Kristu Jayanti College
AUTONOMOUS Bangalore
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DEPARTMENT OF LIFE SCIENCES

Master of Science
(Microbiology)
Curriculum – 2015-2017

http://www.kristujayanti.edu.in

PROCEEDINGS OF THE MEETING OF THE BOARD OF STUDIES (BoS) FOR THE FACULTY OF SCIENCE - LIFE SCIENCES (PG)

The meeting of the B.O.S. (P.G) in Biotechnology, Genetics, Biochemistry & Microbiology was convened on 24th January, 2015 in the panel room P.G block, Kristu Jayanti College, Bangalore.

MEMBERS PRESENT **SIGNATURE**

1. Dr. Calistus Jude A.L
   Dean – Faculty of Sciences, KJC

2. Dr. S.K.Sarangi
   Professor, Department of Biotechnology, BUB

3. Dr. Jaya Prakash
   Professor & Director, Centre for Applied Genetics, BUB

4. Dr. M.S. Shaila
   Department of Microbiology and Cell Biology, IISC

5. Dr. Nitesh Dave
   Senior Scientist, Biocon India Pvt., Ltd, Bangalore

6. Dr. Elcey C.D
   Professor & Head, Department of Life Sciences, KJC

7. Dr. Deepa MA
   Associate Professor, Department of Life Sciences, KJC

8. Dr. Vijayanand S
   Assistant Professor, Department of Life Sciences, KJC

9. Mr. Thomas Abraham
   Assistant professor, Department of Life Sciences, KJC

10. Dr. Shalini Prabhu
    Assistant professor, Department of Life Sciences, KJC

11. Mr. John Caleb T.D
    Assistant professor, Department of Life Sciences, KJC

12. Ms. Apoorva Udhayashankar
    Assistant professor, Department of Life Sciences, KJC

The Dean - Faculty of Sciences Dr. Calistus Jude A.L welcomed the members of the board and initiated discussions on the following:

1. Curriculum overview

The head of the department presented an overview of the academic programme of the department which included programme matrix, assessment methodology, credit system for major core, practical, project and additional impetus. The BOS approved the same with some necessary corrections.

2. Syllabus

The draft syllabi for Autonomous batches for PG programmes in Biotechnology and Microbiology was presented, which was scrutinized thoroughly course wise by the subject experts. The BOS suggested necessary corrections and approved I Semester syllabus.

3. Panel of Examiners:

Panel of Examiners (both external and internal) for M.Sc., Biotechnology and Microbiology was finalized and approved for the academic year 2015-2016.

3. Question Paper Pattern

The End Semester Examination Theory question paper pattern for the PG programme was scrutinized and approved.

CURRICULUM OVERVIEW

1. **Aim of the Programme**
   The programme caters to aspiring students with scientific temper. It is designed to strengthen graduates in basic and applied knowledge of Microbiology, prepare the students for diverse careers in the field and create in them a desire for research.

2. **Eligibility**
   - B.Sc. Degree with 50% marks (45% in the case of SC / ST students) in all subjects.
   - Students who have studied Chemistry / Biochemistry compulsorily as an optional subject along with Biotechnology / Microbiology / Botany / Zoology/ Genetics / Life Science / Applied Botany / Applied Zoology / Environmental Science / Home Science / Sericulture / Biological Science / Agricultural Sciences / Horticultural Sciences / Fisheries / Dairy Sciences / Forestry / BE and B.Tech in Biotechnology / four year BS program.

3. **Credits**

Part	Category	Hours per week	Credits			Total credits	Semester
			Credit	No. of courses	Semester		
I	Major Core (Theory)	4	3	8	2	24	I, II
	Practical	8	5	4	2	20	
	Major Core (Theory)	4	3	6	2	18	III, IV
	Major Core (Practical)	8	5	2	2	10	
	Elective	4	3	1	1	03	
	Elective Practical	4	5	1	1	05	
II	Project	-	-	-	1	10	IV
III	**Additional Impetus**						
	Add on Courses (AOC)*	-	1	-	2	02	II, III
	Social Outreach Programme (SOP)*	-	1	-	1	01	II
	Aptitude Enrichment Programme (AEP)*	-	1	-	1	01	II
	Skill Enrichment Programme (SEP)*	-	1	-	1	01	III
	Award Seminars*	-	1	-	4	02	I – IV
	Internship	-	1	-	1	01	III
	External/Seminars/ Conferences/Workshops *	-	1	-	1	01	IV
	Industrial Visit (IV)*	-	1	-	1	01	IV
	Grand Total	**-**	**-**	**-**	**-**	**100**	

*** Grades/Credits will be reflected in the final marks card**

Sem	Paper Code	Title of the Paper	Hrs	Credits	CIA	ESE	Total
I	MMB151201	Bacteriology and Virology	52	3	30	70	100
	MMB151202	Eukaryotic Microbiology	52	3	30	70	100
	MMB151203	Microbial Physiology and Biochemistry	52	3	30	70	100
	MMB151204	Microbial and Biochemical Techniques	52	3	30	70	100
	MMB1512L1	Bacteriology, Virology and Eukaryotic Microbiology Practical	104	5	15	35	50
	MMB1512L2	Microbial Physiology, Biochemistry, Microbial and Biochemical Techniques Practical	104	5	15	35	50
		Award Seminar	30	-	-	-	-
		Aptitude Enrichment Program (AEP)	30	-	-	-	-
II	MMB152201	Microbial Genetics	52	3	30	70	100
	MMB152202	Molecular Biology	52	3	30	70	100
	MMB152203	Immunology and Immunotechnology	52	3	30	70	100
	MMB152204	Bioinformatics and Biostatistics	52	3	30	70	100

	MMB1522L1	Microbial Genetics, Immunology and Immunotechnology Practical	104	5	15	35	50
	MMB1522L2	Molecular Biology, Bioinformatics and Biostatistics Practical	104	5	15	35	50
		Add on Course (AOC)	25	1	-	-	-
		Social Outreach Program (SOP)	-	1	-	-	-
		Aptitude Enrichment Program (AEP)	30	1	-	-	-
		Award Seminar	30	1	-	-	-
III	MMB153201	Recombinant DNA Technology	52	3	30	70	100
	MMB153202	Medical Microbiology	52	3	30	70	100
	MMB153203	Intellectual Property Rights, Bioethics and Entrepreneurship	52	3	30	70	100
	MMB153A01 MMB153B01	Elective 1: Environmental Microbiology Elective 2: Food and Dairy Microbiology	52	3	30	70	100
	MMB1532L1	Recombinant DNA Technology and Medical Microbiology	104	5	15	35	50
	MMB153AL1 MMB153BL1	Elective 1: Environmental Microbiology Practical Elective 2: Food and Dairy Microbiology Practical	52	3	15	35	50
		Add on Course (AOC)	25	1	-	-	-
		Skill Enrichment Program (SEP)	30	1	-	-	-
		Internship	60	1	-	-	-
		Award Seminar	30	-	-	-	-
IV	MMB154201	Agricultural Microbiology	52	3	30	70	100
	MMB154202	Fermentation Technology	52	3	30	70	100
	MMB154203	Microbial Technology and Biosafety	52	3	30	70	100
	MMB1542L1	Agricultural Microbiology, Fermentation Technology and Microbial Technology Practical	104	5	15	35	50
	MMB1542P1	Project Work	104	5	50	80D+ 20Vv	150
		Project Dissertation		5			
		External Seminars/Conferences/ Workshops	-	1	-	-	-
		Industrial Visit	-	1	-	-	-
		Award Seminar	30	1	-	-	-
		Grand Total	-	**100**	-	-	**2000**

A student has to earn a minimum of 90 credits for successful completion of the programme

4. **Electives**

Two Elective papers are offered during the III Semester and the student can opt one. The electives will be assigned based on the students' preference and their academic merit during the previous semester.

5. **Project**

- The students have to undertake a project on any of the subjects related to Life Science.
- The students will perform the project individually or in groups of 3 members (max), in which case the work done and contribution by members of the group will be assessed on an individual basis.

- Projects may be in-house or can be carried out in other research institutes. Co-guide from other institutions/university/industry is permitted.
- Periodic assessment of the project work will be carried out by a panel of faculty members.
- Two copies of the dissertation to be submitted to the Controller of Examinations.
- Evaluation of the project work to be done by an External and Internal Examiner appointed by the Controller of Examinations. The total marks for evaluation of project will be 150 marks (Dissertation: 80 marks; Viva-voce 20 marks; Continuous Internal Assessment: 50 marks).

6. **Passing Criteria**
   - No minimum pass mark for CIA
   - ESE (End Semester Examination) alone 40% (Theory – 24 marks out of 60; Practical – 12 marks out of 30; Project – 40 marks out of 100)
   - (ESE + CIA) aggregate 40% (Theory – 40 marks out of 100; Practical – 20 out of 50; Project – 75 out of 150)
   - Student should achieve the total number of credits assigned for each programme.

7. **Assessment Methodology**

The End Semester Examination (ESE) will be conducted for 60 marks (Theory), 30 marks (Practicals) and the Continuous Internal Assessment (CIA) will be for 40 marks (Theory) and 20 marks (Practicals). Project evaluation is for 100 marks and CIA will be for 50 marks.

CIA will be awarded as follows:

Assessment Parameters	**I Semester**	**II Semester**	**III Semester**	**IV Semester**
Theory				
			C/E*	
Mid Term Exam	20	20	20	20
Attendance	05	05	05	05
Assignment	05	05	05	05
Class Seminar	05	05	05	05
General Performance	05	05	05	05
Practical				
Practical Record	05	05	05	05
Attendance	05	05	05	05
Term Exam for Practical Subjects (TEPS)	05	05	05	05
General Performance	05	05	05	05
Project				
Review (2)	-	-	-	20
Execution of Project work	-	-	-	30

Note: General Performance marks will be awarded based on discipline, regularity and involvement of the student in subject related activities.
*: C= Core subjects; E= Elective subjects

8. **Attendance**
   - A student should have 85 percentage of attendance in each course
   - Any student who is not complying to this requirement will not be allowed to appear for the End Semester Examination (ESE)
   - In case a student does not appear for the examination due to shortage of attendance, the student has to repeat that semester to make up for the attendance and the student will have to pay the fees for that semester as applicable.

9. **Additional Impetus**

Sl. No.	Activities	Semester (Credits)			
		I	II	III	IV
i.	Orientation and Bridge Programme	-	-	-	--
ii.	Add on Courses (AOC)	-	1	1	-
iii.	Social Outreach Programme (SOP)	-	1	-	-
iv.	Aptitude Enrichment Programme (AEP)	-	1	-	-
	Skill Enrichment Programme (SEP)	-	-	1	-
v.	Award Seminars	-	1	-	1
vi.	Internship	-	-	1	-
vii.	External Seminars/Conferences/ Workshops	-	-	-	1
viii.	Industrial Visit (IV)	-	-	-	1
ix.	Life Skill Education (LSE)	-	-	-	-
x.	Co-curricular activities	-	-	-	-

i. Orientation and Bridge Programme

The orientation programme of the department familiarizes students joining the programme on the culture and functioning of the department. Students are inducted into the main programme through bridge programmes on Fundamentals of Botany, Zoology, Biotechnology, Microbiology and Biochemistry.

ii. Add on Courses (AOC)

The following Add on Courses (AOC) are offered by the Department. AOC on Research Methodology is mandatory and will be offered in the II Semester. In the III Semester, three AOCs are offered and the student can choose any one. The students will be earning one credit per course (total 2 credits during the M.Sc. program), Evaluation of the AOC will be done at the end of the each Semester through an examination. Following are the list of AOCs offered by the Department.

- **Research Methodology**
- **Plant and Animal Histology**
- **Fundamentals in Quality Control**
- **Clinical Research**

iii. Social Outreach Programme (SOP)

A Social Outreach Programme (SOP) is conducted make students realize their social responsibility. The student are expected to participate and contribute in a way to express their concern towards the society. The student participating in SOP will be awarded with one credit during the II Semester.

iv. Aptitude Enrichment Program (AEP) and Skill Enrichment Program (SEP)

This programme will comprise of activities that help students to mould their soft skills and prepare them to face entry level competitions in their career and prepare for competitive exams. The activities organized under AEP are Current Affairs, Latest discoveries in Science, Problem solving activities and Aptitude Test. The student will be earning one credit during the II Semester. The activities organized under SEP are Quiz, Debate, Group Discussion, Preparation for CSIR/NET/other Competitive Exams & Mock Interviews, teaching by student peers. The student will be earning one credit during the III Semester.

v. Award Seminars

During I – IV semesters, students will be presenting seminars on various general topics related to Life Sciences, which will be evaluated by a jury comprising of three faculty members and three students. The student will be earning one credit each during the II and IV Semester. In addition, best seminars will be awarded with a prize and a certificate.

vi. Internship

The students are expected to be an intern in any University / Institute / Industry Hospital/ Diagnostic laboratories / R & D laboratories for a minimum of 15 days during first year of their M.Sc. program. The students should submit the report of the Internship during III semester for evaluation. The student will be awarded one credit for their Internship during III Semester.

vii. External Seminars/Conferences/Workshops

The students presenting papers/posters in seminars / conferences or selected for attending workshops (either with summer/winter fellowships or through screening) or attended any of the above during the course of their study, will be awarded one credit during IV semester.

viii. Industrial Visit

The students should undertake industrial visit during the course of their study organized by the Department. The student will be awarded one credit during IV semester for their participation in the industrial visit.

ix. Life Skill Education (LSE)

Life Skills Education is designed to facilitate the practice and reinforcement of psychological skills in a culturally and developmentally appropriate way: it contributes to the promotion of personal and social development. The student should undergo a training program in LSE during the course of their study, which will familiarize the students in theoretical foundation in Life Skills Education, enable him/her to apply Life Skills in various spheres and empowers youth with the ability to contribute as youth worker specialized in the respective areas.

x. Co-curricular Activities

Co-curricular activities will enhance the team building, competitive spirit and leadership quality in students. Hence, students are encouraged to participate in various intra and inter-collegiate Bio-fests or organize Bio-fests, seminars, conferences etc.

10. **Programme Matrix**

I Semester

Course Code	Name of the Course	Hours	Credits	CIA	ESE	Total
MMB151201	Bacteriology and Virology	52	3	30	70	100
MMB151202	Eukaryotic Microbiology	52	3	30	70	100
MMB151203	Microbial Physiology and Biochemistry	52	3	30	70	100
MMB151204	Microbial and Biochemical Techniques	52	3	30	70	100
MMB1512L1	Bacteriology, Virology and Eukaryotic Microbiology Practical	104	5	15	35	50
MMB1512L2	Microbial Physiology, Biochemistry, Microbial and Biochemical Techniques Practical	104	5	15	35	50
	Award Seminar	30	-	-	-	-
	Aptitude Enrichment Program (AEP)	30	-	-	-	-
	Total	**-**	**22**	**-**	**-**	**500**

II Semester

Course Code	Name of the Course	Hours	Credits	CIA	ESE	Total
MMB152201	Microbial Genetics	52	3	30	70	100
MMB152202	Molecular Biology	52	3	30	70	100
MMB152203	Immunology and Immunotechnology	52	3	30	70	100
MMB152204	Bioinformatics and Biostatistics	52	3	30	70	100
MMB1522L1	Microbial Genetics, Immunology and Immunotechnology Practical	104	5	15	35	50
MMB1522L2	Molecular Biology, Bioinformatics and Biostatistics Practical	104	5	15	35	50
	Add On Course (AOC)	25	1	-	-	-
	Social Outreach Program (SOP)	-	1	-	-	-
	Aptitude Enrichment Program (AEP)	30	1	-	-	-
	Award Seminar	30	1	-	-	-
	Total	**-**	**26**	**-**	**-**	**500**

III Semester

Course Code	Name of the Course	Hours	Credits	CIA	ESE	Total
MMB153201	Recombinant DNA Technology	52	3	30	70	100
MMB153202	Medical Microbiology	52	3	30	70	100
MMB153203	Intellectual Property Rights, Bioethics and Entrepreneurship	52	3	30	70	100
MMB153A01 MMB153B01	Elective 1: Environmental Microbiology Elective 2: Food and Dairy Microbiology	52	3	30	70	100

MMB1532L1	Recombinant DNA Technology and Medical Microbiology Practical	104	5	15	35	50
MMB153AL1 MMB153BL1	Elective 1: Environmental Microbiology Practical Elective 2: Food and Dairy Microbiology Practical	104	5	15	35	50
	Add On Course (AOC)	25	1	-	-	-
	Skill Enrichment Program (SEP)	30	1	-	-	-
	Internship	60	1	-	-	-
	Award Seminar	30	-	-	-	-
	Total		**25**	**-**	**-**	**500**

IV Semester

Course Code	Name of the Course	Hours	Credits	CIA	ESE	Total
MMB154201	Agricultural Microbiology	52	3	30	70	100
MMB154202	Fermentation Technology	52	3	30	70	100
MMB154203	Microbial Technology and Biosafety	52	3	30	70	100
MMB1542L1	Agricultural Microbiology, Fermentation Technology and Microbial Technology Practical	104	5	15	35	50
MMB1542P1	Project Work	156	5	50	80D+ 20Vv	150
	Project Dissertation		5	-		
	External Seminars/Conferences/Workshops	-	1	-	-	-
	Industrial Visit	-	1	-		-
	Award Seminar	30	1	-	-	-
	Total	-	**27**	**-**		**500**

SEMESTER I

MMB151201 BACTERIOLOGY AND VIROLOGY

3 Credits **Total: 52 Hours**

Objectives:

- Understand morphology, morphological groups, cultivation, reproduction and growth of bacteria
- Learn salient features, classification and nomenclature of viruses
- Learn general methods of disease diagnosis and serology of viruses

UNIT 1: Microbial Classification **14 hrs**

Introduction to microbes and prokaryotes; Natural system of classification; Haeckel's three kingdom system of classification; Whittaker's five kingdom system of classification; Three domain classification; Taxon, species, strain, type culture; Criteria used for classification – conventional method; Recent trends in Microbial Taxonomy – Molecular method - nucleic acid base composition (G+C ratio), nucleic acid hybridization (DNA-DNA homology; DNA-RNA homology), nucleic acid sequencing, DNA finger printing, amino acid sequencing; Chemotaxonomy- cell wall components, lipid composition, isoprenoid-quinones, cytochrome composition; Numerical Taxonomy; Genetic methods in Taxonomy; Serological methods; Phylogenetic relationships – Cladogram, Dendrogram; Classification according to Bergey's manual of systematic bacteriology; Binomial nomenclature, ICBN; Dichotomous key.

UNIT 2: Acellular Entities **06 hrs**

Viruses – brief outline on the discovery of viruses; Origin of Viruses; Nomenclature and classification of virus – ICTV system of classification; Distinctive properties of viruses; Morphology and ultra-structure of virus – capsid and their arrangements, types of envelopes and their composition, viral genome (RNA, DNA); Viroids, Prions - structure and importance.

UNIT 3: Cultivation of Viruses **06 hrs**

Cultivation of viruses – embryonated eggs, in vivo culture using animals; invitrol cultures -suspension, monolayer, cell lines.

UNIT 4: Morphology and Ultra structure of Bacteria **10 hrs**

Morphological types, flagella, pili, capsule, cell wall, cell membrane, cytoplasm, genetic material- chromosomes, plasmids, transposons, intracytoplasmic inclusions - gas vacuoles, cellulosomes, carboxysomes, magnetosomes, phycobilisomes, parasporal crystals, reserve food material- metachromatic granules, polysaccharide granules, poly β hydroxybutyrate granules, glycogen, oil droplets, cyanophycean granules and sulphur globules; Endospores and exospores; Cyanobacteria – Ultrastructure, reproduction and significance - *Microcystis, Gleocapsa, Spirulina, Nostoc, Anabaena* and *Scytonema.*

UNIT 5: Morphological Groups of Bacteria **08 hrs**

Spirochaetes, Rickettsiae, Chlamydiae, Mycoplasma, appendaged, sheathed, gliding bacteria; Archaeobacteria, Actinomycetes.

UNIT 6: Bacterial Nutrition, Cultivation, Growth **08 hrs**

Nutritional requirements – micro and macro nutrients, growth factors; Nutritional types of bacteria; Culture media – classification of media - simple, complex and special media; Cultivation - aerobic, anaerobic, batch, continuous and synchronous cultures; Growth – nutritional uptake, generation time, growth rate, growth kinetics, growth curve, factors affecting growth - physical, chemical and biological; Reproduction – mechanism of cell cycle and binary fission.

References:

Atlas, R.M, (1988). *Microbiology, Fundamentals and applications*, (2nd Ed.), Mac Millan Publishing Co., New York.

Balows A, Thuper, A.G., and Dworkin, (1991). *The Prokaryotes*, Springer-Verlag, New York.

Biswas SB and Anita Biswas, (1990). *An Introduction to viruses,* Volume II, Vikas Publishing House (P) Ltd., New Delhi

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Burnet, F.M. and Stanley, W. M., (1989). *The Viruses*, Academic Press. New York.

Edward K, Wagner and Hewlett, J.M., (1991). *Basic Virology*, Blackwell Scientific publication, UK.

Michael T. Madigan, John M. Martinko and Jack Parker, (2000). *Brock biology of microorganisms,* Prentice Hall, London.

Pelzar, M.J, Chan and Krieg, (1986). *Microbiology,* McGraw-Hill Book Co., Singapore.

Robert, E Buchanan, (2005). *Bacteriology*, Oxford & IBH Publishing, New Delhi

Salle A.J, (1983). *Fundamental Principle of Bacteriology*, Tata McGraw Hill Pub. Co. New Delhi.

Stainer R.Y, Ingharam, Wheelis and Painter, (1996). *General microbiology*, Cambridge University press, London.

Sullia S.B and Shantharam, (2005). *General Microbiology*, Oxford IBH Pub Co., New Delhi.

Willey, M.J., Sherwood, M.L. and Woolverton, J.C., (2008). *Prescott, Harley and Klein's Microbiology*, McGraw Hill Higher Education, New York.

MMB151202 EUKARYOTIC MICROBIOLOGY

3 Credits **Total: 52 Hours**

Objectives:

- Understand the various eukaryotic micro organisms
- Learn the culturing methods of Eukaryotic micro organisms
- Learn the application of eukaryotic micro organism in industry and environment

UNIT 1: Morphology and Classification of Algae 08 hrs

Distribution, morphology and different systems of classification of Algae; Life cycle of Chlorophyta, Charophyta, Phaeophyta, Rhodophyta, Bacillariophyta; Algal ecology, isolation from soil and water, media and methods used for culturing algae - *Chlorella, Spirulina, Nostoc*; Measurement of algal growth, strain selection and large scale cultivation – media, methods and harvesting technology.

UNIT 2: Morphology and Reproduction of Blue Green Algae 10 hrs

Blue Green Algae (Cyanobacteria) – distribution, thallus construction and reproduction in general; Ultrastructure of typical cyanophycean cell, symbiosis and economic importance of Cyanobacteria; Structure and reproduction – *Spirogyra, Euglena, Spirulina, Oscillatoria, Rivularia, Nostoc, Anabaena, Exuviella* and *Scytonema.*

UNIT 3: Biological and Economic Importance of Algae 04 hrs

Biological and economic importance of Algae – primary producers, commercial products - food, green energy (biofuel) and therapeutic uses, heavy metal removal; Immobilized and labeled algae; Algal blooms and toxins.

UNIT 4: Morphology and Growth of Fungi 10 hrs

Structure of fungal cells and growth – hyphae, non-motile unicells, motile cells, spores, dormancy, growth of population and colonies; Mechanics of growth in fungi; Measurement of kinetics of growth, nutritional and environmental requirements, effect of environment on growth – pH, temperature; Prevention of fungal growth; Heterothallism, sex hormones in fungi, physiological specialization; Phylogeny of fungi.

UNIT 5: Classification of Fungi 14 hrs

Evolutionary tendencies in fungi; Ainsworth classification of fungi; Salient features of division and subdivision of fungal kingdom: Myxomycota – Acrasiomycetes, Hydromyxomycetes, Myxomycetes, Plasmodiophoromycetes; Eumycota – Mastigomycotina - Chytridiomycetes, Hyphochytridiomycetes, Oomycetes; Zygomycotina - Zygomycetes, Trichomycetes; Ascomycotina - Hemiascomycetes, Plectomycetes, Pyrenomycetes, Discomycetes, Laboulbenomycetes, Loculomycetes; Basidiomycota - Teliomycetes, Hymenomycetes, Gasteromycetes; Deuteromycota - Hyphomycetes, Coleomycetes, Blastomycetes; Structure and reproduction - *Dictyostelium, Allomyces, Pilobolus, Claviceps, Puccina* and *Fusarium.*

UNIT 6: Fungi and Ecosystem 06 hrs

Substrate groups – saprophytic, parasitic, keratinophilic, coprophilous; Substrate successions – parasitism, mutualism and symbiosis with plants and animals; Diversity of aquatic fungi; Economic importance of Fungi.

References:

Alexopolos, C.J. and Mims, C.W, (2001). *Introduction to Mycology*, John Wiley and Sons, New York.

Becker, E.W., (1994). *Microalgae: Biotechnology and Microbiology*, Cambridge University Press, London

Mehrotra, R.S. and Aneja, K.R, (2002). *An introduction to Mycology*, New Age Publications, New Delhi.

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Singh, P.K, Dhar, D.W, Pabbi, S., Prasanna, R. and Arora, A., (2000). *Biofertilizers – Blue Green Algae and Azolla*, National Centre for Conservation of Blue Green Algae, IARI, New Delhi.

Kashyap and Kumar H.D, (1994). *Recent advances in Phycology*, Rastogi Company, Meerut.

Chapman, V.J. and Chapman, D.J, (1973). *The Algae*, English language book society and Mc Milan Publishers, London.

Janet, R. Stein, (1975). *Phycological methods*, Cambridge University Press, UK

MMB151203 MICROBIAL PHYSIOLOGY AND BIOCHEMISTRY

3 Credits **Total: 52 Hours**

Objectives:

- Understand the transport mechanism of metabolites in microbes
- Know about kinetic parameters and inhibition of enzymes
- Learn the structure, properties and metabolism of biomolecules

UNIT 1: Metabolite Transport and Microbial Stress Response 08 hrs

Facilitated diffusion, ATP binding cassette transporter, chemiosmotic transport, ion ingredients; Specific transport system – ATP-linked ion motive pumps, histidine permease, iron, phospho transferase; Stress responses - osmotic, oxidative, thermal, heat shock, nutrient and starvation.

UNIT 2: Enzymes 10 hrs

Definition, specificity, active site, coenzymes, enzyme units, iso-enzymes; Enzyme kinetics – M-M equation, significance of Km and V max, LB plot; Determination of kinetic parameters, multi-substrate kinetics; Mechanism of enzyme action – Lock & key, induced fit hypothesis, acid-base, covalent and metal ion catalysis; Regulation – covalent, allosteric and feed back inhibition; Reversible and irreversible inhibitions; Kinetic analysis of allosteric enzymes, hills binding, ribozymes and abzyme.

UNIT 3: Carbohydrates 14 hrs

Structure and properties of mono, oligo and polysaccharides; Glycolysis – pentose phosphate pathway, Entner Doudoroff pathway, phosphoketolase pathway, Kreb's cycle, Glyoxalate cycle; Gluconeogenesis, Biosynthesis of peptidoglycan; Fermentation – homo (lactic acid fermentation) and heterolactic fermentation - acetic acid, butyric acid, mixed acid and propionic acid; Bioenergetics – Laws of Thermodynamics, high energy compounds; Energy production – substrate level phosphorylation, oxidation-reduction reactions, Redox potential, Electron transport chain, oxidative phosphorylation, generation of ATP in alkalophiles and chemolithotrophs.

UNIT 4: Lipids 08 hrs

Classification, structure of saturated, unsaturated fatty acids, triacyl glycerol, phospholipids, glycolipids and sterols; Oxidation of fatty acids (α, β, ω oxidation); Biosynthesis of fatty acids -saturated and unsaturated, and sterol (ergosterol).

UNIT 5: Nucleic Acids 06 hrs

Structure of bases, nucleosides and nucleotides; Biosynthesis – Purine - *de novo* and salvage pathway and Pyrimidine.

UNIT 6: Amino Acids and Proteins 06 hrs

Classification, structure and properties of amino acids; General aspects of amino acid metabolism – amination, transamination, deamination, decarboxylation; Assimilation of nitrogen, nitrate, ammonia; Synthesis of major amino acids; Urea cycle; Proteins -

classification, properties and structural organization - Primary, Secondary, Tertiary and Quaternary.

References:

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Gerhard Gottschalk, (1985). *Bacterial Metabolism*, Springer Series in Microbiology, USA.

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MMB151204 MICROBIAL AND BIOCHEMICAL TECHNIQUES

3 Credits **Total: 52 Hours**

Objectives:

- Understand techniques to visualize and study microorganisms
- Learn about quantitative determination of bacterial metabolites and their estimation
- Know about radio isotopic techniques and their application in microbiology

UNIT 1: Microscopy and Visualization Techniques 10 hrs

Light microscopy, bright field and dark field microscopy, phase contrast and fluorescent microscopy, electron microscopy (TEM and SEM), confocal microscopy, scanning probe microscopy; X-ray diffraction, crystallography.

UNIT 2: Sterilization Techniques 08 hrs

Physical methods – heat (dry & moist), filtration, radiation; Chemical methods – phenols, alcohols, halogens, heavy metals, aldehydes, quarternary ammonium compounds and gases; Evaluation of antimicrobial agents – phenol coefficient, filter paper method.

UNIT 3: Isolation and Identification of Pure Cultures 08 hrs

Isolation – dilution, spread plate, streak plate, pour plate, micro-manipulator method; Colony morphology and characteristics of broth cultures; Maintenance and preservation of pure cultures; Culture collection centers – National and International;

Identification – stains and staining techniques - nature of stains, principle, mechanism, method and types of staining.

UNIT 4: Measurement of Microbial Growth 08 hrs

Direct microscopic count, standard plate count, membrane filtration, MPN; Indirect method – turbidity, metabolic activity and dry weight; Automated microbial identification system.

UNIT 5: Analytical Methods 12 hrs

Spectrophotometry – principle and applications, UV/Visible and Fluorescence spectrophotometer; Spectroscopy – principle and applications of circular dichroism, NMR, ESR spectroscopy, mass spectroscopy; Chromatography – principles and applications - TLC, ion-exchange, affinity chromatography, GC, HPLC, UPLC; Electrophoresis – principles and applications, PAGE, SDS-PAGE, 2D-PAGE, IEF, AGE, PFGE.

UNIT 6: Radio-isotope Techniques 06 hrs

Stable and radioactive isotopes, radio isotopic labeling, autoradiography, scintillation counters, non-radioactive labeling, safety guidelines.

References:

Alexander N. Glazer and Hiroshi Nikaido, (1994). *Microbial Biotechnology*, W.H.Freeman and Company, New York.

Buchanan,B.B., (2007), *Biochemistry and Molecular Biology of Plants*. I.K. International Publishing house, New Delhi.

Burlage, S.R., Atlas, R., Stahl, D., Geesey, G. and Sayler, G., (1998). *Techniques in Microbial Ecology*, Oxford University Press, New York.

Collins, C.H., Tatrica, M. Lyne and Grange, J.M., (1999). *Microbiological methods*, Arnold Publishers, London

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MMB1512L1 BACTERIOLOGY, VIROLOGY AND EUKARYOTIC MICROBIOLOGY PRACTICAL

5 Credits **Total: 104 Hours**

Objectives:

- Learn to isolate microorganisms and study culture characteristics
- Learn staining techniques and biochemical tests for identification of bacteria
- Learn different stages and measurement of growth in bacteria, fungi and algae

1. Isolation of microorganism – serial dilution, pure culture techniques
2. Culture characteristics of microorganisms – Autotrophic – Benecks broth, Chu's medium; Heterotrophic – nutrient agar; Selective media – MRS, glucose aspargine media; Enriched medium – chocolate agar; Differential media – MaConkey, blood agar, EMB, DCA.
3. Staining techniques – simple, differential – acid-fast, endospore, capsule, cell wall; cytoplasmic inclusion, flagellar staining, nuclear staining and vital staining.
4. Biochemical tests for identification of bacteria – catalase, oxidase, IMViC, motility, gelatin test, urease, coagulase, nitrate reduction; Production of acid and gas – glucose, arabinose, lactose, maltose, mannitol, sucrose, fructose; Hydrolysis – starch, casein.
5. Bacterial growth measurements – cell count, turbidometry, plate count.
6. Isolation of bacteriophages from sewage and analysis of plaques.
7. Effect of various factors on growth of fungi - Environmental - pH, temperature, Nutritional - carbon, nitrogen sources.
8. Isolation and identification of fungi from soil – dilution plate method, stamping method.
9. Isolation and identification of fungi from plant material – Epiphytic fungi - washing method, impression method; Endophytic fungi - maceration method, implant method,.
10. Growth measurement of fungi – linear and biomass.
11. Isolation and identification of microscopic algae from soil and water.
12. Preparation of algal culture media and establishing algal cultures.

MMB1512L2 MICROBIAL PHYSIOLOGY, BIOCHEMISTRY, MICROBIAL AND BIOCHEMICAL TECHNIQUES PRACTICAL

5 Credits **Total: 104 Hours**

Objectives:

- Learn the estimations of biomolecules
- Learn to demonstrate the enzyme kinetics
- Learn to isolate the lipolytic microbes and fractionation of total lipid by column chromatography

1. Estimation of protein by Bradford method
2. Estimation of protein by Lowry *et al* method
3. Estimation of reducing sugar by DNS method
4. Estimation of DNA by DPA method

5. Estimation of RNA by orcinol method
6. Isolation of lipolytic microbes from soil-plate method and estimation of total lipid
7. Fractionation of total lipids by column chromatography
8. Determination of protease activity
9. Determination of malate dehydrogenase and catalase activity
10. Study of enzyme kinetics, Km and Vmax of amylase
11. Analysis of optimum pH, temperature of amylase
12. SDS-PAGE- molecular weight determination

SEMESTER II

MMB152201 MICROBIAL GENETICS

3 Credits **Total: 52 Hours**

Objectives:

- Understand the features of prokaryotic and eukaryotic genome
- Learn the detailed mechanism of gene transfer and genetic recombination
- Understand the regulatory mechanism in phage genome

UNIT 1: Prokaryotic Genome **04 hrs**

E.coli chromosome – coiled, folded fiber model, supercoiled - plectonemic, solenoid ; *Mycoplasma genitalium* and *E.coli* genome.

UNIT 2: Eukaryotic Genome **12 hrs**

Structure of chromatin, chromosome, centromere, telomere, nucleosome, genome organization, split gene, overlapping genes and Cot curves; types of histones, histone modifications – methylation, acetylation, phosphorylation and structure; Function of chromatin; DNA methylation in repetitive and non-repetitive DNA sequence; The law of DNA constancy and C-value paradox; Karyotype and ideogram; Chromosome banding pattern; Organelle genome.

UNIT 3: Gene Mutation **08 hrs**

Gene as unit of mutation, molecular basis of spontaneous and induced mutations and their role in evolution; Mutagens, types of mutations, transposon mutagenesis, site directed mutagenesis, AMES test; Environmental mutagenesis and toxicity testing.

UNIT 4: Genetic Recombination **12 hrs**

Genetic recombination in bacteriophages and *E.coli*, synapsis of homologous duplexes, breakages and re-union, role of Rec A in recombination, Recombination models – Holliday, Meselsons and radding model; Generalized and specialized transduction, transformation and conjugation; Legitimate and illegitimate recombination, gene conversion, overview of bacterial genetic map.

UNIT 5: Gene Transfer Mechanisms **06 hrs**

Bacterial transformation; Host cell restriction; Transduction; complementation; Conjugation; Transfection; Mechanisms and applications; Genetic analysis of microbes - bacteria and yeast; Induction of mutation in *Neurospora crassa* and yeast, cytoplasmic inheritance and biochemical mutants.

UNIT 6: Plasmids and Bacteriophage Genetics **10 hrs**

Plasmids, F-factors – description and their uses in genetic analysis, colicins and Col Factors, R plasmids, plasmids as vectors for gene cloning; Replication of selected plasmids – compatibility, Transposons and their use in genetic analyses; Bacteriophages – Lysogeny and lytic cycle in bacteriophages and their uses in microbial genetics; Lytic phages – T7 and T4, Lysogenic phages – Lambda and PI, M13 and ↹ 174.

References:

Bernard, R.G and Jack, J.P., (2003). *Molecular Biotechnology: Principles and application of Recombinant DNA*, ASM Press, USA.

Bharat Singh, (2007). *Recombinant DNA and Biotechnology*, Pointer Publishers, Jaipur.
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Sambrook J and Russell D (2001). *Molecular Cloning*, (3 Volumes), CSHL Press, John Wiley and Sons, New York.
Strickberger, W.M., (1985) *Genetics*, Macmillan Pub. Co. New York.

MMB152202 MOLECULAR BIOLOGY

3 Credits **Total: 52 Hours**

Objectives:

- Learn the basic concepts in Molecular Biology
- Study the detailed mechanism of various cellular processes.
- Understand the gene regulatory mechanism in prokaryotes and eukaryotes

UNIT 1: Structure and Properties of DNA and RNA 10 hrs

Introduction, flow of information, central dogma of molecular biology, Biochemical evidences for DNA as genetic material; Structure of DNA (Watson & Crick model) and types of DNA (A, B, Z); Properties of DNA – UV absorption, denaturation, renaturation; Thermodynamics of melting of the double helix, kinetics of unwinding of double helix, interaction of small ions; DNA damage – deamination, oxidation, alkylation, UV radiation; DNA Repair – photo-reactivation, excision repair, post-replication repair, mis-match repair and SOS repair; Structure and functions of rRNA, tRNA and mRNA.

UNIT 2: DNA Replication 08 hrs

General properties of replication – semi-conservative, bidirectional, discontinuous, Chemistry and enzymology of replication - DNA helicases, SSB proteins, Topoisomerases, Primases, DNA polymerases, DNA ligases, Telomerases; Fidelity of replication. Mechanism of replication in Prokaryotes and Eukaryotes; Models of replication in prokaryotes – asymmetric replication, looped, rolling circle, concatamer formation; DNA replication in viruses (M13 bacteriophage); Inhibitors of replication;

UNIT 3: Transcription 08 hrs

Enzymes and factors in transcription - RNA polymerases, transcription factors; Mechanism of transcription - initiation, elongation and termination in prokaryotes and eukaryotes; RNA processing - capping, splicing, spliciosome assembly, poly-adenylation; RNA editing; mRNA transport; Inhibitors of transcription.

UNIT 4: Translation 08 hrs

Basic features of genetic code; amino acid activation, mechanism of initiation, elongation and termination; inhibitors of protein synthesis; post-translational modification of proteins.

UNIT 5: Regulation of Gene Expression 14 hrs

Transcriptional control, enzyme induction and repression, constitutive synthesis of enzymes in prokaryotes and eukaryotes; The operon concept, catabolic repression, instability of bacterial RNA, inducers and co-repressors; Negative gene regulation – *E.coli lac* operon; Positive regulation – *E.coli* ara operon; Regulation by attenuation – *his* and *trp* operons, anti-termination – N protein and nut sites, DNA binding protein, enhancer sequences, identification of protein binding site on DNA; Control of gene expression at transcription and translation level – regulation of phage, virus, prokaryotic and eukaryotic gene expression (*cis* control elements, promoters, enhancers, trans acting factors), role of chromatin regulating gene expression

Gene silencing – transcriptional and post-transcriptional, RNAi pathway (siRNA and mi RNA). Molecular mechanism of antisense molecules - inhibition of splicing, poly-adenylation and translation, disruption of RNA structure and capping; Biochemistry of ribozyme, hammerhead, hairpin and other ribozymes; Strategies for designing ribozymes, application of antisense and ribozyme technologies.

UNIT 6: Protein Targeting 04 hrs

Synthesis of secretory and membrane proteins; Import into nucleus, mitochondria, chloroplast and peroxisomes.

References:

Adams R.L.P., (1992). *DNA Replication*, IPL Oxford, England.

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Tropp, E, B., (2012). *Molecular Biology – Genes to proteins*, (4th Ed.), Jones and Bartlett India Pvt. Ltd., New Delhi.

MMB152203 IMMUNOLOGY AND IMMUNOTECHNOLOGY

3 Credits **Total: 52 Hours**

Objectives:

- Familiarize with components of the immune system
- Knowledge on immune responses
- Understand concepts of hypersensitivity and immunization

UNIT 1: Immune System and Immunity 10 hrs

History of immunology; Structure, composition and functions of cells and organs of the immune system; T-cells, B-cells; Antigen processing and presentation, antigen processing cells - macrophages, eosinophils, neutrophils, mast cells and killer T-cells; Microbial infections and immune responses – innate immunity, acquired immunity; Clonal nature of immune response.

UNIT 2: Antigens and Antibodies 10 hrs

Antigens – Structure and properties; Types – iso and alloantigens, haptens, adjuvants, epitopes, chimeric peptides; Antigen specificity; Immunoglobulins – structure, heterogeneity, types and subtypes, physico-chemical and biological properties; Complement system – structure, components, properties and functions; Complement pathways and biological consequences of complement activation; Generation of immunological diversity; Effector mechanisms.

UNIT 3: Antigen-Antibody Reactions 10 hrs

In vitro methods – agglutination, precipitation, complement fixation, immuno-fluorescence, immuno-electrophoresis, immuno-blotting, ELISA, radio-immuno assay; *In vivo* methods – skin tests and immune complex tissue demonstrations; Applications of immunological reactions in diagnosis of microbial infections; Autoimmunity - mechanisms, altered antigens; Autoimmune diseases - Systemic Lupus Erythematosus, Graves disease, Rheumatoid Arthritis, Myasthenia Gravis, Multiple Sclerosis; Immunodeficiency – phagocytic, humoral, Cell Mediated Immunity (CMI), combined HLA association.

UNIT 4: Major Histocompatibility Complex and Tumor Immunology 10 hrs

Structure and functions of MHC and HLA systems; Immuno hematology – blood groups, blood transfusion and Rh incompatibilities. Gene regulation and Ir- genes; HLA and tissue transplantations in humans; Tissue reaction and rejection of transplant - graft versus host reaction, host versus graft reaction; Tumor immunology – tumor markers; Immune response to tumors; Immuno-diagnosis of tumors, detection of tumor markers; tumor antigens – tumor specific (cancer antigens) and tumor associated antigens -AFP, CEA; Immunosurveillance; Genetic control of immune response.

UNIT 5: Hypersensitivity Reactions 08 hrs

Definition of allergy, types of hypersentitivity reactions and symptoms - antibody-mediated Type I – Anaphylaxis; Type II – Antibody dependent cell cytotoxicity; Type III – Immune complex mediated reactions; Type IV – Cell mediated hypersensitivity reactions; Immunological methods of diagnosis; Lymphokines and cytokines – their assay methods; Interleukins and Interferons; Immunological tolerance and modulation.

UNIT 6: Immunization **04 hrs**

Polyclonal and monoclonal antibodies; Hybridoma technology; Catalytic monoclonal antibodies; Vaccines – conventional, peptide vaccines, DNA vaccines, toxoids, antisera, edible vaccines, plantibodies, ISCOMs, recombinant antibodies; Immuno stimulatory complexes; Common immunization programmes – BCG, small pox, DPT, polio, measles, Hepatitis – B.

References:

Abul K. Abbas, Andrew K. Lightman, Jordan S. Pober, (2005). *Cellular and molecular immunology*, Elsevier Publications, Boston.

Chakravarthy, A.K. (2006). *Immunology and Immunotechnology,* Oxford University Press, New Delhi.

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Hannigan, B.M., Moore, C.B.T. and Quinn, D.G., (2009). *Immunology* (2nd Ed.), Scion Publishing Ltd., UK.

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Vaman Rao, (2002). *An introduction to immunology*. Narosa Publishing House, New Delhi.

MMB152204 BIOINFORMATICS & BIOSTATISTICS

3 Credits **Total: 52 Hours**

Objectives:

- Aquaint with essentials of computer programmes and languages
- Understand the concepts of Bioinformatics
- Understand biostatistics and its applications

UNIT 1: Computer Fundamentals **08 hrs**

Computer architecture, softwares, network, internet technologies; C programming and PERL – introduction, algorithm and flowchart; C-programming – structure of C program, header file, global declaration, main function, variable declaration, control statement – conditional, looping and unconditional control statement- sub functions; PERL – basics, pattern matching and regular expression, BLAST output, PERL to Bioinformatics, Application of Bio PERL.

UNIT 2: Biological Databases and Sequence Analysis 08 hrs

Introduction to database generation; Data mining and applications. Accessing bibliographic databases – pubmed, sequence retrieval; Nucleic acid sequence databank – NCBI, EMBL; Protein sequence data bank – NBRF, PIR, SWISSPORT; Structural databases (PDB); Metabolic pathway databank – Kyoto Encyclopedia of Genes and Genomes (KEGG), Microbial Genomic Databases (MBGD), Cell Line Databases (ATCC), Virus Databank (UICTV), Sequence alignment – global and local alignment, scoring matrices; Restriction mapping – WEB CUTTER & NEB CUTTER, similarity searching (FASTA and BLAST); Pair wise comparison of sequences, multiple sequence alignment; Identification of gene in genome and phylogenetic analysis with reference to nucleic acids and protein sequences, identification of ORF, identification of motifs.

UNIT 3: Protein Structure and Molecular Interactions 08 hrs

Chemical bonding and non-bonding interactions, stability of electrovalent bonds; Covalent bond – partial ionic characteristics of co-valent bond and Vander-Waals forces. Introduction to protein structure – secondary structure prediction, tertiary structure prediction, protein modeling – principles of homology and comparative modeling; Threading, structure evaluation and validation and *ab* initio modeling; Applications – rational drug designing and molecular docking - Autodock.

UNIT 4: Introduction to Biostatistics 10 hrs

Basic concepts, classification, data types, frequency distribution, variables, attributes, population, sample, use of random number table for drawing a random sample, need for statistical technique for biological applications, replicable data, tabulation of data, construction of graph and graphical representation of data; Different models and data presentation; Features of statistical software and SPSS.

UNIT 5: Properties of Data 08 hrs

Organization of data, central tendency, dispersion, skewness and curtosis and their various measures, percentile, simple linear correlation and regression analysis; Analysis of Variance.

UNIT 6: Probability 10 hrs

Definition, types of events - sample space, addition and multiplication; rules of probability; Conditional probability (simple problems); Probability distributions-binomial, Poisson and normal distribution (simple problems); Statistical interference – estimation, standard error, confidence intervals for mean and proportion; Testing of hypothesis – basic concepts, types of errors; Tests based on normal student t and chi square distributions, interpretation of *p* value.

References:

Anna Tromontano, (2002). *Introduction to Bioinformatics*, CRC Press, Florida, USA.

Higgins, (2005). *Bioinformatics: Sequence structure and data banks: A practical approach*, Blackwell Publishers, UK.

Higgin D, Taylor, W and Higgins D, (2000). *Bioinformatics: Sequence structure and databanks: A practical approach*, Oxford University Press, New York.

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MMB1522L1 MICROBIAL GENETICS, IMMUNOLOGY AND IMMUNOTECHNOLOGY PRACTICAL

5 Credits **Total: 104 Hours**

Objectives:

- Understand the procedures of mutagenesis in fungal and bacterial cultures
- Learn various methods of transfer of genetic material in bacteria
- Study blood cells and typing, serum seperation and precipitation
- Learn about serum protein interactions, quantitation of antigen and antibody based on the methods derived from the reations and reactive tests

1. Mutagenesis – Identification and isolation of fungal and bacterial mutants (Chemical and UV).
2. Study of Replica plating technique
3. Study of conjugation in *E.coli*
4. Study of transduction in *E.coli*
5. Study of transformation in *E.coli*
6. Phage titration
7. Demonstration of non-specific resistance to bacteria
8. Serum separation from Whole blood & Precipitation of Immunoglobulins (Igs) from serum.
9. Study of antigen-antibody reactions:
   a. Slide agglutination test
   b. Blood grouping and Rh typing
   c. Ouchterlony double diffusion
   d. Single radial immuno-diffusion and determination of Ig concentration
   e. Rocket immuno-electrophoresis
   f. ELISA
10. Electrophoresis of immunoglobulin preparation
11. Separation of lymphocytes from blood and staining.
12. Determination of serum activity of normal serum

MMB1522L2 MOLECULAR BIOLOGY, BIOINFORMATICS AND BIOSTATISTICS PRACTICAL

5 Credits **Total: 104 Hours**

Objectives:

- Learn the isolation and measurements of nucleic acids
- Understand different methods to transfer the genetic material
- Learn to use various bioinformatic tools

1. Isolation of genomic DNA from plant, microbes, animals and agarose gel electrophoresis
2. Estimation of DNA by diphenyl amine method
3. Isolation of RNA and estimation by orcinol method
4. Isolation of plasmid DNA and agarose gel electrophoresis
5. Use of bioinformatics tools for searching bibliographic databases
6. Sequence retrieval from nucleic acid and protein databases
7. Sequence searches and analysis (FASTA and BLAST)
8. Pair wise comparison of sequences, multiple alignments of sequences
9. Restriction mapping
10. Identification of genes in genomes and primer design
11. Evolutionary studies/phylogenetic analysis
12. Protein databank retrieval and visualization RASMOL
13. Ramachandran plot- secondary structure prediction of proteins
14. Demonstration of protein modeling - Autodock
15. Calculation of SD, variance and plotting the graph by using MS excel

SEMESTER III

MMB153201 RECOMBINANT DNA TECHNOLOGY

3 Credits **Total: 52 Hours**

Objectives:

- Study the tools and enzymes used in recombinant DNA technology
- Understand the methods in genetic modification of organisms
- Understand the applications of transgenics in various fields

UNIT 1: Molecular Tools 12 hrs

Introduction, definition and scope; Restriction endonucleases – types, nomenclature, recognition sequences, cleavage pattern; DNA ligases – properties and functions of T4 DNA Ligase and NAD dependant DNA ligase of *E.coli*, ligation techniques; DNA modifying enzymes – polymerases, DNase, RNase, polynucleotide kinases, alkaline phosphatases; Vectors – general characters, desirable characters – size, on site selection/marker gene, restriction sites and unique multiple cloning sites; Cloning and expression vectors – Plasmids - pBR322, pUC vectors, Ti plasmids, M13 derived pUC vectors; Phage vectors - Lambda based vectors, M13 cosmids, Phagemids; ARS, Mini-chromosome, YAC, BAC and PAC; Shuttle vectors, PET, promoters – Lac Z, T7 and Tac; Transcriptional terminators; Plant viral vectors and SV 40.

UNIT 2: Cloning and Expression 12 hrs

Preparation of competent cells of bacteria, yeast, mammalian and plant cells; Methods of DNA transfer - exogenously supplied chemical methods, calcium phosphate precipitation method, liposome mediated method, electroporation, *Agrobacterium* T-DNA mediated method, gene gun method; Determination of transformation / transfection efficiency; Plating, screening and selection; Preparation of nutrient media with selection markers, antibiotics and additives for visual screening of recombinant clones; Selection of clones, amplification, preservation and purification of vector DNA, digestion and end modification.

UNIT 3: Gene Libraries 06 Hrs

Types of gene libraries, cDNA library – preparation, isolation and purification of mRNA, importance of poly-A tailing, synthesis of cDNA (PCR), construction of cDNA Library; Genomic DNA library – isolation and purification of total genomic DNA, partial digestion with suitable enzyme, size fractionation and end modification.

UNIT 4: Molecular Techniques 10 hrs

Agarose gel electrophoresis; Labelling of DNA and RNA; Blotting techniques – Southern, northern, western; Molecular markers and DNA finger printing - RFLP, RAPD, AFLP; PCR, DNA microarray; Global patterns of gene expression; Analysis of Single Nucleotide Polymorphisms (SNP) using DNA chips.

UNIT 5: DNA Sequencing and Synthesis 08 hrs

Dideoxy and chemical methods, sequence assembly, automated sequencing, genome sequencing and physical mapping of genomes and fine structure analysis of genes; Phosphodiester, phosphotriester, phosphate triester approaches; Enzymatic synthesis of DNA; application of synthetic oligonucleotides, synthesis of complete gene.

UNIT 6: Application of rDNA Technology **04 hrs**

Genetically modified organisms (Bt cotton); Overview of Transgenic plants - GM foods (Golden rice, tomato, corn, brinjal), transgenic animals (cow, sheep, poultry, fish); Gene therapy.

References:

Alikhan and Irfan (2004) *Molecular Biology and Genetic Engineering Biotechnology*, Ukaaz publishers, hyderabad.

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Twyman R M, (2001), Principles of Gene Manipulation, Blackwell publishers, London

Watson and Hokins, (1998), Molecular biology og the Gee, Benjamin-cummings

Winnaker and Ernst L., (2003) From Genes to Clones, Panima Publishers, New Delhi.

MMB153202 MEDICAL MICROBIOLOGY

3 Credits **Total: 52 Hours**

Objectives:

- Understand the various diseases caused by different microorganisms and preventive methods for disease control
- Study the mode of infection into the human host through various routes
- Learn about microbiological diagnostics by different serological methods

UNIT 1: Classification of Disease Causing Microorganisms **06 hrs**

Classification of medically important microorganisms; Normal microbial flora of human body and its significance, tissue tropism.

UNIT 2: Bacterial Diseases **10 hrs**

Mode of infection – entry of pathogen into human host – portals of entry, virulence factors and their role in breaching host defence; Establishment, spreading tissue damage and anti phagocytic factors; Mechanism of bacterial adhesion, colonization and invasion of mucous membranes of respiratory, enteric and urogenital tracts; Evasion of host defences; Nonspecific host defences, toxigenesis bacterial toxins and endotoxins; Symptomatology, laboratory diagnosis, epidemiology and control – follicular tonsillitis, systemic flu, typhoid, gonorrhoea, diphtheria, tetanus, enteric fever, cholera, plague, lung influenza, tuberculosis, syphilis, chlamidiosis and pneumonia.

UNIT 3: Protozoan Diseases **04 hrs**

Mode of infection – entry, spread, colonization, establishment; Toxins; Transmission; Symptomatology, laboratory diagnosis, epidemiology and control of – malaria, filariasis, leishmaniasis.

UNIT 4: Fungal Diseases **10 hrs**

Mode of infection – entry, spread, colonization, establisment, mycotoxins, symptomatology, laboratory diagnosis, epidemiology and control – dermatomycoses, superficial systemic mycoses, mycetoma, chromomycoses, sporotrichosis, cryptococcosis, blastomycosis, coccidiomycosis, histoplasmosis; Oppurtunistic and systemic mycosis – aspergillosis and candidiasis.

UNIT 5: Rickettsial and Viral Diseases **10 hrs**

Mode of infection – entry, host interaction, multiplication, establisment, Toxins; Symptomatology, laboratory diagnosis, epidemiology and control– rickettsial flu – yellow fever, q-fever, rickettsial pox, epidemic typhus, murine typhus; Small pox, chicken pox, herpes, common cold, flu, influenza, foot and mouth, influenza of brain, marrow, enteric flu, (swine flu), hepatitis, cancer, AIDS, dengue, encephalitis, chikungunia; mad cow, CJD, KURU.

UNIT 6: Disease Control Measures and Microbial Diagnostics **12 hrs**

Classification of antimicrobial agents, antimicrobial therapy, mechanism of drug action – antibacterial, antifungal, antiprotozoans, *in vitro* and *in vivo* methods of testing drug sensitivity, antibiotic assay in body fluids; Brief account of available vaccines and schedules, passive prophylactic measure; Applications of immuno and molecular diagnostic method - RID, RIE, agglutination test; CFT, RIA, ELISA, PCR, DNA finger printing; Tests to identify microbial infections.

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MMB153203 INTELLECTUAL PROPERTY RIGHTS, BIOETHICS AND ENTREPRENEURSHIP

3 Credits **Total: 52 Hours**

Objectives:

- Understand the fundamentals of Intellectural property rights
- Knowledge on ethical implications, issues related to life sciences
- Familiarize on entrepreneurship and its strategies

UNIT 1: Intellectual Property Rights 12 hrs

IPRs – implications for India, WTO, WIPO, GATT, TRIPS; Patenting and the procedures involved in the applications for patents and granting of patent; Compulsory licenses, patent search, Patent Cooperation Treaty, examples of patents in biotechnology, provisional and complete specification, claims, patentable and non-patentable materials, product planning and development, special applications of patent laws in patenting of living organisms, plant breeders rights, legal implications, traditional knowledge, commercial exploitation, protection.

UNIT 2: Ethical Issues in Plant Genetic Resources 08 hrs

Bioethics in Biodiversity, ethics of resource management, impact of patenting on biodiversity rich developing countries, current status of GM crops in India and other countries, ethical issues associated with GM crops & foods, labeling of GM plants and products.

UNIT 3: Ethical Implications 08 hrs

Ethical implications of Human Genome Project – International ethical and legal issues connected to HGP; Human fetal sex determination – implications in India; Genetic study on ethnic races.

UNIT 4: Ethical Issues in Animal Research 10 hrs

Ethical issues involved in stem cell research, use of cell cultures as alternative for animal models in research, testing of drugs on human volunteers, use of animals for research and testing, ethical and social issues involving human cloning, organ transplantation and xeno transplantation; cGMP, cGLP, guidelines – ICH, KOSHER, MHRA, TGA, OECD and USFDA.

UNIT 5: Entrepreneurship **06 hrs**

Introduction, concept and theory; Entrepreneurial traits and motivation; Nature and importance of Entrepreneurship in India; Barriers in Entrepreneurship, agreements, valuation and business concerns; Government regulations for products.

UNIT 6: Entrepreneurship Strategies **08 hrs**

Potential entrepreneurship activities in biotechnology, product development, marketing, research and training units; Industrial licensing, venture capital, Biotech Parks; Biotechnology industries in India and the potential job opportunities.

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MMB153A01 ELECTIVE 1: ENVIRONMENTAL MICROBIOLOGY

3 Credits **Total: 52 Hours**

Objectives:

- Understand the fundamentals of Environmental chemistry
- Know about ecotoxicology of pollutants from various sources
- Learn the process of waste management and bio remediation
- Familiarize with the Global environmental problems and monitoring systems

UNIT 1:Environmental Chemistry and Chemical Pollutants 08 hrs

Fundamentals of Environmental chemistry – stoichiometry, chemical potential, chemical equilibria, solubility products, solubility of gases in water, carbonate system, unsaturated and saturated hydrocarbons, inorganic and organic pollutants, carcinogenic compounds and their effects; Surfactants – cationic, anionic and non-ionic detergents, modified detergents; Lead and its compounds – properties and effects; Pesticides – Types, analysis, pollution due to pesticides and organo-chlorine pesticide problems – DDT, Endosulphan; Chemistry of corrosive and metallic compounds; Industrial Pollutants.

UNIT 2: Chemistry of Pollutants and Aerobiology 06 hrs

Heavy metals, asbestos and food additives, chemistry of pollutants from pulp and paper mill, sugar and starch industries, textile, cement and pharmaceutical industries; Droplet nuclei, aerosol, assessment of quality – Anderson, Rotorod, Burkard, solid and liquid impingement method and filters; Diseas es caused by air borne microbes and allergens – infection, their detection and enumeration; Biohazards caused by endotoxins.

UNIT 3: Bioremediation and Extremophiles 08 hrs

Concept and principles, bioremediation using microbes, *in situ* and *ex situ* bioremediation; Biosorption and bioaccumulation of heavy metals, phytoremediation; Bioremediation of xenobiotics (heavy metals, pesticides, oil slicks, plastics), soil and water contaminated with hydrocarbons and surfactants, biofilms, xenobiotic compounds and their sources, biomagnifications; Extremophiles – acidophilic, alkalophilic, thermophilic, barophilic, osmophilic and radiodurant microbes; Mechanisms and adaptation, halophilic membrane variation – electron transport, application of thermophiles, extremophiles and extremozymes.

UNIT 4: Water Management and Waste Water Treatment 10 hrs

Water as a scarce natural resource, water management including rain water harvesting; Potability of water, microbial assessment of water; Municipal wastes - sewage and effluent, waste water characteristics, waste water treatment – physical, chemical and biological processes; Aerobic processes – activated sludge, oxidation ditches, trickling filters, oxidation ponds; Anaerobic processes – anaerobic digestion, anaerobic filters, anaerobic sludge, membrane bioreactors; Treatment of industrial effluents - dairy, distillery, tannery, textile, paper and sugar industries, CETP, Reverse osmosis and ultrafiltration.

UNIT 5: Energy, Biomining and Waste Management 10 hrs

Renewable and non-renewable enegry sources; Biomining – bioleaching of ores to retrieve scarce metals, Biofuels – production from algae, *Jatropa, Pongamia* and Castor; Production of oil and fuels from wood waste; Solid waste management - sources and management, waste as a source of energy, microorganisms involved in the degradation of plant fibre, cell wall, lignin, fungal delignification and pulping of wood, solving pitch problems in pulp and paper processes, hemicellulases in pulp bleaching; composting and vermiculture; Biotechnology for solving slime problem in the pulp and paper industry; Biogas Production, methanol production from organic wastes, sugar industry by-products; Bio-deterioration of paper, leather, wood, textiles.

UNIT 6: Environmental Problems, Biosensors and GIS 10 hrs

Global warming, ozone depletion, UVB, green house effect and acid rain, their impact and management; different components of a biosensor; types of biosensors, various transducer principles (conductometric, potentiometric, amperometric and optical detector); specific biosensors – glucose, ammonia, BOD, methane and mutagen sensors; Remote sensing – history, definition, types of maps and map reading, components; Electromagnetic Remote (EMR) sensing process – electromagnetic spectrum and its characteristics; EMR interaction with Earth surface materials – water, vegetation, soil; Geographic Information System (GIS) – definition, categories, components, fundamental operations.

References:

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MMB153B01 ELECTIVE 2: FOOD AND DAIRY MICROBIOLOGY

3 Credits **Total: 52 Hours**

Objectives:

- Understand the mechanism of processing of milk and milk products
- Understand the different types of packaging and distribution of food products
- Familiarize food toxins, adulterants and regulations in food industry

UNIT 1: Fundamentals of Food and Dairy Microbiology 04 hrs

Scope and importance of food and milk processing – National and International perspectives, Preservation – principles, methods, natural food flavours.

UNIT 2: Milk 12 hrs

Processing – Pasteurization, cryogenic cooling, instantization of milk; Factors affecting milk selection – physiological factors, nutritional factors, sensory factors; Properties – sensory – appearance, odour, taste (flavour), texture (mouth feel); Functional – denaturation, coagulation, gelation, foaming and browning; Nutrition – nutrition in milk as a significant factor; Milk as a wholesome and complete food; Planned diets (skimmed milk, fat free milk, enriched milk, mixing milk with soy milk, whey protein and milk; Preservation; Quality assessment – general test – milk, skimmed milk, dried milk, confimatory test, sensory.

UNIT 3: Milk Products 10 hrs

Processing - cream, butter, condensed milk, evaporated milk, whole and skimmed milk powder; Instantization of milk products – ice cream, khoa, paneer, milk sweets; Fermented milk products – cheese, cheese spread, yoghurt, dahi, shrikhand; Judging and grading of milk products; Properties - sensory and functional; Nutrition – nutrients carbohydrates, proteins, lipids, vitamins, minerals; their role in body function (tissue protection, maintenance, digestion, absorption); Effect of nutrition depletion; Spray dried products and its general test.

UNIT 4: Food Product and Processing 12 hrs

Manufacture of texturized vegetable proteins; Preparation of protein gels, expanded products; Preparation skills; Mechanical separation – filtration, membrane concentration, sieving, centrifugation, sedimentation; Mechanical handling – conveying, elevation, size reduction, classification-mixing, kneading, blending; Processing of chocolate, cocoa, cocoa butter, vegetables, fruits, raw and refined sugar, fish, meat, fats and oils, fat substitutes and low-calorie foods; Wheat based products - bread, biscuits, cakes, extruded products (pasta and noodles), baby foods; Imitation dairy products - peanut butter and vegetable ghee; Vegetable proteins as meal extenders; Simulated milk products from soy proteins; Preservation.

UNIT 5: Packaging **08 hrs**

Principles, functions and design; Packaging – perishable and processed foods, special problems; Types of packaging – flexible: bags, pouches (aseptic, retortable, laminated), wrappers, carton and other traditional package; Elastic: shrink packaging; Biodegradable packaging; Active packaging; Modified atmosphere packaging.

UNIT 6: Food Adulteration and Regulation **06 hrs**

Food adulteration and food safety, HACCP; Sensory evaluation – introduction, panel screening; Instrumental analysis in quality control; FSSAI; Optimum nutrition equirements (WHO), additives in food processing and preservation – functions, safety, colours, flavours, sweeteners, acidulants.

References:

Chris Bell, Paul Neaves, Anthony, P. Williams, (2006). *Food Microbiology and Laboratory Practicals* (2nd Ed.), Blackwell Scientific Publishers, UK.

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MMB1532L1 RECOMBINANT DNA TECHNOLOGY AND MEDICAL MICROBIOLOGY PRACTICAL

5 Credits **Total: 104 Hours**

Objectives:

- Learn different tools and techniques used in gene transfer and confirmation
- Familiarize with different staining techniques to identify clinical isolates
- Identify and characterize clinically important microorganisms

1. Restriction digestion of DNA and their molecular weight determination
2. Ligation of DNA
3. Selection of recombinants by scorable and selectable markers
4. Polymerase Chain Reaction (PCR)

5. Random Amplification of Polymorphic DNA (RAPD)
6. DNA microarray
7. Recombinant yeast
8. Isolation and identification of clinically important microbes from clinical specimens (throat swab, sputum, nasal swab, urine, blood and stool)
9. Identification of pathogens on selective, differential and enrichment media
10. Different staining techniques
    a. Ziehl-Neelsen method of AFB
    b. Fluorochrome staining
    c. Leishman's staining
    d. Giemsa's staining
    e. Special staining methods to demonstrate granules, capsules and spores
11. Testing of drug susceptibility according to NCCLS
12. Detection of MBC by broth dilution method.
13. Determination of MIC / FIC by Kirby-Bauer method, T- test, checker board method.
14. Diagnostic immunologic principles and methods.
15. Determination of titre values of *S. typhii* by broth MIC using Widal tube method.
16. Selective enrichment of auxotrophic and antibiotic (*tet, rif*) mutants

MMB153AL1 ELECTIVE 1: ENVIRONMENTAL MICROBIOLOGY PRACTICAL

5 Credits **Total: 104 Hours**

Objectives:

- Acquire the skill of testing various water samples.
- Learn to isolate bacteriophages from polluted water
- Familiarize with various organic and inorganic chemical tests of polluted water

1. Detection of coliforms for the determination of the purity of potable water
2. Determination of total dissolved solids of water
3. Determination of BOD and COD of water sample
4. Estimation of chromium in industrial effluent by colorimetry
5. Estimation of calcium in water sample by titration method
6. Sludge analysis (a) organic matter, (b) nitrogen, (c) phosphorous, (d) potassium
7. Isolation of bacteriophages from sewage
8. Determination of phosphate and nitrate from sewage samples
9. Study of microflora of industrial wastes and effluents
10. Isolation of bacteria degrading xenobiotics by selective enrichment technique
11. Isolation of iron and manganese reducing bacteria

MMB153BL1 ELECTIVE 2: FOOD AND DAIRY MICROBIOLOGY PRACTICAL

5 Credits **Total: 104 Hours**

Objectives:

- Learn the various quality test methods for checking the purity and integrity of milk and various food products
- Learn the methods to determine the toxins and pesticides in food.
- Familiarize with various methods of detections of adultrants in food and packaging of food

1. Tests for quality of milk - alcohol, starch, lech test.
2. Quantitative determination of starch by enzymatic method.
3. Methylene blue reductase test for qualifying milk.
4. Estimation of salt content in butter, cheese and cheddar.
5. Estimation of fat content in milk and milk imitations in market.
6. Determination of percentage of fat in cream.
7. Performance of phosphatase test for pasteurized milk.
8. Burry-smear test and clot on boiling test for milk purity.
9. Estimation of acid value or acid content in butter and hydrogenated butter.
10. Detection of adulteration of fats and oil
11. Factors affecting the food spoilage- (i) Time, (ii) Temperature, (iii) pH, (iv) Inoculum concentration
12. Testing for lacquer coating materials for testing of packaging materials in canned foods

SEMESTER IV

MMB154201 AGRICULTURAL MICROBIOLOGY

3 Credits **Total: 52 Hours**

Objectives:

- Understand the role of microbes in agriculture
- Familiarize with the methods of using microorganisms for modern agricultural practices
- Study the interaction of microorganisms with plant

UNIT 1: Microbes and Soil Fertility **04 hrs**

Role of microbes in soil fertility, decomposition of organic matter by microorganisms – cellulose, hemicellulose, lignin, xylan and pectin; Soil fertility evaluation and improvement; Effect of pesticides on soil microflora.

UNIT 2: Biological Nitrogen Fixation (BNF) **08 hrs**

Nitrification, denitrification; symbiotic nitrogen fixation (*Rhizobium, Frankia*), non-symbiotic nitrogen fixation (*Azotobacter, Azospirillum*); Nitrogenase enzyme, *nif* genes and molecular mechanism of nitrogen fixation; Role of nodulin genes in nodule development and symbiosis; Genetic engineering of BNF.

UNIT 3: Plant-Microbe Interactions **08 hrs**

Mutualism, commensalism, parasitism, amensalism, synergism; Rhizosphere microorganisms – phyllosphere, spermosphere and rhizoplane, methods of enumeration, rhizosphere effect, factors influencing rhizosphere microbes; PGPR and VAM.

UNIT 4: Bioinoculants **08 hrs**

Biofertilizer – types, production and quality control. Cultivation and mass production of bioinoculants- *Azotobacter, Rhizobium, Azospirillum*, Cyanobacteria, phosphate solubilising microorganisms, *Azolla;* Carrier-based inoculants – production and applications; Biopesticides – types and applications – *Pseudomonas fluorescens, Bacillus thuringiensis, Trichoderma harzianum, Trichoderma viride,* Nuclear Polyhedrosis Virus (NPV).

UNIT 5: Molecular Plant Pathology **12 hrs**

Host-parasite interactions – Pathogenesis (pre-penetration, penetration, post-penetration) – Molecular mechanisms of disease establishment – enzymes, toxins, growth regulators; Host defence – elicitors, phytoalexins, resistance mechanism in plants, resistance genes – Role of R and r genes in disease development; Variability in populations; Transgenic approaches for crop protection.

UNIT 6: Plant Diseases **12 hrs**

Symptomatology, etiology and control of diseases caused by

(a) Fungi – wilt diseases, downy mildews, powdery mildews, rusts, smuts

(b) Bacteria – bacterial wilt, bacterial blight of rice, angular leaf spot of cotton, citrus canker

(c) Mycoplasmal diseases – sandal spike, grassy shoot of sugar cane

(d) Viral diseases – cauliflower mosaic disease, banana bunchy top, cucumber mosaic, cow pea mosaic, tobacco mosaic

(e) Protozoa – heartrot of coconut, phloem necrosis of coffee

(f) Viroids – potato spindle tuber viroid
(g) Parasitic plants – dodder, mistletoes
Post-harvest diseases and control measures; Integrated pest management.

References:

Agrios A.G., (2006). *Plant Pathology*, Elsievier Academic Press, New Delhi.

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MMB154202 FERMENTATION TECHNOLOGY

3 Credits **Total: 52 Hours**

Objectives:

- Understand the strategies of strain selection and improvement
- Understand the process of fermentation
- Familiarize with types of fermentors and downstream processing

UNIT 1 : Screening, Selection, and Preservation of Strains 08 hrs

Introduction, screening techniques, primary and secondary screening, strains used in screening; Strain development: mutation, selection of mutants, recombination, regulation, gene technology; Preservation − serial sublculture, use of mineral oil, lyophilization, cryogenic storage.

UNIT 2: Fermentors 09 hrs

Basic features, designing criteria and components – body construction – vessel, agitator, sparger,stirrer glands, bearings, baffles, valves and steam traps, pheripheral parts and accessories and control system; Types of fermentors – typical, air lift, tower, bubble cap, deep-jet, tubular, fluidized bed, and continuous stirred tank fermenters.

UNIT 3: Fermentation Media and Sterilization 09 hrs

Charcterisitics of production media, Types of fermentation media − natural and synthetic media; Media components : carbon sources − saccharine, starch, cellulose, hydrocarbon and vegetable oils; Nitrogenous sources − corn steep liquor, peptones, soyabean meal; Minerals, Growth factors, buffer, oxygen requirements, antifoams, precursor, inducers, elicitors, inhibitors; Medium optimization; Sterlization − principles, sterilization of equipments, media and air; Aseptic inoculation and sampling methods.

UNIT 4: Fermentation Process Parameters 09 hrs

Inoculum preparation, process parameters−temperature control, pH, aeration, agitation, foam control, monitoring microbial growth in culture; cell number, direct and indirect methods; growth kinetics of microorganims; scale up of fermentation process (parameters used in scale up, problems associated), merits & demerits; Computer control of fermentation processes.

UNIT 5: Types of Fermentation 09 hrs

Batch, fed batch, continuous culture: concepts of Newtonian and non- Newtonian fluid, plastic fluids, apparent viscosities; solid state fermentation − estimation of growth, factors influencing SSF, kinetics, design of fermentor in SSF (Koji fermentor), production of commercially important products by SSF, submerged fermentation, comparison of SSF with SmF and shake flask.

UNIT 6: Downstream Processing 08 hrs

Choice of recovery, foam separation, precipitation methods, filtration, centrifugation, cell disruption methods, liquid – liquid extraction, membrane filtration, solvent recovery, super crticial fluid extraction, chromatography, drying devices, crystallization, effluent treatment, quality control of fermented products and process economics.

References:

Luigi Palombi.2010, *Gene Cartels: Biotech Patents in the Age of Free Trade*. Edward Elgar Publishing.

Carlos M. Correa. 2010, *Research Handbook on the Protection Of Intellectual Property Under WTO Rules. Intellectual Property in the WTO* Volume I & II. Edward Elgar Publishing.

Rao. D.G, 2010, *Introduction to Biochemical Engineering*. Tata McGraw-Hill Education 2010.

Robert Mellor. 2009, *Entrepreneurship for Everyone: A Student Textbook*. SAGE Publications.

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MMB154203 MICROBIAL TECHNOLOGY AND BIOSAFETY

3 Credits **Total: 52 Hours**

Objectives

- Learn commercial use of microbial products
- Learn the methods of industrial production of microbial enzymes and microbial transformation
- Learn nanotechnology and biosafety

UNIT 1: Introduction 02 hrs

Principle, applications, economics and milestones in microbial technology.

UNIT 2: Microbial Products for Commercial Use 14 hrs

Industrial production of organic acids (acetic acid, lactic acid), Amino acids (lysine, glutamic acid), Solvents (acetone, ethanol), Antibiotics (Cephalosporin, Streptomycin), Microbial polysaccharides (xanthan) and polyesters (PHB); Hormones (insulin), anti-

cholesterol compound (Lovastatin); Vaccines (recombinant); Microbial insecticides; Secondary metabolites in bacteria and fungi.

UNIT 3: Microbial Enzymes **08 hrs**

Industrial production of lipase, protease & asparaginase; Enzymes in - starch processing, food, textile, detergent, leather, breweries, pharmaceuticals, therapeutics, and diagnostics; Recombinant enzymes. Immobilized enzymes and cells; Techniques and types of immobilization, industrial applications of immobilization; merits and demerits.

UNIT 4: Microbial Transformation and Organic Synthesis **10 hrs**

Transformation of steroids and sterols, over production of glutathione by genetically engineered cells; Metabolic engineering for vitamin C production, synthesis of acrylamide by nitrile hydratase, synthesis of optically pure drugs.

UNIT 5: Nanotechnology **08 hrs**

Introduction, tools of nanosciences, synthesis of nanomaterials using microbes; Biopolymeric nanoparticles; nanosensors, biomedical applications, antimicrobial nanoparticles.

UNIT 6: Biosafety **06 hrs**

Biosafety guidelines and regulations for GMOs, GLP and GMP; Labelling of GM products; Safety of GM food; Testing of drugs on human volunteers.

References:

Elnashar MMM. 2010, *Immobilized Molecules Using Biomaterials and Nanobiotechnology*. J Biomaterials Nanobiotechnology. 01:61-77**.**

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Honda K, Ishige T, Kataoka M and Shimizu S. 2007. *Microbial and Enzymatic Process for production of chiral compounds. Biocatalysis in the Pharmaceutical and Biotechnology Industries*. Book chapter 20.

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MMB1542L1 AGRICULTURAL MICROBIOLOGY, FERMENTATION TECHNOLOGY AND MICROBIAL BIOTECHNOLOGY PRACTICAL

5 Credits **Total: 104 Hours**

Objectives:

- Acquire skills to isolate nitrogen fixing and organic matter degrading microorganisms
- Learn to prepare and apply biofertilizers to crops
- Understand commercial production of microbial products and learn production of biogas, antibiotics, enzymes and fermented beverages

1. Isolation of cellulose, hemicellulose, lignin, xylan and pectin degrading microbes
2. Isolation of symbiotic and non-symbiotic nitrogen fixing microorganisms
3. Isolation of phosphate solubilising bacteria and fungi-plate method
4. Assay of bio fertilizers (seed treatment, seedling, inoculation, growth parameters)
5. Mushroom cultivation using locally available substrates and estimation of total protein content
6. Extraction and estimation of phytoalexins and phenolics from diseased plants
7. Production of organic acids (lactic acid and citric acid) from microbes
8. Immobilization technique: whole cell or enzyme- sodium alginate gel method
9. Production of antibiotic (penicillin) by submerged fermentation
10. Laboratory scale production of ethanol from industrial wastes and estimation of total and volatile acidity
11. Laboratory scale production of wine
12. Detection and quantification of siderophores produced by *Pseudomonas*
13. Production of Amylase by solid substrate fermentation
14. Estimation of Amylase produced by solid substrate fermentation
15. Screening of cellulase producing microorganisms
16. Estimation of cellulose produced by microorganisms
17. Fermentor – design and function
18. Industrial visit