RANI DURGAVATI VISHWAVIDYALAYA, JABALPUR
SYLLABUS PRESCRIBED FOR THE DEGREE OF THE MASTER OF SCIENCE IN MICROBIOLOGY IN UNIVERSITY TEACHING DEPARTMENT
(Academic Session 2020-2021 & Onwards)
[PROGRAMME UNDER CHOICE BASED CREDIT SYSTEM - ORDINANCE 222]

This brochure of the programme for the M.Sc. degree in Microbiology consists of three parts, viz., (A) Information from the relevant Ordinance(s) / Statutes, (B) Scheme of examination and (C) Courses of study.

(A) INFORMATION FROM THE RELEVANT ORDINANCE (S)/STATUTES

1. DURATION OF THE COURSE

M.Sc Microbiology will be a full time two-year programme to be covered in four semesters, each of six months duration. The first year of the programme will complete the I and II semesters, and the second year will complete the third and fourth semesters. The maximum duration of the programme shall be twice of the minimum duration of the programme, i.e. four years.

2. ADMISSION TO THE COURSE

The number of seats shall be in accordance with the directives by the University. A candidate, who after having secured the B.Sc. degree with at least 50 % marks from a recognized university with a subject of Life Science, shall be eligible for admission to the course. The admission to the course will be on the basis of the merit and according to guidelines from the University and Government of Madhya Pradesh. After the term-end examination at the end of each semester, the student will be provisionally admitted to the next semester.

3. TUITION AND OTHER FEES

The admitted candidate shall pay the course fee in addition to the tuition fee and such other fees as prescribed by the University.

4. PROGRAM OF THE STUDY

The semester will consist of 16-18 weeks of academic work. One credit is equivalent to one hour (60 minutes) of teaching (lecture or tutorial) or two hours (120 minutes) of practical work/field work per week throughout a semester. The credits associated with the courses will be valid credits, while credits associated with comprehensive viva voce will be virtual credits. In the end term examination there will be **three components, namely Core Courses, Elective Courses and Skill Development Course,** except for the 4th semester where every student will carry out and submit a **dissertation**.

The syllabus for the theory and practical examination will be prescribed by the Board of Studies in Microbiology, R.D. University, Jabalpur.

5. CONTINUOUS EVALUATION

During the semester, a teacher offering the course will do the continuous evaluation of the student at three points of time by conducting three tests of 20 marks each. Of these, two must be written tests and the third may be written test/quiz/seminar/assignment. Marks obtained in two best tests out of three will be awarded to the student.

6. ATTENDANCE

Approved by
Board of Studies in Microbiology on 08/06/2020, **Faculty of Life Science on** 14/10/2020
Standing committee on **Executive Council on**

The student whose attendance is less than 75% will not be allowed to appear in the end semester examination and he/she will be declared fail in that semester.

7. END SEMESTER EXAMINATION

There shall be end semester examination at the end of first, second & third semester. The semester examination will be held every year normally in December and June or on the dates declared in the academic calendar of the University. A student proceeding to appear in end semester examination will submit through the Head of the Department his / her application on the prescribed form along with required examination fee, etc. to the Registrar of the University. Every student will appear in four respective theory papers and two combined practical examinations in first, second, & third semesters except for the fourth semester. In the fourth semester, every student will be allotted dissertation work in lieu of four theory papers. Allotment of the dissertation will be done by a committee comprising of the Dean of Faculty of Life Science, Head of Department of Biological Science, one Professor and one Associate Professor of the Department by rotation according to seniority. The dissertation may be undertaken in UTD or in any of the National Laboratories/ Institute/ Universities/ Government approved Companies/ Industries. In such cases, there will be two supervisors, one from the parent department and another from the place where the student completes his/her dissertation work.

The dissertation will be evaluated by the external examiner who has expertise in the concerned subject. For the purpose of holding viva-voce, the supervisor will be the internal examiner along with the external examiner who has evaluated the dissertation. The scheme of marks for evaluating the various components of the dissertation will be followed as given in the syllabus.

8. CONDITION FOR A PASS

For each course, each student has to appear in at least two tests and end semester examination, otherwise the student will be awarded "Ab" grade. The total marks obtained in end-semester examination, and best of two tests under continuous evaluation will decide the grade in that course. In addition, student also has to get valid credits for Skill development modules' courses and Virtual credits and grades for Comprehensive viva-voce. The grading will be made on 10-point scale as follows:

Letter Grade	Grade Points	Description	Range of Marks (%)
O	10	Outstanding	90-100
A+	9	Excellent	80-89
A	8	Very Good	70-79
B+	7	Good	60-69
B	6	Above Average	50-59
C	5	Average	40-49
P	4	Pass	35-39
F	0	Fail	0-34
Ab	0	Absent	Absent

For passing the examination in each semester, a candidate must have secured a minimum of 35% marks ("P" Grade: 4 Grade Points) in the course. If the marks obtained by the student in a course are less than the minimum cut-off percentage of marks, then "F" Grade will be awarded. If a student obtains "F" or "Ab" Grade in any course, he/she will be treated to have failed in the course. He/she has to reappear in the examination of the course as and when conducted or arranged by the UTD. Marks obtained earlier in continuous assessment may be carried forward and added to the marks obtained in repeat end semester examination to decide the grade in the repeat course.

The theoretical and practical courses can be repeated whenever offered or arranged by the UTD but within maximum duration of the programme. He/she can avail multiple repeat attempts to pass the course. The

student will be promoted to the next semester if he/she secures at least 12 valid credits in a semester. In case the student secures less than 12 valid credits in any semester, then the student will be asked to repeat entire semester and that semester will be treated as zero semester.

The decision of the teacher regarding the evaluation and the grade shall be final. However, a student submits in writing for review of his Marks/Grade to the Head/Director who will place the case before the board of comprehensive viva voce. The decision of the board will be final. Result of review will be declared by the concerned Head/Director. Review is effective only when grade improves. Review will be allowed only if –

- The prescribed fee is paid.
- The candidate applies within 7 days of the declaration of the grade in that course.

There will be no provision for revaluation: However, the candidates can apply for Re-totaling in one course per semester.

9. In matters not covered under this Ordinance, general rules of the University shall be applicable.

10. In case of any dispute/ambiguity, the ruling of the Vice-Chancellor shall be final and binding.

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B. PROGRAM OBJECTIVES

- The objective of the Master's Program in Microbiology is to equip the students to gain bimolecular knowledge and analytical skills at an advanced level.
- The program emphasizes to apply knowledge acquired about prokaryotic and eukaryotic cellular processes, interaction of microorganisms among themselves, with physical and chemical agents and higher order organisms in environment and biological systems to various conditions.
- The laboratory training in addition to theory is included so that the students will acquire the skills to qualify for a broad range of positions in research, industry, consultancy, education and public administration, or for further education in a doctoral program.
- Students will be able to address broad range of fields including biopolymer chemistry, marine biochemistry, environmental biotechnology, food science, microbiology, microbial genetics, molecular biology and systems biology.

C. PROGRAMME OUTCOMES

The Masters in Microbiology Program will address the increasing need for skilled scientific manpower with an understanding of research ethics involving microorganisms to contribute to application, advancement and impartment of knowledge in the field of microbiology and molecular biology globally. The laboratory training will empower them to prepare for careers in broad range fields.

The M.Sc. Microbiology student will have:

- State of art knowledge about various methodological and analytic approaches that are used within the specialization.
- Knowledge of the leading edge in a chosen specialized area of Microbiology, based on own research experience from a master's project and international literature.
- Can compete in national level competitive exams such as NET-JRF or GATE or International exams such as GRE-TOEFEL and can pursue career in higher studies

- In-depth knowledge in the structure of a repertoire of microorganisms, metabolism in the cell, knowledge of the concepts of molecular genetics and biosynthesis of proteins, enzymology, physiology, microbial pathogenicity, environmental and agricultural microbiology, genetic engineering, bioengineering and a good theoretical and practical insight into methods used to obtain this knowledge.
- Demonstrate practical skills in the use of tools, technologies and methods common to microbiology, and apply the scientific method and hypothesis testing in the design and execution of experiments.
- Develop ability to independently carry out a complete scientific work process, including the understanding of theoretical background, hypothesis generation, collection and analysis of data, and interpretation and presentation of results.
- Has high competence and multidisciplinary project experience within selected topics related to microbiology and ability to contribute in a multidisciplinary team. Is capable to evaluate methods and results within the field of specialization critically.
- Is able to evaluate and apply relevant theory, methods and analytic approaches within the specialized field of microbiology, including statistical methods.
- Can assess and predict the technological, ethical and social effects of their own work /disciplines and of microbiology.
- Acknowledges health, safety and environment (HSE) issues in handling chemicals and biological materials; understands the environmental impacts associated with the activity; performs risk assessments and is familiar with safety instructions in his/her subject area.
- Can communicate scientific results to the general public and experts by writing well structured reports and contributions for scientific publications and posters, and by oral presentations.

D**. PROGRAMME SPECIFIC OUTCOMES (PSOS)**

At the end of the two year programme the student will understand and be able to explain different branches of Microbiology such as Bacteriology and Virology. The student will be able to explain about various applications of Microbiology such as Environmental Microbiology, Industrial Microbiology, Food Microbiology, and Microbial Pathogenicity. He/she will be able to design and execute experiments related to Basic Microbiology, Immunology, Molecular Biology, Recombinant DNA Technology, and Microbial Genetics, and will be able to execute a short research project incorporating techniques of Basic and Advanced Microbiology under supervision. The student will be equipped to take up a suitable position in academia or industry, and to pursue a career in research if so desired.

(E) SCHEME OF EXAMINATION:

SEMESTER I

(A) Continuous evaluation, Theory, Practical		**Credits**	**Maximum Marks**		
			Continuous Evaluation	**End Semester Exam**	**Total**
Course Code	**Course Title**				
I Core courses					
MBC101	Bacteriology	**3**	**40**	**60**	**100**
MBC102	Virology	**3**	**40**	**60**	**100**
MBC103	Mycology	**3**	**40**	**60**	**100**
MBC104	Practical based on MBC101 & MBC102	**4**	**40**	**60**	**100**
MBC105	Practical based on MBC103 & MBE101/ MBE102	**4**	**40**	**60**	**100**
II Electives courses (Any one to choose)		**3**	**40**	**60**	**100**
MBE101	Biomolecules				
MBE102	Bioenergetics and Intermediary Metabolism				
III Skill Development course					
MBS101	Skill Development module 1	**2**	**Grade Point will be provided by Skill Development Centre**		
Total valid credits		**22**			

(B) Comprehensive viva voce (virtual credits)	**4**		**50**

SEMESTER II

(A) Continuous evaluation, Theory, Practical		Credits	Maximum Marks		
			Continuous Evaluation	End Semester Exam	Total
Course Code	**Course Title**				
I Core courses					
MBC201	Molecular biology and Recombinant DNA Technology	**3**	**40**	**60**	**100**
MBC202	Microbial Genetics	**3**	**40**	**60**	**100**
MBC203	Biostatistics & Computer Application	**3**	**40**	**60**	**100**
MBC204	Practical based on MBC201 & MBC202	**4**	**40**	**60**	**100**
MBC205	Practical based on MBC203 & MBE201/ MBE202/ MBE203	**4**	**40**	**60**	**100**
II Electives courses (Any one to choose)		**3**	**40**	**60**	**100**
MBE201	Biology of the Immune System				
MBE202	Resource utilization and conservation				
MBE203	Microbial Metabolism				
III Skill Development course					
MBS201	Skill Development module 2	**2**	**Grade Point will be provided by Skill Development Centre**		
Total valid credits		**22**			

(B) Comprehensive viva voce (virtual credits)	**4**		**50**

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SEMESTER III

(A) Continuous evaluation, Theory, Practical		**Credits**	**Maximum Marks**		
			Continuous Evaluation	**End Semester Exam**	**Total**
Course Code	**Course Title**				
I Core courses					
MBC301	Environmental Microbiology	**3**	**40**	**60**	**100**
MBC302	Medical Microbiology	**3**	**40**	**60**	**100**
MBC303	Practical based on MBC301 & MBC302	**4**	**40**	**60**	**100**
MBC304	Practical based on MBE301/ MBE302/ MBE303/ MBE304 (Any Two)	**4**	**40**	**60**	**100**
II Electives courses (Any two to choose)		**3**	**40**	**60**	**100**
MBE301	Advanced Molecular Biology				
MBE302	Agricultural Microbiology	**3**	**40**	**60**	**100**
MBE303	Industrial & Food microbiology				
MBE304	Microbial Biotechnology				
III Skill Development course					
MBS301	Skill Development module 3	**2**	**Grade Point will be provided by Skill Development Centre**		
Total valid credits		**22**			

(B) Comprehensive viva voce (virtual credits)	**4**		**50**

*Both (A – Core courses; One/Two Elective course(s) and Skill Development modules) & (B) are compulsory components of a semester. The grades awarded in the comprehensive Viva-voce shall be shown separately in the Grade Sheet.

SEMESTER IV

(A) DISSERTATION	**Credits**	**Maximum Marks**
A. Valuation (i) Language & Presentation (ii) Review of Literature (iii) Methodology (iv) Analysis & interpretation of Result	**18**	**300**
B. Viva-Voce EXTERNAL		**50**
C. Viva-Voce INTERNAL		**50**
Total		**400**

(B) Comprehensive viva voce (virtual credits)	**4**	**50**

COURSES OF STUDY IN M.Sc. MICROBIOLOGY
FIRST SEMESTER
COURSE CODE MBC101: BACTERIOLOGY (TOTAL CREDITS: 3)

Course Objectives: The primary objective of the course is to build a strong foundation in the area of bacterial cell structure, division, survival and propagation.

Course Learning Outcomes: Upon successful completion of the course, the student:

- Will be able to describe the morphological features, cell arrangement and structural components of bacterial cell in detail; will be able to differentiate between Gram-positive and Gram-negative bacteria. Will have gained knowledge about cell wall structure and extracellular appendages in different bacteria and is acquainted with current methodologies available for production of protoplasts, sphaeroplasts and L-forms.
- Will have gathered detailed information regarding bacterial cell division and endospore formation. Can enlist the characteristics of archaea that differentiate it from eubacteria, and will have learnt key features of some model archaeal organisms.
- Can enlist the salient features of the genome organization of E.coli and also the features of the unusual genome organization of selected extremophiles that allow them to survive in harsh environments.
- Understands different secretion systems existing in bacteria for toxins and biomolecules secretion, and their role in bacterial survival and pathogenesis.
- Will have gained in-depth knowledge about density-based signal transduction in bacteria and its significance in competence, sporulation and antibiotic resistance; would know about quorum quenching and its use in developing antimicrobial tools.
- Will have the indepth knowledge of various groups of bacteria with their significane.

COURSE CONTENTS

UNIT-I

History, scope and development of bacteriology, sterilization, isolation, enrichment, pure culture and staining techniques, systematic study of bacteria; morphological, physiological, biochemical and serological studies, genetic characterization, identification & classification chart.

UNIT-II

Habitat, structure, reproduction & classification of bacteria (morphological, biochemical, serological, chemical and molecular aspects), Actinomycetes, Mycoplasma, Rickettsiae, Chlamydiae and their significance.

UNIT-III

The photosynthetic bacteria; cyanobacteria, green bacteria, halobacteria and their economic importance. Methanogenic bacteria and their significance. Chemoautotrophs and Methylotrophs; nitrifying bacteria, sulfur oxidizers, iron bacteria, hydrogen bacteria and their economic importance.

UNIT-IV

Enterobacteriaceae and related organisms, their morphological & physiological characters, genetic interrelationship, taxonomic sub-division & their importance in human health. Myxobacteria, cytophage group, filamentous & gliding chaemoheterotrophs & filamentous sulphur oxidizing bacteria.

UNIT-V

Gram positive spore forming bacteria; unicelluar endospore formers- *Bacillus, Clostridia. Miscellaneous bacteria; lactic acid bacteria, Micrococci, Corynebacteria, Mycobacteria.*

List of Recommended Books

1. Sneath, P.H.A .and R.R. Sokal 1973 Numerical taxonomy .The Principles and Practice of Numerical Classification, San Francisco. W.H. Freeman
2. Sneath, P.H.A 1989 Analysis and Interpretation of sequence data for bacterial Systematic. The view of a Numerical taxonomist .Syst.Appl.Microbiol.12:15-31
3. Tom Parker, M. Lerline, H.Collier,1990,Principles of Bacteriology, Virology and Immunity, VIII Ed.
4. Woese,.C,R 1981 Archeabacteria , Sci. Am. 244:98-122
5. Woese,C.R.,Kandler,O. and M.L.Wheelis 1990 Towards a natural System of organisms: Proposal for the Domains Archea, Bacteria and Eucarya. Proc. Nati, Acad, Sci. ,87: 4576- 4570
6. Woese, C. R 1987 Bacterial evolution, Microbiological Reviews. 51: 221-271
7. Madigan, M. T.,J.M.Mrtinko and J.Parker 2000 Brock Biology of Microbiology IX Ed .Prentice Hall Inter, Inc.
8. Holt, J.G, and N.R.Krieg, 1984-1989 Bergey's Manual of Systematic Bacteriology Ist Ed (Vol 1-4) Williams and Wilkins Co Baltimore,Springer.
9. Holt , J.G, and N.R. Krieg, P.H .A .Sneath, J.T.Staley and J.T. Williums ,1994 Bergey's Manual Determinative Bacteriology IX Ed. Williams and Wilkins Co Baltimore, Springer
10. Garrity George, M. Editor-In Cheaf 2005 Bergey's Manual of Systematic Bacteriology II Ed. (Vol- I-V) .J.Brenner,K.R.Krieg, J.T.Stanly. Editors. Springer-Verlog
11. Garrity, M. George. Winters, B.S.Denise 2001 Taxonomic outline of the prokaryotic genera Bergeys Manual of Systematic Bacteriology. II Ed.
12. Balows, A.A.G. Thuper, M. Dworker, W. Harder, K.Schleifer 1991 The Prokaryotes, Springer,
13. VerlogGunsales and Stainer, The Bacteria I-V vol. Academic press
14. Prescott, L.M., J.P Harley and D.AKlein, 2007 Microbiology VII Ed. Mc Grow Hill,
15. Davis R.Y. E.A. Adeberg and J.L. Ingram,1991 General Microbiology
16. Stainer General Microbiology, V Ed., Printice Hall of India Pvt,Ltd. New Delhi
17. Schaechter.R. and Ledenberg.J 2004 The desk encyclopedia of microbiology. Elsevier Acad. Press California.
18. Amann.R. I. Ludwing. W and Schleifer. K .M. 1995 Phylogenetic identification and in detection of individual microbial cell with cultivation. Microbiological Reviews 59, 143-169.
19. Cook .T. 2002 Microbial Biodiversity saving bacteria to save ourselves, Harvard Sci. Review 26-28.
20. Vandanme,D. B.Pot, M.Gillis, P. Devos, K. Kersters and J. Swimgs.1996 Polyphasic taxonomy, a consensus approach to Bacterial Systematic, Microbiological Reviews. 407-438.
21. Bacterial (Prokaryotic) phylogeny web page. 2006, http: www.bacterial phylogeny.com / Index .html.
22. Brun,Y.V. and Schinketes 2000 Prokaryotic developments ASM press
23. Ronald M. Atlas 1997. Principles of Microbiology. II Ed. Mc Graw Hill Pub.
24. Talaro, K.P. and A. Talaro 1999 Foundations in Microbiology. Mc Graw Hil. Pub.
25. Davies et al.,1990 Microbiology 4thEdition Philadelphia, JB Lippincott

COURSE CODE MBC102: VIROLOGY (TOTAL CREDITS: 3)

Course Objectives: The course will facilitate in understanding of virology by examining common processes and principles in viruses to illustrate viral complexity, to understand viral reproduction. The course will teach the strategies by which viruses spread within a host, and are maintained within populations. It covers the molecular biology of viral reproduction and addresses the interplay between viruses and their host organisms

Course Learning Outcomes: Upon successful completion of the course, the student:

- Is able to describe classification of viruses .
- Is able to describe tools for studying virus structure, process of virus attachment and entry, virus
- assembly and release
- Is able to describe steps in replication of genome of RNA viruses, retroviruses, and DNA viruses Is able to describe steps in virus infection, transmission, patterns of infection, virus virulence, and host defense against virus infection
- Is able to describe methods of making virus vaccines and anti-viral drugs, drivers of virus evolution, and emerging viruses
- Is able to describe unusual infectious agents, virus mediated cellular transformation and oncogenesis.
- Is able to describe evasion strategies used by viruses, and learn to apply their knowledge to investigate virus outbreak **.**

COURSE CONTENTS

UNIT-I

General virology: History and development of virology, origin, distinctive properties, ultrastructure and chemistry of viruses. virus related agents (viroids, prions), significance of viruses.

UNIT-II

General methods for isolation, identification, characterization and cultivation of viruses: Methodology for isolation, adsorption, One-step growth and burst size of virus. Determination of titre value, isolation of phage resistant strain, cultivation and maintenance of plant, animal and bacterial / cyanobacterial viruses. identification of viruses by physical, chemical and serological techniques.

UNIT-III

Bacterial/ cyanobacterial viruses: Structure and multiplication of lytic and lysogenic bacteriophage.Significance of lysogeny. Brief account of M13, Mu, T4 and λ, history, structure, genetics and life cycle of cyanophages, significance of bacteriophages and cyanophages.

UNIT-IV

Plant viruses: classification and nomenclature, structure and multiplication of plant viruses with special reference to TMV, cauliflower mosaic virus, effect of viruses on plants. Some common viral diseases of plants (TMV, CMV, leaf Curl of papaya). Transmission of plant viruses and control of viral diseases of plants.

UNIT-V

Animal viruses: Classification and nomenclature of animal and human viruses. Brief account of Adeno-, Herpes, Hepatitis, HIV and other oncogenic viruses. Prevention, treatment and control of viral diseases. Viral vaccines including DNA vaccines and interferons.

List of Recommended Books

1. Medical Virology 10 Th Edition by Morag C and Tim bury M C 1994. Churchil Livingstone, London.
2. Introduction to Modern Virology 4th Edition by Dimmock N J, Primrose S. B. 1994. Blackwell Scientific Publications. Oxford.

3. Virology 3 rd Edition by Conrat H.F., Kimball P.C. and Levy J.A. 1994. Prentice Hall, Englewood Cliff, New Jersey.
4. Text Book on Principles of Bacteriology, Virology and Immunology Topley and Wilsons 1995.
5. Molecular Biology, Pathogenesis and Control by S.J. Flint and others. ASM Press, Washington, D.C.
6. Applied Virology. 1984. Edited by Edonard Kurstak. Academic Press Inc.
7. Introduction to Modern Virology by Dimmock.
8. Prion diseases by Gaschup, M.H.
9. Clinical virology Manual by Steven, S., Adinka, R.L., Young, S.A.
10. Principles of Virology. 2000 by Edward Arnold.

COURSE CODE MBC103: MYCOLOGY
(TOTAL CREDITS: 3)

Course Objectives: To make the students familiar with basic concepts in mycology (e.g., fungal reproduction, physiology, taxonomy, etc.) to gain an overview of the research field.

Learning outcome:

- Be able to reflect on and formulate research questions relating to mycology and how these concepts apply to their areas of research.
- Be able to become enterpreuners by gainig knowledge about mushroom, biofertilizers etc

COURSE CONTENTS

UNIT-I

Status of fungi in the living world, general features of fungi and fungus like organisms; recent trends in the classification of fungi; physiology and growth of fungi; nutritional and environmental factors affecting growth; saprotrophs, parasites and mutualistic symbionts; physiology of reproduction in fungi, phylogeny of fungi.

UNIT-II

Fungal diversity-major taxonomic group, structure, reproduction, life cycle and significance of the following representatives:

i) Gymnomycota-general account – cellular slime moulds (Dictyostelium), plasmodial slime moulds (Myxomycetes).

ii) Mastigomycota- *Coelomomyces, Lagenidlum, Achlya, Phytophthora, Peronospora, Plasmodiophora.*

iii) Amastigomycota- *Zygomyocotina- Mucor, Syncephalastrum, Blakeclea, Cunninghamella, Entomophthora.*

UNIT-III

Fungal diversity contd. structure, reproduction, life cycle and significance of the following representatives:

i) Ascomycotina- *Taphrina, Emericeilla, Chaetomium, Morchella, Neurospora, Claviceps, Erysiphae.*

ii) Basidiomycotina- *Puccinia, Melamspora, Ustilago, Polyporus, Lycoperdon, Ganoderma.*

iii) Deutromycotina- *Fusarium, Cercospora, Curvularia, Beauveria, Microsporum, Phoma, Collectotrichum.*

UNIT-IV

Fungal genetics:

i) Life cycle and sexual process in fungi; structure and organization of fungal genomes (mitochondrial genes, plasmids and transposable elements, virus and viral genes).

ii) Genetic variations in fungi- nonsexual variations-haploidy, heterokaryosis, parasexuality; sexual variations-mating or breeding systems- homothallism and heterothallism, mutation, physiological specialization; strain improvement.

UNIT-V

Fungi and biotechnology: production of alcoholic beverages, antibiotics, organic acids, ergot alkaloids; the cultivation of fungi for food-mushrooms, myco protein and mycofoods; role of fungi in agriculture and forestry- mycorrhizae and their application, mycopesticides, mycotoxins, conservation of fungal germplasm.

List of Recommended Books

1. Tortora, G.J., Funke, B.R. and Case, C.L. 2001. Microbiology: An Introduction. Addison Wesley Longman, New York.
2. Brock Biology of Microorganisms: by Madigan, Mortinko and Parker (2000), Prentice Hall.

3. Microbiology: by Prescott, L.M., Harley, J.P. and Klein, D.A. (1992). WCB Publishers.
4. Introductory Mycology: by Alexopoulos, C.J. Mims, C.W. and Blackwell, M. (1996). John Wiley & Sons.
5. An Introduction to Fungi: by Webster, J. (1985). Cambridge Univ. Press
6. Alexopoulus, C.J., Mims, C.W. and Blackwell, M. 1996. Introductory Mycology. John Wiley & Sons, Inc.
7. Mehrotra, R.S. and Aneja, R.S. 1998. An introduction to Mycology. New Age Intermediate Press.
8. 15. Webster, J. 1985. Introduction to Fungi. Cambridge University Press.

COURSE CODE MBC104: PRACTICAL BASED ON COURSE CODE MBC101 & COURSE CODE MBC102 (COURSE CREDITS = 04)

Suggested list of Practicals: (Course Code MBC101**: Bacteriology)**

1. Preparation of different types of media
2. Isolation and enumeration of bacterial and fungal population in air.
3. Enumeration of bacterial population in water.
4. Isolation and enumeration of bacterial and fungal population in soil
5. Demonstration of bacterial motility by Hanging drop technique
6. Staining techniques: i) Gram staining ii) Cell wall staining iii) Endospore staining iv) Flagella staining v) Capsule staining vi) Staining of PHB granules vii) Staining of phosphate granules
7. IMVIC tests (Indole, methyl red, Voges prausker and citrate test)
8. Oxidast test
9. Carbohydrate fermentation & Gas production
10. Catalase test
11. Gelatinase test
12. Caseinase test
13. Amylase test
14. H 2 S production test
15. Nitrate reduction test
16. Litmus milk reactions
17. Urease test
18. Isolation of Bacteria from curd by streaking methods.
19. Determination of bacterial growth by turbidometric method
20. Effect of temperature on bacterial growth.
21. Effect of p H on bacterial growth

Suggested list of Practicals (Course Code MBC102**: Virology)**

1. Estimation of chlorophyll in healthy and viral diseased plants.
2. Study of symptomology of plant, animal and human diseases caused by viruses.
3. Estimation of proteins in healthy and viral diseased plants.
4. Estimation of DNA in healthy and viral diseased plants.
5. Estimation of RNA in healthy and viral diseased plants.
6. Transmission of viruses by grafting.
7. Transmission of viruses by aphids.
8. Sap transmission of plant viruses.
9. Isolation of phages from sewage.
10. Study of Viral diseases- leaf curl of papaya, TMV.

COURSE CODE MBC105: PRACTICAL BASED ON COURSE CODE MBC103 & MBE101/ MBE102 (TOTAL CREDITS = 04)

Suggested list of Practicals (Course code MBC103: Mycology)

1. Isolation of fungi from soil by warcup's method.
2. Isolation of VAM spores from soil.
3. Identification of fungi by slide culture.
4. Preparation of wet mount and Dry mount slide.
5. Measurement of fungal growth by mycelia dry weight estimation.
6. Study of permanent slide of fungi.
7. Lactophenol and cotton blue mounting of fungi.

List of Elective Papers

COURSE CODE MBE101 : BIOMOLECULES

(TOTAL CREDITS =03)

Course objective: The syllabus of Biomolecules is structured finely to make the students understand the structure and various principles dealing with the working of biomolecules and their mutual interactions to support the life system.

Learning outcomes

- Enabling students to understand the importance of water in maintaining the various biochemical reactions such as buffering, phosphorylation, oxidation-reduction etc.
- The students learn the principle of working of enzyme and the process of enzymology, that is, how the enzymes work and where the active sites play a key role.
- The students also learn the basic and functional structures of all the biomolecules in detail.
- The inter-relationships and communication between the biomolecules is a major part of signal transduction. The students become well versed with this mode of biological process.
- The students learn various techniques such as chromatography, spectroscopy and electrophoresis to understand the purity of biomolecules and their analytical properties for further application.

COURSE CONTENTS

UNIT I

Structure of water and its solvent properties, Acid- bases, pH and buffer, Bi and polyprotic buffer. Free energy and spontaneity of reactions, ATP and other phosphorylated compound with their free energy of hydrolysis, Phosphoryl group transfer, Biological oxidation reductions reaction, Coupled reaction and oxidative phosphorylation, Inhibitors and uncouplers.

UNIT II

Enzyme classification, Specificity, Active site, Enzyme kinetics, Michealis Menton equation, Determination of kinetic parameters, Bi-substrate reaction and their kinetics, Enzyme inhibition and kinetics, Allosteric enzyme. Kinetics and Allosteric regulation of phosphofructo kinase

UNIT III

Structure and chemistry of macromolecules, Proteins, Carbohydrates and Lipids, Protein folding, Structure and chemistry of bimolecules such as antibiotics, Pigments, Vitamins as coenzymes, Lipid analysis by GLC and Mass Spectrometry, Oligosaccharide and Polysaccharide analysis.

UNIT IV

Biosignaling molecular mechanism of signal transduction, Gated ion channels, Nicotinic acetyl choline receptor, Receptor enzyme, The insulin receptor, G- proteins and cyclic AMP membrane transport, Biomembrane, Nutrient

transport across membranes, Active and passive diffusion, Symport, Antiport and uniport, Na^+ K^+ pumps and their metabolic significance.

UNIT V

Chromatographic technique, Paper and TLC , Gel filtration, Ion exchange, Affinity, HPLC, SDS, PAGE, Isoelectric focusing, Western blotting, Protein sequencing, Mass spectrometry, MALDI , TOF, MS.

Books Recommended

J. L., Jain, Sanjay, and Jain Nitin, (1979) Fundamentals of Biochemistry (6th revised Edition). S. Chand & Co. Ltd. New Delhi.
Buchanan . B.B. Gruissem, W. and Jones .R.L. (2000) Biochemistry and Molecular Biology of Plants , American Society of Plant Physiologists, Maryland ,USA.
Albert L. lehninger, Davis L. Nelson, Michael M. Cox. (2004) Lehninger Principles of Biochemistry.
Lea P.J. and Leegood ,R.C. (1999) Plant Biochemistry and Molecular Biology (2 nd Edition) John Wiley and Sons. Chichester, England
Berg Jeremy, Tymoczko John, Stryer Lubert (2001) Biochemistry 4th Ed, W. H. Freeman, New York.
Conn Eric, Stumpf Paul K., Bruuening George, Doi Roy H., (1987) Outlines of Biochemistry 5th Ed , John Wiley and Sons, New Delhi.
Dawes Edwin A. (1972) Quantitative Problems in Biochemistry, Churchill Livingston, Edinburgh.
Hall D. D. and Rao K. K. (1996) Photosynthesis 5th Ed., Cambridge University Press. 5. Mandelstam Joel and McQuillen Kenneth (1976) Biochemistry of Bacterial Growth, Blackwell Scientific Publication London.
Metzler David E. (2001) Biochemistry: The chemical Reactions of Living Cells, Volume 1&2, Academic Press California.
Moat Albert G. and Foster John W. (1988) Microbial Physiology 2nd Ed. John Wiley and Sons New York.
Nelson D. L. and Cox M. M. (2005) Lehninger's Principles of Biochemistry, Fourth edition, W. H. Freeman & Co. New York.
Palmer Trevor (2001) Enzymes: Biochemistry, Biotechnology and Clinical chemistry, Horwood Pub. Co. Chinchester, England.
Segel Irvin H. (1997) Biochemical Calculations 2nd Ed., John Wiley and Sons, New York.
Voet Donald and Voet Judith G. (1995) Biochemistry, 2nd Ed.. John Wiley and sons New York.
White Abraham, Handler Philip, Smith Emil, Hill Rober, Lehman J. (1983) Principles of Biochemistry, Edition 6, Tata Mc-Graw Hill Companies, Inc.
White David (2000) Physiology and Biochemistry of Prokaryotes. 2nd Ed. Oxford
University Press, New York.
Zubay Geoffrey (1998) Biochemistry, 4th Ed., W. C. Brown, New York.

Suggested list of practicals (Course Code MBE101**)**

1. To study working of weighing balance.
2. To study the working of pH meter.
3. To determine the pKa value of acetic acid by pH titration method.
4. Preparation of acetate buffer at pH=5.
5. Prepare Phosphate buffer at pH=8.
6. To prepare tris buffer at pH=9.
7. Estimation of protein by Lowry method.
8. Chromatographic separation by paper and thin layer Chromatography.

9. To determine pKa value of glycine.
10. Determine the absorption maxima of Potassium dichromate.
11. To prove the validity of Beer-Lambert's law.
12. Qualitative assessment of carbohydrate.
13. Qualitative assessment of lipids.
14. Qualitative assessment of proteins.
15. To prepare standard curve of glucose by anthrone method.
16. To determine the Km and Vmax od amylase enzymes.
17. To study the effect of substrate concentration on enzyme activity.
18. To study the effect of temperature on enzyme activity.

COURSE CODE MBE102: BIOENERGETICS AND INTERMEDIARY METABOLISM

(TOTAL CREDITS = 03)

Course Objective: The syllabus of Bioenergetics and Intermediary Metabolism Course is structured to explain the potential role of biomembranes and their extraordinary use in maintaining and regulating all the metabolic cycles taking place inside the cell and outside the cell. These membranes are playing a very crucial role in maintaining the energy dynamics of the cell.

Learning outcomes

- Enabling students to understand finely detailed energy dynamics of a biomembrane, the components involved therein and various physiological attributes driven by aforementioned energy transformation.
- The students learn the principle of working of mitochondria as a model of energy transducer with special reference to its membrane associated respiratory processes leading to formation of ATP.
- The students also learn the anabolic and catabolic processes involving carbohydrates in marinating the energy balance of the cell.
- The biosysnthesis of lipids that constitute the biomenbranes is understood at the level of enzymes and pathways.
- The catabolic role of amino acids in the formation of urea and abnormalities due to metabolic errors in these cycles is learnt by students. The synthesis of nucleic acids, the hereditary material, involving purines and pyrimidines is made acquainted to the learners.

UNIT I

Bioenergetics: energy transformation, biological oxidations, oxygenases, hydroxylases, dehydrogenases and energy transducing membranes; free energy changes and redox potentials, phosphate potential, ion and proton electrochemical potentials, membrane potentials, chemo-osmotic theory; ion transport across energy transducing membranes, influx and efflux mechanisms, transport and distribution of cations, anions and ionophores. Uniport, antiport and symport mechanisms, shuttle systems.

UNIT- II

The mitochondrial respiratory chain, order and organization of carriers, proton gradient, iron sulphur proteins, cytochromes and their characterization; the Q cycle and the stoichiometry of proton extrusion and uptake. Oxidative phosphorylation, uncouplers and inhibitors of energy transfer. Fractionation and reconstitution of respiratory chain complexes. ATP synthetase complex, microsomal electron transport.

UNIT- III

Carbohydrates: glycolysis, citric acid cycle- its function in energy generation and biosynthesis of energy rich bonds, pentose phosphate pathway, alternate pathways of carbohydrate metabolism, gluconeogensis, inter-conversions of sugars, biosynthesis of glycogen, starch and oligosaccharides.

UNIT- IV

Lipids: fatty acid biosynthesis: acetyl CoA carboxylase, fatty acid synthase; fatty acid oxidation: α, β, oxidation and lipoxidation; lipid biosynthesis: of triacylglycerols, phosphoglycerides and sphingolipids, biosynthetic pathways for terpenes and steroids.

UNIT- V

Amino acids and nucleic acids: biosynthesis and degradation of amino acids and their regulation, specific aspects of amino acid metabolism, urea cycle and its regulation, in-born errors of amino acid metabolism; Nucleic acids: degradation of purines and pyrimidines, regulation of purine and pyrimidine biosynthesis, structure and regulation of ribonucleotide biosynthesis, biosynthesis of ribonucleotides, deoxyribonucleotides and polynucleotides, inhibitors of nucleic acid biosynthesis.

Books recommended

M.M. Cox and D.L. Nelson (2008) Lehninger Principals of Biochemistry W.H. Freeman & Company

Otto Hoffmann-Ostenhof (2008) Intermediary metabolism; *Van Nostrand Reinhold (USA)*.

P.H. Clarke (1978) Intermediary metabolism; *John Wiley & Sons Ltd Hoboken, New Jersey (United States).*

Alexander Lowen (1994) Bioenergetics; *Penguin/Arkana Books USA.*

David G. Nicholls and Stuart Ferguson (2013) Bioenergetics; *Academic Press Elsevier United States*.

Suggested list of practicals (Course Code MBE102)

1. 1. To prepare acetate buffer of pH4.7.
2. To perform carbohydrate tests of manosaccharides, polysaccharides, disaccharides.
3. To determine protein of unknown sample by Lowry method.
4. To perform the detection of lipid in the given sample

COURSE CODE MBS101: SKILL DEVELOPMENT MODULES 1
(TOTAL CREDITS = 02)
PERSONALITY DEVELOPMENT- MODULE- 1 (Semester-1)
Hrs.-30

S. No.	Subject	Classroom Activity	Hrs.
01	Orientation , Personality Development	Worksheet	1
02	Role and Impact of Personality	Group Activity	1
03	Pre Self-Assessment (Psychometric Analysis)	PDP Assessment Sheet	2
04	Listening and Caring	Group Activity	1
05	The Art of Communication	Worksheet	1
06	Different level of Effective Communication	Worksheet	1
07	Professional Communication P-A-C	Worksheet	1
08	Rules of Professional Communication	Group Activity	1
09	Body Language - 1	Worksheet	1
10	Language Lab	Worksheet	1
11	Thought Process - 1	Worksheet	1
12	Interpersonal Skills	Worksheet	1
13	Observation & Imagination Power	Group activity	1
14	Creativity	Group Activity	1
15	Extempore - 1	Group activity	1
16	Extempore - 2	Group Activity	1

17	Presentation Skills	Worksheet	2
18	How to Draw the Attention of Audience	Worksheet	1
19	Steps of Effective Presentation	Worksheet	1
20	Prioritizing Matrix	Worksheet	1
21	Leadership Quality	Group activity	1
22	SWOT Analysis	Worksheet	1
23	Interview Skills	Lecture	2
24	Group Discussion	Group Activity	2
25	Resume Preparation	Group Activity	1

SECOND – SEMESTER
COURSE CODE MBC201: MOLECULAR BIOLOGY AND RECOMBINANT DNA TECHNOLOGY (TOTAL CREDITS: 3)

Course objective: The aim of the course is to inculcate the vast knowledge of the structure, function and application of genetic material in diverse life forms in performing and regulating the complex biological processes.

Learning outcomes

- Enabling students to understand fundamental processes of nucleic acid multiplication with respect to the intricacy of the enzymes involved and reactions performed.
- The students also learn the specialized in vivo and in vitro models of genome propagation and about chemicals/ physical agents that can prevent the process.
- Once the genetic material is propagated in progeny, how is the genome expressed to RNA by a process, transcription, and how RNA takes its final shapes is being learned in detail.
- There are several inherent mechanisms to control transcription and process thereafter. The learners get acquainted with knowledge of molecules and procedures which switch off/ on gene expression.
- Application of the functional and structural components of flow of information using diverse tools and techniques in genetic important of important life forms is learned in this course.

COURSE CONTENTS

UNIT – I

Nucleic acids as genetic information carriers: DNA structure, melting of DNA; superhelicity in DNA, linking number and topological properties; DNA replication., general principle, various modes of reading, continuous and discontinuous synthesis, asymmetric & dimeric nature of DNA polymerase III & simultaneous synthesis

of DNA leading and lagging strands, polymerase and exonuclease activities, eukaryotic DNA polymerases; Mechanism of action of topoisomerases, ligases.

UNIT – II

Initiation of replication and construction of replication fork in test tube; retroviruses and their unique mode of DNA synthesis; relationship between replication and cell cycle in prokaryotes and eukaryotes; inhibitors of DNA replication (blocking precursor synthesis, nucleotide polymerization altering DNA structure).

UNIT III

Transcription: general principles, basic apparatus types of RNA polymerase; steps: initiation, elongation and termination, inhibitors of RNA synthesis, polycistronic and monocistronic RNA's; control of transcription by interaction by interaction between RNA polymerases and promoter regions, role of alternate sigma factors; regulation of rRNA and tRNA synthesis; maturation and splicing of mRNA, cutting and modification of tRNA: catalytic RNA, group I and group II splicing.

UNIT – IV

Gene expression in prokaryotes: induction and repression operon concept, regulatory and structural genes, operator, promoter, repressor and co-repressor, catabolite repression, cyclic AMP, CRP/CAP protein, regulation of lactose, tryptophan, histidine and arabinose operons, attenuation regulation. Gene expression in eukaryotes, Britton and Davidson's model of regulation involvement of HCP, NHCP and hormones. Regulation by N protein and nut sites in DNA binding proteins, enhancer sequences and control of transcription. Global regulatory responses: heat shock response, stringent response and regulation by small molecules such as ppGpp.

UNIT – V

Basic principle of gene cloning, genomic libraries, vectors, strategies of gene cloning using DNA or cDNA inserts, gene expression in recombinants, screening method for recombinant clones, important molecular techniques like Southern Blotting, PCR, RAPD, RFLP, DNA sequencing, and probe hybridization.

List of recommended books

1. Molecular cloning: A Laboratory Manual, J. Sambrook; Fritsch and T. Maniatis Cold Spring Harbor Laboratory Press, New York, 2000
2. Introduction to practical molecular biology P.D. Dabre, John Wiley & sons Ltd. New York 1988
3. Molecular Biology LabFax, T.A. Brown (Ed) Bios Scientific Publishers Ltd. Oxford, 1991
4. Molecular Biology of the Gene (4th edition), J.D. Watson N.H. Hopkins, J.W. Roberts J.A. Steitz and A.M. Weiner, The Benjamin/ Cummlngs Publ Co. Inc. California, 1987.
5. Molecular Cell Biology (2nd Edition) J. Darnell, H. Lodish and D. Baltimore, Scientist American Books, Inc., USA, 1994.
6. Molecular Biology of the Cell (2nd Edition) B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts, and J. D. Watson, Garland Publishing, Inc., New York, 1994.
7. Gene VI (6th Edition) Benjamin Lewin, Oxford University press, U.K., 1998.
8. Molecular Biology and biotechnology; a comprehensive desk reference, R.A. Meyers (Ed.) VCH Publishers, Inc, New York, 1995
9. Genomes, T.S. Brown.

COURSE CODE MBC202: MICROBIAL GENETICS
(TOTAL CREDITS: 3)

Course objectives : understanding the fundamental researches in exploitation and manipulation of microbial genes for the betterment of livelihood and safe environment.

Learning Outcomes : will guide the students in the following perspectives as:

- Better knowledge of DNA and gentic recombination.

- Understanding the mutations and mutagens.
- Designing of vectors and its biotechnological applications.
- Clinical applications and Laboratory technology for designing of vaccines,hormones and immunity boosters.
- Understanding the bioethics and biosafety rules.

COURSE CONTENTS

UNIT-I

Gene as unit of mutation and recombination, molecular mechanism of mutation, mutagens, types of DNA damage (deamination, oxdative damage, alkylation, pyridine dimmers). Spontaneous mutations-origin, suppression of mutation.

UNIT-II

Gene transfer and genetic mapping, transformations, transfection, conjugation and transduction, genetic mapping of E,coli; Molecular aspects of genetic recombination.

UNIT-III

Complementation analysis, cis-trans test, deletion mapping; Benzer's concept of cistron, overlapping genes. DNA repair- photo repair, excision or dark repair, recombinational repair, SOS repair, methyl- directed mismatch repair, very short patch repair.

UNIT-IV

Plasmids. F-factors description and their uses in genetic analysis; R factors, colocin and col factors; plasmids as vectors for gene cloning; replication of selected plasmids; compatibility. Transposons and their uses in genetic analysis, plasmid vectors and bacteriophage vectors.

UNIT-V

Important application of advances in microbial genetics, production of proteins, hormones and design of vaccines: conventional as well as new generation recombinant DNA vaccine, their design and advantages.

List of Recommended Books

1. Microbial Genetics by Maloy ET. Al. 1994. Jones and Bartlett Publishers.
2. Molecular Genetics of Bacteria by J. W. Dale. 1994. John Wiley and Sons.
3. Modern Microbial Genetics. 1991 by Streips and Yasbin. Niley Ltd.
4. Moleculat Biology of the Gene 4th Edition by J.D. Watson, N.H. Hoppkins, J.W. Roberts, J.A. Steitz and A.M. Weiner. 1987, The Benjamin / Cummings Publications Co. Inc. California.
5. Gene VII by Lewin Oxford University Press. 2000.
6. Bacterial and Bacteriophage Genetics. 4 th Editions by Birge.
7. Microbial Genetics by Frefielder. 4th Edition.
8. Organization of Prokayotic Genome. 1999 by Robert L.Charlebois, ASM Publications.
9. DNA repair and mutagenesis. 1995 by Errol C. Friedberg, Graham C. Walker and Wolfram, Siede, ASM Publications.
10. Molecular Genetics of Bacteria, 1997 by Larry, Snyder and Wendy, Champness, ASM Publications.
11. Methods of General and Molecular Bacteriology, 1993. Edited by Philip. Gerhardt, ASM Publications.
12. Recombinant DNA by Watson, J.D.
13. Essentials of Molecular Biology by Malacimski.
14. Mobile DNA II by Nancy Craig, Martin Gellet Allan Lambowitz.

COURSE CODE MBC203: BIOSTATISTICS AND COMPUTER APPLICATION (TOTAL CREDITS: 3)

Course Objectives: The course aims to empower the learners with tools and techniques in collection, collation, summarization and interpretation of data along with various experimental designs and bioinformatics.

Course Learning Outcomes:

- Proficiency of students in various techniques of collection, collation, summarization and presentation of data. They could learn basic concepts of probability and probability distribution functions along with applications.
- Understanding and applications of descriptive and inferential statistics enabling students to use tests of significance in biological data.
- Can apply Analysis of Variance tools and different experimental designs to biological experiments, enabling them to minimize experimental and sampling errors.
- Understands concepts of correlation and regression tools and techniques, attempts extrapolation and simulation of biological processes.
- Empowers students to utilize software packages in digital analysis and processing of biological data. Integrate informatics with biology through data submission protocols, sequence alignment and searches, annotations and possible applications in human health and welfare.

COURSE CONTENTS

UNIT-I

Importance and scope of statistics in biochemical experimentation; Elements of Probability- Mathematical and Statistical definitions; Addition and Multiplication theorems; Probability Distribution Functions – Binomial, Poisson and Normal; Area under normal distribution curve.

UNIT-II

Measures of central tendency: Arithmetic, geometric & harmonic means; Measures of dispersion: range, quartile deviation, variance, standard deviation, coefficient of variation, confidence limits of population mean. Tests of significance hypotheses and errors; student t statistics- population mean equals a specified value; equality of 2 independent means (equal & unequal variance), equality of 2 means (paired samples).

UNIT-III

Analysis of variance: one-way analysis (sample sizes equal and unequal), completely randomized design; two-way analysis (one observation per cell), randomized block design; multiple comparisons: least significant difference, Duncan's new multiple range test.

UNIT-IV

Linear regression: regression diagram and equation, regression coefficient, standard error, significant tests, prediction of dependent variable from the independent variable; linear correlation- scatter diagram, correlation coefficient, standard error, significance tests; relationship between regression and correlation coefficients; Non parametric tests: Chi-square statistics, test of goodness of fit, test of independence of attributes; standard line interpolation.

UNIT-V

Introduction to Computers: Basic architecture, generations of computer hardware and software; operating systems-WINDOWS and UNIX; system and application software; introduction to internet- LAN, MAN, WAN, Concept of bioinformatics; application of bioinformatics in microbiology.

List of Recommended Books

1. Statistics in biology, Vol. 1 by Bliss, C.I.K. (1967) Mc Graw Hill, NewYork.

2. Practical Statistics for experimental biologist by Wardlaw, A.C. (1985).
3. Programming in C by E. Ballaguruswamy
4. How Computers work - 2000. By Ron White. Tech. Media
5. How the Internet Work 2000 by Preston Gralla Tech. Media.
6. Statistical Methods in Biology - 2000 by Bailey, N.T. J. English Univ. Press.
7. Biostatistics - 7th Edition by Daniel
8. Fundamental of Biostatistics by Khan
9. Biostatistical Methods by Lachin
10. Statistics for Biologist by CampbellR.C. (1974) Cambridge University Press, UK.
11. INTERNET – CDC publication, India.

COURSE CODE MBC204: PRACTICAL BASED ON COURSE CODE MBC201 & COURSE CODE MBC202 (TOTAL CREDITS: 04)

Suggested list of Practicals (Course Code MBC201: Molecular Biology and Recombinant DNA Technology)

1. Isolation of genomic DNA.
2. Southern blotting
3. RFLP analysis
4. Isolation of RNA
5. Isolation of poly A+ RNA
6. To study the effect of UV Radition on yeast cell.
7. To study the dark repair mechanism in the UV radiated yeast cell.
8. To study the photo repair mechanism in the UV radiated yeast cell.
9. To perform replica plating of yeast cell.

Suggested list of Practicals (Course Code MBC202: Microbial Genetics)

1. To perform conjugation.
2. To study the effect of UV radiated on Bacterial cells.
3. To study the dark repair mechanism and photo repair mechanism in the UV radiated bacterial cells.
4. To perform replica plating of bacterial cells.
5. To study effect of mutagens (Nitrous acid) on bacterial cells.
6. 1. Purification of chromosomal / plasmid DNA and study of DNA profile:
7. Confirmation of nucleic acid by spectral study.
8. Quantitative estimation by diphenylamine test.
9. DNA denaturation and determination of Tm and G+C content.

COURSE CODE MBC205: PRACTICAL BASED ON COURSE CODE MBC203 & MBE201/ MBE202/ MBE203 (TOTAL CREDITS: 04)

Suggested list of Practicals (Course Code MBC203**: Biostatistics and Computer Application)**

1. Representation of Statistical data by a) Histograms b) Pie diagrams
2. Determination of Statistical averages/ central tendencies. a) Arithmetic mean b) Median c) Mode
3. Determination of measures of Dispersion a) Mean deviation b) Standard deviation and coefficient of variation c) Quartile deviation
4. Tests of Significance-Application of following a) Chi- Square test b) t- test c) Standard error

5. Computer operations-getting acquainted with different parts of Computers. [DOS] and basics of operating a computer.
6. Creating files, folders and directories.
7. Applications of computers in biology using MS-Office.
   A] MS-Word B] Excel C] Power Point
8. Creating an e-mail account, sending and receiving mails.
9. An introduction to INTERNET, search engines, websites, browsing and Downloading.

List of Elective Papers

SECOND – SEMESTER

COURSE CODE MBE201: BIOLOGY OF THE IMMUNE SYSTEM (COURSE CREDITS =03)

Course Objectives: The objective of this course is to understand the various components of the host immune system, their structure and organization, and functions to serve as the defense system of the body. It would also make the students understand the operational mechanisms which underlie the host defense system, allergy and organ transplantation.

Course Learning Outcomes: Upon successful completion of the course, the student:

- Will be able to understand the fundamental bases of immune system and immune response .
- Will be able to gather information about the structure and organization of various components of the immune system .
- Will be able to understand the genetic organization of the genes meant for expression of immune cell receptors and the bases of the generation of their diversity.
- Will be able to understand the operation and the mechanisms which underlie the immune response .
- Will be able to apply the knowledge gained to understand the phenomena like host defense, hypersensitivity (allergy), organ transplantation and certain immunological diseases

COURSE CONTENTS

UNIT-I

Introduction: phylogeny of immune system, innate and acquired immunity, clonal nature of immune response; organization and structure of lymphoid organs, nature and biology of antigens and super antigens.

UNIT-II

Antibody structure and function; antigen-antibody interactions, major histocompatibility complex, BCR & TCR, generation of diversity, complement system.

UNIT-III

Cells of the immune system; hematopoiesis and differentiation, lymphocyte trafficking. Blymphocytes, T-lymphocytes, macrophages, dendritic cells, natural killer and lymphokine activated killer cells, eosinophils, neutrophils and mast cells. Regulation of immune response: antigen processing and presentation, generation of humoral and cell mediated immune responses, activation of B-and T-lymphocytes, cytokines and their role in immune regulation; T-cell regulation, MHC restriction, immunological tolerance.

UNIT-IV

Cell- mediated cytotoxicity; mechanism of T cell and NK cell mediated lysis; antibody dependent cell mediated cytotoxicity, macrophage mediated cytotoxicity; hypersensitivity autoimmunity, transplantation.

UNIT- V

Immunity to infectious agents (intracellular parasites, helminthes & viruses); tumor immunology; AIDS and other immunodeficiences, hybridoma technology and monoclonal antibodies.

Recommended Books:

1. Kuby immunology, 4th Edition, R.A. Goldsby, Thomas J.Kindt, Barbara, A.Osbarne. (Freedom)
2. Immunology-A short Course, 4th Edition- Ell Benjamin, Richard Coico, Geoffrey Sunshine (Wiley-Liss).
3. Fundamentals of immunology, William Paul.
4. Immunology, Roitt and others.

Suggested list of practicals (Course Code MBE201**)**

1. To perform test for antibiotics sensitivity by disc method.
2. To determine the minimum inhibitory concentration of given antibiotics.
3. Preparation of blood smear.
4. To isolate serum from blood plasma.
5. To perform agglutination reaction to identification of blood group.

COURSE CODE MBE202: RESOURSE UTILIZATION AND CONSERVATION (COURSE CREDITS = 03)

Course Objectives: The course aims to empower the learners with knowledge pertaining to world biomes, resources, conservation, sustainable development, pollution and its management, and remote sensing in management of earth resources.

Course Learning Outcomes:

- Deep understanding of distribution, structure and function of various aquatic and terrestrial biomes.
- Learn definitions, types and utilities of biodiversity along with threats along their applications in management and sustainable development of resources from various biomes.
- Empowers students to apply in-situ and in-vitro techniques in conservation of aquatic and terrestrial resources in real time.
- Understands concepts of pollution of different environments and can monitor and treat pollution loads in artificial and natural ecosystems; and appreciate nuances of industrial, societal and urban pollutions.
- Gains insight knowledge about remote sensing of earth resources along with platforms, sensors and scanners, visual and digital interpretation of remotely sensed data.

COURSE CONTENTS

UNIT – I

Major Biomes of the world, Tropical rain & Seasonal Forests, Temperate rain & Seasonal forests, Boreal forests, Grasslands, Deserts, Aquatic Ecosystems wetlands, Lakes & Ponds Streams & Rivers, Marine & Estuarine habitats.

UNIT – II

Resource utilization**,** Status & Utilization of Biodiversity, Sustainable development resources from forest, Grassland and aquatic habitats, Food forage, Fodder, Timber & Non-wood forest products, Threats to quality & quantity of Resources due to overexploitation.

UNIT –III

Strategies for conservation of resources: Classifications of resources, Principles of conservation, *In-situ* conservation sanctuaries, National parks, Biosphere reserves for wildlife conservation, Habitat conservation practices of conservation for forests ranges, Soil and water.

UNIT – IV

Air, Water and Soil pollution**,** Kinds, Sources, Quality parameters, Effects on structure & function of ecosystems, Management of pollution, Bioremediation, Climate changes sources, Trends & role of greenhouse gases, Effect of global warming on climate, Ecosystem processes & Biodiversity, Ozone layer & Ozone hole.

UNIT – V

Resource monitoring, Remote sensing concepts & Tools, Satellite remote sensing basics sensors, Visual & digital interpretation, EMR bands and their applications, Indian remote sensing program, Thematic mapping of resources, Application of remote sensing in Ecology &Forestry.

Books recommended

- Chopra R. N. (1933) Indigenous Drugs of India.
- Hayes W. B. (1953) Fruit Growing in India.
- Atkinson E. T. (1980) Economic Botany of Himalayan Regions.

Suggested list of practicals: Course Code MBE202 (Resource Utilization and Conservation)

1. To find the pH of the various sample of soil by pH meter.
2. To determine the presence of carbonate in different soil mixtures.
3. To determine the presence of phosphate in soil and water sample.
4. To determine the presence of nitrate in mixture sample.
5. To determine the presence of nitrite in mixture sample.
6. To determine frequency, density and abundance of herbaceous species from local garden.
7. To determine the biomass of plant vegetation.
8. To determine leaf area, dry weight and moisture content of few species of plant from grassland.

COURSE CODE MBE203: MICROBIAL METABOLISM
(TOTAL CREDITS: 3)

Course Objectives: The major objective of this paper is to develop clear understanding of various aspects of microbial physiology along with diverse metabolic pathways existing in bacteria in relation to its survival and propagation, and to enable students to better understand courses taught later .

Course Learning Outcomes: Upon successful completion of the course, the student:

- Will be acquainted with methods of measuring microbial growth, calculating growth kinetic parameters with understanding of steady state and continuous growth.
- Will have gained an in-depth knowledge of primary, secondary and group translocation transport systems existing in bacteria, simultaneously learning membrane transport proteins and kinetics of solute transport.
- Will have learnt central metabolic pathways for carbon metabolism in bacteria enlisting differences with eukaryotic systems and their regulation in diverse physiological conditions. This allows students to apply the acquired knowledge in engineering metabolic pathways for developing industrially useful strains.
- Will have gathered understanding of inorganic and organic nitrogen assimilation and its regulation. Also knows role of glutathione in cellular redox regulation and biochemistry of glutamate overproducing strains.
- Will have learnt basic concepts of enzyme biochemistry, its kinetics and regulatio
- Will understand details of lipid and nucleotide metabolism in *E. coli* and its regulation along with biochemical basis of lipid accumulation in yeasts.
- Is conversant with intracellular signaling in bacteria in response to various nutritional and physiological stresses.

COURSE CONTENTS

UNIT-I

Microbial growth: mathematical expression of growth, growth measurement, efficient growth curve, synchronous growth and continuous culture, effect of environmental factors on microbial growth, nutrients diffusion, active transport, group translocation, solutes, temperature, oxygen relations.

UNIT-II

Chaemolithotrophy: Sulphur, iron, hydrogen, carbon monoxide, nitrogen oxidations. Methanogenesis, luminescence. Brief account of photosynthetic and accessory pigments chlorophyll, bacteriochlorophyll, carotenoids, oxygenic, anoxygenic photosynthesis. Electron transport- photoautotrophic generation of ATP, fixation of CO2- Calvin cycle, reverse TCA, carbohydrate anabolism.

UNIT-III

Respiratory metabolism: Embden Mayer Hoff pathway, Entner Doudroff pathway, glyoxalate pathway, Krebs cycle, oxidative and substrate level phosphorylation, Pasteur effect, fermentation of carbohydrates-homo and heterolactic fermentations. Synthesis of polysaccharides- gluconeogenesis and other pathways.

UNIT-IV

Assimilation of nitrogen: Dinitrogen - nitrate nitrogen-ammonia- denitrification, synthesis of major amino-acids, polyamines; peptidoglycan-biopolymers as cell components.

UNIT-V

Microbial development, sporulation and morphogenesis, hyphae vs. yeast forms and their significance. Multicellular organization of selected microbes. Dormancy. Endospore-structure, properties and germination.

List of Recommended Books

1. Doelle H.W. 1969. Bacterial Metabolism. Academic Press.
2. Gottschalk G. 1979. Bacterial Metabolism. Springer Verlag. Moat AG. 1979. Microbial Physiology. John Wiley & Sons.
3. Sokatch JR. 1969. Bacterial Physiology and Metabolism. Academic Press.
4. Moat A G., Foster J W., Spector M P. Microbial Physiology, 4th Ed: Wiley India Pvt Ltd 2009.

Suggested list of Practicals (Course Code MBE203: Microbial Metabolism)

1. Determination of Bacterial growth by turbidity measurements (spectrophotometric method).
2. Study of effect of temperature on growth of bacteria.
3. Study of effect of pH on growth of Bacteria.
4. Isolation of rhizobia from root nodules.
5. Slide culture technique for studying morphology and molds.

COURSE CODE MBS201: SKILL DEVELOPMENT MODULES 2 (TOTAL CREDITS = 02)

SOFT SKILLS DEVELOPMENT MODULE-2 (Semester- 2) Hrs. 30

S. No.	Subject	Classroom Activity	Hrs.
01 -	Orientation , Personality Development	Worksheet/ lecture	02
02	Role and Impact of Personality	Group Activity/ lecture	01
03	Pre Self-Assessment (Psychometric Analysis)	PDP Assessment Sheet	02
04	Importance of characteristics and Traits	lecture/Group Activity	02
05	Empowerment of Internal and external traits	lecture	02
06	Definition of Personality	Lecture	02
07	Power of Self	Lecture	03
08	Path to Improve Personality	lecture/Group Activity	03
09	Body Language - 1	Worksheet	02
10	Grooming Yourself	Lecture	02
11	IQ / EQ / MQ / SQ	lecture	02
12	Disposition of Body in various aspects	Group Activity	03
13	Getting desired output	Group Activity	02
14	Post Assessment of Personality	Group Activity	02

THIRD SEMESTER
COURSE CODE MBC301: ENVIRONMENTAL MICROBIOLOGY
(COURSE CREDITS: 3)

Course Objectives: The major objective of this paper is to impart knowledge about structure, composition and functioning of microbial communities of diverse environment. The use of microbial population in agriculture, mineral recovery, management of various types of pollutants and conversion processes of various types of wastes into value added products will be discussed.

Course Learning Outcomes: Upon successful completion of the course, the student:

- Will have an overview of the till date developments in the field of environmental microbiology with special emphasis on the role of microbes in mitigating environment pollution.
- Will have become acquainted with various cultural, biochemical and molecular techniques used in understanding microbial diversity.
- Will be knowledgeable about the diversity, adaptations and biotechnological applications of microbes of extreme environment.
- Will be able to describe the role of soil microbes in nutrient transformation, plant-microbe interactions and biotechnology. Also knows about potability of water and its quality control.
- Understands the role of microbes in management of waste plant biomass and can apply knowledge in designing microbe-based processes for pulp, textile, biofuel and animal feed production industries.
- Is able to describe the role of microbes in solid and liquid waste management, gaining knowledge of various methods employed in sewage treatment and solid waste treatment.
- Understands the role of microbes in bioremediation of environmental pollutants like petroleum hydrocarbons, pesticides, plastic and electronic waste; also understands utility of microbes in mineral and oil recovery.

COURSE CONTENTS

UNIT-I

Environment: Basic concepts and issues; environmental pollution: types and methods for the measurement; methodology of environmental management-problem solving approach, its limitations; air pollution and its control through biotechnology, air sampling techniques; biodiversity: conservation and management. Biodiversity in India: Status, Threats, Utility & Conservation; Indian Biodiversity ACT 2002 and Biodiversity Rules 2004.

UNIT-II

Water pollution and its control: Water as a scarce natural resource, need for water management, sources and measurement of water pollution, waste water treatment-physical, chemical and biological treatment processes; algal blooms and human health.

UNIT-III

Microbiology of waste water treatment: Aerobic process-activated sludge, oxidation ditches, trickling filter, towers, rotating discs, rotating drums, oxidation ponds; anaerobic processesanaerobic digestion, anaerobic filters, upflow anaerobic sludge blanket reactors; treatment schemes for waste waters of dairy, distillery, tannery industries; biotechnological application of microbes form extreme environment.

UNIT-IV

Microbial degradation of xenobiotics in the environment- ecological considerations, decay behaviour & degradative plasmids, hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides; bioaccumulation of metals and radio-nucleids and detoxification; bioremediation.

UNIT-V

Biological N_2 fixation, H2 production, biofertilizers and biopesticides; solid wastes; sources and management (composting, vermiculture and methane production). Single cell protein (Spirulina, yeast, mushroom); global

environmental problems-ozone depletion, UV-B green house effect and acid rain, their impact and biotechnology approaches for management.

List of Recommended Books

1. Wastewater Engineering- Treatment, disposal and Reuse. Metcalf and Eddy, Inc,.Tata McGraw Hill, New Delhi.
2. Comprehensive Biotechnology. Vol. 4, M. Moo-young (Ed-in-chief), Pergamon Press, Oxford.
3. Environmental Chemistry, A.K. De. Wiley Eastern Ltd. New Delhi.
4. Introduction to Biodeterioration. D. Allsopp and K.J. Seal, ELBS/Edward Arnold

COURSE CODE MBC302: MEDICAL MICROBIOLOGY (TOTAL CREDITS: 3)

Course Objective : Develop understanding about immune system, antigen antibody interactions. Gain theoretical knowledge of various diseased conditions generated due to interplay of immune system components.

Learning Outcomes

- Discoveries in the field of medical microbiology, microbial flora and human host.
- Study of fungal pathogens and different kinds of infections , laboratory diagnosis.
- Study of immunity, antigen, antibodies and immunological and serological methods.
- Study of pathogenic bacteria and their classification, diseases, diagnosis.
- Study of virus multiplication methods, viral diseases, protozoans diseases.
- Laboratory control, antimicrobial therapy, different kinds of microbial diseases

COURSE CONTENTS

UNIT-I

Early discovery of pathogenic microorganisms; development of bacteriology as scientific disciplines; contribution made by eminent scientists. Normal microbial flora and the human host; role of resident flora; classification of medically important microorganisms, dermatophytes, dimorphic fungi, opportunistic fungal pathogens, laboratory diagnosis of pathogenic fungi.

UNIT-II

Mechanism of pathogenicity, virulence and protection, organs and cells involved in immune system and immune response; antigens, antigenic specificity, antigenic determinants, cellular and humoral basis of immunity: immunoglobulins, antigen and antibody reactions, immunological (serological as well as cellular) methods.

UNIT-III

Classification of pathogenic bacteria- *Staphylococcus, Streptococcus, Pneumococcus, Corynebacteria, Bacillus, Clostridium,* non-sporing anaerobes, organisms belonging to *Enterobacteriaceae*. Vibrios, non-fermenting bacilli, *Yersinia, Haemophilus, Bordetella, Brucella,Mycobacteria, Spirochaetes, Actinomycetes, Ricketisae, Chlamydiae*.

UNIT-IV

Important RNA and DNA viral pathogens; virus host interactions; pox viruses, adenoviruses, picornaviruses, orthomyxoviruses, paramyxoviruses, arboviruses, rhabdoviruses; general properties of pathogenic protozoans and diseases caused by them, slow virus disease.

UNIT-V

Laboratory control of antimicrobial therapy; strategies/ approaches (conventional and modern) in the diagnosis of important disease/ syndrome; meningitis, urinary tract infection, sexually transmitted diseases, pyrexia of unknown origin, wound infection etc.

List of Recommended Books

1. Mims CA (2004). Medical Microbiology, 3rd ed, Mosby
2. Carter JB & Saunders VA (2007) Virology-Principles and Applications, John Wiley and Sons
3. Paniker CKJ (2007). Ananthanarayan and Paniker's Textbook of Microbiology, Orient Longman Pvt. Limited, India.
4. Greenwood D, Slack RCB & Peutherer JF (2006). Medical Microbiology, A Guide to Microbial Infections: Pathogenesis, Immunity, Laboratory Diagnosis & Control, Churchill Livingstone, Elsevier, India.
5. Baron EJ, Peterson LR & Finegold SM Mosby (1990). Bailey and Scott's Diagnostic Microbiology

6. Brooks GF, Butel JS, Morse SA, Melnick JL, Jawetz E & Adelberg EA (2004). Jawetz M & Adelberg's Medical Microbiology, 23rd ed, Lange Publication.
7. Mackie & McCartney Practical Medical Microbiology (1996). Collee JG, Fraser AG, Marmion BP & Simmons A (eds.), Churchill Livingstone,Edinburgh.
8. Zuckerman AJ, Banatwala JE &Pattison JR(2009). Principles & Practice of Clinical Virology, John Wiley & sons Ltd.
9. Brown AE(2005). Benson's microbiological applications, TataMacGrawHill

COURSE CODE MBC303: PRACTICAL BASED ON COURSE CODE MBC301 & COURSE CODE MBC302 (COURSE CREDITS = 04)

Suggested list of Practicals (Course Code MBC301: Environmental Microbiology)

1. Detection of coliforms for determination of the purity of potable water.
2. Determination of dissolved oxygen concentration of water sample.
3. Determination of biological oxygen demand (BOD) of a sewage sample.
4. Determination of the efficiency of removal of air pollutant by using fibrous air filter/Air sampler.
5. Isolation of xenobiotic degrading bacteria by selective enrichment technique.
6. Test for the degradation of aromatic hydrocarbons by bacteria.
7. Survey of degradative of aromatic hydrocarbons by bacteria.
8. Estimation of nitrate, nitrite, and ammonium in drinking water.
9. To study the impact of heavy metals on growth & survival of microbes.
10. To study the impact of pesticides on the growth and survival of microbes.
11. To study the impact of salt and osmotic stress on the growth survival of microbes.
12. To study the biology of N2- fixing microbes/SCP producing microbes.

Suggested list of practicals (Course Code MBC302: Medical Microbiology)

1. Detection of susceptibility to dental caries.
2. Bacteriological examination of skin and throat.
3. Bacteriological examination of urine sample.
4. Viable count of bacteria in urine sample.
5. Dnase agar tests and coagulation test for identification of *Staphylococcus*.
6. Optochin sensitivity test and bile solubility test for Streptococcus.
7. Isolation of enteric pathogens from stool by direct plating method.
8. Determination of minimal inhibitory concentration (MIC) and MBC.
9. Cultivation and enumeration of coliphages from sewage.
10. General tests for identification of bacteria from clinical samples including IMViC test, Carbohydrate fermentation test, Nitrate reduction test, Triple sugar agar test Urease test, Catalase test, Oxidase test.
11. Isolation and characterization of dermatophytes.
12. Study of dimorphic fungi.
13. Study of agglutination reaction by blood grouping.
14. ELISA (to demonstrate immunological reaction by ELISA technique.
15. Double diffusion technique (study of precipitation reation by Ouchterlony Double Diffusion).

COURSE CODE MBC304: PRACTICAL BASED ON COURSE CODE MBE301/ MBE302/ MBE303/ MBE304
(COURSE CREDITS = 04)

List of Elective Papers

THIRD SEMESTER
COURSE CODE MBE301: ADVANCED MOLECULAR BIOLOGY
(TOTAL CREDITS = 03)

Course Objectives : This course combines special set of tutorials centered around research activities in molecular biology with practical exercises and/or laboratory placements. The content is designed to provide students with a perspective of how cutting edge molecular biology principles and techniques are applied to major research questions. This course will illustrate that cross disciplinary approaches are essential in modern research.

Course Learning Outcomes

- To understand key principles of how cells work, including gene regulation, protein synthesis and signal transduction.
- To locate, analyse, evaluate and synthesise information from a wide variety of sources to understand the key principles of Molecular Biology.
- To read, interpret and discuss major contributions to Molecular Biology research published in scientific research literature.
- To develop effective, creative and innovative solutions, both independently and cooperatively, to current and future research problems in Molecular Biology.

UNIT I
Recombinant DNA technology I: methods of creating recombinant DNA molecule, properties of restriction endonucleases and their mode of action, selection screening construction of DNA library.

UNIT II
Recombinant DNA Technology II: Use of cloned gene, sub-cloning; recombinant proteins production in bacteria, site-directed mutagenesis, RFLP, PCR, DNA-fingerprinting, antisense-RNA technology, chromosomal walking.

UNIT III
Hybridoma technology: monoclonal antibodies mycelium cell infusion selection of hybridomas, protoplast fusion and HAT-medium screening assay purification and application of monoclonal antibodies.

UNIT IV
Cell and tissue culture: micropropagation, somatic cell culture, somoclonal variations, somatic cell hybridization, protoplast isolation, protoplast fusion, protoplast culture, genetic transformation, various methods of gene transfer (all vector and methods), production of transgenic plant and animal; production of secondary metabolites, primary and transferred cell culture, differentiated cells in culture application.

UNIT V
Fermentation technology: continuous and batch type culture techniques, principle types of Fermenters, general design of fementors. Fermentation processes, brewing manufacture of antibiotics, production of single cell protein. Application of genetic and molecular biology procedures in strain improvement.

Books recommended

1. Molecular cloning : A Laboratory Manual , J. Sambrook ; Fritsch and T. Maniatis Cold Spring Harbor Laboratory Press, New York, 2000.
2. Introduction to practical molecular biology P.D. Dabre, John Wiley & sons Ltd. N York 1988
3. Molecular Biology LabFax, T.A. Brown (Ed) Bios Scientific Publishers Ltd. Oxford, 1991
4. Molecular Biology of the Gene (4th edition), J.D. Watson N.H. Hopkins, J.W. Roberts J.A. Steitz and A.M. Weiner, The Benjamin/ Cummlngs Publ Co. Inc. California, 1987.
5. Molecular Cell Biology (2nd Edition) J. Darnell, H. Lodish and D. Baltimore, Scientist American Books, Inc., USA, 1994.
6. Molecular Biology of the Cell (2nd Edition) B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts, and J. D. Watson, Garland Publishing, Inc., New York, 1994.
7. Gene VI (6th Edition) Benjamin Lewin, Oxford University press, U.K., 1998.
8. Molecular Biology and biotechnology; a comprehensive desk reference, R.A. Meyers (Ed.) VCH Publishers, Inc, New York, 1995
9. Genomes, T.S. Brown

Suggested list of practicals (Course Code MBE301)

1. To isolate genomic DNA from fungi by LETS methods.
2. To determine the quantity and quality of the isolated fungal DNA.
3. To determine the agarose gel electrophoresis of the isolated fungal DNA.
4. To isolate plasmid DNA from bacteria by quick method.
5. To purify the DNA from agarose gel.
6. To study the Thermal cycler.
7. To study the gel documentation system.

COURSE CODE MBE302: AGRICULTURAL MICROBIOLOGY (COURSE CREDIT: 3)

Course Objectives: To make students aware about agricultural technique, crop diseases, soil health, composting, agriculture losses, pest management, green revolution and agricultural biotechnology.

Course Learning Outcomes

- Describe role of microorganism in recycling soil nutrients, biodegradation of complex plant polymers, sustaining and improving plant growth through improving nutrient availability, production of plant growth promoting substances and inhibiting pathogens.
- Critically discuss the need for agricultural microbiology and explain their limitations.
- Clarify application of microorganisms in varied fields of agricultural microbiology like bioremediation, biofertilizers and waste water treatment.
- Analyse various aspects of N_2 fixation, Phosphate solubilization, PGPR etc. Pre and post harvesting agricultural losses, management, formulation, mass production and applications.
- Green revolution, transgenic plant, gene protection technology, resistant verities, management of agricultural waste as food, feed and fuel.

COURSE CONTENTS

UNIT – I

History, scope and development of agricultural microbiology, rhizosphere and phyllosphere: concept, importance, factors affecting microbial diversity.

UNIT – II

Soil health: crop residues, humus, mineralization, immobilization, soil-sickness, composting, vermicomposting, green manure. Effect of crop residues on plant growth; biodegradation of

pesticides and pollutants; biodegradation fate, bioavailability, acceleration, bioremediation. Biofertilizers: types, production, formulation and constraints.

UNIT – III

General idea about major agricultural pests: Plant diseases- late blight potato. downy mildew of pea, stem gall of coriander, powdery mildew / rust / smut, rust of linseed, Ergot of bajara, Anthracnose of soybean, Tikka disease of groundnut, wilt of arhar, bacterial blight of paddy, citrus canker, leaf curl of papaya, little left of brinjal. Insects: gram, soybean. Weeds: parthenium, xanthium, waterhyacinth, cyperus, phalaris

UNIT – IV

Post harvest losses of agricultural products: causes, problems and management recent trends in pest management: strategies, mass production, formulation and application technology, achievements, constraints

UNIT – V

Biotechnology in agriculture: the new green revolution, transgenic crops, gene protection technology, frost control technology, resistant varieties. Bioconversion futurology: exploitation of agricultural wastes for food / feed and fuel.

List of Recommended Books

1. Soil microbiology by Subba Rao
2. Soil and microbes by Waksman and Starkey.
3. Plant pathology by Mehrotra.
4. Alexander, M. Introduction to Soil Microbiology, 3rd Edition. Wiley Eastern Ltd., New Delhi
5. Microbiology by S.S. Purohit.

Suggested list of Practicals (Course Code MBE302: Agricultural Microbiology)

1. Isolation and Enumeration of the microorganism from soil by serial dilution agar plate method.
2. Isolation of fungi from soil by warcup's method.
3. Isolation of azotobacter species from soil.
4. Isolation of microorganism from rhizosphere.
5. Isolation of microorganism from phyllosphere (phyloplane) by serial dilution, agar plate method or leaf impression method.
6. Plant diseases – leaf curl of papaya, rust of wheat, citrus canker, red rot of sugarcane.
   Study of weeds- Parthenium, water hyacinth.

COURSE CODE MBE303: INDUSTRIAL & FOOD MICROBIOLOGY (TOTAL CREDITS =03)

Course Objectives: The course will enable students to apply the learning of microbiology concepts toward the exploitation of microbial population for industrial and human benefits. The strategies for development of microbial strains, process optimization, large scale production and product recovery will be covered for industrially relevant microbial products and therapeutic proteins. The course aims to provide instruction in the general principles of food microbiology, the biology and epidemiology of food borne microorganisms of public health significance, including bacteria, yeasts, fungi, protozoa and viruses and Understand food spoilage

microorganisms; the microbiology of food preservation and food commodities; fermented and microbial foods; principles and methods for the microbiological examination of foods; micro biological quality control, and quality schemes.

Course Learning Outcomes: Upon successful completion of the course, the student:

- Will have gained insight on industrially important microbes, recent developments in fermentation processes and various optimization strategies at fermenter level.
- Understands the concept of sterilization methods and principles of batch and continuous processes.
- Attains knowledge about designing of industrial strains and various media optimization strategies .
- Learns about the design, types of fermenters and various critical components of bioreactors
- Is able to describe control parameters, fluid rheology and process constraints in a large scale bioreactor
- Gets introduced to various strategies of product recovery from a fermentation broth . Acquires knowledge about various industrially relevant microbial products and their production process
- Understand the principles of microorganisms during various food-processing & preservation steps.
- Comprehend the interactions between microorganisms and the food environment, and factors influencing their growth and survival.
- Understand the significance and activities of microorganisms in food.
- Recognize the characteristics of food-borne, waterborne and spoilage microorganisms, and methods for their isolation, detection and identification.
- Analyze the importance of microbiological quality control programme's in food production.
- Discuss the microbiology of different types of food commodities
- Describe the rationale for the use of standard methods and procedures for the microbiological analysis of food

COURSE CONTENTS

UNIT-I

Biofermentation: designing and application, principles of biofermentation, monitoring and control of parameters (pH, oxygen, agitation, temperature, foam etc.), batch & continuous; production medium, raw materials, isolations; maintenance, preservation & improvement of industrial strains, computer control of fermentation processes.

UNIT-II

Downstream processing: Filtration of fermentation broths, ultra-centrifugation, recovery of biological products by distillation, superficial fluid extraction.

UNIT-III

Industrial production of solvents: Ethyl alcohol, citric and acetic acids; enzymes; amylases, proteases, cellulases; vitamins: vitamin B12, vitamin C, antibiotics (penicillin, streptomycin, tetracycline and griseofulvin). Microbes in petroleum industry (oil recovery); immobilized cells & enzymes.

UNIT-IV

Microbiology of food: sources and types of microorganisms in food, food borne pathogens, microbiological examination of food, spoilage of food, food preservation, fermented foods, microbial proteins.

UNIT-V

Dairy microbiology: sources and types of microorganisms in milk, microbial examination of

milk, pasteurization and phosphatase test, sterilization of milk, grades of milk, dairy products, fermented milk, butter & cheese.

Recommended Books:

1. Biochemical Engineering, Aiba, S., Humphrey, A.E. and Millis, N.F. Univ of Tokyo Press, Tokyo.
2. Biochemical Reactors, Atkinson, B: Pion Ltd. London.
3. Biochemical Engineering Fundamentals, Baily, J.E. and Ollis, D.F. McGraw-Hill Book Co. New York.
4. Bioprocess Technology: Fundamental and Application, KTH, Stockholm.
5. Process Engineering in Biotechnology, Jackson, A.T., Prentice Hall, Engelwood Cliffs.
6. Bioprocess Engineering: Basic Concepts, Shuler, M.L. and Kargi, F., Prentice Hall, Engelwood Cliffs.
7. Principles of Fermentation Technology, Stanbury, P.F. and Whitaker, A. Pergamon Press, Oxford.
8. Bioreaction Engineering principles, Nielson, J. and Billadsen, J. Plenum Press.
9. Chemical Engineering Problems is Biotechnology, Shuler, M.L. (Ed.) AICHE.
10. Biochemical Engineering, Lee, J.M. Prentice Hall Inc.
11. Bioprocess Engineering-kinetics, Mass Transport, Reactors and Gene Expression, Viet; W.F., John Wiley & Sons, Inc.

Suggested list of Practicals (Course **Code MBE303**)

1. Isolation of micro-organism from canned food.
2. Isolation of bacteria and fungi from spoiled bread.
3. Quantitative test of milk by resazurin test.
4. Quantitative estimation of Amylase production.
5. Isolation of lipase producing bacteria from soil.
6. Isolation of phosphate solubilizing/producing bacteria from soil**.**
7. Estimation of antibiotic property of bacteria.

COURSE CODE MBE304: BIOTECHNOLOGY (TOTAL CREDITS = 03)

Course Objectives: The course will help students to understand various applications of microbes for the development of various products of agriculture, industrial and clinical application. The knowledge of recombinant technology, bioreactors and optimization strategies will be beneficial in development of production processes.

Course Learning Outcomes: Upon successful completion of the course, the student:

- Will learn about various industrially relevant microbial products and their production process, role of biotechnology in environment management.
- Acquires knowledge about strains development, selection of hyper producers, microbial products, metabolic engineering and various industrial relevant microbial products and their production process Learns about the designing of recombinant heterologous expression systems such as E. coli, yeast, mammalian and insect cells.
- Learns about sterilization at reactor scale and different types of sterilization strategies
- Attains knowledge about designing large scale industrial processes and types of cultivation strategies Understands the concept of recombinant biomolecules, therapeutic proteins, vaccines, antibodies, bio-pesticides, bio-fertilizers, and probiotics .
- Understands different types of regulatory approvals required for drug development and difference between biologics, biosimilars and biobetters

COURSE CONTENTS

UNIT I

Biotechnology an Overview, Definition, Perspective and scope of biotechnological processes and products, Biotechnology and Ethics, Introduction, Medical and chemical Biotechnology, Agriculture and Food, Energy and environment and human, Bioethics, Facing problem and finding solutions, Regulating the use of biotechnology, Patenting biotechnology inventions.

UNIT II

Genetic Engineering and gene cloning, Introduction of genetic engineering procedure, restriction endonuclease, cloning vehicle, Vectors for animals and plants, Insertion of DNA molecule in to a vector, Direct transformation, Isolation and cloning, Transformation and growth of cells, Selection and screening of particular recombinants, Genomic library, sequencing of DNA, Gene identification and mapping, Analysis of expression of cloned genes, Polymerase chain reaction, Monoclonal Antibodies.

UNIT III

Plant cell and tissue cultures, Culture techniques, Protoplast fusion, Direct gene transfer, Microinjections, Nuclear transplantation, Plastid and mitochondrial genes, production of secondary metabolites by immobilized plant cell, Development of disease resistant, herbicide resistant, Salt & drought resistant plant varieties, Microbial Toxins, Introduction, Toxins gene isolation, Genetic engineering of *B. thuringiensis* strains, *Baculovirus* as biocontrol agents.

UNIT IV

Culturing microorganisms for the production of biomass, Production of microbial (Bacterial, Cyanobacterial and Fungal) products, Batch culture, Continuous culture, Fed-batch culture, Mass culture, Use of culture system for the production of microbial products, Production of cyanobacterial biomass for food, Feed and health care products, Improvement of microbial strains for industry, Agriculture, Immobilization of microbial cells and enzyme and its applications.

UNIT V

Strain improvement, bioreactor design, Reactor types, Application of immobilized cells and enzyme, improvement in bioreactor to control environment of process organism. use of microorganisms in pollution control, Waste treatment, Bioremediation, Biological removal of eutrophic nutrients, Heavy metals, Toxic chemicals (Herbicide, Insecticide and Fungicide and Other Toxicants) from waste water and industrial effluents, Utilization of waste water for the production of food and feed, Biodegradation, Bioleaching of metals, Application of microorganisms from environment

Books recommended

- Haekett P. B., Fuchs J. A. and Mesing J. W. (1988) An Introduction to Recombinant DNA techniques – basic experiments in gene manipulation.
- Glck B. R. and Thompson J. E. (1993) Methods in Plant Molecular Biology and Biotechnology.
- Bjorn Kristiansen, (2012) Basic Biotechnology third Edition.

Suggested list of practical's (Course Code MBE304)

1. Demonstration:-
   PCR
   Spectrophotometer
   pH meter
   Centrifuge
   Photomicrographic Camera
2. To prepare the media for plant tissue culture.
3. Isolation of pathogenic fungi from infected plants/Disease plants (Leaf/ Stem/ root)
4. Identification of unknown microorganism from given plates.
5. Preparation of tissue culture media.

COURSE CODE MBS301: SKILL DEVELOPMENT MODULES 3 (TOTAL CREDITS = 02)

ENTREPRENEURSHIP DEVELOPMENT PROGRAME AGENDA (Semester-3) TIME - 30 Hrs

1. **ORIENTATION PROGRAM FOR ENTREPRENEURSHIP**

2. **WHAT IS ENTREPRENEURSHIP**
   Definition of Entrepreneurship
   Be a Successful Entrepreneurship

3. **TYPE OF ENTREPRENEURSHIP**
   Manufacturing
   Trading
   Service Provider

4. **NEED TO BE SUCCESSFUL ENTREPRENEURSHIP**
   Knowledge - About work and Concern
   Information - About sources/ market/ Customer's
   Assets - About Technology, Place, Man power and money

5. **CHOOSING A BUSINESS -**
   Micro Scale Unit Small Scale Unit

Large Scale Unit Mega Scale Unit

6. **MARKETING and DISTRIBUTION**
   - **Definition and Type of Marketing**
   - **About Sales and Marketing**
   - **Distribution channels**

7. **PRODUCT DESIGNING / BRANDING / MERCHANDIZING**
   - **Research and Development**

8. **FINANCIAL FLUENCY, PLANNING AND LEGAL ASPECTS**
   - **Taxation**
   - **Rules and norms of the Govt. to run a business**

9. **GOVERMENT SCHEMES AND ASSISTENCE**
   - **About financial loan / Place/ Training / Subsidy.....etc**

10. **INDUSTRY VISITS**

FOURTH SEMESTER (Total Credit 18)

(A) DISSERTATION	Credits	Maximum Marks
A. Valuation (i) Language & Presentation (ii) Review of Literature (iii) Methodology (iv) Analysis & interpretation of Result	**18**	**300**
B. Viva-Voce EXTERNAL		**50**
C. Viva-Voce INTERNAL		**50**
Total		**400**

(B) Comprehensive viva voce (virtual credits)	**4**	**50**

Course Objectives:

The primary object of this course is to expose the student to research culture and technology. The student learns how to choose a research problem, plan and perform experiments, collect data, and analyze the data qualitatively and quantitatively. The student gets trained in presenting the results in the form of an oral presentation as well as a thesis. The student presents his/ her research orally at the end of the semester, and this is coupled to a viva-voce. This not only equips the student for a career in research/ industry, but also fosters self-confidence and self-reliance in the student as he/she learns to work and think independently.

Course Learning Outcomes:

- Student is able to conceive a problem based on current published research.
- Student is able to carry out comprehensive survey of literature on the topic of research
- Student is able to make culture media for various microbes
- Student is able to isolate microorganism from different environmental/ food sources
- Student is able to identify the isolated microorganism using biochemical and molecular methods Student is able to assess the microorganism's ability to produce various enzymes
- Student becomes well-versed in different enzymatic assay systems
- Student learns correct handling and use of instruments
- Student learns correct handling of reagents and chemicals
- Student learns how to execute experiments correctly.
- Student learns the importance of including controls in all experiments
- Student learns how to plot the results.
- Student learns how to analyze data, using statistical tools where necessary
- Student learns how to interpret the results from all possible angles.
- Student learns how to present the project in the form of a slide show before and audience of 20-30 people.
- Student is exposed to the science of thesis writing.