PROCEEDINGS OF THE MEETING OF B.O.S. (PG) IN MICROBIOLOGY AND BIOTECHNOLOGY

The meeting of the B.O.S. (PG) in Microbiology and Biotechnology was held on **25th June, 2014** in the Department of Microbiology and Biotechnology, Bangalore University, Bangalore. At the outset, the Chairman welcomed the members and initiated the proceedings.

Agenda-1: The Choice Based Credit System (CBCS) for M.Sc. in Microbiology and Biotechnology, and the Syllabus (theory and practical) for I, II, III & IV Semesters were finalized and approved.

Agenda-2: The panel of examiners for PG Microbiology and Biotechnology (both external and internal) was modified and approved for the year 2014-15.

Agenda-3: The B.O.S. approved the panel of examiners for adjudication of Ph.D. thesis of the following candidates.

1. Mr. Divakara Y. G.
2. Ms. Chandrika R.
3. Ms. Vyshali P.
4. Ms. Sarvamangala
5. Mr. Sumantha M.G.
6. Ms. Sumalatha K. R.
7. Mr. Lakshmeesha T. R.
8. Mr. Mohammad Shafi Sofi
9. Ms. Vedashree S.
10. Ms. Soumya K.

The meeting concluded with the Chairman thanking all the members for their co-operation.

Members present:

1. Prof. M. Rajashekara
2. Prof. Ravishankar Rai
3. Prof. K. Manjunath
4. Prof. S. Chidananda Sharma
5. Dr. D. Manjulakumari
6. Dr. J. Savitha
7. Prof. S.K. Sarangi (Chairman)

25/6/14

25/6/14

M.Sc. MICROBIOLOGY (CBCS)
(Effective from the academic year 2014-2015)
SCHEME FOR INSTRUCTION AND EXAMINATION
SEMESTER SCHEME

Paper No.	Title of the paper	Type of paper	Periods/ Week	Duration of Exam (Hours)	IA	EA	Maximum Marks	Credits
I Semester		**Theory**						
MBH-101	Bacteriology and Virology	H Core	4	3	30	70	100	4
MBH-102	Eukaryotic Microbiology	H Core	4	3	30	70	100	4
MBH-103	Microbial Physiology and Biochemistry	H Core	4	3	30	70	100	4
MBH-104	Microbial and Biochemical techniques	H Core	4	3	30	70	100	4
MBS-105	Biostatistics	S Core	2	2	15	35	50	2
		Practical						
MBP-106	Bacteriology, Virology and Eukaryotic Microbiology	Pract	4	4	30	70	100	4
MBP-107	Microbial Physiology, Biochemistry, Microbial techniques	Pract	4	4	30	70	100	4
Total Marks and Credits							650	26

II Semester		**Theory**						
MBH-201	Microbial Genetics	H Core	4	3	30	70	100	4
MBH-202	Molecular Biology	H Core	4	3	30	70	100	4
MBH-203	Environmental Microbiology	H Core	4	3	30	70	100	4
MBH-204	Food Microbiology	H Core	4	3	30	70	100	4
MBS-205	Bioinformatics	S Core	2	2	15	35	50	2
		Practical						
MBP-206	Microbial Genetics, Molecular Biology	Pract	4	4	30	70	100	4
MBP-207	Environmental Microbiology and Food Microbiology	Pract	4	4	30	70	100	4
Total Marks and Credits							650	26

Paper No.	Title of the paper	Type of paper	Periods/ Week	Duration of Exam (Hours)	IA	EA	Maximum Marks	Credits
III Semester		**Theory**						
MBH-301	Medical Microbiology	H Core	4	3	30	70	100	4
MBH-302	Immunology	H Core	4	3	30	70	100	4
MBH-303	Recombinant DNA Technology	H Core	4	3	30	70	100	4
MBO-304	Open Elective: Applied Microbiology	OE	4	3	30	70	100	4
Practical								
MBP-305	Medical Microbiology and Immunology	Pract	4	4	30	70	100	4
MBP-306	Recombinant DNA Technology and Bioinformatics	Pract	4	4	30	70	100	4
MBP-307	Industrial and Institutional Visit	Report					50	2
Total Marks and Credits							650	26

IV Semester		**Theory**						
MBH-401	Agricultural Microbiology	H Core	4	3	30	70	100	4
MBH-402	Industrial Microbiology	H Core	4	3	30	70	100	4
MBH-403	Microbial Biotechnology	H Core	4	3	30	70	100	4
Practical								
MBP-404	Agricultural and Industrial Microbiology and Microbial Biotechnology	Pract	4	4	30	70	100	4
MBP-405	Project Work/ Dissertation						100	4
	Project Viva						50	2
Total Marks and Credits							550	22
Total Marks and Credits							**2500**	**100**

Scheme of valuation:

1. Continuous evaluation in theory papers: 10 marks for test, 5 marks for assignment, 10 marks for seminar and 5 marks for attendance.
2. Practical examinations-each practical examination shall carry 70 marks, 10 marks shall be allotted for viva voce to be conducted during each practical examination.
3. Practical IA: 5 marks for Record, 15 marks for test and 10 marks for attendance.

PROJECT WORK

1. Proposed to carry out the project work individually or in group to a maximum of 3 or 4 students.
2. Project shall be allotted at the beginning of the III semester to facilitate students to carry out during semester break.
3. In house projects are encouraged.
4. Students may be allowed to carry out the project work in other research institutes.
5. Faculty members of the respective colleges/ university department must serve as guides
6. Co- guides from the other institutions may be allowed.
7. One copy of the dissertation to be submitted to the University for valuation.
8. **Evaluation of dissertation** has to be done by the two external examiners appointed by the University for **100 marks.**
9. The **project viva voce examination** will be held at the University Department by the BOE for **50 marks** (25 marks for the presentation, 25 marks viva voce).

SCHEME OF THEORY EXAMINATION
(Hard Core)

Time 3 Hours Max. Marks 70

Section A
Write brief notes on **any five** of the following 5 x 3 =15
1-7 questions

Section B
Answer **any four** of the following 5 x 5 = 25
8-14 questions

Section C
Answer **any two** of the following 2 x 15 = 30
15-18 questions

SCHEME OF THEORY EXAMINATION
(Soft Core)

Time 2 Hours Max. Marks 35

Section A
Write brief notes on **any five** of the following 5 x 2 =10
1-7 questions

Section B
Answer **any two** of the following 2 x 5 = 10
8-11 questions

Section C
Answer **any one** of the following 1 x 15 = 15
12-14 questions

SCHEME OF PRACTICAL EXAMINATION

Question No.	Experiment	Marks
1	Major experiment/s	40
2	Minor experiment/s	20
3	Viva voce	10
	Max Marks	70

I SEMESTER (THEORY)

MBH- 101: BACTERIOLOGY AND VIROLOGY

Total Hours 52

Unit 1

Introduction and Classification: Introduction to microbes and prokaryotes. Natural system of classification, binomial nomenclature, international code of nomenclature of prokaryotes. Taxon, species, strain. Criteria used for classification. Three domain classification, classification according to Bergey's manual of systematic bacteriology.

Recent trends in Microbial Taxonomy: a) Chemotaxonomy: cell wall components, lipid composition, isoprenoid-quinones, cytochrome composition. b) Molecular method: DNA homology, DNA-RNA homology, G + C ratio, rRNA sequencing c) Numerical taxonomy d) Genetic methods in taxonomy e) Serological methods f) Taxonomy based on ecology. Bacterial phylogeny, Phylogenetic trees- evolutionary models, homology, methods for tree building, maximum likelihood, organizing data on a tree, evaluating phylogenies. Dichotomous key. **14hrs**

Unit 2

Morphology and ultrastructure of bacteria: Different cell morphology, flagella, pili, capsule, cell wall, cell membrane, cytoplasm. Intracytoplasmic inclusions: nucleoid, plasmids, transposons, gas vacuoles, cellulosomes, carboxysomes, magnetosomes, phycobilisomes, paraspora crystals, reserved food materials (metachromatic granules, polysaccharide granules, poly β hydroxybutyrate granules, glycogen, oil droplets, cyanophycean granules and sulphur globules), endospores and exospores.

Cyanobacteria: Ultrastructure, reproduction and significance of *Microcystis*, *Gleocapsa*, *Spirulina*, *Nostoc*, *Anabaena* and *Scytonema.* **12hrs**

Unit 3

Morphological characterstics of bacteria: Spirochetes, Rickettsia, Chlamydiae**,** Mycoplasma, appendaged, sheathed, gliding and fruiting bacteria, Archaeobacteria, Actinomycetes.

8hrs

Unit 4

Nutrition and Cultivation: Micro and macro nutrients, growth factors. Nutritional types of bacteria. Culture media**:** classification of media (Simple, complex and special media with example). Growth: Nutritional uptake, Growth kinetics, generation time, growth curve, factors affecting growth. Aerobic, anaerobic, batch, continuous and synchronous cultures. Mechanism of cell cycle and binary fission. **8hrs**

Unit 5

Acellular entities- viruses, viriods and prions: Brief outline on discovery of viruses, origin of viruses, Nomenclature and classification of viruses- ICTV system of classification, distinctive properties of viruses. Morphology and ultrastructure of viruses - capsids and their arrangements; types of envelopes and their composition- viral genome (RNA, DNA), structure and importance- Viroids, Prions. **6hrs**

Unit 6

Cultivation and assay of viruses : Cultivation of viruses in embryonated eggs, experimental animals and cell cultures (suspension cell cultures and monolayer cell cultures; cell lines and cell strains). **4hrs**

References:

1. Marjorie Cowan, Kathleen Park Talaro (2009). Microbiology: A Systems Approach. 2nd Edition. The McGraw/Hill.
2. Naveen Kango (2009). Textbook of Microbiology. I.K. International Publishing House Ltd. New Delhi.
3. Falkow, S.; Rosenberg, E; Schleifer, K.-H.; Stackebrandt, E.; Dworkin, M. (Eds.) (2007). The Prokaryotes.3rd. ed., Vols. 1-7 (Set). Springer.
4. Ajit Varma. (2005). Biotechnological Applications of Microbes: Volume II. I.K. International Publishing Ltd.
5. Jacquelyn G. Black, Larry M. Lewis. (2005). Microbiology: Principles & Explorations. Edition 6. Wiley, John & Sons.
6. Edward, K. Wanger & Martinez, J. Heweltt (2004). Basic virology. Blackwell publishing.
7. Lengeler, Joseph W./ Drews, Gerhart. (1999). Biology of the Prokaryotes Blackwell Pub.
8. Atlas, R.M. (1998). Microbiology, Fundamentals and Applications (II ed) Macmillan Publishing Company.
9. Nester, E.W., Roberts, C.E., Pearsall, N.N., Anderson, D.G., Nester, M.T. (1998). Microbiology- A Human Perspective. 2nd Edition. Mc Graw Hill.
10. Sullia, S.B. & Shantharam S. (1998). General Microbiology, Oxford IBH pub. Co. New Delhi.
11. Felsentein, J. (1988). Phylogenies from molecular sequences: inference and reliability. Annual Review of Genetics. 22: 521-565.
12. Pelczar, M.J., Chan, E.C.S., kreig N.R. (1986) Microbiology Tata McGraw- Hill Pub.
13. Salle, A.J. (1967). Fundamental principle of Bacteriology. Tata Mc Graw Hill publishing company.

MBH- 102: EUKARYOTIC MICROBIOLOGY

Total Hours 52

Unit 1

Protozoa: Introduction, structure and significance: *Leishmania, Trichomonas, Entamoeba, Plasmodium,* cultivation of protozoa. **4hrs**

Unit 2

Algae: Distribution, morphology and classification (Smith) of Algae; Isolation from soil and water; algal ecology, Media and methods used for culturing algae, measurement of algal growth, strain selection and large scale cultivation, Symbiotic algae: Lichens, Coral reef and sea sponges. Structure and reproduction of *Spirogyra, Euglena, Exuviaella, Diatoms, Sargassam and Porphyra.* **12hrs**

Unit 3

Biological and economic importance of algae: As primary producers and as commercial products [food, green energy (biofuel) and therapeutic uses], heavy metal removal, immobilized and labeled algae; algal blooms and toxins. **4hrs**

Unit 4

Fungi: Structure of Fungal cells and growth; Hyphae and non-motile unicells, motile cells, spores, dormancy, growth of population and colonies, Mechanism of growth in Fungi, Measurement and kinetics of growth, nutritional and environmental requirements; Prevention of fungal growth. Heterothallism, parasexuality, sex hormones in fungi; physiological specialization, phylogeny of fungi. **10hrs**

Unit 5

Classification: Evolutionary tendencies in fungi, Classification (Ainsworth) of fungi

Salient features of Division and Subdivision of Fungal Kingdom:

Myxomycota: Classes**:** Acrasiomycetes, Hydromyxomycetes, Myxomycetes, Plasmodiophoromycetes

Eumycota:

Mastigomycotina: Classes: Chytridiomycetes, Hyphochytridiomycetes, Oomycetes

Zygomycotina: Classes: Zygomycetes, Trichomycetes

Ascomycotina: Classes: Hemiascomycetes, Plectomycetes, Pyrenomycetes, Discomycetes, Laboulbeniomycetes, Loculoascomycetes

Basidiomycotina: Classes: Teliomycetes, Hymenomycetes, Gasteromycetes

Deuteromycotina: Classes: Hyphomycetes, Coelomycetes, Blastomycetes

Structure and reproduction of: *Dictyostelium, Allomyces, Pilobolus, Claviceps, Puccinia, Fusarium.* **16hrs**

Unit 6

Fungi and ecosystem: Substrate groups: saprophytic, parasitic, keratinophilic, coprophilous; substrate successions, parasitism, predation, mutualism and symbiosis with plants and animals. Diversity of aquatic fungi. Economic importance of fungi. **6hrs**

References:

1. Mark F. Wiser. (2010). Protozoa and Human Disease. Garland Science
2. K R Sridhar. (2009). Frontiers in Fungal Ecology, Diversity and Metabolites. I.K. International Publishing House Ltd. New Delhi.
3. Nagamani. (2006). Handbook of Soil Fungi. I.K. International Publishing House. New Delhi.
4. A.V.S.S. Sambamurty. (2005). A Textbook of Algae. I.K. International Publishing.
5. Nick Talbot. (2005). Molecular and Cellular Biology of Filamentous Fungi: A Practical Approach Oxford
6. Mehrotra, R.S. and Aneja, K.R. (2002). An Introduction to Mycology, New Age Publications.
7. Singh, P.K., Dhar, D.W., Pabbi, S., Prasanna R., Arora, A. (2000). Biofertilizers- Blue Green Algae and Azolla, National Center for Conservation of Blue Green Algae, IARI, New Delhi.
8. Becker, E.W. (1994). Microalgae: Biotechnology and Microbiology, Cambridge University Press.
9. Kashyap and Kumar, H.D. (1994). recent advances in phycology-Rastogi Company
10. Janet R Stein (1975). Phycological methods. Cambridge university press.
11. Chapman, V.J. and chapman, D.J. (1973). The Algae. English language book society & MacMillan.

MBH- 103: MICROBIAL PHYSIOLOGY AND BIOCHEMISTRY

Total Hours: 52

Unit 1

Metabolite transport: Facilitated diffusion, mechanosensitive channels, ATP- binding cassette transporter family, chemiosmotic driven transport, ion ingredients, specific transport systems: ATP- linked ion motive pumps, histidine permease, iron, phospho transferase system.

Microbial stress responses: Osmotic stress, oxidative stress, thermal stress and heat shock response, nutrient stress and starvation stress response.

Bioluminescence in microbes: Mechanism and significance. **6hrs**

Unit 2

Enzymes: Definition, specificity, active sites, coenzymes, enzyme units, isozymes, enzymes kinetics; Michaelis-Menten equation. Sinificance of Km and Vmax, LB plot, Determination of kinetic parameters, multi substrate kinetics. Mechanism of enzyme action- lock and key and induced fit hypothesis, acid-base, covalent and metal ion catalysis. Regulation-Covalent, allosteric and feed back inhibition. Reversible (competitive, noncompetitive and uncompetitive) and irreversible inhibitions. Kinetics analysis of allosteric enzymes, Hills binding. Ribozymes and abzyme. **10hrs**

Unit 3

Carbohydrates: Structure and properties of mono, oligo and polysaccharides Metabolism and regulation- Glycolysis, TCA cycle, Glyoxylate cycle. Pentose phosphate pathway, Gluconeogenesis, Entner – Doudoroff pathway, Phosphoketolase pathway, Biosynthesis of peptidoglycan.

Fermentation pathways: Fermentation reactions**,** Fermentation balances, Homo and Heterolactic fermentation- lactic acid fermentation, acetic acid, butyric acid, mixed acid and propionic acid fermentation.

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 chemolitotrophs. **15hrs**

Unit 4

Lipids: Classification, structure of saturated, unsaturated fatty acids, triacylglycerol, phospholipids**,** glycolipids and sterols; Oxidation of fatty acids (α, β, ω oxidation). Biosynthesis of fatty acids (saturated and unsaturated) and sterol (ergosterol). **9hrs**

Unit 5

Nucleic acids: Structure of bases, nucleosides and nucleotides; Biosynthesis: Purine and pyrimidine, *denovo* and salvage pathway. **4hrs**

Unit 6

Amino acids & proteins: Classification, structure and properties of amino acids. General aspects of aminoacid metabolism; amination, transamination, deamination. decarboxylation, urea cycle. Classification, properties and structural organization of proteins (primary, secondary, tertiary and quaternary). **8hrs**

References:

1. Byung Hong Kim and Geoffrey Michael Gadd. (2008). Bacterial Physiology. Cambridge.
2. Charles Gerday and Nicolas Glansdorff. (2007). Physiology and Biochemistry of Extremophiles. ASM Press.
3. El-Sharoud, Walid (Ed.). (2007).Bacterial Physiology a molecular approach. Springer.
4. Richard J. Simpson. (2005). Proteins and Proteomics: A Laboratory Manual. I.K. International Publishing House Ltd. New Delhi.
5. Voet, D. and Voet, J.G. (2004). Biochemistry, John Wiley and Sons.
6. Alcamo, I.E. (2001). Laboratory fundamentals of Microbiology, Jones and Barlett.
7. Palmer, T. (2001). Enzymes: Biochemistry, Biotechnology and Clinical Chemistry, Horwood Publishing Chichester.
8. Brun, Y.V. and Shimkets, L.J. (2000). Prokaryotic Development, ASM Press.
9. Lehninger (2000). Principles of Biochemistry, 3rd edition by Nelson & Cox (Worth) pub.
10. Moat, A.G. & Foster, J.W. (1999). Microbial physiology, Wiley-Liss.
11. Arora, D.K. and Seema Gupta (1996). Bacterial Physiology. Anmol Publications. New Delhi.
12. Caldwell. D.R. (1995). Microbial Physiology and metabolism, Brown Publishers.
13. Roger, L.P., Adams, Johm T., Knowler and David P., Leader. (1992). The Biochemistry of the Nucleic Acids. 11th edition. Chapman and Hall.
14. Smith and Wood (1991). Energy in Biological Systems. Chapman and Hall.
15. Gerhard Gottschalk. (1985). Bacterial Metabolism. Springer Series in Microbiology

MBH- 104 MICROBIAL AND BIOCHEMICAL TECHNIQUES

Total Hours: 52

Unit 1

Isolation techniques of microorganisms: Isolation of pure cultures; dilution, spread plate, streak plate, pour plate, micromanipulator method, colony morphology and other characteristics of cultures. Maintenance and preservation of pure cultures, culture collection center-national and international.

Microscopy: Working principle of phase contrast microscopy, fluorescent microscopy, electron microscopy (TEM and SEM), confocal microscopy, fluorescent microscope scanning probe microscopy and their staining techniques: image processing methods in microscopy. Micrometry. **12hrs**

Unit 2

Measurement of microbial growth: Direct microscopic count, standard plate count, membrane filtration, MPN, Indirect method: turbidity, metabolic activity and dry weight. Automated microbial identification system.

6hrs

Unit 3

Analysis of metagenomes: Metagenomics, Culture independent analysis of microbes, phospholipids. Fatty acids analysis, Fluorescent *in situ* hybridization (FISH), Genomic *in situ* hybridization (GISH).

Unit 4

Spectrophotometry: Principle and applications of spectrophotometer- UV/visible, fluorescence.

Spectroscopy: Principle and applications of circular dichroism, NMR and ESR spectroscopy, X-ray diffraction. Mass spectroscopy **10hrs**

Unit 5

Chromatography: Principles and applications of Chromatography: Thin layer chromatography (TLC), Gel filtration chromatography, Ion exchange chromatography, Affinity chromatography, Gas chromatography (GC) and High performance liquid chromatography[(HPLC).

Electrophoresis: Definition, principles and applications; different types of Electrophoresis-PAGE, SDS-PAGE, IEF, 2D-PAGE, Agarose gel electrophoresis, PFGE. **12hrs**

Unit 6

Isotope techniques: Stable and radioactive isotopes, radio isotopic labeling, autoradiography, scintillation counters, non-radioactive labeling, safety guidelines. **6hrs**

References:

1. G. Tripathi. (2009). Cellular and Biochemical Science. I.K. International Publishing House Ltd. New Delhi.
2. R.K. Sharma. (2009). Basic Techniques in Biochemistry and Molecular Biology. I.K. International Publishing House Ltd. New Delhi.
3. Ashok K. Chauhan. (2007). Microbes for Human Life. I.K. International Publishing House
4. B.B. Buchanan. (2007). Biochemistry and Molecular Biology of Plants. I.K. International Publishing House Ltd. New Delhi.
5. David White and George D. Hegeman. **(**2006). The Physiology and Biochemistry of Prokaryotes, Third Edition. Oxford University Press.
6. P C Trivedi. (2006). Advances in Physiology. I.K. International Publishing House Ltd. New Delhi.
7. David Greenwood, Richard C.B. Slack, John F. Peutherer (2003). Medical Microbiology. Churchill Livingstone.
8. Prescott, Harley, Klein (2002). Microbiology, Mc Graw Hill.
9. Purohit, S.S. (2002). Microbiology fundamentals and applications. Agrobios (India).
10. Samuel Singer (2001). Experiments in Applied Microbiology. Academic Press.
11. Collins, C.H., Tatrica M. Lyne & Grange, J.M. (1999). Microbiological methods. Arnold publishers.
12. Robert S. Burlage, Ronald Atlas, David Stahl, Gill Geesey, & Gary Sayler. (1998). Techniques in Microbial Ecology. Oxford University Press. NY.
13. Alexander N. Glazer, Hiroshi Nikaido (1994). Microbial Biotechnology, Freeman.

MBS- 105 BIOSTATISTICS
(Soft core)

Total Hours: 26

Unit 1:

Introduction to Bio-statistics, basic concepts, data types. Need for statistical techniques for biological applications, replicable data, Tabulation of data, construction of graph and graphical representations of data. Different models of data presentations.

Frequency distribution, Arithmetic mean, mode, median and percentiles. Measures of variability: Range, mean deviation. standard deviation and co-efficient of variation.

Properties of the data- Organization of data, Central tendency, dispersion, linear regression and correlation-test of significance, skewness and kurtosis and their various measures, percentiles Simple linear correlation and regression analysis. Analysis of variance.

Population and sample: Random sample, use of table of random numbers, parameter and statistics, sampling distribution of sample means, Standard error; confidence intervals.

14 Hours

Unit 2:

Probability: types of event, sample space, definition, conditional probability, addition and multiplication rules of probability and some simple problems. Probability distributions- Binomial, Poisson and Normal distributions and a few simple problems. Statistical Inference- Estimation, standard error, confidence interval for means and proportion. Testing of hypothesis: basic concepts and definitions, types of errors. Tests based on Normal, student's t, chi-square and F distributions, interpretation of 'p' value.

Statistical package- Features of statistical software, SPSS for various applications in Bio-statistical programme.

12 Hours

References:

1. Daniel (1999). Biostatistics (3^{rd} edition) Panima Publishing Corporation.
2. Khan (1999). Fundamentals of Biostatistics, Panima Publishing Corporation
3. Swardlaw, A.C. (1985). Practical Statistics for Experimental Biologists, Joh
4. Bazin, M.J. (1983). Mathematics in microbiology Academic press
5. Green, R.H. (1979). Sampling design & Statistical methods for environmental Biologists, Wiley Int. N.Y.
6. Campbell, R.C. (1974). Statistics for Biologists, Cambridge Univ. Press, Cambridge
7. Bliss, C.I.K. (1967). Statistics in Biology, Vol.1 Mc Graw Hill, New York.
8. Wiley and Sons, Inc. NY.

I SEMESTER (PRATICAL)

MBP-106: BACTERIOLOGY, VIROLOGY AND EUKARYOTIC MICROBIOLOGY

Total Units: 15

1. **Isolation of microorganism:** Serial dilution, pure culture techniques
2. **Culturing and cultural characteristics of microorganisms**:
    i. **Autotrophic** - Benecks broth, Chu's medium
    ii. **Heterotrophic** -Nutrient agar, glucose peptone media
    iii. **Selective** - MRS, actinomycetes agar
    iv. **Enriched** -Dorsetts egg growth medium, chocolate agar
    v. **Differential** - Maconkey, Blood agar, EMB, DCA
3. **Staining techniques:** Simple, Differential: acid-fast, endospore, capsule, cell wall, cytoplasmic inculsion vital stains: flagella, spore and nuclear staining.
4. **Biochemical tests for identification of Bacteria:** Catalase, oxidase, IMViC, motility, gelatine test, urease, levan formed from glucose, H_2S in TSIA and lead acetate paper, coagulase, optochin sensitivity, lecithinase, nitrate reduction, acid and gas from glucose, arabinose, inosital, lactose, maltose, mannitol, rhamnose, salicin, trehalose, sucrose, xylose, fructose, ONPG acid, hippurate hydrolysis, chitin, starch, casein, Tween 80 hydrolysis, pectin, arginine dehydroysis, lysine decarboxylase, ornithine, esculin hydrolysis. Identification of bacteria by API system.
5. Bacterial growth measurement (cell count, turbidometry, plate count)
6. Isolation of bacteriophages from sewage and flies
7. Isolation of plant viruses from sap
8. **Isolation of fungi from soil:** Dilution plate method, Warcup method, stamping method.
9. **Isolation of fungi from plant material:** Epiphytic fungi, washing method, implant method, impression method, maceration method; endophytic fungi.
10. Growth measurement of fungi- linear and biomass
11. Effect of environmental (pH, temperature) and nutritional factors (carbon, nitrogen sources) on growth of fungi.
12. Isolation and identification of microscopic algae from soil and water
13. Isolation and identification of protozoa from soil and water
14. Screening for antibiotic producing microbes (antibacterial, antifungal)
15. Study of phototaxis in Dictyostelium.

MBP- 107: MICROBIAL PHYSIOLOGY, BIOCHEMISTRY AND MICROBIAL TECHNIQUES

Total Units: 14

1. Estimation of protein by Bradford method
2. Estimation of protein by Lowry's method
3. Estimation of protein by Bicinchoninic acid (BCA) method.
4. Estimation of reducing sugar.
5. Estimation of DNA
6. Estimation of RNA
7. Isolation of lipolytic microbes from soil-plate method and estimation of total lipid
8. Fractionation of total lipid (glycolipid, neutral lipid and phospholipid) by column chromatography
9. Extraction and estimation (by TLC) of ergosterol from fungi
10. Determination of protease activity
11. Determination of malate dehydrogenase and catalase activity
12. Study of enzyme kinetics, Km and Vmax of amylase
13. Analysis of optimum pH, temperature of amylase
14. SDS PAGE- Molecular weight determination

II SEMESTER (THEORY)

MBH- 201: MICROBIAL GENETICS

Total Hours: 52

Unit 1

Prokaryotic Genome: *E. coli* chromosome- coiled, supercoiled (plectonemic, solenoid), folded fiber model. *Mycoplasma genitalium* and *E. coli* genome.
4hrs

Unit 2

Eukaryotic Genome: Structure of chromatin, chromosome, centromere, telomere, nucleosome, genome organization, split gene, overlapping genes and Cot curves, chromatin remodeling; types of histones, histone modifications- methylation, acetylation, phosphorylation and their effects on structure and function of chromatin, DNA methylation, repetitive and non-repetitive DNA sequence.

Law of DNA constancy, C value paradox and genome size, karyotype and idiogram, chromosome banding pattern, types of chromosomes. Organelle genome.
12hrs

Unit 3

Gene and Mutation: 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; environmental mutagenesis; Ame's and other toxicity testing. **8hrs**

Unit 4

Genetic recombination: Genetic recombination in bacteriophages and *E. coli*, synopsis of homologous duplexes, breakages and re-union role of RecA and other recombinases, generalized & specialized transduction, transformation and conjugation, legitimate & illegitimate recombination, gene conversion, overview of bacterial genetic map.
10hrs

Unit 5

Gene transfer mechanisms: Bacterial transformation; Host cell restriction; Transduction; complementation; conjugation and transfection, mechanisms and applications, genetic analysis of virus, bacteria and yeast genomes. Genetics of fungi-alteration of generation, induction of mutation in *Neurospora crassa* and yeast, cytoplasmic inheritance and biochemical mutants. **10hrs**

Unit 6

Plasmids and Bacteriophages: Plasmids, F-factors - description and their uses in genetic analysis, Colicins and Col Factors, R plasmids. Lysogeny and lytic cycle in bacteriophages, Life cycle and their uses in microbial genetics. Lytic phages-T7 and T4, Lysogenic phages Lamda, M13 and ΦX174. **8hrs**

References:

1. Jeremy W Dale and Simon F Park. (2010). Molecular Genetics of Bacteria. Fifth Edition. Wiley-blackw.

2. Dale. J.W. (1994). Molecular Genetics of bacteria, John Wiley & Sons.
3. Robert J. Brooker. **(**2009). Genetics: Analysis and Principles, 3rd Edition. McGraw-Hill.
4. Geaorge Lipps. (2008).Plasmids: Current Research and Future Trends. Academic Press.
5. Madhusudan W Pandit. (2007). Scientoonic Tell-Tale of Genome and DNA. I.K. International Publishing.
6. Oladele Ogunseitan. (2004). Microbial Diversity: Form and Function in Prokaryotes. Wiley- Blackwell.
7. Lewin, B. (2002). Genes VIII. Oxford.
8. Streips & Yasbin (2001). Modern microbial Genetics. Wiley Ltd.
9. Bloom, Freyer, Micklos. (1996). Laboratory DNA Science. The Benjamin/Cummings Pub.
10. Silhavy, T. (1994). Experiments with Gene Fusions, Cold Spring Harbour Lab. Press.
11. Miller, J.H. (1992). Short course in bacterial genetics, CSH Laboratories.
12. Roger L.P. Adams, Johm, T., Knowler and David P. Leader. (1992). The Biochemistry of the Nucleic Acids. 11th edition. Chapman and Hall

MBH- 202: MOLECULAR BIOLOGY

Total Hours: 52

Unit 1

Concepts of molecular biology: Introduction, flow of information, central dogma of molecular biology.

Structure of DNA, DNA polymorphism (A, B, Z DNA). Structure and function of different types of RNA.

DNA damage and repair: Types of DNA damage – deamination, oxidative damage, alkylation, pyrimidine dimers; Repair pathways – photo-reactivation, excision repair, post replication repair, SOS repair, methyl directed mismatched repair, very short patch repair.

10hrs

Unit-2

DNA Replication: DNA replication in prokaryotes and viruses (Rolling circle and M13 bacteriophages replication), asymmetric replication, looped rolling circle, semi conservative replication, primer or template, concotamy formation –P1. Origin of replication, replication fork- leading and lagging strands, enzymes involved at different steps of replication. Fidelity of replication. Extrachromsomal replicons.

6hrs

Unit 3

Transcription: Transcription factors and machinery, formation of initiation complex, transcription activators and repressors, RNA polymerases. Initiation, elongation and termination. Heat shock response, stringent response. Inhibitors of RNA synthesis and their mechanism. Polycystronic and monocystronic mRNA. Control of elongation and termination. Alternate sigma factors. Post transcriptional modifications of mRNA- capping, editing, splicing, polyadenylation, modifications of tRNA and rRNA. **10hrs**

Unit 4

Translation: Genetic code- Features and character, wobble hypothesis**.** Ribosome assembly, initiation factors and their regulation, formation of initiation complex, Initiation, elongation and termination of polypeptide chain, elongation factors and releasing factors, translational proof-reading, inhibitors of translation and their mechanism, post-translational modification of proteins-glycosylation. Control of translation in eukaryotes. Differences between prokaryotic eukaryotic translation.

10hrs

Unit 5

Regulation of gene expression: Transcriptional control. Operon concept, catabolite repression. Inducible and repressible systems. 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. Maturation and processing of RNA– methylation, cutting and modification of tRNA degradation system. **10hrs**

Unit 6

Control of gene expression at transcription and translation level: Regulation of phages, viruses, prokaryotic and eukaryotic gene expression, role of chromatin in regulating gene expression.

Gene silencing: Transcriptional and post transcriptional gene silencing-RNAi pathway (siRNA and miRNA) . **6hrs**

References:

1. Robert F. Weaver. (2009). Molecular Biology, 4th Edition. McGraw-Hill.
2. B.B. Buchanan. (2007). Biochemistry and Molecular Biology of Plants. I.K. International Publishing House Ltd. New Delhi.
3. Chris. R. Callbine., Hallace. R. Bin. F. Leus. and Andrew, A. Travers. (2006) Understanding DNA (3rd Ed.). Academic Press.
4. Raymond F Gesteland. (2006). The RNA World, Third Edition. I.K. International Publishing House.
5. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, (2002). Molecular Biology of the Cell. Garland Pub. 4th Ed.
6. Twyman R.M., (1998). Advanced Molecular Biology. 1st Ed. Viva Books Pvt Ltd., New Delhi.
7. Joset F., Michel G, (1993). Prokaryotic Genetics, Genome Organization, Transfer and Plasticity, Boston. Blackwell.
8. Adams R.L.P, (1992). DNA Replication. IPL Oxford, England.
9. Streips and Yasbin, (1991). Modern Microbial Genetics. Wiley Ltd.
10. Thomas D. Brock, (1990). The Emergence of Bacterial Genetics, CSH lab Press.
11. Mark Ptashne, (1986). A Genetic Switch. Gene Control and Phage λ. Cell Press and Blackwell Scientific Publications.

MBH- 203: ENVIRONMENTAL MICROBIOLOGY

Total Hours: 52

Unit 1

Aerobiology: Air spora in different layers of atmosphere**,** bioaerosol, assessment of air quality using principles of sedimentation, impaction, impingement, suction and filtration. Brief account of transmission of airborne microbes; Microbiology of indoor and outdoor. Allergy: Causes and tests for detection of allergy. **10hrs**

Unit 2

Aquatic Microbiology: Fresh and marine ecosystem (estuaries, mangroves, deep sea, hydrothermal vents, salt pans, coral reefs). Zonation of water ecosystem; upwelling, eutrophication; food chain in aquatic ecosystems. Role of methanotrophs in ecosystem. Potability of water, microbial assessment of water, water purification. Ground water types and their contamination. Biofilm.

Waste treatment: sewage and effluent treatment; primary, secondary and tertiary treatment, Solid waste treatment. Solid wastes as sources of energy and food. **12hrs**

Unit 3

Soil Microbiology: Biotic and abiotic interactions, concepts of habitat and niche. Microbial communities; nature, structure and attributes, levels of species diversity, succession and stability, r and K selection, genetic exchange between communities. Biodiversity management and conservation. Role of microbes in organic solid waste treatment matter in various soil types, subterranean microbes. Biogeochemical cycles of carbon, nitrogen, phosphorous and sulphur. **10hrs**

Unit 4

Diversity in anoxic eco system: Methanogens-reduction of carbon monoxide- reduction of iron, sulphur, manganese, nitrate and oxygen. Microbial transformations of Carbon, Phosphorus, Sulphur, Nitrogen and Mercury. **4hrs**

Unit 5

Extremophiles: The domain Archaea, acidophilic, alkalophilic, thermophlic, barophilic and osmophilic and radiodurant microbes- mechanisms and adaptation. Halophilic- membrane variation- electron transport- application of thermophiles and extremophiles. Extremozymes. **6hrs**

Unit 6

Biodegradation: Role of microbes in degradation, Biodegradation of Xenobiotics-hydrocarbons, pesticides and plastics. Biodeterioration of wood, pulp and paper; Biosorption/bioaccumulation of heavy metals. Bioremediation of soil, air and water: various methods, advantages and disadvantages. Bioleaching of iron, copper, gold and uranium. **10hrs**

References:

1. Jagbir Singh. (2010). Solid Waste Management. I.K. International Publishing House Ltd. New Delhi.
2. Volodymgr Ivanov. (2010). Environmental Microbiology for Engineers. CRC Press. US

3. A.L. Bhatia. (2009). Textbook of Environmental Biology. I.K. International Publishing House Ltd. New Delhi.
4. Atlas, R.M., (2005). Handbook of media for environmental microbiology. CRC press.
5. Patrick, K. Jjemba. (2004). Environmental microbiology: principles and applications. Sceince Publishers.
6. Christon J Hurst, Ronald L Crawford, Guy R Knudsen Michael J McInerney, Linda D Stetzenbach, (2002). Manual of Environmental Microbiology2nd Edition. ASM press.
7. Francis H Chapelle, (2000), Ground Water Microbiology and Geochemistry. 2nd Edition. John Wiley & Sons.
8. Robert L Tate, (2000), Soil Microbiology2nd Edition. John Wiley & Sons.
9. Gabriel Bitton, (1999), Waste Water Microbiology. 2nd Edition. Wiley-Liss.
10. Robert S. Burlage, Ronald Atlas, David Stahl, Gill Geesey, Gary Sayler (1998) Techniques in Microbial Ecology. Oxford University Press. New York.
11. Christopher S Cox, Christopher M Wathes, (1995), Bioaerosols Handbook. Lewis Publishers.
12. Ian L. Pepper, Charles P Gerba, Jeffrey W (1995), Environmental Microbiology: A Laboratory Manual. Academic Press.
13. Baker K.H. and Herson, D.S. (1994), Bioremediation. Mc Graw Hill Inc., New York

MBH- 204: FOOD MICROBIOLOGY

Total Hours: 52

Unit 1

Introduction: Development of food microbiology as a science, scope of food microbiology. Food as substrate for microorganisms, intrinsic and extrinsic factors affecting the growth of microbes, important microorganisms in food (molds, yeasts and bacteria) and their source (air, soil, water, plants and animals). **6hrs**

Unit 2

Food contamination and spoilage: Sources of food contamination. Principles of food spoilage; spoilage of cereals, sugar products, vegetables, fruits, meat and meat products, milk and milk products, fish and sea foods, poultry; spoilage of canned foods; conventional and modern methods for detection of spoilage and characterization.

10hrs

Unit 3

Food-borne infections and intoxication: Bacterial- *Brucella, Bacillus, Clostridium, Escherichia, Listeria;* Food intoxication- *Botulism, Staphylococcal.*
Mycotoxins & their types – aflatoxins, ochratoxins, fuminosins, trichothecenes, zealenone, ergot alkaloids; food borne outbreaks and lab testing procedures. Preventive measures. Molds, Algae, Protozoa, Viruses.

10hrs

Unit 4

Food preservation: Principles and methods of food preservation- Physical (temperature, irradiation, drying, canning, processing for heat treatment-D, Z and F values) Chemical (Organic acids, food additives. Class I and Class II preservatives), Biopreservation (Lactic acid bacteria).
Food Packaging- Types of packaging materials, properties and benefits. **10hrs**

Unit 5

Microbial and Fermented foods: SCP- Nutritional & therapeutic importance, Quorn and SCO and their Industrial production. Fermented Vegetables (olives, cucumbers), Meat (sausages), Beverage (cocoa and coffee); Bread, Idli, Dairy foods (cheese, srikhand). production methods of Kefir, Yogurt, Acidophilus milk; Probiotics, Prebiotics and Synbiotics, Nutraceuticals (Cr/Se yeast), functional foods and their quality standards.
Application of fungal pigments in food industry. **12hrs**

Unit 6

Food and sanitation: Good Hygiene Practices, Sanitation in manufacture and retail trade; food control agencies and their regulation, hazard analysis and critical control points (HACCP); GMP, plant sanitation – employees' health standard, waste treatment, disposal, quality control.
Recent trends and development in food technologies in India. **4hrs**

References:

1. James, M. J. Martin, J. Loessner, and David, A.G. (2006) Modern food microbiology (7^{th} ed.)
2. Mary E Torrence, Richard E Isaacson, (2003), Microbial Food Safety in Animal Agriculture: Current Topics. Iowa state University Press.
3. John S Norak, Gerald M Sapers, Vijaya Kumar Juneja, Daniel K Gay. (2002), .Microbial Safety of Minimally Processed Foods. 1^{st} Edition. CRC Press.
4. Bibek Ray (2001).Fundamentals of Food Microbiology.Bibek Ray. 2^{nd} Edition. CRC Press
5. Adams M.R. and Moss M.O (2000) Food Microbiology. Royal Publishing Corporation.
6. T.J. Montville, and K., Wikowski, In: M.P., Doyle, L.R. Beuchat, and T.J., Montville, (Eds). 1997. Food Microbiology: Fundamentals and Frontiers. ASM Press, Washington DC.
7. James M. Jay (1996) Modern food microbiology, CBS Publishers and Distributors, Delhi.
8. Norman G Marriott, (1995).Principles of Food Sanitation, 4^{th} Edition. (Chapman & Hall Food Science Book). Aspen Publishers Inc.
9. James M. and Jay J.M (1991) Food Borne Pathogen An illustrated text, Wolfe publications Ltd, England.
10. Colin Ratledge and Bjorn Kristiansen (2002) Basic Biotechnology (2^{nd} Ed.).Cambridge University Press.

MBS- 205: BIOINFORMATICS
(Soft core)

Total Hours: 26

Unit 1

Introduction to Computer: Binary, Octal and Hexadecimal number systems –Binary arithmetic, Binary code. Computer Architecture- internal and external Devices. Computer softwares- operating system- Windows, UNIX, Linux, Application software- word processor, spread sheet. Introduction to statistical software (SPSS).

5 Hours

Unit 2

Computer Network and Programming Languages: Structure, architecture, Advantages, types (LAN, MAN & WAN), Network protocols- Internal protocol (TCP/IP), File transfer protocols (FTP), WWW, HTTP, HTML, URL. Network Security- Group polices Fire-walls. C Programming and PERL- Algorithm and flowchart, Structure of C program, Header file, Global declaration, Main function, variable declarations, Control statement-conditional and unconditional - sub functions. Introduction to PERL, Application of Bioperl.

8 Hours

Unit 2

Databases: Introduction - Relational Databases Management (RDMS) - Oracle, SQL, Database generation.

3 Hours

Unit 3

Biological Databases: Datamining and applications, accessing bibliographic databases- Pubmed, Nucleic acid sequence databank – NCBI and EMBL. Protein sequence databank- NBRF- PIR, SWISSPROT. Structural databases - protein data Bank (PDB). Metabolic pathway data bank (Pub gene), Microbial genomic database (MBGD), Cell line database (ATCC), Virus data bank (UICTVdb). Sequence alignment - Global and Local alignment, scoring matrices.

Restriction mapping - NEB CUTTER, Similarity searching (FASTA and BLAST), Pair wise comparison of sequences, Multiple Sequence alignment of sequences, Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acids and protein sequences, Identification of ORFs, Identification of motifs.

10 Hours

Unit 3

Protein Structure and Molecular Interaction: Chemical bonding and non-bonding interactions, stability of electrovalent bond. Co-valent bond – partial ionic character of co-valent bonds and Vander Waals forces. Introduction to protein structure - secondary structure prediction, tertiary structure prediction, protein modelling- principles of homology and comparative modelling. Threading, structure evaluation and validation and *ab intio* Modelling, Applications - Molecular docking - Autodoc .

10 Hours

References:

1. Dhananjaya (2002). Introduction to Bioinformatics, www.sd-bio.com series
2. Jan (2001). Nucleic acid research, Genome Database issue
3. Higgins & Taylor (2000). Bioinformatics, OUP.
4. Baxavanis (1998). Bioinformatics.
5. Fry, J.C. (1993). Biological Data Analysis. A practical Approach. IRL Press, Oxford.
6. Swardlaw, A.C. (1985). Practical Statistics for Experimental Biologists, John Wiley and Sons, Inc. NY.

II SEMESTER (PRACTICAL)

MBP- 206: MICROBIAL GENETICS AND MOLECULAR BIOLOGY

Total Units: 16

1. Isolation and electrophoretic analysis of genomic DNA(from bacteria, fungi and algae)
2. Isolation and electrophoretic analysis of plasmid DNA from bacteria
3. Mutagenesis: Identification and isolation of fungal mutants [physical (UV) and chemical(EMS)]
4. Study of replica plating techniques
5. Bacterial transformation by $CaCl_2$ method)
6. Transduction and conjugation in *E. Coli*
7. Ampicillin selection for enrichment of auxotroph
8. Ame's test for detecting chemical carcinogens
9. Genetic mapping in Bacteria
10. Protoplast fusion
11. Generation and screening for mutants in *fur*
12. Induction and assay of β- galactosidase
13. Chromosome banding pattern
14. Western and southern blotting.
15. Induction of mutation in *Neurospora*
16. Identification of lytic and lysogenic cycles in bacteriophage

MBP- 207: ENVIRONMENTAL MICROBIOLOGY AND FOOD MICROBIOLOGY

Total Units: 18

1. Quantification of microorganisms in air (outdoor and indoor occupational environment)-solid impaction and liquid impingement techniques
2. Sampling and quantification of air borne endotoxins by Limulus Amoebocyte assay
3. Isolation, cultivation and characterization of iron and manganese reducing bacteria
4. Isolation of methanogens from enrichments
5. Physical, chemical and microbial assessment of water and potability test for water-Microbiology-Heterotrophic plate count, MPN index, presumptive, confirmatory and completed tests, membrane filter technique for total coliform, faecal coliform, *Clostridia*, *Pseudomonads*
6. Study of microbial tolerance/resistance to heavy metals by agar dilution method, agar diffusion method
7. Chemical characterization of bacterial exopolymers produced in a biofilm
8. Screening of microorganisms for biodegradation of recalcitrant compounds
9. Study of Bacteriocin producing Lactic Acid Bacteria(LAB): Isolation, identification and partial purification
10. Study of antimicrobial activity of chemical preservatives
11. Isolation and identification of common food borne pathogens (Enterobacteriaceae, *Pseudomonas*, *Staphylococcus*, *Salmonella*, *Listeria*, *Vibrio*)
12. Detection of Aflatoxin from fungi-Qualitative and quantitative analysis
13. Study of fermented foods- Isolation and identification of microbes from yogurt, sauerkraut, idli batter, sausages.
14. Role of yeast in bread making
15. Production, antimicrobial effect and nutritional value of probiotics-
16. yoghurt, kefir and acidophilus milk
17. Quality testing for milk and milk products
18. Production and estimation of single cell protein from agricultural waste.

III SEMESTER (THEORY)

MBH- 301: MEDICAL MICROBIOLOGY

Total Hours: 52

Unit 1

Human pathogens: Normal microbial flora of human body and its significance, tissue tropism. Emerging and reemerging pathogens**:** Viral, bacterial, protozoan and fungal pathogens.

Infection and transmission: Entry of pathogen into human host – portals of entry. Virulence factors and their role in breaching host defense, mechanism of microbial adhesion, colonization and invasion of mucous membranes of respiratory, enteric and urinogenital tracts. G protein signaling-Establishment, spreading, tissue damage and anti-phagocytic factors; Evasion of host defense, non-specific host defense, toxigenesis-bacterial toxins and its types, Quorum sensing in *Staphylococcus pyogenes.* Modes of transmission and factors influencing. Communicable diseases; Nosocomial and community infections and their control. **10hrs**

Unit 2

Bacterial and Protozoan diseases: Study of diseases caused by pathogenic bacteria: pathogenicity, laboratory diagnosis, epidemiology and control measures– *Streptococcus Staphylococcus, Shigellla, Salmonella, Neisseria, Corynebacterium, Vibrio, Yersinia, Haemophilus, Mycobacterium*. Spirochetes-*Trepornema ,Chlamydiae, Mycoplasma*. Protozoan diseases-malaria, leishmaiasis and filariasis. **10hrs**

Unit 3

Fungal diseases: Aetiology, clinical symptoms, laboratory diagnosis and treatment of superficial infections (dermatomycoses): Epidermophyton, Microsporum and Trichophyton; Madura foot; Subcutaneous mycoses: Sporotrichosis and Systemicmycosis: Blastomycosis, Coccodiodomysis, Candidiasis, Opportunistic mycoses: Aspergillosis. **10hrs**

Unit 4

Viral diseases: Etiology, clinical symptoms, laboratory diagnosis and treatment: Pox virus, Herpes virus (HSV I & II) Varicella-zoster, Adenovirus, Picorna virus, Orthomyxoviruses (influenza), Paramyxoviruses (Mumps and Measles), Rhabdoviruses, Hepatitis viruses (HAV, HBV HCV, HDV), H1N1, Oncogenic viruses (HPV, epstein-barr virus, CMV), HIV, Arboviruses (Dengue, Encephalitis, chikungunya, rubella). Prion infection- Mad Cow, CJD, Kuru. **10hrs**

Unit 5

Antimicrobial agents: Classification of antimicrobial agents, Mechanism of drug action – antibacterial (Bacteriostatic and bactericidal) antifungal and antiprotozoans. Methods of testing drug sensitivity (*in vitro* and *in vivo*), antibiotic assay in body fluids. Mechanism of drug resistance and dissemination of multi drug resistance. Probiotics as therapeutic agents. Brief account of vaccines (conventional and recombinant) and immunization schedules; Passive prophylactic measures; Interferons. **6hrs**

Unit 6

Diagnostic Microbiology: Principles and applications of immuno and molecular diagnostic methods: RID, RIE, Agglutination test; CFT, RIA, ELISA, PCR, DNA finger printing. **6hrs**

References:

1. Connie R Mahon. (2010). Textbook of Diagnostic Microbiology. 3rd edition. Pearson.
2. Fritz H. Kayser. (2005). Medical microbiology. Thieme Verlag.
3. Wadher, and Bhoosreddy. (2005). Manual of Diagnostic Microbiology. Himalaya Publisher.
4. Credric, A. Mims. (2004) Medical microbiology. (3rd Ed.). Moshy Inc.
5. Kufe, et al., (2003). Cancer Medicine. BC Decker Inc.
6. Frank, Steven A. (2002). Immunology and Evolution of Infectious Disease. Princeton University Press.
7. Warren Levinson Ernest Jawetz (2002), Medical Microbiology and Immunology: Examination and Board Review, 7th Edition. McGraw-Hill/Appleton and Laye.
8. Leslic Collier, John Oxford. (2000) Human virology: a text book for students of medicine, dentistry & microbiology (2nd Ed.) Oxford University Press.
9. Warren Levinson. (2000) Medical microbiology and immunology: examination and board review. (8th Ed.) McGraw Hill.
10. Nester, Roberts, Pearsall, Anderson. (1998). Microbiology -A Human Perspective, 2nd edition, McGraw- Hill
11. Jenson, Wright, Robinson. (1997), Microbiology for the Health Sciences 4th edition, Prentice hall.
12. Mackie and McCarthey (1996), Medical microbiology vol 1, Microbial infection. vol 2, practical medical microbiology, Churchil Livingstone,

MBH- 302: RECOMBINANT DNA TECHNOLOGY

Total Hours: 52

Unit 1

Tools of recombinant DNA technology: Restriction endonucleases: types, nomenclature, recognition sequences, cleavage pattern. Ligases: mechanism of ligation, other DNA modifying enzymes-**(Polymerases, DNase, RNase, Polynucleotide kinases, Alkaline Phospahtases)**. Vectors:Cloning and expression vectors, plasmids (pBR 322, pUC, Ti), phages, cosmids, Phagemids, shuttle vectors, ARS, mini chromosomes, BACs, PACs and YACs. Promoter probe vectors, PET, BAC vectors, SV40, plant viruses as vectors. **14hrs**

Unit 2

Cloning and Expression: Cloning in Prokaryotes*(E.coli)* and Eukaryotes: (*Saccharomyces cerevisiae* and *Pichia pastoris);* construction of *cDNA* and genomic *DNA* library. Transformation into bacteria and yeast, transfection into plant and animal cells, selection of recombinant cells, expression of recombinant proteins.

10hrs

Unit 3

Molecular techniques: Agrose gel electrophoresis; labelling of DNA and RNA; Blotting techniques- Southern, northern, western. Molecular markers, RFLP, RAPD, AFLP, DNase foot printing. PCR, DNA microarray. Human genome project: global patterns of gene expression. Analysis of single nucleotide polymorphisms (SNP) using DNA chips.

12hrs

Unit 4

DNA sequencing: Dideoxy and chemical methods, sequence assembly, automated sequencing, genome sequencing, mapping of genes and fine structure analysis of genes.

5hrs

Unit 5

Chemical synthesis of genes: Phosphodiester, phosphotriester, phosphate triester approaches: Enzymatic synthesis of DNA; application of synthetic oligonucleotides, synthesis of complete gene. **5hrs**

Unit 6

Application of rDNA technology: genetically modified organisms (Bt cotton). Overview of Transgenic plants, GM foods (golden rice, tomato, corn, brinjal), transgenic animals (cow, sheep, poultry, fish). Gene therapy. **6hrs**

References:

1. Glick B.R and Pasternak J.J. (2010), Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press.
2. Brown T.A. (2009). Genome 3. Tylar and Francis.
3. Nigel Halford. (2006). Plant Biotechnology: Current and Future Applications of Genetically Modified Crops.Wiley Dreamtech India.

4. Bernard, R.G. and Jack, J.P. (2003). Molecular Biotechnology: principles and application of recombinant DNA. ASM Press.
5. Pierre Baldi G, Wesley Hatfield, (2002). DNA Microarrays and Gene Expression: From Experiments to Data Analysis and Modelling. Cambridge University Press.
6. Primrose, S. B. Twyman, P.M. and Old, R. W. (2001) Principles of gene manipulation (6^{th} Ed.). Black well publishers.
7. Sambrose and Russell. (2001), Molecular Cloning. 3 volumes. CSH Lab Pres. Hellen, K., Adrian, M. and John W. (2000). Recombinant DNA and Biotechnology.
8. Glover D.M and Hames. B.D, (1996), DNA Cloning. A Practical Approach. 4-volume set. OUP.
9. Howe C. (1995). Gene Cloning and Manipulation. Cambridge University Press.
10. Old and Primrose. (1994). Principles of Gene Manipulation, Blackwell Scientific Publications.
11. Anthony JF Griffiths, William M Gelbart, Jeffrey H Miller, and Richard C Lewontin (1999) Modern Genetic Analysis (1^{st} Ed.)W. H. Freeman Publishers.NY.
12. Benjamin Lewis, (2004) Genes VIII (3^{rd} Ed.) Oxford University & Cell Press,NY.

MBH- 303: IMMUNOLOGY

Total Hours: 52

Unit 1

Immune System and immunity: History of immunology; innate and acquired immunity. Cells and organs involved in immune system – T-cells, B-cells, lymphoid organ, spleen and bone marrow. Antigenic properties, T and B cell epitopes, chimeric peptides, macrophages, antigen-processing cells, eosinophils, neutrophils, mast cells and natural killer cells; immune responses – cell mediated and humoral, clonal selection and nature of immune response.

10hrs

Unit 2

Antigen and antibodies: Types, structure and properties of antigens, haptens; adjuvant - antigen specificity. Immunoglobulins – structure, types and subtypes, properties, primary and secondary responses, Antibody diversity. Complement system – Structure, components, properties and functions, complement fixation and complement pathways, biological consequences. Inflammation- effector mechanisms. **10hrs**

Unit 3

Antigen-antibody reactions: Agglutination, precipitation, immunoelectrophoresis, immuno-fluorescence, ELISA, RIA; Flow cytometry, Montaux test. Applications of these methods in diagnosis of microbial infections, autoimmunity mechanisms, altered antigens, systemic lupus erythematosus, Graves's diseases, rheumatoid arthritis, myasthenia gravis, multiple sclerosis.

Immunodeficiency-phagocytic, humoral, CMI, combined HLA association. **10hrs**

Unit 4

Hypersensitivity reactions: Allergy, Type I- Anaphylaxis; Type II- Antibody dependent cell cytotoxicity, Type III- Immune complex mediated reactions, Type IV- delayed type hypersensitivity. Symptoms and Immunological methods of diagnosis of hypersensitive reactions.

Lymphokines and cytokines – Assay methods. Immunological tolerance and modulation.

8hrs

Unit 5

Major histocompatibility complex(MHC): Structure and functions of MHC and the HLA systems. Gene regulation and Ir-genes; HLA and tissue transplantation – Tissue typing methods for transplantations in humans; graft versus host reaction and rejection.

Tumor immunology: tumor specific antigens, Immune response to tumors, immunodiagnosis of tumors – detection of tumor markers – alphafoetal proteins, carcinoembryonic antigen, Cancer therapeutics. **10hrs**

Unit 6

Immunization: Common immunization practice, types of vaccines and its application. Edible vaccines. Production of Polyclonal and monoclonal antibodies; catalytic monoclonal antibodies; antibody engineering, plantibodies. **4hrs**

References:

1. Madigan, Martinko, Dunlap, Clark. (2009). Brock Biology of Microorganisms, Twelfth Edition. Benjamin Cummings.
2. Marjorie Cowan, Kathleen Park Talaro. (2009). Microbiology: A Systems Approach. 2nd Edition. The McGraw/Hill.
3. Tortora, Funke, Case. (2009). Microbiology, Ninth Edition. Benjamin Cummings.
4. Jacquelyn G. Black, Larry M. Lewis. (2005). Microbiology: Principles & Explorations. Edition 6. Wiley, John & Sons.
5. Richard, A., Goldsby, Thomas J., Kindt, Barbara A. & Osborne (2000). Kuby Immunology. 4th edition. W. H. Freeman and Company, New York.
6. Abul K. Abbas, Andrew K. Lightman, Jordan S. Pober. (1998). Cellular and Molecular Immunology. Saunders College Pub.
7. Roitt, I.M. (2006). Essential of Immunology. 7th Edition. Elsievier.
8. Klaus D. Elgert (1996). Immunology-understanding of Immune system. Wiley-Liss. NY.
9. Tizard, I.R. (1995). Immunology. 4 ed. Saunders College Pub.
10. Topley & Wilson's (1995). Textbook on Principles of Bacteriology, Virology and Immunology, IX Edition (5 volumes) Edward Arnold, London.
11. Kuby, J. (2006). Immunology 6th Edition . WH. Freeman and Company, New York.
12. Warren Levinson (2000) Medical Microbiology and Immunology: Examination and Board Review. 8th ed. McGraw Hill.

OPEN ELECTIVE
MBO- 304: APPLIED MICROBIOLOGY

Total Hours: 52

Unit -1
Microbiology of Air: Airspora of indoor and outdoor environment, factors affecting airspora, Techniques of trapping air borne microorganisms. **2 hrs**

Unit -2
Soil Microbiology: Historical accounts and the "Golden Age" of soil microbiology and significant contributions of pioneer soil microbiologists. Diversity and abundance of dominant soil microorganisms, Methods of isolation of soil microflora, soil organic matter decomposition. **8 hrs**

Unit -3
Food microbiology: Definition, concepts and scope. Food as substrate for microbes. Factors influencing microbial growth in food-Extrinsic and intrinsic factors.
Principles of food preservation- Chemical preservatives and Food additives, Asepsis-Removal of microorganisms, (anaerobic conditions, high temperatures, low temperatures, drying). Canning, processing for Heat treatment. Contamination and food spoilage: Cereals, sugar products, vegetables, fruits, meat and meat products, Fish and sea foods- poultry-spoilage of canned foods. **12 hrs**

Unit -4
Dairy Microbiology: Microbiology of raw milk, Milk as a vehicle of pathogens, Prevention of contamination of raw milk, Microbiology of processed milk, Spoilage and defects fermented milk and milk products, Microbiological standards for milk and milk products. Ceram and butter bacteriology **12 hrs**

Unit -5
Clinical Microbiology: Role of Microbiologist in Diagnostic laboratory, General concepts for specimen collection, handling, transportation, processing, specimen workup, Laboratory safety and infection control. Scientific and Laboratory basis for Clinical/Diagnostic Microbiology: Microscopic examination of infectious diseases, Growth and biochemical characteristics, Rapid methods of identification **12 hrs**

Unit -6
Agricultural Microbiology: Introduction to agricultural microbiology, concepts and scope of agricultural microbiology, Agronomy and production of important crop plants, Green revolution. **6 hrs**

References:

1. Microbiology by MJ Pelczar Jr, ECS Chan, NR Krieg 5th Edition, Pub: Tata Mcgra-Hill Publishing Co Ltd.
2. Introductory Microbiology by Heritage Pub Heritage
3. General Microbiology by Stainer Pub; Ingraham and Wheeler (McMillan)
4. Alexander M (1977) Introduction to soil microbiology, John Wiley and Sons Inc.N.Y.
5. Atlas R.M. (1998) Microbiology, Fundamentals and applications 2nd Edition, Milan

Publishing Co.

6. Brock T.D. and Madigan M.T (1992) Biology of Microorganisms 6th Edn. Prentice Hall, Eagle wood cliffs N.j.
7. Prescott L.M, Harley T.P and Klein D.A. (1996) Microbiology WMC. Brown publishers Connie R Mahon. (2010). Textbook of Diagnostic Microbiology. 3rd edition. Pearson.
8. Fritz H. Kayser. (2005). Medical microbiology. Thieme Verlag.
9. Wadher, and Bhoosreddy. (2005). Manual of Diagnostic Microbiology. Himalaya Publisher.
10. Credric, A. Mims. (2004) Medical microbiology. (3rd Ed.). Moshy Inc.

III SEMESTER (PRACTICAL)

MBP- 305: MEDICAL MICROBIOLOGY AND IMMUNOLOGY

Total Units: 14

1. Isolation and identification of clinically important microbes from clinical specimens(throat swab, sputum, nasal swab, urine, blood, stool)
2. Isolation and identification of mycosis (Dermatomycosis)
3. Identification of pathogens on selective, differential and enrichment media
4. Different staining techniques
    a) Ziehl-Neelsen method of AFB
    b) Fluorochrome staining
    c) Leishman's staining
    d) Giemsa's staining
5. Special staining methods to demonstrate granules, capsules and spores
6. Testing of drug susceptibility according to NCCLS
7. Determination of MIC by Kirby-Bauer method, T test, checker board method
8. Purification of antigens(bacterial, fungal)
9. Induction and purification of antibodies
10. Precipitation reaction
11. Agglutinations (slide)
12. Blood grouping and Rh typing
13. Determination of bactericidal activity of normal serum
14. ELISA and Tests for allergens

MBP- 306: RECOMBINANT DNA TECHNOLOGY AND BIOINFORMATICS

Total Units: 18

1. Restriction digestion of DNA and molecular weight determination.
2. Ligation.
3. Selection of recombinants by scorable and selectable markers.
4. Polymerase chain reaction (PCR).
5. Agarose Gel Electrophoresis
6. SDS-PAGE
7. RAPD.
8. Isolation of RNA and analysis by formaldehyde gel electrophoresis
9. Blotting techniques
10. Retrieval of Protein Sequence and Nucleotide Sequence
11. Retrieval of Protein Structure from PROTEIN DATA BANK
12. Similarity Search using BLAST
13. Similarity Search Using FASTA
14. Pair wise Sequence Alignment Using EBI
15. Multiple Sequence Alignment Using CLUSTAL W
16. Identification Of ORFs Using NCBI-ORF FINDER
17. Restriction Mapping Using NEBCUTTER
18. Molecular Visualization of Protein using RasMol

IV SEMESTER (THEORY)

MBH- 401: AGRICULTURAL MICROBIOLOGY

Total Hours: 52

Unit 1

Microbes and soil fertility: 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. **4hrs**

Unit 2

Biological nitrogen fixation(BNF): 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 **8hrs**

Unit 3

Plant-microbe interactions: Mutualism, commensalism, parasitism, amensalism, synergism. Rhizosphere microorganisms- phyllosphere, spermosphere and rhizoplane, methods of enumeration, rhizosphere effect, factors influencing rhizosphere microbes. PGPR, Siderophores and VAM.

10hrs

Unit 4

Bioinoculants: 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 fluroscence, Bacillus thuringiensis, Trichoderma harzianum, Trichoderma viridae, Nuclear Polyhedrosis Virus*) **10hrs**

Unit 5

Molecular plant pathology: Recognition and entry of pathogens into host cells. Alteration of host cell behaviour by pathogens. Molecular mechanisms of disease establishment; enzymes, phytotoxins, growth regulators. involvement of elicitors; role of R and r genes in disease development. Molecular mechanisms of disease diagnosis. Resistance mechanisms in plants, Systemic resistance, resistance genes, phytoalexins, PR proteins, signalling mechanisms. Transgenic approaches for crop protection.

6hr

Unit 6

Plant diseases: (Symptomatology, etiology & control)

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: (Hartrot 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.

14hrs

References

1. Agrios G.N. (2009), Plant Pathology. 5th Ed. Academic Press.
2. Paul E.A.2007. Soil Microbiology: Ecology and Biochemistry,3Edn. Academic Press.
3. Richrd, E., Issacson., Marry, E. and Torrece. (2005) Microbial food safety in animal sagriculture: current topics. Blackwell publishers.
4. John L. Havlin et al., 2004. Soil Fertility and Fertilizers: An Introduction to Nutrient Management (7th Edition). Prentice Hall.
5. Dickinson M. 2003. Molecular Plant Pathology. BIOS Scientific,
6. Beynon J Dickinson M.2000. Molecular plant pathology Sheffield Academic Press.
7. Coyne M. 1999. Soil Microbiology Delmar Cengage Learning
8. Mehrotra, Aggarwal R, Ashok.2004. Plant Pathology. 2nd Edition Tata McGraw-Hill..
9. Rangaswami . Gand D.J. Bagyaraj. (1998) Agricultural Microbiology. 2nd Ed. PHI. India.
10. Subbarao, N.S. and Dommergues, Y.R. (1998) Microbial interactions in agriculture and forestry. Science publishers.

MBH- 402: INDUSTRIAL MICROBIOLOGY

Total Hours: 52

Unit 1

Introduction: Scope of Industrial Microbiology and fermentation technology. Study of industrially important micro-organisms and their preservation. Criteria for selection and strategies for strain improvement; maintenance and containment of recombinant organisms. **8hrs**

Unit 2

Fermentation process: Batch culture: growth kinetics; effect of environment: temperature, pH, nutrient concentration; monitoring microbial growth in culture: cell number, direct and indirect methods. Continuous culture: concepts of Newtonian and Non- Newtonian fluid, plastic fluids, apparent viscosities; anti-foam agents.

10 hrs

Unit 3

Fermentors: basic features, design & components – Typical fermentor. Sterilization of fermentor, medium, air supply; aseptic inoculation and sampling methods; scale up of fermentation process (parameters used in scale up, problems associated). Merits & demerits. Fermentation media: Media formulation strategies, sources of carbon, nitrogen, vitamins and minerals; role of buffers, precursors, inhibitors and inducers. Specialized bioreactors (Photobioreactors, Membrane, Fluidised bed, Tubular and Packed bed bioreactor). **10 hrs**

Unit 4

Solid state fermentation (SSF): Estimation of growth in SSF, concept of sterility. Comparison of SSF with SmF. Factors influencing SSF, kinetics, design of fermentor in SSF(Koji fermentor). Production of commercially important products by SSF (cellulases, penicillin, gibberillic acid). **6 hrs**

Unit 5

Downstream processing: Objectives and criteria, foam separation, precipitation methods, filtration, centrifugation, cell disruption methods, liquid extraction, membrane filtration, chromatography, drying devices, crystallization. Solvent recovery. Effluent treatment. Quality control of fermented products, Process economics. **8hrs**

Unit 6

Intellectual Property Rights (IPR): Introduction to Intellectual Property & IPR, patent, copyrights, trademarks, trade secret, geographical indications, Industrial designs. Patent laws, Legislations covering IPR's in India, Patenting of living organisms, procedure involved in patenting, patent infringement, patent filing and international patent law, PCT, provisional and complete specification, patentable and non-patentable materials, product planning and development, Trade related aspects (TRIPS), WTO, WIPO, international & regional

Entrepreneurship: Introduction, concept and theories of entrepreneurship, Entrepreneurial traits and motivation, Nature and importance of entrepreneurs. Entrepreneurship in India, barriers in entrepreneurship, agreements, Valuation & business concerns. Government regulations for microbial products. **10 hrs**

References:

1. 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.
2. Robert Mellor. 2009. Entrepreneurship for Everyone: A Student Textbook. SAGE Publications.
3. Holger Palzelt, Thomas Brenner 2008. Handbook of Bioentrepreneurship. Springer Sciences.
4. Matthew Rimmer. "Intellectual Property and Biotechnology: Biological Inventions" Edward Elgar. (2008).
5. Pandey A, Soccol RC and Larroche C. Current Developments in Solid-state Fermentation. 2008. Springer
6. Glazer N.A. and Nikaido H. Microbial Biotechnology: Fundamentals of Applied Microbiology 2nd Edn, 2007. Cambridge University Press
7. Robert, H. (2006) Microbiology and technology of fermented foods. Blackwell publishers.
8. Santaniello V; Evenson RE; Zilberman D and Carlson GA. Agriculture and Intellectual Property Rights : Economic, Institutional and Implementation Issues in Biotechnology. Universities Press, 2003.
9. Fauris R, J Thommel (2003) Microbial Production of L-Amino acids. Springer Verlag.
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11. Stanbury, P.F, Whitaker A. and Hall S.J. (1999). Principles of Fermentation Technology. 2nd Ed. Aditya Books (P) Ltd. New Delhi.

MBP- 403: MICROBIAL BIOTECHNOLOGY

Total Hours: 52

Unit 1

Introduction: Principle, applications, economics and milestones in microbial technology. **2hrs**

Unit 2

Microbial products for commercial use: 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), anticholesterol compound (Lovastatin). Vaccines (recombinant). Microbial insecticides. Secondary metabolites in bacteria and fungi (anti-cancer and anti-diabetic compounds). **14 hrs**

Unit 3

Microbial enzymes: 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. **10 hrs**

Unit 4

Microbial transformation and organic synthesis: 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. **10 hrs**

Unit 5

Nanotechnology: Introduction, Tools of nanosciences, Synthesis of Nanomaterials using microbes. Biopolymeric nanoparticles; nanosensors, biomedical applications, antimicrobial nanoparticles. **8hrs**

Unit 6

Bioethics and biosafety: Introduction, Human genome project and its ethical, legal and social implications. Biosafety guidelines and regulations for GMOs. GLP and GMP. Labelling of GM products. Ethics and safety of GM food. Testing of drugs on human volunteers. **8 hrs**

References:

1. Moo-Young M, Butler MM , Colin Webb C, Moreira A, Grodzinski B, Cui ZF & Agathos S. 2011. Comprehensive Biotechnology, 2nd Edn. Elsevier.
2. Hui YH, Meuiner-Goddick, Hansen AS, Josephsen J, Nip W, Stanfield PS and Toldrih F. 2011. Handbook of food & beverage fermentation technology. CRC Press.
3. Grewal S and Mutha P. 2010. Enzyme technology. The Book Planet.
4. Zheng R, Zheng Y, and Shen Y. 2010. Acrylamide, Microbial Production by Nitrile Hydratase. Wiley.
5. Elnashar MMM. 2010. Immobilized Molecules Using Biomaterials and Nanobiotechnology. J Biomaterials Nanobiotechnology. 01:61-77.

6. 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.
7. P. S. Teng. 2008. Bioscience entrepreneurship in Asia: creating value with biology. World scientific publishing Co.
8. Rastall RA. 2007. Novel enzyme technology for food applications. CRC press.
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12. Lawrence Philip, Wackett, C Dosylas Hershberger, (2001). Biocatalysis and Biodegradation: Microbial transformation of organic Compounds. American Society of Microbiology

IV SEMESTER (PRACTICALS)

MBP- 404: AGRICULTURAL MICROBIOLOGY, FERMENTATION TECHNOLOGY AND MICROBIAL BIOTECHNOLOGY

Total Units: 18

1. Isolation of cellulose, hemicelluloses, lignin, xylan and pectin degrading microbes.
2. Isolation of symbiotic and nonsymbiotic nitrogen fixing microorganisms
3. Isolation of phosphate solubilising bacteria and fungi-plate method.
4. Isolation of bioinoculants: *Bacillus thuringiensis, Bauveria bassiana, Trichoderma , Pseudomonas.*
5. Assay of bio fertilizers (seed treatment, seedling, inoculation and measurement of root and shoot length).
6. Mushroom cultivation using locally available substrates and evaluation of total protein content.
7. Extraction and estimation of phytoalexins and phenolics from diseased plants
8. Production of organic acids(lactic acid and citric acid) from microbes
9. Immobilization technique: whole cell or enzyme- sodium alginate gel method and demonstration of its significance.
10. Production of antibiotic (penicillin) by submerged and solid substrate fermentation.
11. Laboratory scale production of ethanol from industrial wastes and estimation of total and volatile acidity.
12. Laboratory scale production of wine/beer.
13. Detection and quantification of pigment from microbes: Melanin.
14. Detection and quantification siderophore produced by *Pseudomonas* spp.
15. Microbial assay of vitamin B12 and Glutamic acid
16. Sterility tests for pharmaceutical products
17. Production of amylase by solid substrate fermentation (at least 4 substrates).
18. Demonstration of a fermentor.