW$	MTE	ETE
Spring Semester	**Core Courses**									
	MB20.502	Virology and Mycology	3	-	-	3	3	25	25	50
	MB20.504	Microbial Genetics	3	-	-	3	3	25	25	50
	MB20.506	Microbiology Laboratory-II	-	-	6	3	6	25	25	50
		Elective Course	3	-	-	3	3	25	25	50
	BT20.502	Bioinformatics	3	-	-	3	3	25	25	50
	BT20.504	Immunology	3	-	-	3	3	25	25	50
	BT20.506	Genetics Engineering	3	-	-	3	3	25	25	50
	BT20.516	Bioinformatics and Immunology Laboratory	-	-	6	3	6	25	25	50
	FL-II	Foreign Language-II	3	-	-	3	3	25	25	50
		Sub Total	**21**		**12**	**27**				
	SF 102 (Non credit)	Social Grooming, Home & Decor and Business Communication				1				

$CW (Course work) includes teacher assessment, assignments, class /quiz test.

Elective Courses	BT20.512 Food Technology FS20.510 Introduction to Forensic Biotechnology

Session 2020-2021 onwards											
Name of the Programme: M.Sc. Microbiology								**Year: Second**			
	Course Code	Course Title	Contact Hours per Week			Credits	ETE Duration Hours	Weightage (%)			
			L	T	P			CW[$]	MTE	ETE	
Autumn Semester											
	MB20.601	Environmental and Agricultural Microbiology	3	-	-	3	3	25	25	50	
	MB20.603	Industrial Microbiology	3	-	-	3	3	25	25	50	
	MB20.605	Medical Microbiology	3	-	-	3	3	25	25	50	
	MB20.607	Critical Analysis of Classical Papers	2	-	-	2	-	100			
	MB20.609	Project Proposal	2	-	-	2	-	100			
	MB20.611	Research Seminar	1	-	-	1	-	100			
	BT20.603	Emerging Technologies	2	-	-	2	3	25	25	50	
		Elective Course	3	-	-	3	3	25	25	50	
	MB20.615	Microbiology Laboratory –III	-	-	6	3	6	25	25	50	
		Sub Total	**20**	**-**	**6**	**22**					
	Course Code	Course Title	Contact Hours per Week			Credits	ETE Duration Hours	Weightage (%)			
			L	T	P			CW[$]	MTE	ETE	
Spring Semester											
	MB20.602	Dissertation	-	-	40	20	-	25	-	75	
		Sub Total				**20**					
Total			94								

Elective Courses	MB20.613 Plant pathogen interaction BT20.615-- Biocatalysis and Biotransformation BT20.617. Molecular Diagnostics

MB20.501 Microbial Physiology and Metabolism 4-0-0-4

Course Objective: To develop understanding of variable aspects of microbial physiology along with diverse metabolic pathways existing in bacteria.

Transport Mechanisms: Basic features of transport- Role of cell membrane in transport, Thermodynamics of transport, Types of transport- passive diffusion, facilitated diffusion, active transport, group translocation, uniport, symport and antiport, Transport of siderophores, Catabolite repression, inducer exclusion and expulsion. [10]

Microbial Respiration and Fermentation: Oxidative and Substrate level phosphorylation, Aerobic and Anaerobic pathways: Glucose Metabolism- Reactions and control of Glycolysis, Pentose Phosphate Pathway, Gluconeogenesis, Citric acid cycle, Amphibolic and Anaplerotic reaction, , Glyoxylate cycle, Homo and heterolactic fermentation, Pasteur effect, Fermentation pathways in specific group of microorganisms: Lactic acid, propionic acid, butyric acid producing fermentation [14]

Photosynthesis: Brief account of photosynthetic and accessory pigments- Chlorophyll, Bacteriochlorophyll, Carotenoids and Phycobiliproteins, Details of Oxygenic and Anoxygenic photosynthesis, Major groups of photosynthetic bacteria and their pathways: Fixation of CO_2- Calvin cycle, C_3 and C_4 pathway. [13]

Nitrogen and Lipid Metabolism: Nitrogen cycle, Assimilation of nitrogen, Biosynthesis of amino acids, Nitrogen fixation- basic concepts, nitrogenase enzyme, Fatty acid oxidation, Fatty acid biosynthesis, Degradation of cellulose. Disorders of amino acid metabolism (phenylketonuria, alkaptonuria) [10]

Sporulation and Morphogenesis: Endospore formation- structure, properties and germination; Dormancy in selected microbes [5]

Course Outcome: student will be acquainted with methods of measuring microbial growth, calculating growth kinetic parameters, in-depth knowledge of transport systems existing in bacteria, central metabolic pathways for carbon metabolism and various other biochemical properties of bacteria.

Suggested Readings:

Text Books:

1. Microbial Physiology by A.G. Moat, J. W. Foster, M. P. Spector. 3rd Edition. John Wiley & Sons. 2002
2. Lehninger Principles of Biochemistry by D. L. Nelson, M. M. Cox. 6th Edition. W. H. Freeman. 2012
3. Biochemical Calculations: by Irwin H. Segel. 2nd Edition. Wiley. 2004.

4. Understanding Enzymes by T. Palmer, E.Horwood. 3rd Edition. Wiley. 1991.

Reference Books:

1. Biochemistry by Geoffrey L. Zubay. 4th Edition. Brown Co, USA. 1999.
2. The Physiology and Biochemistry of Prokaryotes by D. White, J. Drummond, C. Fuqua. 4th Edition. Oxford University Press. 2011.
3. Microbial Biochemistry by G. N. Cohen. 2nd Edition. Springer. 2014.
4. Lippincott's Illustrated Reviews: Biochemistry edited by D. R. Ferrier. 6th Edition. Lippincott Williams & Wilkins. 2013

MB20.503 Bacteriology and Phycology 3-0-0-3

Course Objective: To gain knowledge in the area of bacterial cell structure, division, survival and propagation.

General Concepts of Microbiology: History and development of Microbiology as a discipline of science, spontaneous generation vs biogenesis, Koch's postulates Basic features of microscopy-Compound, fluorescence, dark field, phase contrast, SEM and TEM, Staining methods-simple, differential and sample preparation for electron microscopy. [5]

Origin and Classification of Microorganisms: Origin and evolution of microbial world, concept of Hackle's three kingdom system, Whittaker's five kingdom system, Eight kingdom system by Thomas Cavalier-Smith and three domain concept of Carl Woese; Tools for Systematics: Numerical taxonomy, Phylogenetic analysis, Polyphasic approach; Bacterial Classification by Bergeys manual of Systematic Bacteriology; General characteristics of various groups of prokaryotic bacteria, significance of Gram-positive and Gram negative bacteria. Modern methods of studying microbial diversity; Microbial culture collections. Phyla of Archaea, Significance of Archaea, Evolutionary developments of Archaea (Detailed account of some model archaeal organisms: Methanococcus, Halobacterium, Pyrococcus and Sulfolobus) [15]

Morphology and Ultrastructure of Bacteria: Basic ultrastructure, morphological types, cell wall of gram positive, gram negative and archeobacteria and comparison with eubacteria, cell wall biosynthesis, cytoplasmic membrane-structure, composition and functions, function of various cell structure appendages: flagella- structure, assembly and [8]

mechanism of movement; pili and fimbriae- types, structure and their role. External cell surface structures and functions: capsule, glycocalyx, slime layer S-layer and L-form.

Cultivation of Bacteria: Aerobic and anaerobic cultivation, Nutrient media- selective and differential, Nutrient types of bacteria, Growth curve and kinetics of growth, Batch culture, fed-batch culture and continuous culture, synchronous growth, Factors affecting growth, Control of bacteria-physical and chemical agents. [6]

Algae: General Characteristics, Classification, Nutrition, Reproduction, Algal ecology, Economic importance of Diatoms, Rhodophyta and Green algae. [5]

Course Outcome: Will be able to attain in-dept knowledge about the bacterial morphological features, cell arrangement, cell structure, its division and the process of sporulation and apply it to practical work.

Suggested Readings:

Text Books:

1. Prescott's Microbiology by J. Willey, L. Sherwood, C. J. Woolverton. 10th edition. McGraw Hill Education. 2017.
2. Brock Biology of Microorganisms by M. Madigan, K. Bender, D. Buckley, W. Sattley, D. Stahl. 15th Edition. Pearson Education. 2018.

Reference Books:

1. Alcamo's Fundamentals of Microbiology by J. C. Pommerville. 10th Edition. Jones and Bartlett Learning. 2013.
2. Archaea Molecular and Cellular Biology by Ricardo Cavicchioli. American Society of Microbiology. 2007.
3. The Physiology and Biochemistry of Prokaryotes by D. White, J. Drummond, C. Fuqua. 4th Edition. Oxford University Press. 2011.

MB20.505 Microbial Physiology and Instrumentation Laboratory 0-0-6-3

Course Objective: The objective of this laboratory is to teach a variety of techniques used in physiology research and principles of instruments used in a microbiology laboratory.

- To learn the working and principle of the basic instruments used in the microbiological laboratory (like Microscope, LAF, Spectrophotometer, Autoclave, Centrifuge, Colony counter etc.)
- Demonstration of PCR
- Determination of growth curve of bacteria.
- Bacterial population count by turbidity method.
- Estimation of fungal growth by gravimetric estimation.
- Effect of pH, Oxygen, temperature on bacterial growth.
- Biochemical characterization of bacterial cultures: catalase, urease, cytochrome oxidase and sugar fermentation, citrate utilization, gelatin liquefaction, sulfide indole motility test.
- Nitrification and denitrification by bacteria.
- Preparing various stock solutions and working solutions that will be needed for the course.
- To prepare an Acetic-Na Acetate Buffer and validate the Henderson-Hasselbach equation.
- To determine an unknown protein concentration by plotting a standard graph of BSA using UV-Vis Spectrophotometer and validating the Beer- Lambert‟s Law.
- Titration of Amino Acids and separation of aliphatic, aromatic and polar amino acids by thin layer chromatography.

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Course Outcome: On completion of this course, the student will be able to apply the learnt knowledge in various practical streams.

MB20.507 Microbiology Laboratory-I 0-0-6-3

Course Objective: To provide understanding towards the basic concepts of microbiological techniques.

1. General instructions, Microbiology laboratory and its discipline
2. Handling of microscopes
3. Methods of sterilization
4. Preparation of culture media plates, agar slants and agar deep tubes for microbes.

5. Demonstration of techniques for isolation of pure culture of microorganisms.
6. Aseptic transfer of pure culture of microorganisms.
7. Isolation and culturing of fungi (yeasts and molds) and algae
8. Culturing methods of microbes – slant and stab cultures, tube culture, flask cultures, shake flask cultures.
9. Concept ofAnaerobic culturing methods – anaerobic jar and its use, pyrogallol method, thioglycollate media culturing, anaerobic glove box and its application.
10. Microbial growth experiments – Viable count of growing cultures
11. Staining techniques for bacteria: simple, differential (Gram staining etc.), special staining (spore staining etc.)
12. Identification and cultivation of algae
13. Identification of an unknown sample as DNA, RNA or protein using available laboratory tools. (Optional Experiments)
14. Protein characterization using different gel-based proteomic tools
15. Agarose gel electrophoresis

Course Outcome: On completion of this course, the student will be able to apply the learnt knowledge in various practical streams.

BT20.507	**Cell and Molecular Biology**	**3-0-0-3**
Course Objective	The objectives of this course are to sensitize the students to the fact that as we go down the scale of magnitude from cells to organelles to molecules, the understanding of various biological processes becomes deeper and inclusive.	
	Dynamic Organization of Cell: Universal features of cells; cell chemistry and biosynthesis: chemical organization of cells; internal organization of the cell - cell membranes: structure of cell membranes and concepts related to compartmentalization in eukaryotic cells; intracellular organelles: endoplasmic reticulum and Golgi apparatus, lysosomes and peroxisomes, ribosomes, cellular cytoskeleton, mitochondria, chloroplasts and cell energetics; nuclear compartment: nucleus, nucleolus and chromosomes.	6
	Chromatin Structure and Dynamics: Chromatin organization - histone and DNA interactome: structure and assembly of eukaryotic and prokaryotic DNA polymerases, DNA-replication, repair and recombination; chromatin control: gene transcription and silencing by chromatin-Writers,-Readers and –Erasers; Transcriptional	12

	control: Structure and assembly of eukaryotic and prokaryotic RNA Polymerases, promoters and enhancers, transcription factors as activators and repressors, trancriptional initiation, elongation and termination; post-transcriptional control: splicing and addition of cap and tail, mRNA flow through nuclear envelope into cytoplasm, breakdown of selective and specific mRNAs through interference by small non-coding RNAs (miRNAs and siRNAs), protein translation machinery, ribosomes-composition and assembly; universal genetic codes, degeneracy of codons, Wobble hypothesis; Iso-accepting tRNA; mechanism of initiation, elongation and termination; co- and post-translational modifications, mitochondrial genetic code translation product cleavage, modification and activation.	
	Cellular Signalling: Transport and Trafficking Molecular mechanisms of membrane transport, nuclear transport, transport across mitochondria and chloroplasts; intracellular vesicular trafficking from endoplasmic reticulum through Golgi apparatus to lysosomes/cell exterior. Manipulating and Studying Cells, Isolation of cells and basics of cell culture; observing cells under a microscope, different types of microscopy; analyzing and manipulating DNA, RNA and proteins.	6
	Cellular Processes: Cell cycle and its regulation; cell division: mitosis, meiosis and cytokinesis; cell differentiation: stem cells, their differentiation into different cell types and organization into specialized tissues; cell-ECM and cell-cell interactions; cell receptors and trans-membrane signalling; cell motility and migration; cell death: different modes of cell death and their regulation.	8
	Genome Instability and Cell Transformation: Mutations, proto-oncogenes, oncogenes and tumour suppressor genes, physical, chemical and biological mutagens; types of mutations; intra-genic and inter-genic suppression; transpositions- transposable genetic elements in prokaryotes and eukaryotes, role of transposons in genome; viral and cellular oncogenes; tumor suppressor genes; structure, function and mechanism of action; oncogenes as transcriptional activators.	7
Course Outcome	Student should be equipped to understand three fundamental aspects in biological phenomenon: a) what to seek; b) how to seek; c) why to seek?	
Suggested Readings	**Text Book:** Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2002). Molecular biology of the cell. New York: Garland Science. Lodish, H. F. (2000). Molecular cell biology. New York: W.H. Freeman.	

References:

Krebs, J. E., Lewin, B., Kilpatrick, S. T., & Goldstein, E. S. (2014). Lewin's genes XI. Burlington, MA: Jones & Bartlett Learning.

Cooper, G. M., & Hausman, R. E. (2009). The cell: A molecular approach. Washington: ASM ; Sunderland.

Hardin, J., Bertoni, G., Kleinsmith, L. J., & Becker, W. M. (2012). Becker's world of the cell. Boston: Benjamin Cummings.

Watson, J. D. (1987). Molecular biology of the gene (7th ed.). Menlo Park, CA: Benjamin/Cummings.

MS20.501 Math and Statistics for Biology 2-0-0-2

Objective: To acquire fundamental knowledge of bio statistics.

Introduction: Collection of primary and secondary data, Classification and tabulation of data, Graphs of frequency distribution and Curves, Measures of central tendency — mean, median and mode, Mathematical properties of arithmetic mean, Geometric and harmonic Mean **05**

Measures of Dispersion: Absolute and Relative Measures of Dispersion, Range, Mean deviation, Standard deviation, Mathematical properties of standard deviation, Coefficient of variation, Variance, Skewness and its measures, Kurtosis and its measures **05**

Correlation and Regression Analysis: Meaning, significance and types, Scatter diagram method, Correlation graph, Karl Pearson's correlation coefficient, Coefficient of determination, Spearman's Rank correlation coefficient, Lines of Regression, Regression equations, Difference between correlation and regression analysis **05**

Tests of Significance: Student's t-test, Chi-square tests, Yate's correction factor, ANOVA– One and two way classification with examples **05**

Probability and Probability Distributions: Elements of probability-definition, addition and multiplication, Probability distribution function-Binomial, Poisson and normal, Area under normal probability distribution curve **06**

Course Outcome: After completion of the course, students would be able to apply the knowledge of bio statistics in sciences and applied sciences with solve curriculum problems.

Text Books:

1. Fundamental of Mathematical Statistics by Gupta and Kapoor, SCS Publisher, 2002.
2. Bailey; Statistical Methods in Biology; Cambridge Publications, UK.

Reference Books:

1. Prasad S.; Elements of Biostatistics; Rastogi Publication, Meerut.
2. Probability, Random Variables and Stochastic Processes by Papoulis, TMH.

RM20.501 **Research Methodology and Scientific Communication Skills** **2-0-0-2**

Course Objectives

- To give a background on the history of science, emphasizing the methodologies used to do research
- To use the framework of these methodologies for understanding effective lab practices and scientific communication
- To use the framework of these methodologies to understand and appreciate scientific ethics

History of Science and Science Methodologies **5**

Empirical science; The scientific method; Interrogative perturbation experiments and controls; Deductive and inductive reasoning; Descriptive science; Reductionist vs holistic biology. Preparation for Research

Choosing a mentor, lab and research question; Maintaining a lab notebook with date-wise entry.

Sampling, Scale and Analysis: Sampling and sampling distribution: Meaning, sampling Vs Census, Steps in Sampling process, Types of sampling - Probability and Non probability Sampling Techniques, Data collection: Primary and Secondary data Sources - Advantages/Disadvantages, Data collection Methods: Observations, Survey, Interview and Questionnaire design, Qualitative Techniques of data collection.Nominal Scale, Ordinal Scale, Interval Scale, Ratio Scale, Criteria for good measurement, Attitude measurement Scale – Likert's Scale, Semantic Differential Scale, Thurstone-equal appearing interval scale **10**

Scientific Communication **11**

Technical Writing Skills - Types of reports; Layout of a formal report; Scientific writing skills - Importance of communicating science; Problems while writing a scientific document; Plagiarism; Scientific publication writing: Elements of a scientific paper including Abstract, Introduction, Materials & Methods, Results, Discussion, References; Drafting titles and framing abstracts; Publishing scientific papers - the peer review process and problems, recent developments such as open access and non-blind review; Plagiarism; Characteristics of effective technical communication; Scientific presentations; Ethical issues; Scientific misconduct.

Student Learning Outcomes

- Understanding of the history and methodologies of scientific research, applying these to recent published papers
- Understanding and practicing scientific reading, writing, presentations
- Appreciating scientific ethics through case studies.

Suggested Readings:

1. Valiela, I. (2001). Doing science: Design, analysis, and communication of scientific research. Oxford: Oxford University Press.
2. On being a scientist: A guide to responsible conduct in research. (2009). Washington, D.C.: National Academies Press.
3. Gopen, G. D., & Smith, J. A. (n.d.). The Science of Scientific Writing.

American Scientist, 78(Nov-Dec 1990), 550-558.
4. Mohan, K., & Singh, N. P. (2010). Speaking English effectively. Delhi: Macmillan India.
5. Movie: Naturally Obsessed, The Making of a Scientist.

BT20.513 IPR , Biosafety and Bioethics **2-0-0-2**

Course Objective

- To provide basic knowledge on intellectual property rights and their implications in biological research and product development.
- To learn biosafety and risk assessment of products derived from biotechnology and regulation of such products.
- To understand ethical issues in biological research.

Introduction to IPR Introduction to intellectual property; types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs; International framework for the protection of IP; IP as a factor in R&D; IPs of relevance to biotechnology and few case studies; introduction to history of GATT, WTO, WIPO and TRIPS; plant variety protection and farmers rights act; concept of „prior art": invention in context of "prior art"; patent databases - country-wise patent searches (USPTO, EPO, India); analysis and report formation. 5

Patenting: Basics of patents: types of patents; Indian Patent Act 1970; recent amendments; WIPO Treaties; Budapest Treaty; Patent Cooperation Treaty (PCT) and implications; procedure for filing a PCT application; role of a Country Patent Office; filing of a patent application; precautions before patenting-disclosure/non-disclosure - patent application- forms and guidelines including those of National Bio-diversity Authority (NBA) and other regulatory bodies, fee structure, time frames; types of patent applications: provisional and complete specifications; PCT and conventional patent applications; international patenting-requirement, procedures and costs; financial assistance for patenting-introduction to existing schemes; publication of patents- gazette of India, status in Europe and US; patent infringement- meaning, scope, litigation, case studies and examples; commercialization of patented innovations; licensing – outright sale, licensing, royalty; patenting by research students and scientists-university/organizational rules in India and abroad, collaborative research - backward and forward IP; benefit/credit sharing among parties/community, commercial (financial) and non-commercial incentives. 5

Biosafety and Biosecurity - introduction; historical background; introduction to biological safety cabinets; primary containment for biohazards; biosafety levels; GRAS organisms, biosafety levels of specific microorganisms; recommended biosafety levels for infectious agents and infected animals; definition of GMOs & 5

	LMOs; principles of safety assessment of transgenic plants – sequential steps in risk assessment; concepts of familiarity and substantial equivalence; risk – environmental risk assessment and food and feed safety assessment; problem formulation – protection goals, compilation of relevant information, risk characterization and development of analysis plan; risk assessment of transgenic crops vs cisgenic plants or products derived from RNAi, genome editing tools.	
	National and International Regulations: International regulations – Cartagena protocol, OECD consensus documents and Codex Alimentarius; Indian regulations – EPA act and rules, guidance documents, regulatory framework – RCGM, GEAC, IBSC and other regulatory bodies; Draft bill of Biotechnology Regulatory authority of India - containments – biosafety levels and category of rDNA experiments; field trails – biosafety research trials – standard operating procedures - guidelines of state governments; GM labeling – Food Safety and Standards Authority of India (FSSAI).	5
	Bioethics Introduction, ethical conflicts in biological sciences - interference with nature, bioethics in health care - patient confidentiality, informed consent, euthanasia, artificial reproductive technologies, prenatal diagnosis, genetic screening, gene therapy, transplantation. Bioethics in research – cloning and stem cell research, Human and animal experimentation, animal rights/welfare, Agricultural biotechnology - Genetically engineered food, environmental risk, labeling and public opinion. Sharing benefits and protecting future generations - Protection of environment and biodiversity – biopiracy.	6
Course Outcome	Students will be able to – • Understand different types of intellectual property rights in general and protection of products derived from biotechnology research and issues related to application and obtaining patents. • Gain knowledge of biosafety and risk assessment of products derived from recombinant DNA research and environment release of genetically modified organisms, national and international regulations • Understand ethical aspects related to biological, biomedical, health care and biotechnology research.	
Suggested Readings	**Text Book:** • Ganguli, P. (2001). Intellectual property rights: Unleashing the knowledge economy. New Delhi: Tata McGraw-Hill Pub. • Complete Reference to Intellectual Property Rights Laws.	

(2007). Snow White Publication Oct.

References:

- Kuhse, H. (2010). Bioethics: An anthology. Malden, MA: Blackwell.
- Office of the Controler General of Patents, Design & Trademarks; Department of Industrial Policy & Promotion; Ministry of Commerce & Industry; Government of India. http://www.ipindia.nic.in/
- World Trade Organisation. http://www.wto.org
- World Intellectual Property Organisation. http://www.wipo.int
- International Union for the Protection of New Varieties of Plants. http://www.upov.int
- National Portal of India. http://www.archive.india.gov.in
- National Biodiversity Authority. http://www.nbaindia.org
- Recombinant DNA Safety Guidelines, 1990 Department of Biotechnology, Ministry of Science and Technology, Govt. of India. Retrieved from http://www.envfor.nic.in/divisions/csurv/geac/annex-5.pdf
- Wolt, J. D., Keese, P., Raybould, A., Fitzpatrick, J. W., Burachik, M., Gray, A., Wu, F. (2009). Problem formulation in the environmental risk assessment for genetically modified plants. Transgenic Research, 19(3), 425-436. doi:10.1007/s11248-009-9321-9

MB20.502 Virology and Mycology 3-0-0-3

Course Objective: The course will facilitate in understanding of molecular virology and Mycological aspects in detail.

General Concepts of Viruses: Discovery of viruses, Distinctive features, Morphology and Ultrastructure, Envelope and its properties, Structural proteins – envelope proteins, matrix proteins and lipoproteins, Virus related agents (Viroids and Prions). Classification-General properties, Nomenclature, Viral genomic organization, structure and replication – types of nucleic acid DNA (double stranded and single-stranded), RNA (double stranded, single stranded – positive sense and negative sense). [5]

General Methods of Diagnosis of Viruses: Methods of Isolation, Identification and Cultivation methods-embryonated eggs, experimental animals, cell cultures (Primary and secondary), Methods of detection- Direct using microscopes and Serological methods- heamagglutination, complement fixation, [10]

18athogenicity18ence, ELISA and RIA, infectivity assay (end point method), Western Bloting, Nucleic acid based diagnosis: Nucleic acid hybridization, polymerase chain reaction, microarray and nucleotide sequencing, Infectivity assay for animal and bacterial viruses – plaque method, LD_{50}.

Bacterial and Plant Viruses: Classification of bacterial and plant viruses. Bacteriophage structure- general characteristics, Life cycle- Lytic and Lysogeny, One step growth curve, Regulation of lytic cycle, brief details of M13, Mu, Lambda and T4, Effect of viruses on plant appearance, histology, cytology, Transmission of plant viruses- Vector (insects, nematodes) and without vector, Common diseases of Paddy, Cotton, Tomato and Sugarcane, Life cycles- TMV, CMV and Potato Virus X. Control and prevention of plants and animal viral (Phage Therapy) diseases. [9]

Animal Viruses: Classification of animal viruses Life cycle and 18athogenicity of RNA viruses- Picorna, Orthomyxo, Paramyxo, Rhabdo, Rota and HIV, Oncogenic viruses, DNA viruses- Pox, Herpes, Adeno, SV 40, Hepatitis viruses [9]

Emerging Viruses and Prevention: Theories/Drivers on origin of virus, evolution of new viruses, emerging new viruses, Factors that drive viral emergence, genetic shift and drift. Basic concept of an effective vaccine

General Concepts of Mycology: General features of fungi, Classification of fungi, Life cycles of *Aspergillus, Saccharomyces, Deuteromycetes*, Mycorrhiza: Ecto, endo and VAM, Lichens- general features, Fungal diseases- Systemic and Sub cutaneous Mycoses, Candidiasis, Dermatomycosis. [6]

Course Outcome: On completion of the course, the student will be able to describe, classify and learn various processes associated to viruses and fungi.

Suggested Readings:

Text Books:

1. Basic Virology by Edward K. Wanger, M. Hewiett, D. Bloom, D. Camerini. 3rd edition. Blackwell Publishing. 2007.
2. Principles of Molecular Virology by A.J. Cann. 6th edition. Elsevier Academic Press. 2015.

Reference Books:

1. Principles of Virology: Molecular Biology, Pathogenesis and Control of Animal Viruses by S.J. Flint, L.W. Enquist, V.R. Racaniello, A.M. Skalka. 4th edition. ASM Press. 2015.
2. Introduction to Modern Virology by N. Dimmock, A.

Easton, K. Leppard. 7th edition. Blackwell Publishing. 2016.

MB20.504 Microbial Genetics **3-0-0-3**

Course Objective: The objective of this course is to understand how microorganisms can be used as tools to understand various biological phenomena.

Mutations: Basic concepts of mutation, Molecular nature of mutations, Spontaneous mutation, Reverse mutation, Frameshift mutation, Site directed mutagenesis- deletions, insertions, localized point mutation, Mutations by synthetic oligonucleotides, Evolutionary role of mutation. [4]

Gene transfer and mapping by conjugation: Basis of fertility in bacteria. Self-transmissible and mobilizable plasmids. Hfr strains. Mapping bacterial genomes using Hfr strains. Chromosomal DNA transfer by plasmids – by integrated plasmids, by chromosome mobilization and by creation of prime factors. Transfer systems in gram positive bacteria. Ti plasmid transfer system and its application in creating transgenics [10]

Lytic bacteriophages and gene transfer by transduction and transformation: Lytic cycle using phages T4 and T7 as models. Regulation of expression of genes in phage T4 and phage T7. Replication of T4 versus T7 phages. Replication and packaging of filamentous phages M13 and f1. Genetic analysis of phages – complementation and recombination tests with phages. [11]

Natural transformation and competence. Molecular basis of natural transformation – DNA uptake competence systems in gram positive and gram negative bacteria. Regulation of competence in *B. subtilis*. Importance of natural transformation. Artificially induced competence. Generalized versus specialized transduction: T4, lambda phage. Mapping bacterial genes by transduction.

Lysogenic phages: Lambda phage – gene and promoter organization. Lambda lytic cyle – regulation of gene expression – very early, early and late gene expression. Establishment and maintenance of lysogeny. Regulation of gene expression in lysogenic phase – role of cI, cII and cIII proteins. Lambda immunity region and immunity to superinfection. Events leading to induction – role of cI and cro repressors in regulating the events. Other lysogenic phages – P2 and P4. Lysogenic phages and bacterial pathogenesis. [9]

Transposons: Discovery of transposition. Classes of bacterial transposons. Regulation of transposition activity. Effects of transposition in bacteria. Assays to 19nalyse transposition events – suicide vectors and mating out assays. Molecular mechanisms of transposition – genetic evidence supporting the mechanisms.

Vectors: Plasmids, Colicins and col factors, Plasmids as vectors for gene cloning, Transposons and their use in genetic analysis, Mechanisms of antibiotic resistance by transposons. [5]

Gene expression and regulation: Control of gene expression. Positive gene regulation, negative gene regulation and attenuation, using the lac, gal, trp, ara, tol operons.

Course Outcome: Upon successful completion of the course, the student: will be able to discuss the importance of mutations, describe the processes of transformation, transduction and conjugation, lytic and lysogeny and regulation of these processes.

Suggested Readings:

Text Books:

1. Modern Microbial Genetics edited by U.N. Streips, R.E. Yasbin. 2nd edition. Wiley-Liss Publishers. 2002.
2. Microbial Genetics by S.R. Maloy, J.E. Cronan, Jr., D. Freifelder. 2nd edition. Jones and Bartlett Publishers. 1994.

Reference Books:

1. Molecular Genetics of Bacteria by L. Snyder, J. Peters, T. Henkin, W. Champness. 4th edition. ASM Press. 2013.
2. Fundamental Bacterial Genetics by N. Trun, J. Trempy. 1st edition. Wiley-Blackwell Publishing. 2004.

MB20.506 Microbiology Laboratory-II 0-0-6-3

Course Objective: To provide understanding of techniques associated with microbial genetics and virology.

- Isolation of genomic DNA from E.coli and Yeast.
- Estimation of DNA and RNA (colorimetry)
- Determination of molecular weight of DNA, resolved on agarose gel electrophoresis.
- Effect of UV radiations to study the survival pattern of E. coli/yeast.
- Replica plating technique
- Transformation in bacteria
- Conjugation in bacteria
- Isolation of phage from different soil samples using laboratory bacterial cultures (*Staphylococcus*, *Bacillus*)
- Isolation of phage from sewage using *Pseudomonas* and *E. coli* as host.
- Cultivation and preservation of phages.
- Quantification of phages
- One step growth curve for determination of virus titre.
- Study of fungal morphology and their identification by cotton blue staining

- Study of fungal diseases in plants and viruses

Course Outcome: On completion of this course, the student will be able to apply the learnt knowledge in various practical streams and join the path labs.

BT20.512 Food Technology 3-0-0-3

Course Objective: To impart knowledge of various areas related to Food Science and Technology, To enable the students to understand food composition and its physicochemical, nutritional, and microbiological aspects

Food and Fermentation Technology: Origin, Scope and development of fermented food products, Microbial starters for food fermentations. 10

Fermented Foods- Bread, Vinegar, Beer, Wine, polysaccharides, low calorie sweeteners, Vitamins, Fermented vegetables, Nutraceuticals, Prebiotic and Probiotic foods, Genetically modified foods, Nano foods.

Fermented dairy products- Milk and Curd, Yoghurt, Buttermilk, Cheese, Oriental fermented foods,

Single cell protein, Mushroom cultivation

Spoilage and Preservation: 9

Factors affecting microbial growth in foods- extrinsic and intrinsic,

Contamination of foods (cereals, Vegetables and Fruits, Meat and Meat products and Fish, Milk and milk products, canned foods) and their involvement in disease outbreaks,

Spoilage detection and characterization.

Methods of food preservation (thermal processing, refrigeration, dehydration, irradiation, microfiltration, chemical preservatives).

Food Borne Infections and Intoxications: Microbial toxins in food- Chemical Structure and Types, Food borne illnesses caused by- *Brucella, Clostridium, Escherichia, Salmonella, Shigella, Staphylococcus, Vibrio and Yersinia*, Diseases caused by Fungi, Emerging pathogens, *E.coli*O157:H7, *Listeria monocytogens, Campylobacter jejuni, Helicobacter pylori* 9

Packaging and Quality Control: 5

Need and method of packaging (glass, metal, plastics, moulded pulp and aluminium foil), Controlled atmosphere packaging,

Tetra pack, Nano capsule, Nano membrane.

Detection of food pathogens- Culture methods, Rapid detection using PCR 6

Food standards- Standards for Milk, Poultry, Food control agencies- BIS, Codex commission,

Food laws and current concepts in food safety (HACCP, quantitative risk assessment and prediction based systems)

Disposal and treatment of food industry waste

Course Outcome: The students will have knowledge about different processing and preservation methods and principals involved. Students will have learnt about packaging materials, methods and their applications in food industry.

Suggested Readings

Text Book

- Frazier and Westhoff, Food Microbiology, Tata McGraw Hill Publishing Company, Ltd, New Delhi
- Banwart,GJ: Basis of Food Microbiology, CBS Publishers and Distributors, New, Delhi

References

Adams and Moss, Food Microbiology, Royal Society of Chemistry Publication, Cambridge

BT20.502	**Bioinformatics**	**3-0-0-3**
Course Objective	The objectives of this course are to provide students with the theory and practical experience of the use of common computational tools and databases which facilitate investigation of molecular biology and evolution-related concepts.	
	Bioinformatics basics: Computers in biology and medicine; Importance of Unix and Linux systems and its basic commands; Database concepts; Protein and nucleic acid databases; Structural databases; databases and search tools: biological background for sequence analysis; Identification of protein sequence from DNA sequence; searching of databases similar sequence; NCBI; publicly available tools; resources at EBI; resources on the web; database mining tools.	7
	DNA sequence analysis: gene bank sequence database; submitting DNA sequences to databases and database searching; sequence alignment; pairwise alignment techniques; motif discovery and gene prediction; local structural variants of DNA, their relevance in molecular level processes, and their identification; assembly of data from genome sequencing.	7
	Multiple sequence analysis; multiple sequence alignment; flexible sequence similarity searching with the FASTA3 program package; use of CLUSTAL W and CLUSTAL X for multiple sequence alignment; submitting DNA protein sequence to databases: where and how to submit, SEQUIN, genome centres; submitting aligned set of sequences, updates and internet resources; methods of phylogenetic analysis.	7
	Protein modelling: introduction; force field methods; energy, buried and exposed residues; side chains and neighbours; fixed regions; hydrogen bonds; mapping properties onto surfaces; fitting monomers; RMS fit of conformers; assigning secondary structures	8
	Protein structure prediction: protein folding and model generation; secondary structure prediction; analyzing secondary structures; protein loop searching; loop generating methods; loop analysis; homology modelling: potential applications, description, methodology, homologous sequence identification; align structures, align model sequence; construction of variable and conserved regions; threading techniques; topology fingerprint approach for prediction; evaluation of alternate models; structure prediction on a mystery sequence; structure aided sequence techniques of structure prediction; structural profiles, alignment algorithms, mutation tables, prediction, validation, sequence based methods of structure prediction, prediction using inverse folding, fold prediction; significance analysis, scoring techniques, sequence-sequence scoring; protein function prediction; elements of insilico drug design.	10

Course Outcome

Student should be able to –

- Develop an understanding of the basic theory of these computational tools.
- Gain working knowledge of these computational tools and methods.
- Appreciate their relevance for investigating specific contemporary biological questions.
- Critically analyse and interpret the results of their study.

Suggested Readings

Text Book:

- Lesk, A. M. (2002). Introduction to bioinformatics. Oxford: Oxford University Press.
- Mount, D. W. (2001). Bioinformatics: Sequence and genome analysis. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.

References:

- Baxevanis, A. D., & Ouellette, B. F. (2001). Bioinformatics: A practical guide to the analysis of genes and proteins. New York: Wiley-Interscience.
- Pevsner, J. (2015). Bioinformatics and functional genomics. Hoboken, NJ.: Wiley- Blackwell.
- Bourne, P. E., & Gu, J. (2009). Structural bioinformatics. Hoboken, NJ: Wiley-Liss.
- Lesk, A. M. (2004). Introduction to protein science: Architecture, function, and genomics. Oxford: Oxford University Press.

BT20.504 **Immunology** **3-0-0-3**

Course Objective

The objectives of this course are to make students learn about the structural features of the components of the immune system as well as their function. The major emphasis of this course will be on the development of the immune system and mechanisms by which our body elicit the immune response. This will be imperative for the students as it will help them to think like an immunologist and predict about the nature of immune response that develops against bacterial, viral or parasitic infection, and prove it by designing new experiments.

Immunology fundamental concepts and anatomy of the immune system Components of innate and acquired immunity; phagocytosis; complement and inflammatory responses; pathogen recognition receptors (PRR) and pathogen associated molecular 6

pattern (PAMP); innate immune response; mucosal immunity; antigens - immunogens, haptens; Major Histocompatibility Complex - MHC genes, MHC and immune responsiveness and disease susceptibility.

Immune responses generated by B and T lymphocytes 9
Immunoglobulins - basic structure, classes & subclasses of immunoglobulins, antigenic determinants; multigene organization of immunoglobulin genes; B-cell receptor; Immunoglobulin superfamily; principles of cell signaling; basis of self & non-self discrimination; kinetics of immune response, memory; B cell maturation, activation and differentiation; generation of antibody diversity; T-cell maturation, activation and differentiation and T-cell receptors; functional T Cell subsets; cell-mediated immune responses, ADCC; cytokines-properties, receptors and therapeutic uses; antigen processing and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; cell-cell co-operation, Hapten-carrier system.

Antigen-antibody interactions Precipitation, agglutination and complement mediated immune reactions; advanced immunological techniques - RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence, flow cytometry and immunoelectron microscopy; surface plasmon resonance, biosenor assays for assessing ligand –receptor interaction, CMI techniques-lymphoproliferation assay, mixed lymphocyte reaction, cell cytotoxicity assays, apoptosis, microarrays, transgenic mice, gene knock outs. 7

Vaccinology Active and passive immunization; live, killed, attenuated, subunit vaccines; vaccine technology- role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; peptide vaccines, conjugate vaccines; antibody genes and antibody engineering- chimeric, hybrid monoclonal antibodies; catalytic antibodies and generation of immunoglobulin gene libraries, idiotypic vaccines and marker vaccines, viral-like particles (VLPs), dendritic cell based vaccines, vaccine against cancer, T cell based vaccine, edible vaccine and therapeutic vaccine. 8

Clinical Immunology Immunity to infection : bacteria, viral, fungal and parasitic infections (with examples from each group); hypersensitivity – Type I-IV; autoimmunity; types of autoimmune diseases; mechanism and role of CD4+ T cells; MHC and TCR in autoimmunity; treatment of autoimmune diseases; transplantation – immunological basis of graft rejection; clinical transplantation and immunosuppressive therapy; tumor immunology – tumor antigens; immune response to tumors and tumor evasion of the immune system, cancer immunotherapy; immunodeficiency - primary immunodeficiencies, acquired or secondary immunodeficiencies, 9

autoimmune disorder, anaphylactic shock, immunesenescence, immune exhaustion in chronic viral infection, immune tolerance, NK cells in chronic viral infection and malignancy.

Course Outcome

Students should be able to –

- Evaluate the usefulness of immunology in different pharmaceutical companies.
- Identify the proper research lab working in the area of their own interests.
- Apply their knowledge and design immunological experiments to demonstrate innate, humoral or cytotoxic T lymphocyte responses and figure out the kind of immune responses in the setting of infection (viral or bacterial) by looking at cytokine profile.

Suggested Readings

Text Book:

- Kindt, T. J., Goldsby, R. A., Osborne, B. A., & Kuby, J. (2006). Kuby immunology. New York: W.H. Freeman.
- Brostoff, J., Seaddin, J. K., Male, D., & Roitt, I. M. (2002). Clinical immunology. London: Gower Medical Pub.

References:

- Murphy, K., Travers, P., Walport, M., & Janeway, C. (2012). Janeway's immunobiology. New York: Garland Science.
- Paul, W. E. (1993). Fundamental immunology. New York: Raven Press.
- Goding, J. W. (1986). Monoclonal antibodies: Principles and practice: Production and application of monoclonal antibodies in cell biology, biochemistry, and immunology. London: Academic Press.
- Parham, P. (2005). The Immune System. New York: Garland Science.

BT20.506	**Genetic Engineering**	**3-0-0-3**
Course Objective	The objectives of this course are to teach students with various approaches to conducting genetic engineering that they can apply to their future career in biological research as well as in biotechnology industries. Genetic engineering is a technology that has been developed based on our fundamental understanding of the principles of molecular biology and this is reflected in the contents of this course. This technology has revolutionized the way modern biological research is done and has impacted mankind with a number of biological products and processes.	
	Impact of genetic engineering in modern society; general requirements for performing a genetic engineering experiment; restriction endonucleases and methylases; DNA ligase, Klenow enzyme, T4 DNA polymerase, polynucleotide kinase, alkaline phosphatase; cohesive and blunt end ligation; linkers; adaptors; homopolymeric tailing; labelling of DNA: nick translation, random priming, radioactive and non-radioactive probes, hybridization techniques: northern, southern, south-western and far-western and colony hybridization, fluorescence in situ hybridization.	6
	Plasmids; Bacteriophages; M13 mp vectors; PUC19 and Bluescript vectors, hagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Principles for maximizing gene expression expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; Inclusion bodies; methodologies to reduce formation of inclusion bodies; mammalian expression and replicating vectors; Baculovirus and pichia vectors system, plant based vectors, Ti and Ri as vectors, yeast vectors, shuttle vectors.	7
	Principles of PCR: primer design; fidelity of thermostable enzymes; DNA polymerases; types of PCR – multiplex, nested; real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products; T-vectors; proof reading enzymes; PCR based site specific mutagenesis; PCR in molecular diagnostics; viral and bacterial detection; sequencing methods; enzymatic DNA sequencing; chemical sequencing of DNA; automated DNA sequencing; RNA sequencing; chemical synthesis of oligonucleotides; mutation detection: SSCP, DGGE, RFLP.	7
	Insertion of foreign DNA into host cells; transformation, electroporation, transfection; construction of libraries; isolation of mRNA and total RNA; reverse transcriptase and cDNA synthesis; cDNA and genomic libraries; construction of microarrays – genomic arrays, cDNA arrays and oligo arrays; study of protein-DNA interactions: electrophoretic mobility shift assay; DNaseI footprinting; methyl interference assay, chromatin	7

	immunoprecipitation; protein-protein interactions using yeast two-hybrid system; phage display.	
	Gene silencing techniques; introduction to siRNA; siRNA technology; Micro RNA; construction of siRNA vectors; principle and application of gene silencing; gene knockouts and gene therapy; creation of transgenic plants; debate over GM crops; introduction to methods of genetic manipulation in different model systems e.g. fruit flies (drosophila), worms (C. elegans), frogs (xenopus), fish (zebra fish) and chick; Transgenics - gene replacement; gene targeting; creation of transgenic and knock-out mice; disease model; introduction to genome editing by CRISPR- CAS with specific emphasis on Chinese and American clinical trials.	12

Course Outcome

Given the impact of genetic engineering in modern society, the students should be endowed with strong theoretical knowledge of this technology. In conjunction with the practicals in molecular biology & genetic engineering, the students should be able to take up biological research as well as placement in the relevant biotech industry.

Suggested Readings

Text Book:

- Old, R. W., Primrose, S. B., & Twyman, R. M. (2001). Principles of gene manipulation: An introduction to genetic engineering. Oxford: Blackwell Scientific Publications.
- Green, M. R., & Sambrook, J. (2012). Molecular cloning: A laboratory manual. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.

References:

- Brown, T. A. (2006). Genomes (3rd ed.). New York: Garland Science Pub.
- Selected papers from scientific journals, particularly Nature & Science.
- Technical Literature from Stratagene, Promega, Novagen, New England Biolab etc.

BT20.516 **Bioinformatics and Immunology Laboratory** **0-0-6-3**

Course Objective

The objectives of this laboratory course are to make students develop an understanding about practical aspects of the components of the immune system as well as their function. Basic as well as advanced methods will be taught to detect different antigen and antibody interactions, isolation of different lymphocyte cells etc. and how they can be used in respective research work.

- Selection of animals, Preparation of antigens, Immunization and methods of bleeding, serum separation and storage.
- Antibody titre by ELISA method.
- Double diffusion, Immuno-electrophoresis and Radial Immuno diffusion.
- Complement fixation test.
- SDS-PAGE, Immunoblotting, Dot blot assays.
- Biological Databases: Sequence databases, Structure databases
- ORF Finder
- Pairwise sequence alignment using BLAST
- MSA using Clustal Omega and MEGA
- Phylogenetic analysis using MEGA software
- Primer Design
- 3-D structure Prediction

Course Outcome

Students should be able to –

- Evaluate the usefulness of immunology and Bioinformatics in different pharmaceutical companies.
- Identify proper research lab working in the area of their own interests.
- Apply their knowledge and design immunological experiments to demonstrate innate, humoral or cytotoxic T lymphocyte responses and figure out the kind of immune responses in the setting of infection (viral or bacterial) by looking at cytokine profile.
- Apply the bioinformatics tools for evolutionary analysis and drug designing

MB20.601 Environmental and Agricultural Mirobiology 3-0-0-3

Course Objective: The objective of this course is to understand various environmental and agricultural aspects of microbiology.

Aerobiology: Droplet nuclei, aerosols, Assessment of air quality- solid, liquid impingment, Air borne transmission of microbes [3]

Soil and water microbiology: Types of Soils- physical and chemical characteristics, microflora, Rhizosphere and Phyllosphere. [12]

Water Microbiology: Fresh water and marine habitats- general characteristics, Types of microbes, Microbial activity, Eutrophication and its effects, Assessment of water quality- water purification, Potability standards.

Importance of soil microorganisms, nutrient transformation processes, plant-microbe symbiosis, microbial antagonism, biofilms and their biotechnological applications, drinking water microbiology and quality control.

Biomass waste management of plant's residues: Lignocellulolytic microorganisms, enzymes and their biotechnological applications in: (i) biopulping, (ii) biobleaching, (iii) textiles (iv) biofuels, (v) animal feed production. [8]

Biogeochemical Cycling: Carbon, Nitrogen and Sulphur cycle- role of microbes, Biodegradation- recalcitrant and xenobiotics, Degradation of pesticide, Wood and Textiles; Role of microbes in biodeterioration- Metal corrosion, Paper; Metal detoxification, Biopesticides. [10]

Nitrogen Fixation: Biological nitrogen fixation- Symbiotic (Rhizobium, Frankia), Asymbiotic (Azotobacter, Azospirillum), Nitrogenase and nif genes, Biofertilizers, VAM- brief account and applications.

Microbes in Waste Treatment: Types of wastes- Solid and Liquid waste, Waste treatments- Physical, Chemical and Biological (Primary, Secondary and Tertiary treatment), Trickling filter, Biocontactor, Activated sludge, Oxidation pond, Solid waste treatment- composting, biogas production. 6

Course Outcome: Upon successful completion of the course, the student: will be able to understand the cology od air, water and soil, biogeochemical cycles and processes like nitrogen fixation and waste treatment.

Suggested Readings:

Text Books:

1. Biotechnology-A textbook of Industrial Microbiology. II edition.Wulf Crueger and Anneliese Crueger.
2. Industrial Microbiology, A.H.Patel

3. Industrial microbiology, Casida

Reference Books:

1. Industrial Microbiology by L.E Casida, John Wiley and sons INC.
2. Industrial microbiology by A.H.Patel, Macillan India Ltd.
3. Principles of fermentation technology by P.Stanbury & Allan Whitekar, Pergamon.
4. Manual of Industrial Microbiology and Biotechnology,II edition. Arnold L.Demain and Juilan E.Davies.

MB20.603 Industrial Microbiology 3-0-0-3

Course Objective: The objective of this course is to learn and understanding the microbiological concepts applied in industries.

General Concepts: Isolation, Preservation and Improvement of Industrially important organisms, Enrichment culture technique, Storage at low temperature, Liquid nitrogen, Lyophilization, Strain improvement by mutation, Feed-back repression and inhibition, Modification in characteristics of inhibitors, Isolation of auxotrophic mutants, Use of recombinant methods. [5]

Growth Kinetics: Microbial growth kinetics and product kinetics, Microbial biomass, Enzymes, metabolites, Batch and continuous culture- comparison, external and internal, Fed batch and its applications. [10]

Basic Concepts in Fermentation: Fermentation media, Sterilization, Batch and Continuous Sterilization, Filter sterilization, Fermenter design, Control of Fermenter, Mass and gas transfer, Product recovery and Effluent treatment.

Applications of industrial microbiology-I: production aspects: Development of heterologous expression platforms like bacteria, yeast, mammalian and insect cells, process optimization of recombinant biopharmaceuticals; industrial enzymes (cellulases, laccase, amylases, biosurfactants, thaumatin, food additives etc.), therapeutic proteins (hormones and recombinant vaccines), antibodies (chimeric and humanized antibodies, antibody fragments) [9]

Applications of industrial microbiology-II: microbial transformation process, cell surface display technology, development of biosimilars, good manufacturing practices, intellectual property rights and technology transfer, different phases of clinical trials of therapeutic biomolecules. Basic objective for successful economically viable fermentation process, cost breakdown for well-established fermentation processes, market potential of the products, cost aspects of various stages in the processes development including effluent treatment [8]

Industrial Production: Industrial production of Ethanol, Acetone, Butanol, Citric acid, Gluconic acid, Acetic acid, Lactic acid and Kojic acid, Glutamic acid, Lysine and Tryptophan, Amylases, Proteases and Lipases, Antibiotics (β-lactam, aminoglycosides). 7

Production of other Metabolites: Production of single cell proteins, Recombinant vaccines, Interferon and Steroids in brief.

Course Outcome: On completion of the course, the student will be competent enough to be an Industrial Microbiologists, who can progress in its diverse fields.

Suggested Readings:

Text Books:

1. Nduka Okafor, Benedict C. Okeke (2017). *Modern Industrial Microbiology and Biotechnology*. 2nd Edition: CRC Press Publishers.
2. Waites, M.J., Morgan, N.L., Rockey, J.S. and Higton, G. (2002). *Industrial Microbiology: An Introduction.* Blackwell Science Publishers.

Reference Books:

1. W. Crueger & A. Crueger (2017). Cruegers Biotechnology: A Text Book of Industrial Microbiology. Edited by K.R. Aneja. Panima Publishing Corporation.
2. Reed. G. (1999). Prescott and Dunn's Industrial Microbiology. CBS Publishers.
3. Demain, A. L. (2001). Industrial Microbiology and Biotechnology IInd Edition. ASM Press, Washington.
4. P.F. Stanbury, W. Whitaker & S.J. Hall (2016). Principles of Fermentation Technology. 3rd edition. Elsevier publication.

MB20.605 Medical Microbiology **3-0-0-3**

Course Objective: This course deals with importance of the microorganisms in human health.

Normal Flora of Human Body: Skin, Oral cavity, Gastrointestinal tract, Respiratory tract, Urinogenital tract, Concept of opportunistic pathogens. [6]

Infection: Sources of infection for man, Vehicles or reservoirs of infection, Vertical and horizontal transmission of infection, Pathogenesis of infecting microorganisms-Virulence factors (adhesions, enzymes-coagulases, fibrinolysins, mucinases, lipase, proteases, nucleases, collagenase, neuraminidase). Toxins-endotoxins and exotoxins as agents of disease.

Microbial Strategies for Evading Immune Response: Evading phagocytosis, Survival in phagocytes, Immunosuppression, [10]

Induction of ineffective antibodies, Antigenic variation, Avoiding induction of immune response.

Bacterial Diseases: Pathogenesis, epidemiology, laboratory diagnosis, treatment and vaccination of bacterial diseases caused by- *Staphylococcus, Streptococcus, Pneumococcus, Neisseria, Corynebacterium, Bacillus, Clostridium, Escherichia, Salmonella, Shigella, Vibrio, Yersinia, Mycobacterium, Treponema, Mycoplasma, Campylobacter, Helicobacter, Rickettsiae and Chlamydiae.* [8]

Viral Diseases: Pathogenesis, epidemiology, laboratory diagnosis, treatment and vaccination of viral diseases- Pox viruses (Small pox), Herpes viruses (HSV, Epstein-barr virus), Adenoviruses, Picorna viruses (Polio, Rhinoviruses), Orthomyxoviruses (Influenza), Paramyxoviruses (Mumps, Measles, RSV), Arboviruses (Dengue, Yellow fever,), Rhabdoviruses (Rabies), Hepatitis viruses, Rubella, Reovirus, Rotavirus, Viral Haemorrhagic Fevers, HIV, Oncogenic Viruses. [8]

Fungal and Protozoan Diseases: Pathogenesis, laboratory diagnosis and treatment of fungal and protozoan (Malaria, Kala Azar) diseases. 7

Antimicrobial Agents: Mode of action of important antibacterial, antifungal, antiviral and antiprotozoan agents.

Course Outcome: Students will have clear understanding of microbial diseases, host-pathogen dynamics and challenges involved in keeping drug resistant microbes under control.

Suggested Readings:

Text Books:

1. Brooks, G.F., Carroll, K. C., Butel, J. S. and Morse, S. A. (2007) Jawetz, Melnick, & Adelberg's Medical Microbiology, Twenty-Fourth Edition. McGraw-Hill Companies, UK
2. Murray P.R., Pfaller M.A., Tenover F.C., and Yolken R.H. (2007). Medical Microbiology 6th Edn., ASM Press, U.S.A.
3. Bauman, R.W. (2005). 4th Edition. Microbiology: with diseases by body system; Pearson Education, Inc., U.S.A.
4. Ryan K. J. and Ryan C.G. (2004) Sherris Medical Microbiology: an Introduction to infectious diseases. 2nd edition. McGraw-Hill, U.S.A.

Reference Books:

1. Nester E. W., Anderson D. G. and Nester M. T. 2006. Microbiology: A Human Perspective, McGraw-Hill, U.S.A.
2. Brogden, K. A., Minion, C., Roth, J.A., Bolin, C.A. and Stanton, T. B. (2000) Virulence Mechanisms of Bacterial

Pathogens 2nd Edition. ASM Press, U.S.A.
3. Salyers, A. A. and Whitt, D.D. (2002) Bacterial Pathogenesis: A molecular Approach –2nd Edn. ASM Press, U.S.A.

MB20.609 Critical Analysis of Classical Papers 2-0-0-2

Course Objective The objectives of this course are to familiarize the students with classic literature to make them appreciate how ground-breaking discoveries were made without, necessarily, use of high-end technologies.

Execution: There are sixteen classical papers. Each students will be taking one paper for analysis. Each week there may be a 1.5-hour presentation cum discussion for each of the papers. At the end of the semester each student will be asked to write a mini-review (2-3 pages long) on any of the sixteen papers, other than the one he/she presented/discussed.

Course Outcome Students should be able to train in the exercise of hypothesis building and methods of addressing the hypothesis with readily available technology.

Molecular Biology

1 Studies on the chemical nature of the substance inducing transformation of Pneumococcal types: Induction of transformation by a desoxyribonucleic acid fraction isolated from Pneumococcus type III.
Avery OT, Macleod CM, McCarty M.; J Exp Med. 1944 Feb 1;79(2):137-58.
Note: This paper demonstrates that DNA is the transforming Principle originally described by Fredrick Griffith.

2 Independent functions of viral protein and nucleic acid in growth of bacteriophage
Hershey AD and Chase M.; J Gen Physiol. 1952 May;36(1):39-56.
Note: This paper demonstrates that DNA, and not protein, component of phages enter bacterial cells.

3 Molecular structure of nucleic acids; a structure for deoxyribose nucleic acid
Watson JD and Crick FH; Nature. 1953 Apr 25;171(4356):737-8
Note: In this one page paper Watson and Crick first described the structure of DNA double helix
Study help - Watson_Crick_Nature_1953_annotated

4 Transposable mating type genes in Saccharomyces cerevisiae
James Hicks, Jeffrey N. Strathern & Amar J.S. Klar; Nature 282, 478-483,1979
Note: This paper provided evidence for „cassette hypothesis" of yeast mating type switches i.e. interconversion of mating types in yeast (S. cerevisiae) occurs by DNA rearrangement.

5 Messelson and Stahl experiment demonstrating semi-conservative replication of DNA

Meselson M and Stahl FW.; Proc Natl Acad Sci U S A. 1958 Jul 15;44(7):671-82

Note: The experiment demonstrating semi-conservative mode of DNA replication is referred to as "the most beautiful experiment in biology"

6 In vivo alteration of telomere sequences and senescence caused by mutated Tetrahymena telomerase RNAs

Guo-Liang Yu, John D. Bradley, Laura D. Attardi & Elizabeth H. Blackburn; Nature 344, 126-132, 1990

Note: This paper demonstrates that the telomerase contains the template for telomere synthesis

Cell Biology

1 A protein-conducting channel in the endoplasmic reticulum

Simon SM AND Blobel G.; Cell. 1991 May 3;65(3):371-80

Note: This paper demonstrates the existence of a protein conducting channel

Study help - A brief history of Signal Hypothesis

2 Identification of 23 complementation groups required for post-translational events in the yeast secretory pathway

Novick P, Field C, Schekman R.; Cell. 1980 Aug;21(1):205-15

Note: In this groundbreaking paper Randy Schekman's group used a mutagenesis screen for fast sedimenting yeast mutants to identify genes involved in cell secretion

3 A yeast mutant defective at an early stage in import of secretory protein precursors into the endoplasmic reticulum

Deshaies RJ and Schekman R.; J Cell Biol. 1987 Aug;105(2):633-45

Note: Using another yeast mutation screen Schekman lab identifies Sec61, a component of ER protein Conducting Channel (PCC)

Suggested reference paper - A biochemical assay for identification of PCC.

4 Reconstitution of the Transport of Protein between Successive Compartments of the Golgi

Balch WE, Dunphy WG, Braell WA, Rothman JE.; Cell. 1984 Dec;39(2 Pt 1):405-16

Note: This paper describes setting up of an in vitro reconstituted system for transport between golgi stacks which eventually paved the way for identification of most of the molecular players involved in these steps including NSF, SNAP etc.

5 A complete immunoglobulin gene is created by somatic recombination

Brack C, Hirama M, Lenhard-Schuller R, Tonegawa S.; Cell. 1978 Sep;15(1):1-14

Note: This study demonstrates DNA level molecular details of somatic rearrangement of immunoglobulin gene sequences leading to the generation of functionally competent antibody generating gene following recombination.

6 A novel multigene family may encode odorant receptors: a molecular basis for odor recognition

Buck L and Axel R; Cell. 1991 Apr 5;65(1):175-87

Note: This paper suggests that different chemical odorants associate with

different cell-specific expression of a transmembrane receptor in Drosophila olfactory epithelium where a large family of odorat receptors is expressed.

7 Kinesin walks hand-over-hand

Yildiz A, Tomishige M, Vale RD, Selvin PR.; Science. 2004 Jan 30;303(5658):676-8

Note: This paper shows that kinesin motor works as a two-headed dimeric motor walking hand-over-hand rather than like an inchworm on microtubule tract using the energy of ATP hydrolysis.

Developmental Biology/ Genetics

1 Mutations affecting segment number and polarity in Drosophila

Christiane Nusslein-Volhard and Eric Weischaus; Nature 287, 795-801, 1980

Note: This single mutagenesis screen identified majority of the developmentally important genes not only in flies but in other metazoans as well.

2 Information for the dorsal--ventral pattern of the Drosophila embryo is stored as maternal mRNA

Anderson KV and Nüsslein-Volhard C; Nature. 1984 Sep 20-26;311(5983):223-7

Note: This landmark paper demonstrated that early dorsal-ventral pattern information is stored as maternal mRNA in flies and devised the method of identifying genes encoding such genes

3 Hedgehog signalling in the mouse requires intraflagellar transport proteins

Huangfu D, Liu A, Rakeman AS, Murcia NS, Niswander L, Anderson KV.; Nature. 2003 Nov 6;426(6962):83-7

Note: One of the architects of original fly mutagenesis screens conducted a mouse mutagenes screen which identified a gene Kif3a as a major component of hedgehog signaling pathway. Eventually this discovery revolutionizes our understanding of mechanisms of action of signaling pathways by demonstrating central role of cillia in it

Suggested Reference paper - Design and execution of a embryonic lethal mutation screen in mouse

BT20.603	**Emerging Technologies**	**2-0-0-2**
Course Objective	This course is 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 the basic principles of the new principles to the students and make them appreciate the current-day research tool-kit better.	
	Optical Microscopy Methods The Light Microscopy: lenses and microscopes, resolution: Rayleigh‟s Approach, Darkfield; Phase Contrast; Differential Interference Contrast; fluorescence and fluorescence microscopy: confocal microscope: scanning optical microscope, advanced fluorescence techniques: FLIM, FRET, and FCS, Fluorescence Lifetime, Fluorescence Resonant Energy	8

	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).	
	Mass Spectroscopy Ionization techniques; mass analyzers/overview MS; FT-ICR and Orbitrap, fragmentation of peptides; proteomics, nano LC-MS; Phospho proteomics; interaction proteomics, mass spectroscopy in structural biology; imaging mass spectrometry.	4
	Systems Biology and Structural Biology: High throughput screens in cellular systems, target identification, validation of experimental methods to generate the omics data, bioinformatics analyses, mathematical modeling and designing testable predictions. X-ray diffraction methods, solution & solid-state NMR.	6
	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.	4
	Nanobodies 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.	4
Course Outcome	Students should be to learn the history, theoretical basis and basic understanding of some of the latest technologies in the area of biotechnology. They should also be able to learn about various applications of these technologies. They may learn one application in depth through an assignment and/or seminar.	

Suggested Readings

Text Book:

- Campbell, I. D. (2012). Biophysical techniques. Oxford: Oxford University Press.
- Serdyuk, I. N., Zaccai, N. R., & Zaccai, G. (2007). Methods in molecular biophysics: Structure, dynamics, function. Cambridge: Cambridge University Press.

References:

- Phillips, R., Kondev, J., & Theriot, J. (2009). Physical

biology of the cell. New York: Garland Science.
- Biological physics: Energy, information, life. New York: W.H. Freeman.
- Huang, B., Bates, M., & Zhuang, X. (2009). Super-Resolution Fluorescence Microscopy. Annu. Rev. Biochem. Annual Review of Biochemistry, 78(1), 993-1016. doi:10.1146/annurev.biochem.77.061906.092014.
- 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.

MB20.609 **Project Proposal** **2-0-0-2**

Course Objective

The objectives of this course are to prepare the students to present their topic of research and explain its importance to their fellow classmates and teachers.
Poster Presentation: Students will have to present the topic of their project proposal after few months of their selection of the topic. They should be able to explain the novelty and importance of their research topic.

Oral Presentation: At the end of their project, presentation will have to be given by the students to explain in detail the work done by them. Along with summarizing their findings they should also be able to discuss the future outcomes of their work.

Course Outcome

Students should be able to learn how to present and explain their research findings to the audience affectively.

MB20.611 **Research Seminar** **1-0-0-1**

The objectives of this course are to train the students to evaluate research papers, to assess quality of the papers and how the papers are refereed and published as well as learn how to get the papers published.
Student presentations: Each student will need to present one paper during the term. They should select research papers, which deal with upcoming or most recent scientific findings/breakthrough and technologies developed.

Class evaluations and discussions: Every week, each student will be

asked to write a short review and evaluations of the paper presented in the class and then indulge in discussion with flaws of the paper, important questions and impact of the overall paper. Recent technologies, can be discussed, where it can be applied.
Students should be able to –

- Critically analyse the research papers from different upcoming topics.
- Understand the weaknesses and strengths of the paper and what additional experiments could have been done to strengthen the research study.
- Understand the context of the paper and identify important questions.
- Acquire the skills in paper writing and getting it published.

MB20.602 **Dissertation** **0-0-40-20**

Course Objective The objectives of this course are to prepare the students to adapt to the research environment and understand how projects are executed in a research laboratory. It will also enable students to learn practical aspects of research and train students in the art of analysis and thesis writing.

Planning & performing of experiments: Based on the project proposal submitted in earlier semester, students should be able to plan, and engage in, an independent and sustained critical investigation and evaluate a chosen research topic relevant to biological sciences and society. They should be able to systematically identify relevant theory and concepts, relate these to appropriate methodologies and evidence, apply appropriate techniques and draw appropriate conclusions. Senior researchers should be able to train the students such that they can work independently and are able to understand the aim of each experiment performed by them. They should also be able to understand the possible outcomes of each experiment. Thesis writing: At the end of their project, thesis has to be written giving all the details such as aim, methodology, results, discussion and future work related to their project. Students may aim to get their research findings published in a peer-reviewed journal. If the research findings have application-oriented outcomes, the students may file patent application.

Course Outcome Students should be able to learn how to select and defend a topic of their research, how to effectively plan, execute, evaluate and discuss their experiments. Students should be able to demonstration

considerable improvement in the following areas:

- In-depth knowledge of the chosen area of research.
- Capability to critically and systematically integrate knowledge to identify the issues that must be addressed within the framework of the specific thesis.
- Competence in research design and planning.
- Capability to create, analyse and critically evaluate different technical solutions.
- Ability to conduct research independently.
- Ability to perform analytical techniques/experimental methods.
- Project management skills.
- Report writing skills.
- Problem solving skills.
- Communication and interpersonal skills.

MB20.613 Plant Microbe Interaction **3-0-0-3**

Introduction: Plant and microbe interaction, Plants as a host environment, The effects of microbes on plant physiology such as effects on photosynthesis, respiration, and the translocation of water and nutrients. Plants defense including structural defenses, biochemical defenses, and the hypersensitive response, Biotechnological perspectives of plant-microbe interaction

Plant-Bacteria Interaction: Introduction, Abundance and distribution of bacteria in plants, Epiphytic/Endophytic bacteria, Rhizobacteria, Plant growth-promoting rhizobacteria/bacteria (PGPR/PGPB), Pseudomonads *Bacillus* and as PGPR, Bacteria and plant health, Root nodule formation on legumes by *Rhizobium*spp for nitrogen fixation; other nitrogen fixing systems such as in alder/ *Frankia* and *Azolla*/*Anabaena*, Molecular mechanism of plant growth-promotion and biocontrol by bacteria, Microbial response to plants under habitat-imposed stresses (abiotic and biotic), Pathogenic interactions of bacteria with plants

Plant-fungal Interaction: Introduction to fungal biology, Abundance and distribution of fungus in plants (Epiphytic/Endophytic), Mycorrhiza: Ecto, endo and VAM, Survey of fungal diseases important in plant pathology, Diagnostics and preventive measures

Plant-virus Interaction: Diversity of plant viruses, Plant diseases caused by

virus, Life cycles of plant viruses, Diagnostics and preventive measures

Plant-nematode Interaction: Root-knot nematode, role of *Meloidogyne*, Plant health and nematode, Diagnostics and preventive measures

Suggested Readings:

1. Burns and Slater. Experimental Microbial Ecology, Blackwell Scientific Publications, Oxford
2. Alexander M. Microbial Ecology, John Wiley and Sons
Atlas RM and Bartha R. Microbial Ecology: Fundamentals and Principles, Benjamin Cummins, USA

MB20.615 Microbiology Laboratory-III 0-0-6-3

Course Objective: To provide understanding towards the basic concepts of microbiological techniques related to agriculture, environment and medical aspects.

1. Culturing bacteria in laboratory and study its characteristics.
2. Estimation of microbial flora on seeds.
3. To determine the food quality and its deterioration by measuring the microbial population.
4. To prepare the selective and differential (EMB) medium.
5. Isolation of *E. coli* from sewage water samples with the help of EMB agar medium.
6. Isolation of symbiotic *Rhizobium* from plant root nodules.
7. To learn the technique of Immobilization of microbial cells
8. To study the flora of skin and determining its morphological characteristics.
9. To study the flora of human blood sample and determining its morphological characteristics.
10. To study the flora and its morphological characteristics using human urine sample.
11. Antibiotic sensitivity test disc preparation.
12. To determine the MIC of given antibiotic (streptomycin) by observing its effect on bacterial culture.
13. Widal test.
14. Blood film preparation and identification of cells
15. Detection of bacteria in milk
16. Reductase test for milk – Methylene Blue / Resazurin.
17. Isolation of Lactobacilli and Streptococci from curd.
18. Collection of fungal samples and study using KOH and Lactophenol cotton blue.
19. Enumeration of microbial population from soil: Bacteria,

Fungi, Actinomycetes.

20. Bacterial examination of water (qualitative) and Standard plate count (quantitative test)
21. Estimation of BOD and COD.
22. Enumeration of microorganism from air.

Course Outcome: On completion of this course, the student will be able to apply the learnt knowledge in various practical streams and enhance their placement opportuities in pathological labs, industries or run its private ventures.

FS20.510	**Introduction to Forensic Biotechnology**	**3-0-0-3**
Course Objective:	To give insight of biotechnology applicable in forensic area	

Serology and Immunology **6**

Cell structure and functions. Structure and function of carbohydrates, fats and proteins, serum proteins, haemoglobin and its variants, haptoglobins, HLA, polymorphic enzymes, blood groups-history, biochemistry and genetics of ABO, Rh, Mn and other systems, Methods of ABO blood grouping from fresh blood and biological stains, body fluids, determination of secretor status, polymorphic enzyme typing, serogenetic markers, determination of origin of species, immunology, immune response, antigens, haptens and antibodies, function and rising of antisera, lectins.Bloodstains investigations: Blood pattern analysis, ageing of bloodstains, difference between human and animal bloodstains, spectroscopic analysis.

Forensic Biology **8**

General plant classification schemes. Sub specialisation of forensic botany- plant morphology, plant anatomy, plant systematic, palynology, plant ecology.Wood and timber analysis.Diatoms and their forensic importance.Study and identification of various diatoms.Paper and pulp identification.

Hair examination **8**

Collection and preservation of hair samples.Morphological and microscopic examination of human and animal hair. Hair growth and development, determination of origin, race, sex, site from hair. Comparison between human and non-human hair.Macroscopic and microscopic features of hair.

Wildlife Forensics **8**

Introduction and importance of wild life. Protected and endangered species of animals and plants.Sanctuaries and their importance.Introduction to Wildlife (Protection) Act 1972 and

CITES, Relevant provision of wild life and environmental act. Types of wildlife crimes, different methods of killing and poaching of wildlife animals

DNA Profiling **9**

Double helical structure of DNA, alternate forms of DNA double helix, denaturation and renaturation of DNA, DNA binding proteins, factors affecting DNA stability, types and structure of RNA. Chemical nature of DNA and RNA.Nature and structure of human genome and its diversity.mt-DNA, Y-Chromosomes and the peopling, migration, of modern humans, Forensic DNA profiling and its application in criminal and civil investigations.

Text Books

Butler, J; Advanced Topics in Forensic DNA Typing: Methodology, 1st Ed., Academic Press, London, 2009.

Easteal, S. McLeod, N. & Reed, K; DNA Profiling: Principles, Pitfalls and Potential, Harwood Academic Publishers, New Jersey, 1991.

Reference Books

Rudin, N. & Inman, K; An Introduction to Forensic DNA Analysis, Second Ed.,CRC press, New York, 2001.

Spencer, C; Genetic testimony: a guide to forensic DNA profiling, Pearson, New Delhi, 2004.

Brown, T; Gene cloning and DNA analysis: An Introduction , 5th ed. Blackwellpublishing, London, 2006

BT20.617 **Molecular Diagnostics**

Course Objective

The objectives of this course are to sensitize the students about the recent advances in molecular biology and various facets of molecular medicine which has the potential to profoundly alter many aspects of modern medicine including the pre- or post-natal analysis of genetic diseases and identification of individuals predisposed to disease ranging from common cold to cancer.

Genome Biology in Health & Disease DNA, RNA, Protein: An overview; chromosomal structure & mutations; DNA polymorphism: human identity; clinical variability and genetically determined adverse reactions to drugs.

Genome: Resolution, Detection & Analysis PCR: Real-time; ARMS; Multiplex; ISH; FISH; ISA; RFLP; DHPLC; DGGE; CSCE; SSCP; Nucleic acid sequencing: new generations of automated sequencers; Microarray

chips; EST; SAGE; microarray data normalization & analysis; molecular markers: 16S rRNA typing; Diagnostic proteomics: SELDI-TOF MS; Bioinformatics data acquisition & analysis.

Diagnostic Metabolomics Metabolite profile for biomarker detection in the body fluids/tissues under various metabolic disorders by making use of LCMS & NMR technological platforms.

Detection & Identity of Microbial Diseases Direct detection & identification of pathogenic-organisms that are slow growing or currently lacking a system of invitro cultivation as well as genotypic markers of microbial resistance to specific antibiotics.

Detection of Inherited Diseases Exemplified by two inherited diseases for which molecular diagnosis has provided a dramatic improvement of quality of medical care: - Fragile X Syndrome: Paradigm of the new mutational mechanism of the unstable triplet repeats, von-Hippel Lindau disease: recent acquisition in the growing number of familial cancer syndromes.

Molecular Oncology Detection of recognized genetic aberrations in clinical samples from cancer patients; types of cancer-causing alterations revealed by next-generation sequencing of clinical isolates; predictive biomarkers for personalized onco-therapy of human diseases such as chronic myeloid leukemia, colon, breast, lung cancer and melanoma as well as matching targeted therapies with patients and preventing toxicity of standard systemic therapies.

Course Outcome

Students should be able to understand the various facets of molecular procedures and basics of genomics, proteomics and metabolomics that could be employed in the early diagnosis and prognosis of human diseases.

Suggested Readings

Text Book:

- Campbell, A. M., & Heyer, L. J. (2006). Discovering genomics, proteomics, and bioinformatics. San Francisco: Benjamin Cummings.

References

- Brooker, R. J. (2009). Genetics: Analysis & principles. New York, NY: McGraw-Hill.
- Glick, B. R., Pasternak, J. J., & Patten, C. L. (2010). Molecular biotechnology: Principles and applications of recombinant DNA.

Washington, DC: ASM Press.
- Coleman, W. B., & Tsongalis, G. J. (1997). Molecular diagnostics: For the clinical laboratorian. Totowa, NJ: Humana Press.

BT20.615	**Biocatalysis and Biotransformation**	**3-0-0-3**
Course Objective	To introduce the students about importance of biocatalysts in industry and role of biotransformation for product developments	
	Introduction: Importance of catalyst, Catalyst vs Biocatalyst, Kinetics, Mechanisms of action, Mode of Regulation, Allosteric enzymes, Investigation of active sites and catalytic mechanism, Enzyme Engineering, Non protein enzymes	8
	Sources of a Biocatalyst, Isolation strategies, Assay Methods, Strain Improvement, Extracellular and Intracellular enzymes, Properties, Mechanisms of secretion, regulation of enzyme synthesis, Recovery and Purification of fermentation product, Enzymes in non-aqueous system	8
	Industrial Application of Enzymes: Immobilization Kinetics, Batch and Continuous Mode of Fermentation	8
	Application of enzymes in Diagnosis and Treatment, Research Sector, Biotransformation Industry and Biodegradation of Xenobiotic compounds	
	Enzymes in soil nutrients recycling, Green House gases sequestration, Nitrogen Fixation etc.	8
	Stresses related defense enzymes in plants and animals, Enzymes in energy production: Bioethanol, Biogas, Biohydrogen etc.	8
Course Outcome	After successful completion of this course, students will be able to reflect a broad knowledge about enzymes and their applications in academia and industry and have an overview of relevant bio-transformations	
Suggested Readings	**Text Book:**	

- Comprehensive Biotechnology, 2004. Murray M Y (ed). Pergamon Press
- Enzyme Technology, 1990. Chaplin M F and Bucke C. Cambridge University Press

References:

- Biotol- Technological Applications of Biocatalysts, 1993. Barker R D J (ed). Butterworth Heinemann Ltd. Oxford
- Enzymes: Biochemistry, Biotechnology, Clinical Chemistry, 2007. Palmer T. and Bonner P L R. Harwood Publication, London.

FS20.510	**Introduction to Forensic Biotechnology**	**3-0-0-3**
Course Objective:	To give insight of biotechnology applicable in forensic area	

Serology and Immunology **6**

Cell structure and functions. Structure and function of carbohydrates, fats and proteins, serum proteins, haemoglobin and its variants, haptoglobins, HLA, polymorphic enzymes, blood groups-history, biochemistry and genetics of ABO, Rh, Mn and other systems, Methods of ABO blood grouping from fresh blood and biological stains, body fluids, determination of secretor status, polymorphic enzyme typing, serogenetic markers, determination of origin of species, immunology, immune response, antigens, haptens and antibodies, function and rising of antisera, lectins.Bloodstains investigations: Blood pattern analysis, ageing of bloodstains, difference between human and animal bloodstains, spectroscopic analysis.

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DNA Profiling **9**

Double helical structure of DNA, alternate forms of DNA double helix, denaturation and renaturation of DNA, DNA binding

proteins, factors affecting DNA stability, types and structure of RNA. Chemical nature of DNA and RNA.Nature and structure of human genome and its diversity.mt-DNA, Y-Chromosomes and the peopling, migration, of modern humans, Forensic DNA profiling and its application in criminal and civil investigations.

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