Program outcome, Program specific outcome and course outcome

Program Name: M. Sc. Microbiology

Academic year: 2019-20

Program outcome:

Master of Science in Microbiology is designed to develop students for academic and industrial excellence. The course includes emphasizes the applications of microbiology to address environmental problems and provide microbial remedial measures. The outcome of the study is the usage of knowledge in developing a sustainable environment. The major areas focussed in the course is microbial diversity, environmental microbiology, molecular biology and genetic engineering, Biophysical techniques and instrumentations, enzyme kinetics, microbial ecology and physiological adaptations, molecular pathogenesis, immunology and immunological techniques, fermentation technology, bioprocess engineering, pharmaceutical microbiology, microbial products and the applied subjects for the better understanding of the applications of microbiology.

Students shall be enabled to distinguish, differentiate, identify and classify various types of microorganisms. They shall be able to use various bioanalytical instrumentations and techniques to study various aspects of microbiology. The course shall develop capacitance to address environmental problems with microbial solutions. Students shall gain an understanding of the molecular pathogenesis of infectious diseases and advances in immunology. The study of fermentation technology and pharmaceutical microbiology shall prepare the students for the various industries in South Gujarat region. The study of microbial products and the knowledge of industrial microbiology as well as microbial technology shall enable the students to envision themselves as bio entrepreneurs.

Students shall develop aptitude for research, learn to formulate hypothesis and design experiments to test the hypothesis. The research accomplished in their dissertations shall make them understand the relevance of microbiology in addressing the environmental problems and finding out microbial solutions and maintaining sustainable environment. Students shall be inclined towards research and shall learn to pursue and formulate plan of work to achieve the set objectives.

Program specific outcome:

Student shall gain through knowledge and skills aligned to microbial technology. They shall obtain polished skill set for analytical investigations related to microbial research and allied life sciences field. Student shall empower by the curriculum having theoretical, experimental and dissertation components in M.Sc. Microbiology. Multi-faceted learning approach provide student great chances to acumen in industrial and professional arena.

Course outcome {Subject wise}:

Semester I

Course subject code	MB 1001
Course title	Microbial diversity
Course outcome	Students shall acquire knowledge of principles underlying classification, Students shall learn the rules of bacteria nomenclature and taxonomic framework for prokaryotic microorganisms. Student shall study major phyla of the domain bacteria and archaea. Student shall learn principles of virus structure, replication of viruses and newer forms of viruses. Students shall gain an insight regarding the emerging viral diseases. Students shall study fungal and algal cell biology.

Course subject code	MB 1002
Course title	Molecular biology and genetic engineering
Course outcome	Student shall gain knowledge of genome organization and replication. Students shall understand the relevance and biochemistry of DNA structure. Students shall understand the processes involved in expression of genome. and the various tools and technology applied for the construction of rDNA. Students shall learn to apply tools and techniques to carry out transfection in plants and animals.

Course subject code	MB 1003
Course title	Biophysical techniques and instrumentation
Course outcome	The course shall introduce the students to the principles of detection and measurement systems and principles of the major molecular techniques to study the prokaryotes. Students shall study the various separation techniques and the spectroscopic techniques for the detection of bio-molecules. Students shall gain insight of NMR and X-ray spectrometers and its applications.

Course subject code	MB 1004
Course title	Environmental microbiology and biofuels
Course outcome	The course shall enrich the students with the principles of microbial ecology and the various microbial processes prevailing in the environment. Students shall understand the principles of environmental microbiology and its application for sustainable development. Student shall learn the aspects of waste water engineering and reuse of water, versatility of microbial ecology, bioremediation and biodegradation as well as intricacies of microbial fuels.

Semester II

Course subject code	MB 2001
Course title	Enzymology and Microbial Physiology

Course outcome	Students shall gain an insight of the kinetics of enzymes and enzyme inhibition. Students shall learn about the general methodology of protein engineering applications of enzymes. Students shall know about the physiological adaptations of microorganisms, the biochemistry and genetic mechanisms to withstand adverse conditions. Students shall learn microbial metabolism and the diverse metabolic processes of microorganisms.
Course subject code	MB 2002
Course title	Bioinformatics & bio nanotechnology
Course outcome	Students shall gain an understanding on genomics, proteomics, transcriptomics, metagenomics and the various tools and techniques in its study. Students shall be enabled to apply bioinformatics in real research problems. The course shall make them familiar with the various databases and online tools for predictive results used in formulation of research problems. Students shall understand bio-nanotechnology and its applications in microbiology.
Course subject code	MB 2003
Course title	Advances in immunology and pathogenesis
Course outcome	Students shall understand the principles of immunology, molecular pathogenesis, immune-technology and immunotherapy. The course shall develop an understanding of the molecular mechanism of pathogen in causing infections and the response of the host against the pathogens. Students shall develop an insight in developing therapy, vaccine development and the control of transmission of infectious diseases.
Course subject code	MB 2004
Course title	Biostatistics and Research methodology
Course outcome	Students shall be enriched with the basic principle of research methodology. Students shall learn the fundamentals of research methodology and shall learn essential steps involved in research. They shall be enabled to define and formulate a research problem and also form a research report. Students shall develop an understanding of importance of biostatistics and its applications in analysis and interpretation of data.

Semester III

Course subject code:	MB 3001
Course title:	Fermentation technology
Course outcome:	Students shall learn the methods of isolation and screening of microorganisms for various microbial products. Students shall understand the relevance of strain improvements and the techniques of strain improvement. The course shall enable them to learn various media components and the role of media optimization for maximized product yield. Students shall understand the design, operations and applications of bioreactors used in industrial scale production. Students

shall gain knowledge of product recovery and the various methods in down streaming processing.

Course subject code: MB 3002
Course title: Microbial products
Course outcome: Students shall gain an insight regarding the applications of microorganisms for the industrial processes which includes production of high-value products such as drugs, chemicals, fuels and food product. Students shall acquire knowledge for the microbial fermentations of antibiotics, hormones, organic acid, amino acid, enzymes and vitamins using microbial strains. Students shall learn process for the production of microbial products like biosurfactants, PHA, carotenoids, dextrans, microbial flavors. SCP, bioinsecticides, biofertilizers and monoclonal antibodies. The course shall develop the capability in students for commercializing microorganisms.

Course subject code: MB 3003
Course title: Biochemical engineering
Course outcome: This course is designed to impart the knowledge of principle of fermenters and its configuration. Students shall gain knowledge to design, develop and operate industrial level fermentation process and would learn rheological behaviour of fluids and mass transfer and population dynamics in a fermentor. Students shall understand the mechanisms of heat and mass transfer, oxygen transfer and its importance in designing a fermentor.

Course subject code: MB 3004
Course title: Pharmaceutical microbiology
Course outcome: The course gives insight of microbiological analysis and quality control in pharmaceutical industries. Students shall understand the relevance of good manufacturing practices and its monitoring in pharmaceutical companies. The students would also learn quality check and quality maintenance of pharmaceutical products and microbiological auditing.

Course subject code: MB 4001
Course title: Seminar Presentation
Course outcome: Students shall learn the skill of presenting scientific advancement through seminar presentation. The student shall able to search, review, scrutinize and represent the scientific concept with suitable evidences regarding recent developments in the field of microbiology. It shall make student gain confidence in representation of scientific data at larger forums in future.

Course subject code: MB 4002
Course title: Dissertation
Course outcome: M.Sc. Microbiology students shall learn to design scientific experiment, analysing the scientific data obtained, validate hypothesis and communicating the outcome in form of thesis. Additionally, student shall

get opportunity to learn several tools used to transform data in to appropriate statistical-graphical format, grammar correction for scientific writeups, scientific research article management and similarity check through plagiarism finder. Student shall get exposure to microbial research of scientific community which shall increase their inclination towards research.

વીર નર્મદ દક્ષિણ ગુજરાત યુનિવર્સિટી

–: પરિપત્ર :–

વિજ્ઞાન વિદ્યાશાખા હેઠળની સંલગ્ન માઈક્રોબાયોલોજી વિષય ચલાવતી સ્નાતક અને અનસ્નાતક કોલેજોનાં આચાર્યશ્રીઓને તથા ડિપાર્ટમેન્ટનાં વડાશ્રીને જણાવવાનું કે, શૈક્ષણિક વર્ષ ૨૦૨૦–૨૧ અમલમાં આવનાર બી.એસસી. એન્ડ એમ.એસસી. (માઈક્રોબાયોલોજી) સેમેસ્ટર–૧ અને ૨ નાં અભ્યાસક્રમ અંગે માઈક્રોબાયોલોજી વિષયની અભ્યાસસમિતિની તા.૦૬/૦૩/૨૦૨૦ ની સભાનાં ઠરાવ ક્રમાંકઃ ૨ અન્વયે નીચે મુજબ કરેલ ભલામણ વિજ્ઞાન વિદ્યાશાખાનાં અધ્યક્ષશ્રીએ વિદ્યાશાખાની મંજૂરીની અપેક્ષાએ વિજ્ઞાન વિદ્યાશાખાવતી મંજૂર કરી એકેડેમિક કાઉન્સિલને કરેલ ભલામણ એકેડેમિક કાઉન્સિલએ તેની તા. ૩૦/૦૬/૨૦૨૦ ની સભાના **ઠરાવ ક્રમાંકઃ૨૭** અન્વયે સ્વીકારી મંજૂર કરેલ છે. તેની જાણ સંબંધકર્તા શિક્ષકો અને વિદ્યાર્થીઓને કરવી, તદ્ઉપરાંત તેનો અમલ કરવો.

માઈક્રોબાયોલોજી વિષયની અભ્યાસસમિતિની તા.૦૬/૦૩/૨૦૨૦ ની સભાનાં ઠરાવ ક્રમાંકઃ ૨

:: આથી ઠરાવવામાં આવે છે કે, શૈક્ષણિક વર્ષ ૨૦૨૦–૨૧ અમલમાં આવનાર બી.એસસી. એન્ડ એમ.એસસી. (માઈક્રોબાયોલોજી) સેમેસ્ટર–૧ અને ૨ નાં અભ્યાસક્રમ માટે તા.૧૬/૧૨/૨૦૧૯ ની સભામાં નીમેલ પેટાસમિતિએ તૈયાર કરેલ અભ્યાસક્રમમાં પેપર નંબર અને પેપરના શિર્ષક [illegible] માં જરૂરી ફેરફારો કરી સર્વાનુમતે મંજૂર કરી તે મંજૂર કરવા વિજ્ઞાન વિદ્યાશાખાને ભલામણ કરવામાં આવે છે.

એકેડેમિક કાઉન્સિલની તા.૩૦/૦૬/૨૦૨૦ ની સભાનાં ઠરાવ ક્રમાંકઃ ૨૭

:: આથી ઠરાવવામાં આવે છે કે, માઈક્રોબાયોલોજી વિષયની અભ્યાસસમિતિએ તેની તા.૦૬/૦૩/૨૦૨૦ ની સભાના ઠરાવ ક્રમાંક : ૨ અન્વયે ભલામણ કરેલવિજ્ઞાન વિદ્યાશાખાનાં અધ્યક્ષશ્રીએ વિદ્યાશાખાની મંજૂરીની અપેક્ષાએ મંજૂર કરેલ શૈક્ષણિક વર્ષ ૨૦૨૦–૨૧ થી અમલમાં આવનાર બી.એસસી. એન્ડ એમ.એસસી. (માઈક્રોબાયોલોજી) સેમેસ્ટર–૧ અને ૨ નાં અભ્યાસક્રમ મંજૂર કરવામાં આવે છે.

બિડાણઃ ઉપર મુજબ

ક્રમાંક : એકે./પરિપત્ર/૫૮૦૫/૨૦૨૦
તા. ૧૫–૦૭–૨૦૨૦

ઈ.ચા. કુલસચિવ

પ્રતિ,

૧) વિજ્ઞાન વિદ્યાશાખા હેઠળની સંલગ્ન માઈક્રોબાયોલોજી વિષય ચલાવતી સ્નાતક અને અનસ્નાતક કોલેજોનાં આચાર્યશ્રીઓ તથા ડિપાર્ટમેન્ટનાં વડાશ્રી.
૨) અધ્યક્ષશ્રી, વિજ્ઞાન વિદ્યાશાખા.
૩) પરીક્ષા નિયામકશ્રી, પરીક્ષા વિભાગ, વીર નર્મદ દ. ગુ. યુનિવર્સિટી, સુરત.

.....તરફ જાણ તેમજ અમલ સારૂ.

Translated from Gujarati to English for the purpose of NAAC Only

Circular

No. : A.C./Circular/5805/2020
Date: 15/07/2020

The Principals of affiliated colleges and the Head of the graduate and post-graduate department offering Microbiology subject under the Faculty of Science are hereby informed that the new syllabus of B.Sc. and M.Sc. Microbiology Sem -I and Sem- II has been recommended as below according to the Resolution No.: 2 in Academic Council of Microbiology dated 06/03/2020. This recommendation has been forwarded by the Dean of the Science Faculty to the Academic Council with the view of approval according to the Resolution no.: 27 of the Academic Council dated 30/06/2020 has been accepted and approved. Report it to the concerned teachers and students, and implement it.

Resolution No.: 2, Academic Council of Microbiology dated 06/03/2020:

Therefore, it is resoluted that the recommendation to the Faculty of Science for the approval of the syllabus of B.Sc. and M.Sc. Microbiology Sem -I and Sem- II with appropriate changes according to the paper number and paper title prepared by the elected sub-committee to accept and allow unanimously to be implemented from the academic year 2020-21

Resolution No.: 27, Academic Council dated 30/06/2020:

Therefore, it is resoluted that syllabus of B.Sc. and M.Sc. (Microbiology) Sem-I and Sem-II to be implemented from the academic year 2020-21 has been approved as per the recommendation under the Resolution No.:2 of Academic Council of Microbiology dated 06/03/2020.

Attachment: As above

No. : A.C./Circular/5805/2020
Date: 15/07/2020

I/C Registrar

To,

1. The Principals of affiliated colleges and the Head of post-graduate department offering Microbiology subject under the Faculty of Science
2. The dean, Faculty of Science
3. Exam Superintendent, Examination Department, V.N.S.G. University, Surat

....For information and implementation

Registrar
Veer Narmad South Gujarat University

Head
Department of Biosciences
Veer Narmad South Gujarat University,
Surat-395 007.

'A' Grade
VEER NARMAD SOUTH GUJARAT UNIVERSITY
University Campus, Udhna-Magdalla Road, SURAT - 395 007, Gujarat, India.
વીર નર્મદ દક્ષિણ ગુજરાત યુનિવર્સિટી
યુનિવર્સિટી કેમ્પસ, ઉધના-મગદલ્લા રોડ, સુરત - ૩૯૫ ૦૦૭, ગુજરાત, ભારત.
Tel : +91 - 261 - 2227141 to 2227146, Toll Free : 1800 2333 011, Fax : +91 - 261 - 2227312
E-mail : info@vnsgu.ac.in, Website : www.vnsgu.ac.in

-: પરિપત્ર :-

વિજ્ઞાન વિદ્યાશાખા હેઠળની માઈક્રોબાયોલોજી વિષય ચલાવતી સંલગ્ન સ્નાતક તથા અનુસ્નાતક કોલેજોના આચાર્યશ્રીઓને તથા ડિપાર્ટમેન્ટના વડાશ્રીઓને જણાવવાનું કે, શૈક્ષણિક વર્ષ ૨૦૨૧-૨૨ અમલમાં આવનાર બી.એસસી.સેમે. -૩ અને ૪ તથા એમ.એસસી. સેમેસ્ટર-૩ અને ૪ (માઈક્રોબાયોલોજી) વિષયનાં અભ્યાસક્રમ અંગે ચર્ચા કરતા માઈક્રોબાયોલોજી વિષયની અભ્યાસસમિતિની તા.૧૫/૦૩/૨૦૨૧ ની સભાનાં ઠરાવ ક્રમાંકઃ ૨ અન્વયે નીચે મુજબ કરેલ ભલામણ વિજ્ઞાન વિદ્યાશાખાની તા.૧૭/૦૬/૨૦૨૧ની સભાનાં ઠરાવ ક્રમાંકઃ ૬ અન્વયે મંજૂર કરી એકેડેમિક કાઉન્સિલને કરેલ એકેડેમિક કાઉન્સિલએ તેની તા.૨૫-૨૬/૦૬/૨૦૨૧ ની સભાના ઠરાવ ક્રમાંકઃ ૨૫ અન્વયે સ્વીકારી મંજૂર કરેલ છે. તેની જાણ સંબંધકર્તા શિક્ષકો અને વિદ્યાર્થીઓને કરવી, તદ્ઉપરાંત તેનો અમલ કરવો.

માઈક્રોબાયોલોજી વિષયની અભ્યાસસમિતિની તા.૧૫/૦૩/૨૦૨૧ ની સભાનાં ભલામણ ક્રમાંકઃ૨

:: આથી ઠરાવવામાં આવે છે કે, શૈક્ષણિક વર્ષ ૨૦૨૧-૨૨ અમલમાં આવનાર બી.એસસી. એન્ડ એમ.એસસી. (માઈક્રોબાયોલોજી) સેમેસ્ટર-૩ અને ૪ નાં અભ્યાસક્રમ સર્વાનુમતે મંજૂર કરી તે મંજુર કરવા વિજ્ઞાન વિદ્યાશાખાને ભલામણ કરવામાં આવે છે.

વિજ્ઞાન વિદ્યાશાખાની તા.૧૭/૦૬/૨૦૨૧ની સભાનાં ઠરાવ ક્રમાંકઃ ૬

:: આથી ઠરાવવામાં આવે છે કે, માઈક્રોબાયોલોજી વિષયની અભ્યાસસમિતિની તા.૧૫/૦૩/૨૦૨૧ ની સભાનાં ઠરાવ ક્રમાંકઃ૨ અન્વયે મંજૂર કરેલ શૈક્ષણિક વર્ષ ૨૦૨૧-૨૨ અમલમાં આવનાર બી.એસસી. & એમ.એસસી.માઈક્રોબાયોલોજી સેમેસ્ટર-૩ અને ૪ નાં અભ્યાસક્રમ મંજૂર કરી એકેડેમિક કાઉન્સિલને ભલામણ કરવામાં આવે છે.

એકેડેમિક કાઉન્સિલની તા.૨૫-૨૬/૦૬/૨૦૨૧ ની સભાનાં ઠરાવ ક્રમાંકઃ ૨૫

:: આથી ઠરાવવામાં આવે છે કે, માઈક્રોબાયોલોજી વિષયની અભ્યાસસમિતિએ તેની તા.૧૫/૩/૨૦૨૧ની સભાના ઠરાવ ક્રમાંક : ૨ અન્વયે ભલામણ કરેલ અને વિજ્ઞાન વિદ્યાશાખાએ તેની તા.૧૭/૦૬/૨૦૨૧ ની સભાનાં ઠરાવ ક્રમાંક : ૬ અન્વયે સ્વીકારેલ શૈક્ષણિક વર્ષ ૨૦૨૧-૨૨ થી અમલમાં આવનાર બી.એસસી. & એમ.એસસી. માઈક્રોબાયોલોજી સેમેસ્ટર-૩ અને ૪ નાં અભ્યાસક્રમ મંજૂર કરવામાં આવે છે.

બિડાણઃ ઉપર મુજબ

ક્રમાંક : એકે./પરિપત્ર/૯૦૦૪ /૨૧
તા.૨૮-૦૬-૨૦૨૧

ઈ.ચા. કુલસચિવ

પ્રતિ,
૧) વિજ્ઞાન વિદ્યાશાખા હેઠળની માઈક્રોબાયોલોજી વિષય ચલાવતી સંલગ્ન કોલેજોના આચાર્યશ્રીઓ.
૨) અધ્યક્ષશ્રી, વિજ્ઞાન વિદ્યાશાખા
૩) પરીક્ષા નિયામકશ્રી, પરીક્ષા વિભાગ, વીર નર્મદ દ. ગુ. યુનિવર્સિટી, સુરત.

.....તરફ જાણ તેમજ અમલ સારૂ.

Translated from Gujarati from English for the purpose of NAAC Only

Circular

No. : A.C./Circular/9004/21
Date: 28/06/2021

The Principals of affiliated colleges and the Head of the graduate and post-graduate department offering Microbiology subject under the Faculty of Science are hereby informed that the new syllabus of B.Sc. Sem- III and Sem- IV and M.Sc. Sem -III and Sem- VI (Microbiology) to be implemented from the academic year 2021-22 has been recommended as below according to the Resolution No.: 2 in Academic Council of Microbiology dated 15/03/2021. This recommendation has been forwarded to the Faculty of Science dated 17/06/2021 according to the Resolution No.: 6 which is forwarded to the Academic Council with the view of approval according to the Resolution no.: 25 dated 25-26/06/2021 has been accepted and approved. Report it to the concerned teachers and students, and implement it.

Resolution No.: 2, Academic Council of Microbiology dated 15/03/2021:

Therefore, it is resoluted that the recommendation to the Faculty of Science for the approval of the syllabus of B.Sc. and M.Sc. (Microbiology) Sem -III and Sem- IV to accept and allow unanimously to be implemented from the academic year 2021-22

Resolution No.: 6, Faculty of science dated 30/06/2021:

Therefore, it is resoluted that the syllabus of B.Sc. and M.Sc. (Microbiology) Sem -III and Sem- IV to be implemented from the academic year 2021-22 approved by the Academic Council of Microbiology dated 15/03/21 according to the Resolution No.: 2 has been recommended to accept and allow unanimously by the Academic Council

Resolution No.: 25, Academic Council dated 26/06/2021:

Therefore, it is resoluted that the syllabus of B.Sc. and M.Sc. (Microbiology) Sem -III and Sem- IV to be implemented from the academic year 2021-22 approved by the Academic Council of Microbiology dated 15/03/21 according to the Resolution No.: 2 and accepted by the Faculty of Science dated 17/06/21 according to the Resolution No.: 6 in response to the recommendation by the Academic Council of Microbiology has been approved

Attachment: As above

No. : A.C./Circular/9004/21
Date: 28/06/2021

I/C Registrar

To,

Registrar
Veer Narmad South Gujarat University
Surat.

Head
Department of Biosciences
Veer Narmad South Gujarat University,
Surat-395 007.

1. The Principals of affiliated colleges and the Head of post-graduate department offering Microbiology subject under the Faculty of Science
2. The dean, Faculty of Science
3. Exam Superintendent, Examination Department, V.N.S.G. University, Surat

....For information and implementation

Head
Department of Biosciences
Veer Narmad South Gujarat University,
Surat-395 007.

Registrar
Veer Narmad South Gujarat University
Surat.

Veer Narmad South Gujarat University, Surat

M.Sc. (Microbiology) Syllabus

(Effective from June, 2020)

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT
M.Sc. MICROBIOLOGY

Teaching & Evaluation Scheme
Semester I

Paper No.	Paper Title	Theory (Hrs/Week)	Practical (Hrs/Week)	External	Internal	Total	Credit
MB-1001	Microbial diversity	4	-	70	30	100	**4**
MB-1002	Molecular biology and genetic engineering	4	-	70	30	100	**4**
MB-1003	Biophysical techniques and instrumentation	4	-	70	30	100	**4**
MB-1004	Environmental microbiology and biofuels	4	-	70	30	100	**4**
MBP-1005	Practicals	-	16	140	60	200	**8**
Total		**16**	16	420	180	600	**24**

M.Sc. Semester I
MB 1001: MICROBIAL DIVERSITY

Student Learning Objective: The main aspect of this paper is to study the diverse forms of microorganisms and principles underlying its classification, study of major phyla of the domain bacteria and archaea. The paper also includes the study of viruses, fungi and algae.

UNIT 1	PROKARYOTIC TAXONOMY
	Teaching Duration: Lectures 15
1.1	Prokaryotic domain
1.2	Classification of prokaryotic organisms
1.3	Identification of prokaryotes
1.4	Numerical and polyphasic taxonomy
1.5	Prokaryotic systematic
1.6	Bacterial nomenclature
1.7	Taxonomic framework for prokaryotic systematic
1.8	Intellectual property of prokaryotes

UNIT 2	ARCHAEA AND PROTEOBACTERIA
	Teaching Duration: Lectures 15
2.1	The *Archaea*
	2.1.1 Overview of *Archaea*
	2.1.2 Phylum *Creanarchaeota,*
	2.1.3 Phylum *Euarcheaeota*
2.2	The Proteobacteria
	2.2.1 *Alphaproteobacteria*
	2.2.2 *Betaproteobacteria*
	2.2.3 *Gammaproteobacteria*
	2.2.4 *Deltaproteobacteria*
	2.2.5 *Epsilonproteobacteria*

UNIT 3	VIROLOGY
	Teaching Duration: Lectures 15
3.1	Principles of virus structure
3.2	virus replication strategies
3.3	Viral conquest of the host cell
3.4	Emerging viral diseases
3.5	Viroids and prions
3.6	Plant phages: TMV
3.7	Protists viruses: Chlorella viruses
3.8	Animal viruses: HIVs and their replication
3.9	Bacteriophages: phage λ, phage Mu-1

UNIT 4	MYCOLOGY AND PHYCOLOGY Teaching Duration: Lectures 15
4.1	Natural classification of fungi
	4.1.1 Members of kingdom Fungi 4.1.2 The species concept in fungi 4.1.3 The untrue fungi 4.1.4 Ecosystem mycology
4.2	Hyphal cell biology: Mycelium: the hyphal mode of growth, Spore germination and dormancy, The fungal lifestyle: colony formation, Mycelium growth kinetics
4.3	Fungal cell and tissue differentiation: Mycelial differentiation, Making spores
4.4	Arbuscular (AM) endomycorrhizas
4.5	Characteristics of algae 4.5.1 Structure of algal cell 4.5.2 Nutrition of algae 4.5.3 Classification of algae
4.6	Cyanobacteria 4.6.1 Ecology of Cyanobacteria
	4.6.2 Classification

REFERENCES:

- Bergey's manual of systematic bacteriology, (2009) 2nd edition, vol 1 Springer. (ISBN; 978-0-387-95041-9).
- Wiley J., Sherwood I., (2011), Prescott, Harley and Kleins Microbiology, 9th edition., Mc Graw Hill. (ISBN; 978-0073402406)
- David M. Knipe, Peter M. Howley, (2007). 5th edition., vol. 1, Fields Virology. (ISBN; 978-0-7817-6060-7)
- David Moore, Geoffrey Robson, Anthony Trinci, (2011) 21st century guidebook to fungi, Cambridge University Press. (ISBN; 978-0-521-18695-7)
- Robert Edward Lee, (2008) Phycology, Cambridge University Press. (ISBN; 978-0-521-14144-4).

MB 1002: MOLECULAR BIOLOGY AND GENETIC ENGINEERING

Student Learning Objectives: The student will be able to gain knowledge on the structure of genetic material and molecular mechanisms in bacteria. It shall include the various tools and technology applied for the construction of rDNA and the applications of tools and techniques to carry out transfection in plants and animals.

UNIT 1	GENOME ORGANIZATION AND REPLICATION
	Teaching Duration: Lectures 15
1.1	Nucleosomes
1.2	DNA Structure
1.3	DNA topology
1.4	RNA Structure
1.5	The replication fork
1.6	The specialization of DNA polymerases
1.7	DNA replication in prokaryotes
	1.7.1 Synthesis at the replication fork
	1.7.2 Initiation
	1.7.3 Binding and unwinding
	1.7.4 Finishing replication

UNIT 2	EXPRESSION OF THE GENOME
	Teaching Duration: Lectures 15
2.1	Transcription
	2.1.1 RNA polymerase
	2.1.2 Features of prokaryotic promoters
	2.1.3 The transcription cycle in Bacteria
2.2	Translation
	2.2.1 Messenger RNA
	2.2.2 Structure and role of tRNA
	2.2.3 Ribosome structure
	2.2.4 Genetic code
	2.2.5 Initiation, elongation and termination of protein synthesis in prokaryotes

UNIT 3	TOOLS AND TECHNIQUES OF RECOMBINANT DNA TECHNOLOGY
	Teaching Duration: Lectures 15
3.1	Enzymes
	3.1.1 Enzymes used in Genetic Engineering
	3.1.2 Restriction Endonucleases
	3.1.3 Ligation of DNA fragments using DNA Ligases
3.2	Vectors: plasmids as vectors in Genetic engineering, λ and M13 bacteriophages as cloning vehicle, phagemids, cosmids, YAC, BAC, HAC, MAC
3.3	Polymerase Chain Reaction
3.4	Construction of Genomic and cDNA libraries

UNIT 4	APPLICATIONS OF RECOMBINANT DNA TECHNOLOGY
	Teaching Duration: Lectures 15
4.1	Nucleic acid as therapeutic agents
	4.1.1 Anti-sense RNA
	4.1.2 Interference RNA
	4.1.3 Nucleic acid delivery
4.2.	Transfection of Plants
	4.2.1 Plant Transformation with Ti plasmid
	4.2.2 Ti plasmid derived vector systems
	4.2.3 Plants as Bioreactors
4.3	Methods of Transgenesis in Animals
	4.3.1 Retroviral Vector Method for mice
	4.3.2 DNA microinjection method
	4.3.3 Cre-loxP Recombination System

REFERENCES:

- Watson, J. D. et al (2017). Molecular Biology of the Gene. 7th edition., Pearson India Education Services Pvt. Ltd. (ISBN; 9780321762436)
- Glick B.R. and Patten C.L. (2017, 2018 Indian reprint). Molecular Biotechnology Principles and Applications of Recombinant DNA. 5th edition, ASM Press Washington DC, USA. (ISBN; 978-1-555-81936-1)
- Rastogi S. and Pathak N. (2016). Genetic engineering. 7th impression, Oxford University Press. (ISBN; 978-0195696578)
- Primrose S.B. and Twyman R.M. (2007), Principles of gene manipulation and Genomics. 7th edition. Blackwell Publishing, USA. (ISBN; 978-1-405-13544-3)

MB 1003: BIOPHYSICAL TECHNIQUES AND INSTRUMENTATION

Student Learning Objective: The objective of this course is to introduce the students to the principles of detection and measurement systems and principles of the major molecular techniques to study the prokaryotes. The study also emphasis the study of the various separation techniques and the spectroscopic techniques for the detection of bio-analytes.

UNIT 1	MOLECULAR TECHNIQUES
	Teaching Duration: Lectures 15
1.1	Non-amplified nucleic acid probes
1.2	Amplified nucleic acid technique
	1.2.1 Signal Amplification technique
	1.2.2 Target amplification technique
	1.2.3 Probe Amplification technique
1.3	Genetic fingerprinting methods
	1.3.1 RFLP to analyse lower eukaryotic pathogens and prokaryotes.
	1.3.2 RFEL
	1.3.3 RAPD
	1.3.4 Other PCR-Based method for DNA fingerprinting.

UNIT 2	SEPARATION TECHNIQUES
	Teaching Duration: Lectures 15
2.1	Chromatographic techniques
	2.1.1 Principles of chromatography
	2.1.2 Chromatographic performance parameters
	2.1.3 Partition chromatography
	2.1.4 Adsorption chromatography
	2.1.5 Thin layer chromatography
	2.1.6 Gel permeation chromatography
	2.1.7 Ion exchange chromatography
	2.1.8 Affinity chromatography
	2.1.9 High-Performance Liquid chromatography
	2.1.10 Gas chromatography
2.2	Electrophoresis
	2.2.1 Principle
	2.2.2 Modes of electrophoresis
	2.2.3 Support media
	2.2.4 Different types of electrophoresis
	2.2.5 Electrophoresis of DNA
	2.2.6 Immuno-electrophoresis

UNIT 3	SPECTROSCOPIC TECHNIQUES Teaching Duration: Lectures 15
3.1	3.1.1 General properties of electromagnetic radiation 3.1.2 The electromagnetic spectrum 3.1.3 Interactions of radiation and matter 3.1.4 Transmittance, Absorbance & Beer's law 3.1.5 Measurement of Transmittance and Absorbance
3.2	UV/Vis Spectrometry 3.2.1 Instrument component 3.2.2 Types of instruments 3.2.3 Some typical instruments: Photometers & Spectrophotometers 3.2.4 Qualitative Applications of UV/Vis Spectroscopy
3.3	IR Spectrometry 3.3.1 Theory of IR absorption spectrometry 3.3.2 IR instrumentation 3.3.3 IR sources and transducers 3.3.4 Sample handling for IR spectrometry 3.3.5 Application of IR spectrometry
3.4	Mass spectrometer 3.4.1 Molecular mass spectra 3.4.2 Ion Sources 3.4.3 Mass Spectrometers: Instrument components 3.4.4 Mass Analyzers 3.4.5 Tandem Mass Spectrometry 3.4.6 Application of Mass spectrometry

UNIT 4	BIOPHYSICAL TECHNIQUES Teaching Duration: Lectures 15
4.1	Nuclear Magnetic Resonance spectrometers 4.1.1 Theory of NMR: Quantum & Classical Description 4.1.2 Types of NMR Spectrometers 4.1.3 Theory of chemical shift 4.1.4 NMR Spectrometers: Instrumentation 4.1.5 Application of NMR
4.2	X-Ray Spectrometers 4.2.1 X-Ray Spectrum 4.2.2 Instrumentation for X-Ray Spectrometry 4.2.3 X-Ray Diffractometers 4.2.4 X-Ray Absorption meter 4.2.5 X-Ray Fluorescent spectrometer 4.2.6 Electron probe microanalyzer

REFERENCES:

- Murray, P. R., Baron, E. J., Pfaller, M. A., Tenover, F. C., & Yolken, R. H. (2005). Manual of clinical microbiology. 9th edition, Vol.2, American Society of Microbiology Press, Washington DC, (ISBN; 1-55581-255-4)
- Wilson, K. and Walker, J., (2010). Principles and Techniques of Biochemistry and Molecular Biology, 7th edition, Cambrige University Press (Low price edition), New York. (ISBN; 978-0521731676)
- Ghosal, S., & AVASTHI, A. S. (2018). Fundamentals of bioanalytical techniques and instrumentation. PHI Learning Pvt. Ltd. (ISBN; 978-8120338555)
- Skoog, D. A., Holler, F. J., & Crouch, S. R. (2017). Instrumental analysis. Cengage learning. (ISBN; 978-8131505427)
- Khandpur, R. S., (2008). Handbook of analytical instruments. 2nd edition, Tata McGraw-Hill Publishing Company Limited (New Delhi). (ISBN; 978-0070604605)

MB 1004: ENVIRONMENTAL MICROBIOLOGY AND BIOFUELS

Student Learning Objective: The objective of the course is to enrich the students with the current problems and research being focused to address environmental problems. The understanding of principles of environmental microbiology and its application for sustainable development. The course focuses on aspects of waste water engineering and reuse of water, versatility of microbial ecology, bioremediation and biodegradation as well as intricacies of microbial fuels.

UNIT 1	MICROBIAL ECOLOGY
	Teaching Duration: Lectures 15
1.1	Principles of microbial ecology
1.2	Strategic approach to study microbial ecology
1.3	Microbial mats
1.4	Biofilms
1.5	Algal blooms
1.6	Endophytic microbes
1.7	Quorum sensing

UNIT 2	WASTEWATER TREATMENT AND REUSE
	Teaching Duration: Lectures 15
2.1	Constituents in wastewater treatment, sampling, analysis methods
2.2	Aggregate organic constituents
2.3	Types of biological processes for wastewater treatment
2.4	Biological nitrification, denitrification and phosphorus removal
2.5	Guidelines for planning and designing treatment plants and CETPs

UNIT 3	BIODEGRADATION AND BIOREMEDIATION
	Teaching Duration: Lectures 15
3.1	Biodegradation and Bioremediation
3.2	Bioremediation technologies
3.3	Biodesulfurization
3.4	Biotreatment of pharmaceuticals and nuclear wastes
3.5	Biotreatment of textile effluent, food and dairy industry
3.6	Biodegradation of dyes
3.7	Biodegradation of polymers
3.8	Microbial transformation of pesticides
3.9	Microbial transformation of heavy metals

UNIT 4	BIOFUELS AND BIOENERGY
	Teaching Duration: Lectures 15
4.1	Cellulosic ethanol technology 4.1.1 Enzymatic processes 4.1.2 Cellulosic hydrolysis and fermentation 4.1.3 Ethanol extraction 4.1.4 Process economics

4.2	Algal fuels 4.2.1 Microalgae: growth and harvesting 4.2.2 Algae oil extraction 4.2.3 Transesterification for biodiesel 4.2.4 Prospects and economics

REFERENCES:

- T. M. Schmidt and M. Schaechter, (2012). Topics in ecological and environmental microbiology. edited by Academic press. (ISBN; 978-0-12-383878-0)
- Metcaff & Eddy Inc, (2002). Wastewater engineering: Treatment and Reuse, 4th edition, McGraw Hill higher education. (ISBN; 9780070495395)
- Doble, M. & Anil kumar. (2005). Biotreatment of industrial effluents. Butterworth Heinemann- an imprint of Elsevier. (ISBN; 9780080456218)
- Mohapatra P.K. (2010). Environmental Biotechnology, I.K. International. (ISBN 978-8188237548)
- Sungyu Lee and Shah Y.T., (2013). Biofuels and Bioenergy Processes and Technologies, CRC Press. (ISBN 978-1-4200-8955-4)

M.Sc. Microbiology Semester-I

LIST OF PRACTICALS
MBP-1005

1. Determination of burst size of coliphage lysate by One-step growth curve.
2. Extraction and detection (Electrophoretic & spectrophotometric) of bacterial genomic DNA.
3. Ligation of DNA fragments.
4. Amplification of gene by PCR.
5. Study of RFLP
6. Study of bacterial transformation
7. Extraction of total RNA from yeast.
8. Demonstration of HPLC and GC
9. Thin layer chromatography of sugars and amino acids.
10. Analysis of physico-chemical analysis of domestic water and wastewater.
    - Acidity
    - Alkalinity
    - Hardness –EDTA titrimetric method
    - Solids: TDS and TSS
    - Chlorine demand
    - Chloride
11. Analysis of aggregate organic constituents
    - Biochemical oxygen demand
    - Chemical oxygen demand
12. Enzyme substrate coliform test for drinking water.
13. Isolation and cultivation of cyanobacteria.
14. Study of bacterial growth curve.
15. Study of fungal growth by slide culture technique.

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT
M.Sc. MICROBIOLOGY

Teaching & Evaluation Scheme
Semester II

Paper No.	Paper Title	Theory (Hrs/Week)	Practical (Hrs/Week)	External	Internal	Total	Credit
MB-2001	Enzymology and Microbial Physiology	4	-	70	30	100	**4**
MB-2002	Bioinformatics & bio-nanotechnology	4	-	70	30	100	**4**
MB-2003	Advances in immunology and pathogenesis	4	-	70	30	100	**4**
MB-2004	Biostatistics and Research methodology	4	-	70	30	100	**4**
MBP -2005	Practicals	-	16	140	60	200	**8**
Total		**16**	16	420	180	600	**24**

M. Sc. Semester II
MB 2001: ENZYMOLOGY AND MICROBIAL PHYSIOLOGY

Student Learning Objective: This subject will give insights into the kinetics of enzymes and enzyme inhibition. Students will learn about the general methodology of protein engineering applications of enzymes. Also, this paper will focus on the diverse metabolic processes of microorganisms along with concepts of physiological adaptations in microorganisms.

UNIT 1	ENZYME KINETICS
	Teaching Duration: Lectures 15
1.1	Kinetics of uncatalyzed chemical reaction
1.2	Kinetics of Enzyme catalyzed reactions
1.3	Kinetics of single substrate enzyme catalyzed reaction
	1.3.1 Michaelis-Menten equation, its modification and its significance
	1.3.2 Vmax and Km
	1.3.2 Lineweaver-Burk plot, Eadie-Hofstee plot, Hanes plot.
1.4	Enzyme inhibition kinetics:
	1.4.1 Reversible inhibition:
	1.4.2 Competitive inhibition
	1.4.3 Non-Competitive inhibition
	1.4.4 Un Competitive inhibition
	1.4.5 Allosteric inhibition
	1.4.6 Substrate inhibition
	1.4.7 Partial inhibition
	1.4.8 Irreversible inhibition.
1.5	Kinetics of multi-substrate enzyme catalyzed reaction:
	1.5.1 Ping-pong reaction
	1.5.2 Random-order reactions
	1.5.3 Compulsory order reactions

UNIT 2	PROTEIN ENGINEERING AND APPLICATIONS OF ENZYMES
	Teaching Duration: Lectures 15
2.1	Enzyme Engineering of industrial enzymes.
	2.1.1 Rational design methods
	2.1.2 Site directed mutagenesis
2.3	Chemical modifications and unnatural amino acids
	2.3.1 Random methods
	2.3.2 Sequence space
	2.3.3 Methods for mutagenesis
	2.3.4 Methods for recombination
	2.3.5 Sequence homology independent recombination
	2.3.6 Screening and selection
2.4	Application of enzymes in Industry.
	2.4.1 Milling and Baking: Enzyme in Flour.
	2.4.2 Enzymes in Starch production, Sweetner and syrup production, Starch liquefaction and dextrose.
	2.4.3 Pectic enzymes in fruit and juice manufacture: Food processing related properties of pectic enzymes.

	2.4.4 Textiles and laundry detergents: Enzymes in laundry detergents 2.4.5 Pulp and paper: Enzyme application in pulp and paper processes. 2.4.6 Enzymes and Bioremediation: Enzymology of n-alkane oxidation

UNIT 3	**PHYSIOLOGICAL ADAPTATION** **Teaching Duration: Lectures 15**
3.1	Two component regulation 3.1.1 Prototypical Two Component regulatory system
3.2	Spectrum of Functions: 3.2.1 Osmolarity Changes and Porin Regulation 3.2.2 Quorum sensing and staphylococcal virulence 3.2.3 The Phosphorelay and Sporulation Initiation in *Bacillus subtilis* 3.2.4 Chemotaxis and Atypical Output Response
3.3	Physiology, Biochemistry & Genetic Aspects of: 3.3.1 Oxidative Stress Response and Regulation 3.3.2 Heat Shock Response 3.3.3 Nutritional Stress and Starvation Stress Response 3.3.4 pH Stress and Acid Tolerance
3.4	Biochemistry and Physiology of Radiation Resistant Microorganisms

UNIT 4	**MICROBIAL METABOLISM** **Teaching Duration: Lectures 15**
4.1	Assimilation and Dissimilation of Nitrate and Sulphate
4.2	Nitrogen Fixation
4.3	Phototrophic Prokaryotes.
4.4	Purple Photosynthetic Bacteria
4.5	Green Sulphur Bacteria.
4.6	The Structure of Photosynthetic Membranes in Bacteria.
4.7	Cell wall and Capsule Biosynthesis. 4.7.1 Peptidoglycan Structure and Synthesis. 4.7.2 Lipopolysaccharide Structure and Synthesis.

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- Pandey A., Webb, C., Fernandes, M. and Larroche, C. (2006). Enzyme Technology. Springer-Verlag., New York. (ISBN; 978-0-387-29294-6)
- Price N. and Stevens L. (1999). Fundamentals of Enzymology. 3rd Edition Oxford University Press., London. (ISBN; 9780198502296)
- Streips U.N. and Yasbin R.E. (2002). Modern Microbial Genetics. 2nd Edition. Wiley-Liss, A John Wiely and sons Inc., publication, New York. (ISBN; 978-0-471-38665-0)
- Moat A., Foster J. and Spector M. (2009). Microbial Physiology, 4th Edition, Wiley. (ISBN; 978-81-265-2106-7)
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- Gray N., Calvin M., and Bhatia SC. (2012). Enzymes Biotechnology. 1st Edition. CBS Publishers, New Delhi. (ISBN; 9788123918297)
- White D. (2003). The Physiology and Biochemistry of Prokaryotes, 2nd Edition, Oxford University Press. (ISBN: 0-19-512579-7)

MB 2002: BIOINFORMATICS & BIO-NANOTECHNOLOGY

Student learning Objectives: The basic objective is to introduce the basic techniques of bioinformatics. Emphasis will be given to the application of bioinformatics and biological databases to problem solving in real research problems. The students will become familiar with the online tools for predictive results for the formulation of research problems. This paper also describes rapidly growing branch of bio-nanotechnology and its applications.

UNIT 1	**GENOMICS, PROTEOMICS & OTHER "OMICS"**
	Teaching duration: Lectures 15
1.1	Next generation sequencing method
1.2	Genome assembling
1.3	Genome Annotation
1.4	Genome Mapping: RFLPs, SNPs, AFLPs
1.5	Interaction Proteomics: Methods of Protein-Protein Interaction
1.6	Expression proteomics: 2-D Differential gel electrophoresis
1.7	Functional Proteomics: Protein chips, Antibody array
1.8	Application of Proteomics: In the field of Medical, Pharmaceutical and Plant Biotechnology
1.9	Transcriptomics: RNA level Gene Expression: DNA Micro array Technology
2.0	Metagenomics
	2.0.1 Metagenomics offer a way forward and Contribution in various fields. 2.0.2 Designing a Metagenomics Project: Sequence based and Function based analysis.

UNIT 2	**DATABASES: IN SILICO RESOURCE FOR THE INFORMATION**
	Teaching duration: Lectures 15
2.1	Biological Databases
2.2	Nucleotide sequence database: EMBL, gene bank, DDBJ
2.3	Protein Database: Protein sequence database: PIR, Swiss-Prot Structure database: PDB, MMDB
2.4	Classification database: CATH, SCOPE
2.5	Sequence-based Database Searches: BLAST, PSI-BLAST, RPS-BLAST
2.6	Metabolic pathway Database: KEGG

UNIT 3	**SEQUENCE ALIGNMENTS AND PHYLOGENY**
	Teaching duration: Lectures 15
3.1	Pairwise Sequence Alignment
3.2	3.2.1 Sequence Homology versus Sequence Similarity 3.2.2 Sequence Similarity versus Sequence Identity 3.2.3 Methods: Global and Local
3.3	Multiple Sequence Alignment

	3.3.1 Exhaustive Algorithms 3.3.2 Heuristic Algorithms
3.4	Phylogeny: 3.4.1 Methods of Phylogeny: Maximum likelihood, UPGMA, N-J method 3.4.2 Statistical evaluation of obtained phylogenetic tree 3.4.3 Software for phylogenetic analysis: Phylip
3.5	Secondary structure prediction: 3.5.1 Computation methods for secondary structure prediction: Chou Fasman and GOR.
3.6	Protein Modeling: methods of Protein Modeling, Homology Modeling; fold recognition and threading approaches, and Ab-initio structure prediction methods.

UNIT 4	**BIO-NANOTECHNOLOGY** **Teaching duration: Lectures 15**
4.1	An Introduction to Nano World: Nano, The Unit Nanometer, Nanoscience, Nanotechnology
4.2	Types and properties of Nanomaterials
4.3	Introduction to Bio-Nanotechnology, In the dominion of Biological machines
4.4	Nano motors of biological Systems, ATP Synthase: A Nano-turbine
4.6	Physical and Chemical methods for synthesis of nanoparticles.
4.7	Self-assembly techniques for synthesizing nanoparticles
4.8	Applications of nanotechnology
	4.8.1 Application of DNA and protein nanostructures in molecular nanotechnology and nanoelectronics
	4.8.2 Application of carbon nanotubes in Biological systems: Biosensors, Surgical supplements, Gene delivery using CNT instead of vector, Pollution control by CNT
	4.8.3 Nano particles and its amalgamation with drugs for drug delivery: Liposomes

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- Primrose S. and Twyman R. (2006). Principles of Gene Manipulation & Genomics, 7th edition. Black well Publishing, Malden. (ISBN: 978-1405135443)
- Xiong, J., (2009). Essential Bioinformatics, Cambridge University press. (ISBN: 978-0521706100)
- Twyman, R. (2004). Principles of proteomics. Taylor & Francis. (ISBN: 978-1859962732)
- National Research Council. (2007). The new science of metagenomics: revealing the secrets of our microbial planet. National Academies Press. (ISBN 978-0-309-10676-4)
- Ghosh, Z., & Mallick, B. (2008). Bioinformatics: Principles and Applications. Oxford University Press. (ISBN:978-0195692303)
- Kanehisa M, Goto S (2000). "KEGG: Kyoto Encyclopaedia of Genes and Genomes". Nucleic Acids Res. 28 (1): 27–30.
- Sharon, M., Sharon, M., Pandey, S., & Oza, G. (2012). Bio-nanotechnology: Concepts and Applications. ANE Books, New Delhi. (ISBN: 978-1439852149)

MB 2003: ADVANCES IN IMMUNOLOGY AND PATHOGENESIS

Student learning Objectives: This paper focuses on principles of immunology, molecular pathogenesis, immune-technology and immunotherapy. It also provides understanding and studying the molecular mechanism of pathogen in causing infections and the response of the host against the pathogens which would enable in developing therapy, vaccine development and the control of transmission.

UNIT 1	RECEPTOR BIOLOGY
	Teaching duration: Lectures 15
1.1	The MHC Complex
	1.1.1 Structure of MHC molecules
	1.1.2 Binding of peptide to MHC molecules
	1.1.3 Genomic organization of the MHC
	1.1.4 Expression of MHC molecules
1.2	B cell surface receptor for antigen
1.3	T cell surface receptor for antigen
1.4	Transplantation

UNIT 2	HAEMATOPOIESIS AND ACTIVATION OF LYMPHOCYTES
	Teaching duration: Lectures 15
2.1	Activation of T cells
	2.1.1 Activation of CD4+ Lymphocyte
	2.1.2 Activation of CD8+ T cells
2.2	Activation of B cells
	2.2.1 Antigen recognition and antigen induced B cell activation
	2.2.2 Helper T cell dependent antibody response to protein antigen
	2.2.3 Antibody response to T cell independent antigen
2.4	Primary B and T cells deficiencies

UNIT 3	CANCER AND IMMUNOTHERAPY
	Teaching duration: Lectures 15
3.1	Cancer: Origin and Terminology
3.2	Malignant transformation of cells
3.3	Oncogenes and cancer induction
3.4	Tumors of the immune system
	3.4.1 Tumor antigens
	3.4.2 Tumor invasion of immune system
	3.4.3 Cancer Immunotherapy
3.5	Engineered antibodies for therapy
3.6	Immuno conjugates and its applications

UNIT 4	MOLECULAR PATHOGENESIS
	Teaching duration: Lectures 15
4.1	Attachment and entry of microorganisms into the body
	4.1.1 Gastrointestinal Tract
4.2	Encounter of microbes with phagocytic cells
	4.2.1 Cell biology of phagocytosis
	4.2.2 Phagocytosis in polymorpho-nuclear leucocytes
	4.2.3 Phagocytosis in macrophages
	4.2.4 Microbial strategies in relation to phagocytes
4.3	The spread of microbes through the body
	4.3.1 Microbial factors promoting spread
	4.3.2 Spread via lymphatics
	4.3.3 Spread via Blood
4.4	Mechanism of cell and tissue damage
	4.4.1 Microbial toxins

REFERENCES:

- Mims, C. A. et al., (2000). MIMS' Molecular pathogenesis of Infectious Disease, 5th Edition. Academic Press. (ISBN 9780123971883)
- Abbas A.K., Lichtman A.H., Pillai S., (2007) Cellular and Molecular Immunology, 6th Edition, Saunders Elsevier. (ISBN;978-81-312-1034-5)
- Delves P.J., Martin S. J., Burton D.R., and Roitt I.M., (2017) Roitt's Essential Immunology, 13th Edition, Willy Blackwell. (ISBN;978-1-118-41577-1)
- Kindt T.J., Goldsby R.A., and Osborne B.A., (2007) Kuby Immunology, 6th Edition, W.H.Freeman and Company, New York. (ISBN;0716767643)
- Nash A.A., Dalziel R.G., and Fitzgerald J.R., (2015) Mims' Pathogenesis of Infectious Disease, 6th Edition, Academic Press (Elsevier). (ISBN;978-0-12-397188-3)

MB-2004 BIOSTATISTICS AND RESEARCH METHODOLOGY

Student learning objective: The learning objective of the paper will enrich the students with the basic principle of research methodology which help the students to learn essential steps involved in research. It also increases the understanding in use of biostatistics in analysis and interpretation of data.

UNIT 1	RESEARCH METHODOLOGY - 1
	Teaching Duration: Lectures 15
1.1	Meaning and objective of Research.
1.2	Motivation in research.
1.3	Criteria of good research.
1.4	Problems encountered by researchers in India.
1.5	Types of research.
1.6	Reviewing the literature for research purpose.

UNIT 2	RESEARCH METHODOLOGY - 2
	Teaching Duration: Lectures 15
2.1	Constructing hypothesis.
2.2	Research design.
2.3	Defining a research problem.
2.4	Contents of research proposal.
2.5	Research report.
	2.5.1 Research report- Tables.
	2.5.2 Research report- Figures.
	2.5.3 Research report- Formatting & Typing.

UNIT 3	FUNDAMENTALS OF BIOSTATISTICS
	Teaching Duration: Lectures 15
3.1	Introduction to Biostatistics
	3.1.1 Definition, development & application of Biostatistics
	3.1.2 Role of Biostatistics
	3.1.3 Data collection and treatment.
3.2	Preliminary Concepts.
3.3	Diagrammatic representation of data.
3.4	Graphical representation of data.
3.5	Frequency Distribution.

UNIT 4	METHODS OF DATA ANALYSIS
	Teaching Duration: Lectures 15
4.1	Measures of Central Tendency.
	4.1.1 Arithmetic mean.
	4.1.2 Median.
	4.1.3 Mode.
	4.1.4 Geometric mean.
	4.1.5 Harmonic mean.
	4.1.6 Illustrative problems.
4.2	Student t-test Student t-test.

4.3	4.2.1 Introduction. 4.2.2 Student's t-Distribution. 4.2.3 Application of t-Distribution. Analysis of Variance (ANOVA). 4.3.1. Principle of Anova.

REFERENCES:

- Arora P. N. (2017) Biostatistics, Himalaya Publishing House. (ISBN; 978-93-5142-823-7)
- Gurumani N. (2011) Research Methodology for Biological Sciences, MJP Publishers, Chennai. (ISBN; 978-81-8094-016-0)
- Gurumani N. (2010) An Introduction to Biostatistics, Revised 2nd Edition, MJP Publishers, Chennai. (ISBN; 978-81-8094-006-4)
- Khan I.A. and Khanum A. (2009) Fundamentals of Biostatistics, Revised 5th Edition, Ukaaz Publications, Hyderabad. (ISBN; 978-81-9004-410-3)
- Ranjit Kumar. (2011) Research Methodology-A step by step Guide for Beginners. 3rd Edition, Sage Publications. (ISBN; 978-1-84920-301-2)
- C. R. Kothari and Gaurav Garg (2004) Research Methodology Methods and Techniques, 2nd Revised Edition, Newage International Publication. (ISBN; 978-81-224-2488-1)

M.Sc. Microbiology Semester-II

LIST OF PRACTICALS
MBP-2005

1. Determination of cellulase activity using CMC as substrate
2. Determination of *Km* & *Vmax* of amylase/cellulase.
3. Determination of effect of pH, temperature, activators and inhibitors on amylase activity.
4. Immobilization of amylase/cellulase and determine its activity yield.
5. Isolation of respiratory deficient mutants by UV radiation in yeast.
6. Study of chemical mutagenesis in *E. coli*.
7. Isolation of VAM spores from soil.
8. Microbial synthesis of nanoparticles and its characterization by UV-VIS spectroscopy.
9. Sequence retrieval for nucleic acid and proteins.
10. Study of protein structure database (PDB).
11. Sequence based analysis by BLAST and MSA.
12. EMBOSS applications for nucleotide and protein sequence analysis.
13. Computer assisted oligonucleotide primer designing.
14. Protein secondary structure prediction.
15. Biostatistical analysis:
    - Calculate mean, median, mode, range, variance, standard deviation, standard error, confidence interval of microbiological data using MSExcel/suitable software.
    - Calculate regression analysis for maltose/glucose standard curve data using LINEST function of MSExcel/suitable software.
    - Plot line-scatter graph, bar graph with error bars of microbiological data using MSExcel/suitable software.

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Veer Narmad South Gujarat University, Surat

M.Sc. (Microbiology) Syllabus

(Effective from June, 2021)

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT
M.Sc. MICROBIOLOGY

Teaching & Evaluation Scheme

Semester III

Paper No.	Paper Title	Theory (Hrs/Week)	Practical (Hrs/Week)	External	Internal	Total	Credit
MB 3001	Fermentation technology	4	-	70	30	100	**4**
MB 3002	Microbial products	4	-	70	30	100	**4**
MB 3003	Biochemical engineering	4	-	70	30	100	**4**
MB 3004	Pharmaceutical microbiology	4	-	70	30	100	**4**
MBP 3005	Practical	-	16	140	60	200	**8**
Total		**16**	**16**	**420**	**180**	**600**	**24**

M.Sc.SEMESTER III

MB 3001: FERMENTATION TECHNOLOGY

Student Learning Objective: The objective of this paper is to introduce students to fermentation process and impart knowledge required for fermentation. The paper also provides the information about the industrial applications and recent technological advances in fermentation technology.

UNIT 1	THE ISOLATION AND IMPROVEMENT OF INDUSTRIALLY IMPORTANT MICROORGANISMS
	Teaching Duration: Lectures 09
1.1	Isolation methods utilizing selection
1.2	Isolation methods not utilizing selection of the desired characteristic—from the "waksman platform" to the 1990s of the desired characteristics
1.3	Screening methods and high throughput screening
1.4	Broadening the base of the discovery process and maximizing gene expression
1.5	Improvement of strains producing primary biosynthetic products
1.6	Improvement of strains producing secondary biosynthetic products

UNIT 2	MEDIA FOR INDUSTRIAL FERMENTATIONS
	Teaching Duration: Lectures 09
2.1	Introduction
2.2	Typical media
2.3	Medium formulation
2.4	Water
2.5	Energy sources
2.6	Carbon sources
2.7	Nitrogen sources
2.8	Minerals
2.9	Growth factors
2.10	Nutrient recycle
2.11	Buffers
2.12	The addition of precursors and metabolic regulators to media
2.13	Oxygen requirement and antifoams
2.14	Medium optimization

UNIT 3	FERMENTORS: DESIGN, OPERATION, AND APPLICATIONS
	Teaching Duration: Lectures 09
3.1	Bioreactors: an overview
3.2	Component parts of bioreactors
3.3	Component parts of a "typical" vessel
3.4	Peripheral parts and accessories
3.5	Alternative vessel designs
3.6	Bioreactor instrumentation
3.7	Common measurement and control systems
3.8	Additional sensors
3.9	"Substrate sensors"
3.10	Bioreactor preparation and use
3.11	Examples of common bioreactor applications

3.12	Current trends and future prospects in fermenter design and applications

UNIT 4	THE RECOVERY AND PURIFICATION OF FERMENTATION PRODUCTS
	Teaching Duration: Lectures 09
4.1	Introduction
4.2	Removal of microbial cells and other solid matters
4.3	Foam separation (floatation)
4.4	Precipitation
4.5	Filtration
4.6	Centrifugation
4.7	Cell disruption
4.8	Liquid–liquid extraction
4.9	Solvent recovery
4.10	Two-phase aqueous extraction
4.11	Reversed micelle extraction and supercritical fluid extraction
4.12	Adsorption
4.13	Removal of volatile products
4.14	Chromatography
4.15	Membrane processes
4.16	Drying
4.17	Crystallization
4.18	Whole broth processing

References:

- Creuger W,Crueger A. and Aneja K. R., (2000) Biotechnology: A textbook of industrial microbiology, 3rd Edition, Panima, New Delhi, (ISBN: 978-93-85998-63-8)
- E.M.T. El-Mansi, Bryce C.F.A., Demain A. L. and Allman A. R., (2012) Fermentation Microbiology and Biotechnology, 3rd Edition, , Taylor & Francis, (ISBN: 978-1-4398-5581-2)
- Okafor N., (2017), Modern industrial microbiology and biotechnology, 2nd edition, Science publishers, USA., (ISBN: 978-1-1385-5018-6)
- Stanbury P. F., Whitaker A. and Hall S. J., (2016), Principles of Fermentation Technology, 3th Edition, , Elsevier, (ISBN: 978-0-08-099953-1)
- Waites, M.J., (2001) Industrial microbiology: An Introduction, 1st Edition, Blackwell publishing, (ISBN: 0-632-05307-0)

MB 3002: MICROBIAL PRODUCTS

Student Learning Objective: Industrial microbiology is a branch of applied microbiology in which microorganisms are used in industrial processes which includes production of high-value products such as drugs, chemicals, fuels and food product. This paper includes the production and processes of various microbial metabolites at industrial scale by use of microbes.

UNIT 1	**FERMENTED FOOD AND DAIRY**
	Teaching Duration: Lectures 09
1.1	Fungal biomass production: Bakers' yeast
1.2	Milk based fermented foods: Yogurt and Cheese
1.3	Grain based fermented foods: Soy sauce, Soy paste
1.4	Alcohol based fermented products: Beer and Wine
1.5	Vegetable based fermented foods: Sauerkraut and Olives
1.6	Fermented sausages and fish
1.7	Mushroom production

UNIT 2	**MICROBIAL FERMENTATIONS**
	Teaching Duration: Lectures 09
2.1	Antibiotics: Cephalosporin
2.2	Hormones: Insulin
2.3	Anticancer agents: Anthracyclines
2.4	Organic acids: Citric acid
2.5	Amino acids: L-Lysine
2.6	Enzymes: Cellulase and Protease
2.7	Vitamins: B12

UNIT 3	**MODERN TRENDS IN MICROBIAL PRODUCTION - I**
	Teaching Duration: Lectures 09
3.1	Biosurfactants
3.2	PHA: Separation, purification and manufacturing methods
3.3	Carotenoids: β carotene
3.5	Microbial polysaccharides: Dextran
3.6	Microbial flavors: Vanillin, Terpenes
3.7	Microbial biotransformation of steroids and sterols

UNIT 4	**MODERN TRENDS IN MICROBIAL PRODUCTION - II**
	Teaching Duration: Lectures 09
4.1	Techniques and technologies to produce biomass of cyanobacteria and microalgae
4.2	Single Cell Protein (SCP)
4.3	Bioinsecticides
4.4	Rhizobium inoculants
4.5	Monoclonal antibodies: Production and recovery
4.6	Bacterial siderophores
4.7	Ergot alkaloids

References:

- Adam M. and Dick M., (2014), Food Microbiology: An introduction, 1st edition, Medtec Publication, (ISBN: 978-93-81714-61-4)
- Clarke W., (2016), Biotechnology: Industrial Microbiology, 1st edition, CBS Publishers, (ISBN: 978-81-239-2864-7)
- Flickinger M. C. and Drew S. W., (1999), Encyclopedia of Bioprocess Technology, Volumes 1-5, Wiley-Inter-science, (ISBN: 978-0471138228)
- Okafor N., (2017), Modern Industrial Microbiology and Biotechnology, 2nd edition, Science Publishers, (ISBN: 978-1-138-03614-7)
- Peppler H. J. and Perlman D., (2004), Microbial Biotechnology, Volume 1 and Volume 2, 2ndedition, Academic press, (ISBN: 978-81-8147-495-7/978-81-8147-496-1)
- Ratledge C. and Kristiansen B., (2006), Basic Biotechnology, 3rd edition, Cambridge University Press, (ISBN: 978-0-521-72947-5)
- Reed G., (2004), Prescott & Dunn's Industrial Microbiology, 4th edition, CBS Publishers, (ISBN: 81-239-1001-0)
- Rehm H. J. and Reed G., (2010), Biotechnology, Vol. 10, Wiley India Pvt. Ltd., (ISBN: 978-3527283200)
- Rehm H. J. and Reed G., (2010), Biotechnology, Vol. 7, Wiley India Pvt. Ltd., (ISBN: 978-81-265-2535-5)

MB 3003: BIOCHEMICAL ENGINEERING

Student Learning Objective: This course is designed to impart the knowledge of principle of fermenters and its configuration. Students shall gain knowledge to design, develop and operate industrial level fermentation process and would learn rheological behavior of fluids and mass transfer and population dynamics in a fermentor.

UNIT 1	**REACTOR ENGINEERING** **Teaching Duration: Lectures 09**
1.1	Bioreactor configurations: Overview
1.2	Monitoring and control of bioreactors
1.3	Bioprocess control
1.4	Sterilization
1.5	Microtiter Plate fermentation: Introduction, Routine and next generation MTP fermenter, Impact on bioprocessing and synthetic biology
1.6	Statistical optimization of fermentation

UNIT 2	**FLUID FLOW AND MIXING** **Teaching Duration: Lectures 09**
2.1	Classification of fluids
2.2	Fluids in motion
2.3	Factors affecting broth viscosity
2.4	Viscosity measurement
2.5	Non-Newtonian fluids
2.6	Mixing
2.7	Role of shear in stirred fermenters
2.8	Rheological properties of fermentation broths

UNIT 3	**HEAT AND MASS TRANSFER** **Teaching Duration: Lectures 09**
3.1	Heat transfer equipment
3.2	Mechanisms of heat transfer and conduction
3.3	Heat transfer between fluids
3.4	Relationship between heat transfer, cell concentration and stirring conditions
3.5	Convective mass transfer
3.6	Oxygen uptake in cell cultures
3.7	Oxygen transfer in fermenters
3.8	Measurement of *kLa*

UNIT 4	**MULTIPLE INTERACTING MICROBIAL POPULATIONS** **Teaching Duration: Lectures 09**
4.1	Classification of interactions between two species
4.2	Competition
4.3	Predation and parasitism
4.4	Spoilage and product manufacture by spontaneous mixed cultures

References:

- Doran P. M., (2013),Bioprocess Engineering Principles,2nd Edition, Academic Press, (ISBN 9780122208515)
- E.M.T. El-Mansi, Bryce C.F.A., Demain A. L. and Allman A. R., (2012) Fermentation Microbiology and Biotechnology, 3rd Edition, Taylor & Francis, (ISBN: 978-1-4398-5581-2)
- Ollis D. F. and Bailey J. E., (2010), Biochemical Engineering Fundamentals. 2nd edition McGraw-Hill Education (India) Private Limited, (ISBN: 978-0070701236)
- Vogel H. C and Todaro C. M., (2014), Fermentation and biochemical engineering handbook. 3rd edition, William Andrew publisher, (ISBN: 978-1-4557-2553-3)

MB 3004: PHARMACEUTICAL MICROBIOLOGY

Student Learning Objective: This paper gives insight of microbiological analysis and quality control in pharmaceutical industries. It includes the learning of good manufacturing practices and its monitoring in pharmaceutical companies. The students would also learn quality check and quality maintenance of pharmaceutical products and microbiological auditing.

UNIT 1	**BIOPHARMACEUTICAL: INTRODUCTION AND MICROBIOLOGICAL ASSAY**
	Teaching Duration: Lectures 09
1.1	Introduction to pharmaceuticals: Microorganisms and medicines
1.2	The agar diffusion assay: Its quantitative basis
1.3	The theory and practice of tube assays for growth promoting substances
1.4	The theory and practice of tube assays for growth inhibiting substances
1.5	Standard reference materials

UNIT 2	**MONITORING MICROBIOLOGICAL QUALITY**
	Teaching Duration: Lectures 09
2.1	Principles of good manufacturing practice
2.2	Monitoring microbiological quality – Conventional testing methods
2.3	Monitoring microbiological quality – Application of rapid methods

UNIT 3	**MICROBIAL ASPECTS OF PHARMACEUTICAL PROCESSING**
	Teaching Duration: Lectures 09
3.1	Microbial spoilage and preservation of pharmaceutical products
3.2	Sterilization control and sterility assurance
3.3	The quality assurance and quality control of pharmaceutical products

UNIT 4	**PHARMACEUTICAL STERILE PRODUCTS AND MICROBIOLOGICAL AUDITING**
	Teaching Duration: Lectures 09
4.1	Types of sterile products: Injections, non-injectable sterile fluids, ophthalmic preparations, dressing, implants, absorbable haemostats, surgical ligatures and sutures, instruments & equipment
4.2	Vaccines: Seed lot system, production, fermentation, blending, filling, and drying
4.3	In-vitro diagnosis
4.4	Immune sera
4.5	Human immunoglobulin &monoclonal antibodies
4.6	Microbiological auditing

References:

- Barredo, J. L., (2005), Microbial Processes and Products. Humana Press, New Jersey, (ISBN: 978-1-59259-847-2)
- Denyer, S. P. and Baird, R. M., (2008), Guide to microbiological control in pharmaceuticals and medical devices. 2nd Edition, CRC Press, Boca Raton, (ISBN: 9781444330632)
- Flickinger, M. C. and Drew, S. W., (1999), Encyclopedia of Bioprocess Technology. Wiley- Interscience, New Jersey, (ISBN: 9780471138228)
- Gad, S. C., (2007), Handbook of Pharmaceutical Biotechnology. Wiley-Interscience, New Jersey, (ISBN: 978-0-470-25958-0)
- Hewitt,W.(2004). Microbiological Assays for Pharmaceutical Analysis-A rational approach, Indian Edition, CRC, (ISBN: 0-203-58859-2)
- Hugo and Russells, (2007), Pharmaceutical Microbiology, Blackwell Publishing.
- Walsh G., (2007), PharmaceurcalBiotechnolog- Concepts and Applications, Wiley (ISBN: 978-0-470-01244-4)

M.Sc. Microbiology Semester III
LIST OF PRACTICALS

MBP-3005

1. Screening of citric acid and lactic acid producing microorganisms.
2. Screening of cellulase, amylase and protease producing microorganisms.
3. Production of fungal amylase by solid state fermentation.
4. Production of fungal amylase by submerged fermentation
5. Partial purification of amylase by ammonium sulphate precipitation and dialysis/column chromatography and calculation of specific activity & fold purification.
6. Determination of *KLa*of laboratory fermenter.
7. Sterility testing of pharmaceutical products by direct inoculation & membrane filtration methods as per Indian Pharmacopoeia (IP).
8. Cell disruption by sonication and estimation of intracellular protein.
9. Production of ethanol using pure carbohydrate.
   (a) Determination of pH, TSS (ºBrix)
   (b) Determination of alcohol (ethanol) percentage.
   (c) Determination of phenol content
   (d) Estimation of reducing & total sugar.
10. Production of ethanol using agro-industrial waste.
    (a) Determination of pH, TSS (ºBrix)
    (b) Determination of alcohol (ethanol) percentage
    (c) Determination of phenol content
    (d) Estimation of reducing & total sugar
11. Microbial production of dextran/xanthan by *Leuconostocmesenteroides/Xanthomonascampestris.*
12. Microbiological assay of amino acid.
13. Detection of anti-HIV sera by ELISA.
14. Detection of anti-HBsAgsera by ELISA.

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT
M.Sc. MICROBIOLOGY

Teaching & Evaluation Scheme

Semester IV

Paper No.	Paper Title	Theory (Hrs/Week)	Practical (Hrs/Week)	External	Internal	Total	Credit
MB 4001	Seminar Presentation	4		70	30	100	**4**
MB 4002	Dissertation	12	16	350	150	500	**20**
TOTAL		**16**	**16**	**420**	**`180**	**600**	**24**

<table>
<tr><th colspan="2">Guidelines for MB 4001 & MB 4002</th></tr>
<tr><td>MB 4001</td><td>

Faculty has to mentor the allotted students for selected topics of seminar.
Students have to individually deliver a seminar on the advance or novel topic other than that mentioned in the curriculum.
Teacher has to evaluate seminar of individual student and prepare for the final presentation of the allotted students
Topic should not be related to his/her dissertation.
A seminar should be delivered within 15 minutes.
Students have to submit one copy of colour printed handouts (4 slides /page) of his/her presentation to the examiner.

</td></tr>
<tr><td>MB 4002</td><td>

Faculty has to mentor the allotted students for the dissertation.
Faculty will mentor the students for Scientific writing& communicationwhich includes:

Communication skill in science
Searching of scientific journals & resources
Reviewing scientific literature
Preparation of graphs and tables to present the scientific data
Online grammar checking in scientific writing
References management by online tools
Delivering effective oral presentation
Preparing and presenting research poster
Writing a research paper and compiling a dissertation thesis
Plagiarisms checking
Publishing in scientific journal

References:

Davis M, Davis K. and Dunagan M., (2012), Scientific papers and presentations: Effective scientific communication, 3rd edition, Elsevier and Academic press, (ISBN: 978-0-12-384727-0)
Wallwork A., (2011), English: for writing research papers, Springer science plus Business media, LLC, (ISBN: 978-1-4419-7921-6)

Dissertation work can be done individually or in a pair on any topic related to microbiology.
Dissertation may be carried in-houseor outside the campus after due permission grantedby the supervising teacher and institute head at the following recognized institutions or industries like:

Any UGC recognized University PG departments.
Any Agriculture University.
All National and State level research institute.
ISO or FDA/USFDA industry or research center having R & D and Q.C. facilities.

The thesis will be evaluated by examiner(s) which includes thesis evaluation and dissertation presentation.
The dissertation presentation shall be done in audio-visual mode by the candidate within 15 minutes.
The candidate has to submit their dissertation in a standard hard-bound thesis and soft copy in PDF format.

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Veer Narmad South Gujarat University, Surat

M.Sc. (Microbiology) Syllabus

(Effective from June, 2017 to April 2020)

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

M.Sc. MICROBIOLOGY

Teaching & Evaluation Scheme

Semester – I

Paper No.	Paper Title	Theory (Hrs/Wk)	Practical (Hrs/Wk)	External	Internal	Total	Credit
MB-101	Taxonomy,Virology & Cytology	4	-	70	30	100	**4**
MB-102	Molecular Biology & rDNA Technology	4	-	70	30	100	**4**
MB-103	Bioanalytical techniques and Instrumentation	4	-	70	30	100	**4**
MB-104	Advances In Environmental Microbiology	4	-	70	30	100	**4**
Practicals		-	16	140	60	200	**8**
Total		**16**	16	420	180	600	**24**

Semester – II

Paper No.	Paper Title	Theory (Hrs/Wk)	Practical (Hrs/Wk)	External	Internal	Total	Credit
MB-201	Microbial Physiology	4	-	70	30	100	**4**
MB-202	Bioinformatics & Other "OMICS"	4	-	70	30	100	**4**
MB-203	Enzyme Kinetics & Technology	4	-	70	30	100	**4**
MB-204	Research methodology, Biostatistics and IPR	4	-	70	30	100	**4**
Practicals		-	16	140	60	200	**8**
Total		**16**	16	420	180	600	**24**

Semester – III

Paper No.	Paper Title	Theory (Hrs/Wk)	Practical (Hrs/Wk)	External	Internal	Total	Credit
MB-301	Fermentation Technology & Bioprocess Engineering	4	-	70	30	100	**4**
MB-302	Industrial Microbiology	4	-	70	30	100	**4**
MB-303	Immunology & Pathogenesis	4	-	70	30	100	**4**
MB-304	Advances in Pharmaceutical Microbiology	4	-	70	30	100	**4**
Practicals		-	16	140	60	200	**8**
Total		**16**	16	420	180	600	**24**

Semester – IV

Paper No.	Paper Title	Theory (Hrs/Wk)	Practical (Hrs/Wk)	External	Internal	Total	Credit
MB-401	Seminar Presentation	6	-	70	30	100	**4**
MB-402	Report on Industrial / Conference / Symposium visit	4	-	-	50	50	**4**
MB-403	Review Article	6	-	-	100	100	**4**
MB-404	**PROJECT/DISSERTATION**	-	16	250	100	350	**12**
Total		**16**	16	320	280	600	**24**
Total credit of the course							**96**

M.Sc. Semester - I

MB 101: TAXONOMY, VIROLOGY AND CYTOLOGY

OBJECTIVE: The main aspects of this paper includes Taxonomy and Classification of Bacteria & Virus, Fundamentals of Virology along with concepts of new emergent virus, it also includes molecular aspects of phage and different organelle studies.

Unit-1	**Taxonomy and classification of bacteria and virus**		
	Ref: Bergey's manual, 2 edition,vol 1	**Teaching Duration:**	**Lectures: 9**
1.1	Taxonomy and classification of bacteria		
1.2	Procaryotic domains		
1.3	Classification of Procaryotic organisms and the concept of bacterial species		
1.4	Identification of procaryotes		
1.5	Polyphasic Taxonomy		
1.6	Bacterial nomenclature		
1.7	Culture Collections		
1.8	Virus taxonomy		**(Ref. Fields)**
1.9	The Baltimore scheme of virus classification		**(Ref. Wagner)**
1.10	Banking diverse data in ICTVdB		**(Ref. Murray)**

Unit-2	**Fundamentals of virology**		
	Ref: Shors	**Teaching Duration:**	**Lectures: 7**
2.1	Virus properties, structure and morphology		
2.2	Viruses that challenge the definition of a virus		
2.3	One step growth curve		
2.4	Key steps of virus replication cycles		
2.5	New Viruses and Viruses that are reemerging		
2.6	Prions and viroids		

Unit-3	**Bacteriophages**		
	Ref: Fields	**Teaching Duration:**	**Lectures: 8**
3.1	Virulent Phages		
	3.1.1 Phage T4		
	3.1.2 Ø x174		
	3.1.3 MS2		
3.2	Temperate phages		
	3.2.1 Phage λ.		
	3.2.2 Phage Mu-1 as a Model Transposon.		
	3.2.3 Phage P 1 as a Model plasmid		
3.3	Evolution and natural biology of Phages		
3.4	Bacteriophage creates pathogenic bacteria in nature		**(Shors)**

Unit-4	Cytology		
	Ref: Campbell and Reece	**Teaching Duration:**	**Lectures: 8**
4.1	Eucaryotic cell structure		
4.2	The Nucleus		
4.3	Ribosomes		
4.4	Endoplasmic reticulum		
4.5	Golgi apparatus		
4.6	Lysosomes		
4.7	Vacuoles		
4.8	Mitochondria		
4.9	Chloroplast		
4.10	Peroxisomes		
4.11	Cytoskeleton		
4.12	Cell wall		
4.13	Extracellular matrix and intercellular junctions		

REFERENCES:

1. *Bergey's manual of systematic bacteriology*, 2nd Edition, Vol.1, Springer, ISBN:0-387-98771-1
2. Murray, Barron, Jorgenson, Pfaller, Yolken. *Manual of clinical microbiology*, 8th Edition, Vol. 2, ASM Press: ISBN: 1-55581-255-4.
3. Wagner, Hewlett, Bloom & Camerini, (2008). *Basic virology*, 3rd Edition, Blackwell publishers, ISBN-13:978-1-4051-4715-6.
4. Alan. J. Cann, (2005). *Principles of molecular virology*, 4th Edition. Elservier academic press, ISBN: 0-12-088787-8.
5. David. M. Knipe, Peter M. Howley, (2007). *Fields virology*, 5th Edition Vol. 1, LWW, ISBN-13: 978-0-7817-6060-7.
6. Geoffrey M. Cooper, Robert E. Hausman, (2007). *The cell*, 4th edition, ASM press, ISBN-13:978-0-87893-220-7.
7. Moselio Schaechter, (2004). *Desk encyclopedia of microbiology*, Elsevier Academic Press, ISBN 0-12-621361-5.
8. Shors, T., (2013). *Understanding viruses*, 2nd edition, Jones and Bartlett, ISBN: 978-1-4496-4892-3.
9. Campbell, J. et al., (2015). *Biology: A Global Approach*, 10th edition, Pearson Education Pvt. Ltd.

MB 102: MOLECULAR BIOLOGY & rDNA technology

OBJECTIVE: The paper intends to deal basic reactions of molecular biology at its most advanced level.

Unit-1	**GENOME ORGANIZATION, REPLICATION**		
	Ref: Watson	**Teaching Duration:**	**Lectures: 8**
1.1	The Structures of DNA		
1.2	Nucleosome		
1.3	DNA topology		
1.4	The structure of RNA		
1.5	The replicon		**(Ref.Lewin)**
1.6	DNA replication		

Unit-2	**GENE EXPRESSION**		
	Ref: Watson and Baker	**Teaching Duration:**	**Lectures: 8**
2.1	Transcription 2.1.1 RNA Polymerase 2.1.2 Features of Prokaryotic promoters 2.1.3 Assembly synthesis and processing of prokaryotic transcripts 2.1.4 Regulation of transcription in prokaryotes		
2.2	Translation 2.2.1 Structure and role of tRNA 2.2.2 Ribosome structure 2.2.3 Genetic code 2.2.4 Translation in prokaryotes		
2.3	DNA topology		
2.4	The structure of RNA		
2.5	The replicon		**(Ref.Lewin)**
2.6	DNA replication		

Unit-3	**TOOLS OF RECOMBINANT DNA TECHNOLOGY**		
	Ref: Watson and Baker	**Teaching Duration:**	**Lectures: 8**
3.1	Enzymes and vectors 3.1.1 Restriction enzymes 3.1.2 DNA ligase 3.1.3 Vectors: plasmids, bacteriophage, M13 based vectors, phagemids, cosmids, YAC, BAC, HAC/ MAC		
3.2	Polymerase Chain Reaction		**(Murray)**
3.3	Genomic and chromosome libraries		**(Russel)**

Unit-4	APPLICATIONS OF RECOMBINANT DNA TECHNOLOGY		
	Ref: Primrose	**Teaching Duration:**	**Lectures: 8**
4.1	DNA Fingerprinting & DNA Forensics		**(Watson)**
4.2	Gene Therapy		
	4.2.1 Human Gene Therapy		**(Glick)**
	4.2.2 DNA Vaccines		
	4.2.3 Gene Augmentation		
	4.2.4 Gene therapy for Cancer Cells		
4.3	Recombinant products: hormones and vaccines		**(Rastogi)**
4.4	Regulation of gene action by RNAi		**(Watson)**
4.5	Transgenesis in plants		
	4.5.1 Gene transfer to plants		
	4.5.2 Plants as bioreactor		
4.6	Transgenesis animals		**(Glick)**
	4.6.1 Retroviral vector method		
	4.6.2 Cre-*lox P* recombination system		

REFERENCES:

1. Lewin, B., (2004). *Genes VIII*. Pearson.
2. Watson, J. D. *et al* (2008). *Molecular Biology of the Gene.* 5th Edition, Pearson
3. Murray, Barron, Jorgenson, Pfaller, Yolken. *Manual of clinical microbiology*, 8th Edition, Vol. 2, ASM Press, ISBN: 1-55581-255-4.
4. Primrose, S. and Twyman, R. (2006). *Principles of gene manipulation & genomics*, 7th edition. Black well publishing, Malden.
5. Glick, B. R., Pasternak, J. J. and Patten C. L., (2010), *Molecular Biotechnology: Principles and Applications Recombinant DNA*, 4th edition, ASM Press.
6. Rastogi, S. and Pathak, N. (2009), *Genetic Engineering*, Oxford Uni. Press.

MB 103: BIOANALYTICAL TECHNIQUES AND INSTRUMENTATION

OBJECTIVE: The objective of the course is to introduce the students to the concepts of physical principles of detection and measurement systems. Emphasis will also be given to understand the principles of major experimental techniques applied to understand these physical problems. The course will cover theoretical aspects and applications of modern analytical techniques in Modern Biology.

Unit-1	**Molecular techniques**		
	Ref: Murray	**Teaching Duration:**	**Lectures: 7**
1.1	Non amplified nucleic acid probes		
1.2	Amplified nucleic acid technique		
1.3	Target Amplification technique		
1.4	Probe Amplification technique		
1.5	Post amplification detection and Analysis		
1.6	Current Application		
1.7	RFLP, RAPD, VNTR, STR and SNP analysis		

Unit-2	**Chromatographic techniques**		
	Ref: Wilson	**Teaching Duration:**	**Lectures: 8**
2.1	Principle and classification of chromatography 2.1.1 Partition chromatography 2.1.2 Adsorption chromatography 2.1.3 Thin layer chromatography 2.1.4 Gel permeation chromatography 2.1.5 Ion exchange chromatography 2.1.6 Affinity chromatography 2.1.7 High-Performance Liquid chromatography 2.1.8 Gas chromatography 2.1.8.1 GC-MS 2.1.8.2 LC-MS		

Unit-3	**Spectroscopic and X-ray diffraction techniques**		
	Ref: Khandpur	**Teaching Duration:**	**Lectures: 9**
3.1	Principles, Instrumentation and applications in biological sciences 3.1.1 UV-VIS spectroscopy 3.1.2 Infrared spectroscopy 3.1.3 Nuclear Magnetic Resonance spectroscopy. 3.1.4 Mass spectrometer 3.1.4.1 Basic mass spectrometer 3.1.4.2 Principle of operation 3.1.4.3 Types of mass spectrometers		

3.2	3.1.4.4 Components of a mass spectrometer 3.1.4.5 Application of mass spectrometry X-ray Diffraction 3.2.1 Principle & applications of Debey scharrer camera

Unit-4	**Electrophoretic techniques**		
	Ref: Walker	**Teaching Duration:**	**Lectures: 8**
4.1	General principles		
4.2	Support media		
4.3	Electrophoresis of proteins		
4.4	Electrophoresis of nucleic acids		
4.5	Capillary electrophoresis		
4.6	Microchip electrophoresis		

Reference:

1. Wilson, K. and Walker, J., (2010). *Principles and Techniques of Biochemistry and Molecular Biology*, 7th edition, Cambrige University Press (Low price edition), New York.
2. Khandpur, R. S., (2008). *Handbook of analytical instruments*. 2nd edition, Tata McGraw-Hill Publishing Company Limited (New Delhi).
3. Webster J. G., (2009). *Bioinstrumentation*, Student edition, Wiley India (P) Ltd. New Delhi.
4. Upadhyay, A., Upadhyay, K and Nath, N., (2003). *Biophysical Chemistry (Principles and Techniques)*, 8th edition, Himalaya Publishing House.
5. Khopkar, S. M., (2008). *Basic concepts of Analytical Chemistry,* 3rd edition, New age international publishers (New Delhi.
6. Sharma, B. K., (2005). *Instrumental methods of chemical analysis*, 24th edition, GOEL publishing house, Meerut.
7. Murray, Barron, Jorgenson, Pfaller, Yolken. *Manual of clinical microbiology*, 8th Edition, Vol. 2, ASM Press, ISBN: 1-55581-255-4.

MB 104: ADVANCES IN ENVIRONMENTAL MICROBIOLOGY

OBJECTIVE: The paper focuses on several aspects of waste water engineering and also on the application of microbes to solve several environmental problems. The paper also makes the students familiar with current research in making the environment safe and healthy. It also exploits the principles of environmental microbiology and applies this understanding for economic purpose.

Unit-1	**Characteristics of waste water**		
	Ref: Metcalf & Eddy	**Teaching Duration:**	**Lectures: 8**
1.1	Waste water constituents.		
1.2	Sampling and analytical procedures		
1.3	Physical characteristics		
1.4	Inorganic non-metallic constituents.		
1.5	Metallic constituents.		
1.6	Aggregate organic constituents.		
1.7	Microbial growth kinetics		

Unit-2	**Bioremediation**		
	Ref: Doble &Anilkumar	**Teaching Duration:**	**Lectures: 8**
2.1	Bioremediation technologies		
2.2	Biotreatment of waste 2.2.1 Textile effluent 2.2.2 Food and Dairy industry 2.2.3 Sugar and Distillery waste 2.2.4 Pharmaceuticals 2.2.5 Hospital waste 2.2.6 Waste from nuclear plants		
2.3	Biodesulfurization		

Unit-3	**Biodegradation**		
	Ref: M. Alexander	**Teaching Duration:**	**Lectures: 8**
3.1	Fundamentals of Biodegradation 3.1.1 Growth linked biodegradation 3.1.2 Acclimation 3.1.3 Detoxication 3.1.4 Activation 3.1.5 Bioavailability 3.1.6 Cometabolism 3.1.7 Inoculation		
3.2	Biodegradation of pesticides		**(Doble&Anilkumar)**

3.3	Biodegradation of polymers	**(Doble&Anilkumar)**
3.4	Biodegradation of dyes	**(Doble&Anilkumar)**

Unit-4	**Microbial ecology and Environmental Biotechnology**		
	Ref:	**Teaching Duration:**	**Lectures: 8**
4.1	Microbial ecology – New Directions, new importance **(BMSB Ed. 2 Vol 1)**		
4.2	Nucleic acid probes and their application in environmental microbiology **(BMSB Ed. 2 Vol 1)**		
4.3	Metagenomic libraries from uncultured microorganisms		**(Osborn)**
4.4	Microbial transformation of heavy metals		**(Mohapatra)**
4.5	Microbial transformations of Pesticides		**(Mohapatra)**
4.6	Bioprospecting		**(Sumit Ray)**
4.7	Investigative Biodeterioration		**(Allsopp)**
4.8	The control of Biodeterioration		**(Allsopp)**

References:

1. Hawksworth, D. L., (1995). *Biodiversity: Measurement and Estimation,* 1st edition, Chapman & Hall - The royal society.
2. Garrity, G. M. and Boone, D. R., (2001). *Bergey's Manual of Systematic Bacteriology Volume 1: The Archaea and the Deeply Branching and Phototrophic Bacteria*; 2nd edition, Springer.
3. Metcalf & Eddy Inc., (2002). *WastewaterEngineering: Treatment and Reuse,* 4th edition, McGraw Hill Higher Education.
4. Doble, M. & Anil kumar., (2005). *Biotreatment of Industrial Effluents.* Butterworth-Heinemann – An imprint of Elsevier.
5. Alexander, M., (1999). *Biodegradation and Bioremediation,* 2nd edition, Academic Press.
6. Osborn, A.& Smith, C., (2005). *Molecular Microbial Ecology (Advanced methods),* 1st edition. BIOS Scientific Publisher, Taylor & Francis group.
7. Hurst, C., (2007). *Manual of Environmental Microbiology,* 3edition, ASM Press.
8. Allsopp, D. *et al.,* (2004). *Introduction to Biodeterioration,* 2nd edition, Cambridge University Press.
9. Mohapatra P. K., (2010). *Environment Biotechnology*, I K International.
10. Ray S & Ray A K (2010) Biodiversity & Biotechnology, New Central Book Agency, London (ISBN: 81-7381-505-4)

LIST OF PRACTICALS
SEMESTER 1

1. One-step growth curve.
2. Digesting DNA with Restriction Endonuclease.
3. Ligation of DNA fragments.
4. Amplification of gene by PCR.
5. To study RFLP.
6. Extraction of total RNA from Yeast
7. DNA isolation from filamentous fungi.
8. Demonstration HPLC and GC
9. Thin layer chromatography of sugars, amino acids.
10. Extraction of plasmid DNA from bacterial cell
11. Proteins quantification by SDS-PAGE.
12. Analysis of domestic water and waste water

    12.1Physical

    - Acidity
    - Alkalinity
    - Hardness –EDTA titrimetric method
    - Chlorine demand
    - Solids : TDS and TSS

    12.2 Inorganic non-metallic constituents

    - Chloride

    12.3Aggregate organic constituents

    - Biological oxygen demand
    - Chemical oxygen demand

M.Sc. Semester – II

MB: 201 MICROBIAL PHYSIOLOGY

Objective: This paper deals with the understanding of the processes of life of microorganisms as mediated by its structures and chemical components operating together to accomplish the common tasks of life. The paper introduces inter-relatedness of microbiology, biochemistry and genetics in context of the functioning of bacterial cell

Unit-1	**MOLECULAR TOOLS FOR MICROBIAL PHSIOLOGY:**		
	Ref.: Moat	**Teaching Duration:**	**Lectures: 08**
1.1	Mutant Hunts		
1.2	Blotting procedures:		
1.3	3.1.1 Southern Blotting		[Primrose]
	3.1.2 Northern Blotting		[Primrose]
	3.1.3 Western Blotting		[Primrose]
	3.1.4 South western blots		(A.G.Moat)
1.4	Reporter genes		
1.5	DNA Mobility Shifts		
1.6	Primer Extension		
1.7	Two Hybrid Analysis		
1.8	FISH		

.

Unit-2	**MOLECULAR ADAPTATION PHYSIOLOGY:**		
	Ref.: U. N. Streips, Moat, Desk Encyclopedia & David White	**Teaching Duration:**	**Lectures: 09**
2.1	Prototypical Two Component Signalling		
2.2	Regulation of Signal Transduction		
2.3	Spectrum of Functions		
	2.3.1 Osmolarity Changes and Porin Regulation		
	2.3.2 Quoram Sensing and Staphylococcal Virulence		
	2.3.3 Chemotaxis and Atypical Output Response		
	2.3.4 The Phosphorelay and Sporulation Initiation in Bacillus subtillis		
2.4	Physiology, Biochemistry & Genetic Aspects of:		
	2.4.1 Oxidative Stress Response and Regulation		
	2.4.2 Heat Shock Response		
	2.4.3 Nutritional Stress and Starvation Stress Response		

	2.4.4 pH Stress and Acid Tolerance
2.5	Biochemistry and Physiology of Radiation Resistant Microorganisms

Unit-3	**INORGANIC METABOLISM & ENERGY PRODUCTION:**		
	Ref.: David White:	**Teaching Duration:**	**Lectures: 08**
3.1	Assimilation of Nitrate and Sulphate		
3.2	Dissimilation of Nitrate and Sulphate		
3.3	Nitrogen Fixation		
3.4	Catabolism of Aliphatic Hydrocarbons		
	Growth on C_1 compounds other than CO_2 – The Methylotrophs		

Unit-4	**PHOTOSYNTHESIS & BIOSYNTHESIS:**		
	Ref.: David White & Moat	**Teaching Duration:**	**Lectures: 08**
4.1	Phototrophic Prokaryotes		
4.2	Purple Photosynthetic Bacteria		
4.3	Green Sulphur Bacteria		
4.4	Cyanobacteria and Chloroplast		
4.5	The Structure of Photosynthetic Membranes in Bacteria		
4.6	Cell wall and Capsule Biosynthesis		
	4.6.1 Peptidoglycan Structure and Synthesis		
	4.6.2 Lipopolysaccharide Structure and Synthesis		
	4.6.3 Extracellular Polysaccharide, Synthesis and Export in Gram negative Bacteria		

References:

1. The Physiology and Biochemistry of Prokaryotes, 2nd Edition, David White, Oxford University Press 2003, ISBN: 0-19-512579-7
2. Microbial Physiology, 4th Edition, 2009, Albert G. Moat, John W. Foster, Michael P. Spector, Wiley, ISBN: 978-81-265-2106-7.
3. Streips U.N. and Yasbin R.E. (2002). *Modern Microbial Genetics.*Scond edition. Wiley-Liss, A John wiely and sons Inc., publication, New York.
4. Schaechter M. (2004). *The Desk Encyclopedia of Microbiology.* Elsevier Academic Press, California USA.

MB 202: BIOINFORMATICS & OTHER "OMICS"

OBJECTIVES: The basic objective is to give students an introduction to the basic techniques of bioinformatics. Emphasis will be given to the application of bioinformatics and biological databases to problem solving in real research problems. The students will become familiar with the use of a wide variety of internet applications, biological database and will be able to apply these methods to research problems. This paper describe a rapidly growing branches of highthroughput, large scale biology & maturing scientific discipline like Genomics, Proteomics, Transcriptomics.

Unit-1	**GENOME AND GENOMICS**		
	Ref: Primrose	**Teaching Duration:**	**Lectures: 07**
1.1	Introduction to Genomics: Structural, Functional and Comparative		
1.2	Comparative Genomics of Prokaryotes, Eukaryotes and Organelles		
1.3	Genome Mapping: RFLPs, SNPs, AFLPs		
1.4	Next generation sequencing method		
1.5	Genome assembling **Ref: Xiong**		
1.6	Genome Annotation **Ref:Xiong**		

Unit-2	**PROTEOMICS AND OTHER "OMICS"**		
	Ref:R.M.Twyman:	**Teaching Duration:**	**Lectures: 09**
2.1	Interaction Proteomics: Methods of Protein-Protein Interaction		
2.2	Expression proteomics		
	2.2.1 Basic techniques and approaches (2-D Differencial gel electrophoresis		
2.3	Functional Proteomics		
	2.3.1 Protein Microarray and its Application, 2.3.2 Types and Manufacture of protein chip		
2.4	Application of Proteomics: In the field of Medical, Pharmaceutical and Plant Biotechnology		
2.5	Transcriptomics: RNA level Gene Expression: DNA Micro array Technology and its Application, Printing Technologies **Ref: Primrose**		
2.6	Metagenomics: **Ref: The Science of Metagenomics**		
	2.6.1 Metagenomics offer a way forward and Contribution in various fields.		
	2.6.2 Designing a Metagenomics Project: Sequence based and Function based analysis.		

Unit-3	**DATABASES: IN SILICO RESOURCE FOR THE INFORMATION.**		
	Ref: Ghosh	**Teaching Duration:**	**Lectures: 09**
3.1	Biological Database and database design.		
3.2	Nucleotide sequence database: EMBL, gene bank, DDBJ		
3.3	Protein Database: 3.3.1 Protein sequence database:PIR, Swiss-Prot 3.3.2 Structure database: PDB, MMDB		

3.4	Classification database: CATH, SCOPE
3.5	Sequence-based Database Searches: BLAST, PSI-BLAST, RPS-BLAST
3.6	Metabolic pathway Database: KEGG

Unit-4	**APPLIED BIOINFORMATICS:**		
	Ref: Ghosh	**Teaching Duration:**	**Lectures: 09**
4.1	Pairwise Sequence Alignment **Ref: Xiong**		
	4.1.1 Sequence Homology versus Sequence Similarity		
	4.1.2 Sequence Similarity versus Sequence Identity		
	4.1.3 Methods: Global amd Local		
	4.1.4 ScoringMatrices: PAM and BLOSUM		
4.2	Multiple Sequence Alignment **Ref: Xiong**		
	4.2.1 Scoring Function		
	4.2.2 Exhaustive Algorithms		
	4.2.3 Heuristic Algorithms		
4.3	Markov Model And Hidden Markov Model **Ref: Xiong**		
4.4	Phylogeny: Statistical methods to obtained phylogenetic tree, Software for phylogenetic analysis		
4.5	Secondary structure prediction: Computation methods for secondary structure prediction: Chou Fasman, GOR and Softwares for Secondary structure prediction		
4.6	Protein Modeling: methods of Protein Modeling, Homology Modeling; fold recognition and threading approaches, and Ab-initio structure prediction methods.		

REFERANCES:

1. Twyman R. (2008). Principles of Proteomics. Taylor & Francis Publisher, Oxon.
2. Primrose S. and Twyman R. (2006). Principles of Gene Manipulation & Genomics, 7th edition. Black well Publishing, Malden.
3. Xiong, J., (2009).*Essential Bioinformatics*, Cambridge University press.
4. Board on Life Sciences. (2007). The Science of Metagenomics. Division of Earth and Life sciences, The Natonal Academies Press, washington DC.
5. ZhumarGhosh and BibekanandMallick(2008) Principles and ApplicationsOUP India

MB-203 Enzyme Kinetics & technology

Objective: This paper will give insight on kinetics of enzmes and enzyme inhibition. Students will learn about the general methodology of enzyme extraction & purification along with its applications. A recent trends in enzymology focus on modification of enzymes for its efficient applicability, an approach covered in enzyme engineering.

Unit-1	**ENZYME KINETICS:**		
	Ref: T. Palmer	**Teaching Duration:**	**Lectures:09**
1.1	Kinetics of uncatalyzed chemical reaction		
1.2	Kinetics of Enzyme catalyzed reactions		
1.3	Methods use for investigating kinetics of enzyme catalyzed reaction:		
	1.3.1 Initial velocity studies		
	1.3.2 Rapid enzyme catalysis		
1.4	Kinetics of single substrate enzyme catalyzed reaction:		
	1.4.1 Michaelis-Menten equation, its modification and its importance		
	1.4.2 *Vmax*and *Km*		
	1.4.3 Lineweaver-Burk plot, Eadie-Hofstee plot, Hans plot, Dixan plots		
1.5	Enzyme inhibition kinetics:		
	1.5.1 Reversible inhibition:		
	1.5.2 Competitive inhibition		
	1.5.3 Non Competitive inhibition		
	1.5.4 Un Competitive inhibition		
	1.5.5 Allosteric inhibition		
	1.5.6 Substrate inhibition		
	1.5.7 Partial inhibition		
	1.5.8 Irreversible inhibition		
1.6	Kinetics of multi-substrate enzyme catalyzed reaction:		
	4.6.1 Ping-pong reaction		
	4.6.2 Random-order reactions		
	4.6.3 Compulsory order reactions		

Unit-2	**Enzyme Extraction, Isolation and Purification**		
	[Ref. Shanmugam]	**Teaching Duration:**	**Lectures: 08**
2.1	Enzyme extraction and isolation		
2.2	Purification of enzymes		

Unit-3	**Enzyme Engineering of industrial enzymes**

	Ref: Ashok Pandey	Teaching Duration:	Lectures: 07
3.1	Introduction		
3.2	Targets and results for industrial enzymes		
	3.2.1Detergent enzymes		
	3.2.2 Starch hydrolysis and fructose manufacturing		
	3.2.3 Animal feed enzymes		
	3.2.4 Xylanase in pulp bleaching		
	3.2.5 Chemoenzymatic synthesis		
3.4	Rational Design methods		
	3.4.1 Site directed mutagenesis		
	3.4.2Chemical modifications and unnatural amino acids		
3.5	Random methods		
	3.5.1 Sequence space		
	3.5.2 Methods for mutagenesis		
	3.5.3 Methods for recombination		
	3.5.4 Sequence homology independent recombination		
	3.5.5 Screening and selection		

Unit-4	Applications of enzyme		
	Ref. Shanmugam	**Teaching Duration:**	**Lectures: 07**
4.1	Large scale applications of enzymes		
4.2	Role of enzymes in detergent industries		
4.3	Enzymes in starch industries		
4.4	Applications of enzymes in baking industries		
4.5	Applications of enzymes in dairy industries		
4.6	Applications of enzymes in animal feed biotechnology		
4.7	Applications of enzymes in textile, paper and pulp industries		
4.8	Diagnostic and therapeutic enzymes		

REFERENCES:

1. Palmer T (2004): *Enzymology.* East-West Press Pvt. Ltd., New Delhi.
2. Price N C and Stevens L (1999) *Fundamental of Enzymology* , 3rd Ed. Oxford
3. Shanmugam S and Sathishkumar T, (2009), Enzyme technology, 1st ed., I. K. Int. pub. House

MB-204 RESEARCH METHODOLOGY, BIOSTATISTICS AND IPR

Objectives: The learning objective of the paper will enrich the students with basic principle of research methodology which help the students to learn essential steps involved in research. It also increase the understanding in use of biostatistics in analysis and interpretation of data. This paper also provide opportunity to learn importance of IPR in the todays knoeledge based industry and role of international organization in protection of IPR.

UNIT 1	**RESEARCH METHODOLOGY**		
	Reference: Gurumani, Ranjit Kumar	**Teaching Duration**	**Lectures: 08**
1.1	Research: What does it means? **(Ranjit Kumar)**		
1.2	Types of research. **(Ranjit Kumar)**		
1.3	The research process: A quick glance**(Ranjit Kumar)**		
1.4	Formulating a research problem **(Ranjit Kumar)**		
1.5	Constructing hypothesis **(Ranjit Kumar)**		
1.6	Selecting a study design**(Ranjit Kumar)**		
1.7	Contents of research proposal - outline**(Ranjit Kumar)**		
1.8	Literature citation **(Gurumani)**		
1.9	Research report **(Gurumani)**		
1.10	Research report- Tables **(Gurumani)**		
1.11	Research report- Figures **(Gurumani)**		
1.12	Research report- Formatting & Typing. **(Gurumani)**		

UNIT 2	**FUNDAMENTALS OF BIOSTATISTICS**		
	Reference: Arora	**Teaching Duration**	**Lectures: 09**
2.1	Introduction to Biostatistics 2.1.1 Defination, Development & Application of Biostatistics 2.1.2 Role of Biostatistics 2.1.3Data and its collection 2.1.4Classification of Data		
2.2	2.1.3 Importance and usefulness of Statistics Preliminary Concepts 2.2.1 Variables and constants 2.2.2 Populations and Samples 2.2.3 Random Samples 2.2.4 Discrete and Continuous Variables 2.2.5 Relationship and Prediction		
2.3	2.2.6 Variables in biology		
2.4	Sampling Techniques **(Khan)**		
2.5	Diagramatic and Graphical Representation of Data **(Khan)** Frequency Distribution **(Gurumani)**		

UNIT 3	METHODS OF DATA ANALYSIS		
	Reference: Khan	**Teaching Duration**	**Lectures: 10**
3.1	Measures of Central Tendancy 3.1.1 Arithmetic Mean 3.1.2 Median 3.1.3 Mode 3.1.4 Geometric Mean 3.1.5 Harmonic Mean 3.1.6 IllustrativeProblems		
3.2	Student t-test **Ref: Gurumani** **3.**2.1 Introduction 3.2.2 Student's t-Distribution 3.2.3 Application of t-Distribution		
3.3	Analysis of Variance (ANOVA) **Ref: Gurumani** **3.**3.1 Principle of Anova 3.3.2 Partitioning of Anova 3.3.3 Comparison of pairs of Means 3.3.4 Assumption Underlying Anova 3.3.5 Application of Anova		

UNIT 4	Intellectual Property Right (IPR)		
	Reference: Sateesh M.K.	**Teaching Duration**	**Lectures:06**
4.1	Introduction		
4.2	Forms of intellectual property		
4.3	International and regional agreement/treaties in IPR		
4.4	IPR related legislation in india		
4.5	International organization and IPR		
4.5.1	World Trade Organization (WTO)		
4.5.2	WTO treaties		
4.5.3	Genenral Agreement on tariffs and trade (GATT)		
4.5.4	Trade – Related Aspects Of IPR (TRIPS)		
4.5.5	World Intellectual Property Organization (WIPO)		

REFERENCES:

1. Sateesh M.K. (2008) Bioethics and Biosafety, I.K.International Publishing House Pvt. Ltd.
2. Gurumani N. (2011) Research Methodology For Biological Sciences, MJP Publishers, Chennai (ISBN: 978-81-8094-016-0)
3. Arora, P. N. (2007). *Biostatistics*. Himalaya Publishing House.
4. Kumar, R. (2005). *A Step-by-step Guide for Beginners*. Sage Publications.
5. Khan I. A. & Khanum A Fundametals of Biostatistics, Ukaaz Publications, Hyderabad. (ISBN: 9788190044103)

LIST OF PRACTICALS
SEMESTER 2

1. Find out the cellulase activity by using CMC as substrate.
2. To determine Km &Vmaxof alpha amylase.
3. To study the effect of pH, temperature on alpha amylase activity.
4. To study the effect of activators and inhibitors on alpha amylase activity.
5. Immobilization studies:Preparation of urease/Amylase entrapped in alginate beads and determination of percent entrapment
6. Ultraviolet irradiation survival curve.
7. Perform chemical mutagenesis.
8. Isolation of mutants: Respiratory deficient.
9. Sequence retrival systems for Nucleic acid and Proteins
10. To Study the protein Structure database (PDB)
11. Sequenc based search analysis by BLAST
12. Any two EMBOSS applications for nucleiotide and protein sequence analysis.
13. Sequence analysis by Multiple sequences alignment.
14. Computer assisted oligonucleotide primer designing.
15. Rasmol application for protein structure visualization. (Demonstration)
16. Protein Secondary structure prediction
17. Homology modeling: SwissModel

M.Sc. Semester – III

MB-301: Fermentation Technology & Bioprocess Engineering

Objective: This course is designed to impart the knowledge of basic principle of fermentation process. Which help students to design, develop and operate industrial level fermentation process along with the engineering aspects of bioprocess with rheological behavior of fluids and mass transfer.

UNIT 1	**Microbial growth kinetics & Fermentor control systems**		
	Reference: Stanbury	**Teaching Duration**	**Lectures: 08**
1.1	Batch culture		
1.2	Continuous culture		
1.3	Multistage & Feedback systems		
1.4	Fed-batch culture.		
1.5	Methods of measuring process variables		
1.6	On-line analysis of other chemical factors.		
1.7	Control systems		

UNIT 2	**Strain improvement & Recovery of fermentation product**		
	Reference: Stanbury	**Teaching Duration**	**Lectures: 08**
2.1	Strain improvement (**Nduka Okafor)**		
2.2	Removal of microbial cells and other solid matter.		
2.3	Cell disruption		
2.4	Liquid-liquid extraxtion		
2.5	Solvent recovery		
2.6	Two phase solvent extraction		
2.7	Chromatography		
2.8	Membrane processes		
2.9	Drying		
2.10	Crystalization		
2.11	Whole broth processing		

UNIT 3	**Fluid flows and mixing**		
	Reference: Doran	**Teaching Duration**	**Lectures: 08**
3.1	Classification of fluids.		
3.2	Fluids in motion		
3.3	Viscosity.		
3.4	Momentum transfer		
3.5	non-newtonian fluids		
3.6	viscosity measurement		
3.7	Rheological properties of fermentation broth.		

3.8	Factors affecting broth viscosity.
3.9	Mixing.
3.10	Power requirement for mixing.
3.11	Scale-up of mixing system.

UNIT 4	**Mass transfer**		
	Reference: Doran	**Teaching Duration**	**Lectures: 07**
4.1	Molecular diffusion.		
4.2	Role of diffusion in bioprocessing.		
4.3	Convection mass transfer.		
4.4	Oxygen uptake in cell culture.		
4.5	Mass transfer correlation.		
4.6	Measurement of Kla.		

Reference:

1. Stanbury P.F., Whitaker A., Hall S.J.,(1997) *Principles of fermentation technology.* 2nd ED, Aditya books(P) Ltd, New Delhi.
2. Okafor N. (2007) *Modern industrial microbiology and biotechnology,* Science publishers, USA.
3. Doran P.M. (2008) Bioprocess engineering principles, Academic press, California.

Further Reading:

1. Shuler M. L. and Kargi F. (2003) *Bioprocess engineering Basic concepts*, 2nd ED, Pearson education Pvt Ltd, India.
2. Bailey J. S. and Bhatia S.C. (2009) Biochemical engineering. CBS publishers & distributors, India.
3. Moo-Young M. (2004) Comprehensive biotechnology, Vol- 1 to 4, Pergamon press Ltd, England.

302: Industrial Microbiology

Objective: Industrial microbiology is a branch of applied microbiology in which microorganisms are used in industrial processes; for example, in the production of high-value products such as drugs, chemicals, fuels and food product. This paper explains production and processes of various microbial metabolites at industrial scale by use of microbes.

UNIT 1	**Industrial production of Biomolecules**		
	Reference: Flickinger	**Teaching Duration**	**Lectures: 08**
1.1	Antibiotics: Cephalosporin and Streptomycin		
1.2	Organic acids: Citric acid and Lactic acid Ref: Ratledge		
1.3	Amino acids: Glutamic acid and L-Lysine		
1.4	Enzymes: Amylase and Protease		
1.5	Hormones: Erythropoietin and Human Insulin		
1.6	Immuno therapeutic: Monoclonal Antibody production and Recovery		
1.7	Anticancer agent: Anthracyclines		

UNIT 2	**Modern trends in microbial production -1**		
	Reference: Flickinger	**Teaching Duration**	**Lectures: 08**
2.1	PHA: Sseparation, purification, and manufacturing Methods		
2.2	Food grade pigments Ref: Dufossé L		
2.3	Biosurfactant Ref: Lederberg J.		
2.4	1, 2 pentane diols (Optically active 1,2 diols)		
2.5	Nitrile Hydratase (Acrylamide)		

UNIT 3	**Modern trends in microbial production-2**		
	Reference: Nduka Okafor	**Teaching Duration**	**Lectures: 08**
3.1	Biocatalyst: Immobilized enzymes and immobilized cells		
3.2	Production of microbial insecticides		
3.3	Manufacture of *Rhizobium* inoculants		
3.4	Techniques and technology to produce biomass of cyanobacteria and Microalgae Ref; Rhem and Reed		
3.5	Cyanobacteria and Microalgae exploitation Ref; Rhem and Reed, Vol 10		

UNIT 4	Microbial production of Food and Beverages		
	Reference: Prescott & Dunn	**Teaching Duration**	**Lectures: 07**
4.1	Fermented Milk Products		
4.1.1	Cheese		
4.1.2	Yogurt		
4.1.3	Kefir		
4.2	Fermented Soy Products Ref: Flickinger		
4.2.1	Soy sauce		
4.2.2	Soy paste		
4.2.3	Tempeh		
4.2.4	Natto		
4.2.5	Tofu		
4.3	Wine and Brandy Ref; Rhem and Reed, Vol 9		

References:

1. Moo-Young, M. *et al* (1985) *Comprehensive Biotechnology: The Practice of Biotechnology: Current Commodity Products.* Pergamon.

2. Flickinger, M. & Drew, S.(1999) *Encyclopedia of Bioprocess Technology,(Volumes 1 - 5)* Wiley-Interscience.

3. Ratledge, C. & Kristiansen, B.(2006) *Basic Biotechnology 3Ed.* New Delhi: Cambridge University Press.

4. Lederberg, J. (2000) *Encyclopedia of Microbiology, 2Ed (Volumes 1 to 4).Academic Press.*

5. Reed, G.(1981) *Prescott and Dunn's Industrial Microbiology.* Chapman & Hall.

6. Dufossé, L.(2006): *Food Grade Pigments.* Food Technol. Biotechnol. 44 (3) 313–321.

7. Nduka Okafor, (2007): *Modern Industrial Microbiology and Biotechnology.* Science pulishers, Enfield, NH, USA

8. H.J. Rehm and G.Reed (2010) *Biotechnology*. (Vol 9) Wiley India Pvt. Ltd.

9. H.J. Rehm and G.Reed (2010) *Biotechnology*. (Vol 10) Wiley India Pvt. Ltd.

MB-303: Molecular Pathogenesis and Immunology

Objective: This paper focuses on principles of immunology, molecular pathogenesis, immunotechnology and uses in immunotherapy. It also throws light on understanding and studying molecular pathogenesis of the disease causing organisms which lends helping hands to therapy, control of transmission, vaccine development and to the science of immunology. This paper is planned to acknowledge the students regarding advances in immunology, immunotechnology and immunotherapy.

UNIT 1	**Receptor Biology**		
	Reference: Abbas	**Teaching Duration**	**Lectures: 08**
1.1	The Major Histocompatibility Complex		
1.1.1	Structure of MHC molecules		
1.1.2	Genomic organization of MHC		
1.1.3	Antigen processing & presentation MHC I & II molecules.		
1.2	T-cell receptor		
1.2.1	T cell receptor complex: TCR-CD and accessory membrane molecules		
1.2.2	T cell activation		
1.3	B-cell receptor		
1.3.1	The B cell receptor and co-receptor complex		
1.3.2	Signal transduction by BCR		
1.3.3	Second signals for B cells provided by complement receptors		
1.3.4	Presentation of protein antigens by B lymphocytes to helper T cells		
1.3.5	Helper Tcell mediated activation of B lymphocytes		

UNIT 2	**Immunotherapy**		
	Reference: Paul	**Teaching Duration**	**Lectures: 08**
2.1	A major goal for immunotherapy - Immunotolerance.		
2.2	Cellular therapeutics		
2.3	Antibody therapeutics		
2.4	Engineered antibodies for therapy		
2.5	Engineering antibodies for cancer therapy		
2.6	Immunomodulators and their application in cancer (Paul 5th ed.)		
2.7	Cytokines and their application in cancer (Paul 5th ed.)		
2.8	Immunoconjugates and their application.		

Unit-3	Molecular Pathogenesis		
	Reference: MIMS	**Teaching Duration**	**Lectures: 08**
3.1	Attachment and Entry of microorganisms in to the body		
3.1.1	Enteropathogenic *E. coli*		
3.1.2	Phagocytosis in polymorhonuclear leucocytes		
3.1.3	Phagocytosis in macrophages		
3.1.4	Consequences of defects in the phagocytic cell		
3.2	The spread of microbes through the body		
3.2.1	Microbial factors promoting spread		
3.2.2	Spread via lymphatics		
3.2.3	Spread via the blood		
3.3	Antigenic variation		
3.4	Mechanisms of tissue and cell damage		
3.4.1	Microbial toxins		
3.5	Host and Microbial factors Influencing Susceptibility		
3.5.1	Genetic Factors in the Microorganisms		
3.5.2	Genetic Factors in the Host		
3.5.3	Pathogenesis of animal virus (Hepatitis)		

UNIT 4	Molecular Plant Pathology		
	Reference: Mehrotra and Agarios	**Teaching Duration**	**Lectures: 07**
4.1	Host pathogen interaction Ref. Mehrotra and Agarios		
4.2	Genetics of virulence in pathogens and of resistance in host plant.		
4.3	Horizontal and vertical resistance, Disease Escape		
4.4	Examples of molecular genetics of selected plant diseases : Powdery mildew		
4.5	and Rice blast		
4.6	Compatible and incompatible reactions		
4.7	Recognition of host and gene for gene concept Ref. Flor and Agarios		
4.8	Resistance genes of plants, Signal transduction between pathogenicity and resistance genes, Signaling and regulation of programmed cell death		
4.9	Pathogenesis of plant virus (TMV)		

References:

1. Murray, P. (2003). *Manual of Clinical Microbiology Vol-1*, 8th Ed. ASM Press.
2. Mims, C. A. *et al* (2000).*MIMS' Molecular pathogenesis of Infectious Disease,5th Ed.* Academic Press.
3. Pa005) *Plant Pathology: Pathogen and Plant disease*, S. Chand & Company Ltd. New Delhi. ehrotra, R. S. and Aggarwal, A. (2007) *Plant Pathology*, 2nd Ed., Tata McGraw-Hill Publishing Company Limited New Delhi.
5. Agarios, G. N. (2005). *Plant Pathology*, 5th ed. Elsevier.

6. Flor, H. H. (1971). Current status of the gene-for-gene concept. *Ann. Rev. Phytopath.,* 9:275-296.
7. Mitra, S. (2007). *Genetic Engineering-Principles and Practise*. Macmillan India Ltd, New Delhi.
8. Kindt, T; Osborne, B.& Goldsby, R.(2006) *Kuby Immunology 6Ed.* W. H. Freeman.
9. Janeway, C. *et al*. (2004) *Immunobiology 6 Ed.* Garland Science.
10. Lichtman, A. & Abbas, A.(2003) *Cellular and Molecular Immunology 5Ed.*Saunders.
11. Paul, W. (1999) *Fundamental Immunology 4Ed.* Lippincott Williams & Wilkins.

MB-304: ADVANCES IN PHARMACEUTICAL MICROBIOLOGY

Objective: This paper gives insight of microbiological analysis and quality control in pharmaceutical industries. It includes the learning of good manufacturing practices and its monitoring in pharmaceutical companies.

UNIT 1	**MICROBIOLOGICAL ASSAY FOR PHARMACEUTICAL ANALYSIS**		
	Reference: Ref: W. Hewitt	**Teaching Duration**	**Lectures: 08**
1.1	Microbiological assay		
1.2	The agar diffusion assay: Its quantitative basis		
1.3	The theory and practice of Tube assays for growth promoting substances		
1.4	The theory and practice of Tube assays for growth inhibiting substances		
1.5	Standard reference materials		

UNIT 2	**MONITORING MICROBIOLOGICAL QUALITY**		
	Reference: Denyer, S.P	**Teaching Duration**	**Lectures: 08**
2.1	Good manufacturing practice and good industrial large scale practice **Ref: Flickinger**		
2.2	Monitoring microbiological quality – Conventional testing methods		
2.3	Monitoring microbiological quality – Application of rapid methods		

UNIT 3	**MICROBIAL ASPECTS OF PHARMACEUTICAL PROCESSING**		
	Reference: Hugo and Russell's	**Teaching Duration**	**Lectures: 08**
3.1	Microbial spoilage and preservation of pharmaceutical products		
3.2	Sterilization control and sterility assurance		
3.3	The quality assurance and quality control of pharmaceutical products		

UNIT 4	**PHARMACEUTICAL MICROBIOLOGY**		
	Reference: Denyer, Walsh, Gad	**Teaching Duration**	**Lectures: 07**
4.1	Pharmaceuticals, biologists and biopharmaceuticals r**ef: G. Walsh**		
4.2	Bioinformatics and Pharmacogenomics for developing information – Based medicine and pharmacotyping in health care management **Ref: Gad**		
4.3	Microbiological auditing **Ref: Denyer, S.P**.		

Reference:

1. Denyer, S. P. and Baird, R. M. (2008). *Guide to microbiological control in pharmaceuticals*

and medical devices. 2nd Edition, CRC Press, Boca Raton.
2. Flickinger, M. C. and Drew, S. W. (1999). *Encyclopedia of Bioprocess Technology.* Wiley-Interscience, New Jersey.
3. Barredo, J. L. (2005). *Microbial Processes and Products.* Humana Press, New Jersey.
4. Gad, S. C. (2007). *Handbook of Pharmaceutical Biotechnology.* Wiley-Interscience, New Jersey.
5. Hugo and Russell's(2007). *Pharmaceutical Microbiology*, Blackwell Publishing.
6. Walsh, G. (2007). *Pharmaceurcal Biotechnolog- Concepts and Applications*, Wiley.
7. Hewitt,W.(2004). *Microbiological Assays for Pharmaceutical Analysis-A rational approach*, Indian Edition, CRC.

LIST OF PRACTICALS
SEMESTER 3

1. Screening of citric acid and lactic acid producing microorganisms.
2. Screening of cellulase, amylase and protease producing microorganisms.
3. Production of fungal amylase by solid state or submerged fermentation.
4. Partial purification of amylase by ammonium sulphate precipitation and dialysis/column chromatography and calculation of specific activity & fold purification.
5. Determination of *KLa* of laboratory fermenter.
6. Sterility testing of pharmaceutical products by direct inoculation & membrane filtration methods as per Indian Pharmacopoeia (IP).
7. Cell disruption by sonication and estimation of intra cellular protein.
8. Comparison of ethanol production using pure carbohydrate and agro industrial waste.
   a) Determination of pH, TSS (0Brix).
   b) Determination of alcohol (ethanol) percentage.
   c) Determination of phenol content.
   d) Estimation of reducing & total sugar.
9. Microbial production of dextran by *Leuconostoc mesenteroides.* (Estimation of reducing & total sugar, Dextransucrase activity, extraction of dextran, pH, Characterization by TLC and viscosity)
10. ELISA detection of anti-HIV sera.
11. ELISA detection of HBsAg.

M.Sc. Semester - IV

MB-401	Seminar Presentation
	➢ Students have to individually deliver a seminar on the advance or novel topic other than that mentioned in the curriculum. ➢ Topic should not be related to his/her dissertation. ➢ Maximum number of presentation slide should not exceed **25**. ➢ A topic should be explained within **12 minutes,** followed by counter questions from the examiners for **3 minutes**. ➢ Students have to submit one copy of colour printed handouts (**4 slides /page**) of his/her presentation to the examiner.
MB-402	**Report on Industrial Visit OR participation in Conference OR Symposium**
	➢ Students have to individually submit a printed copy of the report on Industrial visits and their participation in Conference/Symposium as per the prescribed format given below: ➢ **Industrial Visit:** • Profile of industry and including its management. • Product profile. • Flow sheet diagram of the entire process under taken. • List of instruments & process observed along with their significance. • Summary. • Proof of visit (Photographs/Images) ➢ **Conference / Symposium:** • Details of the Organizer & the Sponsor. • Scope of the conference. • List of resource person. • Abstract of topics delivered by them. • Category of theme covered in conference along with number of participants. • Knowledge enrichment and value addition from the proceedings. • Type of involvement/role of the student participant.
MB-403	**Review Article**
	➢ **Review Article** • Students will be individually allotted a research paper for review. • The selected paper should be from a reputed peer reviewed journal having ISSN. • Selected Research paper should have been published during the last five years. • The research paper should not exceed 15 pages including

	references. • Students have to answer the questionnaire as per the attached format and submit it to the department.
MB-404	**Project/Dissertation**
	➢ Project work should be done individually on any topic of importance related to the subject. ➢ Project may be done in-house or at a recognized institution outside the campus as specified in the guidelines. ➢ The concerned candidates have to submit their Project/Dissertation in a standard Hard-Bound thesis format. ➢ The Thesis will be evaluated by an external examiner. ➢ The Project/Dissertation must be presented in a Power-Point Presentation by the concerned candidates within **15 minutes** during their Dissertation Viva

QUESTIONNAIRE FOR REVIEW OF PAPER

INTRODUCTION

1. Is the information provided in the 'Introduction' section helps to understand the problem?
2. State the reasons for performing this study.
3. Define the objectives/hypothesis of the research.

METHODS

4. Can you suggest other samples, if applicable, that can be taken for the prescribe study to get the similar results?
5. Find other methods, if applicable, that can be appropriately used to fulfill the aim of the study.
6. Have you understood the rationale for the selection of technique(s) /method(s) in the given study?
7. Can you suggest alternate technique(s) /method(s), if applicable, that can be use to perform same analysis with its pros and cons?
8. Has sufficient information been provided to carry out the experiment? Do you think of any further information?
9. Can you think of additional experiments for this paper?

RESULTS AND DISCUSSION

10. Is all the essential data represented in form of figures and tables?
11. Is there any duplication/repetition of work in the form of tables or graphs?
12. What are the limitations of the study carried out?

CONCLUSION

13. Report the conclusion of the study supported by appropriate evidence from 'Literature Review'.
14. Can you suggest the name of any other journal for this type of publication?
15. Suggest a 'Future Line of Investigation' for this type of research.

Guidelines and Rules for Dissertation

Standard Format / Style of Submission of Manuscripts

Submission of all manuscripts/thesis should be in a single MS Word file strictly adhering to the following parameters:

1. Thesis is to be printed in Times New Roman typing.
2. Font size to be kept 12.
3. Line Spacing should be 1.5
4. Thesis should contain:
   - **a)** Title page with the name(s) of the candidate, their Examination Seat Number, Name of the supervising teacher and the Name of the institute.
   - **b)** Authentication certificate of the institute.
   - c) Declaration
   - **d)** Acknowledgement.
   - **e)** Chapter wise Index with Sub-heads and page numbers.
   - **f)** Introduction (Maximum 05 Page).
   - **g)** Review of Literature. (Maximum 15 Page)
   - **h)** Aim & Objectives
   - **i)** Materials and Methods.
   - **j)** Results and Discussion.
   - **k)** Conclusion
   - **l)** Future line of investigation
   - **m)** Appendix
   - **n)** References.
5. All tables, charts, images should be at their appropriate places.

Figures & Tables: Each figure/table Should be numbered, titled. The position of figure or table should be placed at an appropriate place within the article only.

Project may be carried out in-house, or the student, after due sanction from the supervising teacher and institute, can opt for pursuing dissertation at following recognized institutions or industries like:

1. Any UGC recognized University PG departments.

2. Any Agriculture University.
3. All National and State level research institute.
4. ISO or FDA/USFDA industry or research center having R & D and Q.C. facilities.

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