

SU/BOS/Science/497

Date: 10/07/2023

To,

The Principal, All Concerned Affiliated Colleges/Institutions Shivaji University, Kolhapur	The Head/Co-ordinator/Director All Concerned Department (Science) Shivaji University, Kolhapur.
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Subject: Regarding syllabi of M.Sc. Part-II (Sem. III & IV) as per NEP-2020 degree programme under the Faculty of Science and Technology.

Sir/Madam,

With reference to the subject mentioned above, I am directed to inform you that the university authorities have accepted and granted approval to the revised syllabi, nature of question paper and equivalence of M.Sc. Part-II (Sem. III & IV) as per NEP-2020 degree programme under the Faculty of Science and Technology.

M.Sc.Part-II (Sem. III & IV) as per NEP-2020			
1.	Microbiology (HM)	8.	Food Science & Nutrition
2.	Pharmaceutical Microbiology (HM)	9.	Food Science & Technology
3.	Microbiology	10.	Biochemistry
4.	Computer Science	11.	Biotechnology
5.	Computer Science (Online Mode)	12.	Medical Information Management
6.	Data Science	13.	Environmental Science
7.	Information Technology (Entire)	14.	Physics

This syllabus, nature of question and equivalence shall be implemented from the academic year 2023-2024 onwards. A soft copy containing the syllabus is attached herewith and it is also available on university website www.unishivaji.ac.in

The question papers on the pre-revised syllabi of above-mentioned course will be set for the examinations to be held in October /November 2023 & March/April 2024. These chances are available for repeater students, if any.

You are, therefore, requested to bring this to the notice of all students and teachers concerned.

Thanking you,



Dy Registrar
Dr. S. M. Kubal

Copy to:

1	The Dean, Faculty of Science & Technology	8	P.G. Admission/Seminar Section
2	Director, Board of Examinations and Evaluation	9	Computer Centre/ Eligibility Section
3	The Chairman, Respective Board of Studies	10	Affiliation Section (U.G.) (P.G.)
4	B.Sc. Exam/ Appointment Section	11	Centre for Distance Education

Choice Based Credit System with Multiple Entry and Multiple Exit Option (NEP-2020)
M.Sc. Programme Structure
M.Sc. Part – II (Level-9)
M.Sc. Pharmaceutical Microbiology (Horizontal Mobility) CBCS Pattern

SEMESTER-III (Duration- Six month)											
	Sr. No.	Course code	Teaching Scheme			Examination Scheme					
			Theory and Practical			University Assessment (UA)			Internal Assessment (IA)		
			Lectures (per week)	Hours (per week)	Credit	Maximum Marks	Minimum Marks	Exam. Hours	Maximum Marks	Minimum Marks	Exam. Hours
CGPA	1	CC-301: Genetic Engineering	4	4	4	80\$	32	3	20	8	1
	2	CCS-302: Microbial Diversity and Extremophiles	4	4	4	80\$	32	3	20	8	1
	3	CCS-303: Pharmaceutical Microbiology	4	4	4	80\$	32	3	20	8	1
	4	DSE-304: Immunology	4	4	4	80\$	32	3	20	8	1
	5	CCPR-305: Laboratory Course	16	16	8	200*	80	-	-	-	#
Total (C)			-	-	24	520	-	-	80	-	-
Non-CGPA	1	AEC-306	2	2	2	-	-	-	50	20	2
	2	EC (SWMMOOC)-307 Food Microbiology and Food Safety	Number of lectures and credit shall be as specified on SWAYAM MOOC								
SEMESTER-IV (Duration- Six month)											
CGPA	1	CC-401: Quality Management and IPR	4	4	4	80\$	32	3	20	8	1
	2	CCS-402: Fermentation Technology and Process Designing	4	4	4	80\$	32	3	20	8	1
	3	CCS-403: Bioinformatics	4	4	4	80\$	32	3	20	8	1
	4	DSE-404: Medical Microbiology	4	4	4	80\$	32	3	20	8	1
	5	CCPR-405:Laboratory Course and Project	16	16	8	200*	80	-	-	-	#
Total (D)			-	-	24	520	-	-	80	-	-
Non-CGPA	1	SEC-406	2	2	2	-	-	-	50	20	2
	2	GE-407: Basics of Microbiology	2	2	2	-	-	-	50	20	2
Total (C + D)			-	-	48	1040	-	-	160	-	-

1. *Practical Examination will be internal/external as per department choice
2. \$ Question no. 1 of each question paper will be subjective (short answer question instead of objective)
3. # Duration of Practical Examination will be 5 days (1 inspection day and 4 Practical days)

<ul style="list-style-type: none"> • Student contact hours per week : 32 Hours (Min.) 	<ul style="list-style-type: none"> • Total Marks for M.Sc.-II : 1200
<ul style="list-style-type: none"> • Theory and Practical Lectures : 60 Minutes Each 	<ul style="list-style-type: none"> • Total Credits for M.Sc.-II (Semester III & IV) : 48
<ul style="list-style-type: none"> • CC-Core Course • CCS- Core Course Specialization • CCPR-Core Course Practical and Project • DSE-Discipline Specific Elective • AEC-Mandatory Non-CGPA compulsory Ability Enhancement Course • SEC- Mandatory Non-CGPA compulsory Skill Enhancement Course • EC (SWM MOOC) - Non-CGPA Elective Course • GE- Multidisciplinary Generic Elective 	<ul style="list-style-type: none"> • Practical Examination is annual. • Examination for CCPR-305 shall be based on Semester III Practical's. • Examination for CCPR-405 shall be based on Semester IV Practical's. • *Duration of Practical Examination as per respective BOS guidelines • <i>Separate passing is mandatory for Theory, Internal and Practical Examination</i>
<ul style="list-style-type: none"> • Requirement for Entry at Level 9: Completed all requirements of the relevant Post Graduate Diploma (Level 8) in Diploma in Pharmaceutical Microbiology (HM) 	
<ul style="list-style-type: none"> • Exit at Level 9: Students will exit after Level 9 with Master's Degree in Pharmaceutical Microbiology (HM) if he/she completes the courses equivalent to minimum of 96 credits. 	

	M.Sc.-I	M.Sc.-II	Total
Marks	1200	1200	2400
Credits	48	48	96

I. CGPA course:

1. There shall be 10 Core Courses (CC)per programme.
2. There shall be 04 Core Course Practical's (CCPR) per programme.
3. There shall be 04 Core Course Specialization (CCS)of 16 credits per programme.
4. There shall be 02 Discipline Specific Elective (DSE) courses of 08 credits per programme
5. Total credits for CGPA courses shall be of 96 credits per programme

II. Mandatory Non-CGPA Courses:

1. There shall be 02 Mandatory Non-CGPA compulsory Ability Enhancement Courses (AEC I and II) of 02 credits each per programme.
2. There shall be 02 Mandatory Non-CGPA compulsory Skill Enhancement Course (SEC I and II) of 02 credits per program.
3. There shall be one Elective Course (EC) (SWAYAM MOOC). The credits of this course shall be as specified on SWAYAM MOOC.
4. There shall be one Generic Elective (GE) course of 02 credits per programme. Each student has to take generic elective from the department other than parent department.
5. The total credits for Non-CGPA course shall be of 08 credits + 2-4 credits of EC as per availability.
6. The credits assigned to the course and the programme are to be earned by the students and shall not have any relevance with the work load of the teacher.

Shivaji University, Kolhapur



Accredited By NAAC with 'A++' grade with CGPA 3.52

Syllabus for

Master of Science (M.Sc.)

In

Pharmaceutical Microbiology (NEP-2020) (HM)

(Under Faculty of Science and Technology)

Part II

(Subject to modifications to be made time to time)

Syllabus to be implemented from 2023-2024

M.Sc. Pharmaceutical Microbiology (NEP-2020) (HM)

Part - II Syllabus

SEMESTER III	
CC-301	: Genetic Engineering
CCS-302	: Microbial Diversity and Extremophiles
CCS-303	: Pharmaceutical Microbiology
DSE-304	: Immunology
CCPR-305	: Laboratory Course
AEC-306	: Mandatory Non-CGPA compulsory: Ability Enhancement Course
EC-307 (SWMMOOC)	: Non-CGPA Elective Course: Food Microbiology and Food Safety
SEMESTER IV	
CC-401	: Quality Management and IPR
CCS-402	: Fermentation Technology and Process Designing
CCS-403	: Bioinformatics
DSE-404	: Medical Microbiology
CCPR-405	: Laboratory Course and Dissertation (Project)
SEC-406	: Mandatory Non-CGPA compulsory Skill Enhancement Course
GE-407	: Generic Elective: Basics of Microbiology

SEMESTER III

	CC-301: Genetic Engineering	60 Hrs
Credit I	<p>Basics Of Recombinant DNA Technology</p> <p>Restriction analysis: Types of restriction enzyme, Type I, II and III, restriction modification systems, type II restriction endonucleases and properties, isoschizomers and neoschizomers, mcr/mrr genotypes, Cohesive and blunt end ligation, linkers, adaptors, homopolymeric tailing.</p> <p>Labeling of DNA: Nick translation, random priming, radioactive and non-radioactive probes, use of Klenow enzyme, T4 DNA polymerase, bacterial alkaline phosphatase, polynucleotide kinase. Hybridization techniques: Northern, Southern, Western and Colony hybridization, Fluorescence in situ hybridization, Restriction maps and mapping techniques, DNA fingerprinting, chromosome walking & chromosome jumping.</p> <p>DNA-Protein Interactions: Electro mobility shift assay, DNase I footprinting, methyl interference assay.</p>	15 Hrs
Credit II	<p>Cloning Vectors</p> <p>Gene Cloning Vectors: Plasmids (Natural and synthetic), bacteriophages, M13, MP vectors, phagemids, Lambda vectors; insertion and replacement vectors, EMBL, λDASH, λgt10/11, λZAP etc. Cosmid vectors. Artificial chromosome vectors (YACs, BACs), Animal Virus derived vectors- SV-40, vaccinia/baculo& retroviral vectors. Expression vectors; pMal, GST, pET-based vectors Baculovirus and <i>Pichia</i> vectors system.</p> <p>Applications: His-tag, GST-tag, MBP-tag etc. Restriction proteases, intein-based vectors. Inclusion bodies, methodologies to reduce formation of inclusion bodies.</p>	15 Hrs
Credit III	<p>Cloning Methodologies</p> <p>Insertion of Foreign DNA into Host Cells: Transformation, Transduction, Conjugation, Transfection: Chemical and physical methods, liposomes, microinjection, macroinjection, electroporation, biolistics, somatic cell fusion, gene transfer by pronuclear microinjection.</p> <p>Plant transformation technology: Basis of tumor formation, hairy root, features of Ti and Ri plasmids, mechanism of DNA transfer, role of virulence genes, use of Ti and Ri as vectors.</p> <p>Cloning and expression in yeasts (<i>Saccharomyces</i>, <i>Pichia</i> etc.), animal and plants cells, methods of selection and screening, cDNA and genomic cloning, expression cloning, yeast two hybrid system, phage display.</p> <p>DNA Libraries: Construction of cDNA libraries in plasmids and screening methodologies, Construction of cDNA and genomic DNA libraries in lambda vector, jumping libraries. Principles in maximizing gene expression.</p>	15 Hrs

Credit IV	<p>PCR Primer design, Fidelity of thermostable enzymes, DNA polymerases, Types of PCR: multiplex, nested, reverse transcriptase, real time, touchdown, hot start, colony, cloning of PCR products, T-vectors, proof reading enzymes, PCR in gene recombination, deletion, addition, overlap extension, and SOEing, site directed mutagenesis, PCR in molecular diagnostics, viral and bacterial detection, PCR based mutagenesis.</p> <p>Applications Sequencing methods: Enzymatic DNA sequencing, Chemical sequencing of DNA, principle of automated DNA sequencing, NextGene DNA sequencing Methods (SOLiD, Illumina and pyrosequencing), RNA sequencing, Chemical Synthesis of oligonucleotides.</p> <p>Gene silencing techniques: Introduction to siRNA and siRNA technology, micro RNA, construction of siRNA vectors, principle and application of gene silencing. CRISPR, CRISPR/Cas9 technology.</p> <p>Gene knockouts and Gene Therapy: Creation of knockout mice, disease model, somatic and germ-line therapy in vivo and ex-vivo, suicide gene therapy, gene replacement, gene targeting.</p> <p>Other applications: Transgenics, Genome projects and their implications, application in global gene expression analysis. Applications of recombinant DNA technology in medicine, agriculture, veterinary sciences and protein engineering.</p>	15 Hrs
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Suggested readings:

1. Sambrook J, Fritsch E. F. and Maniatis (1989) Molecular cloning, vol. I, II, III, II nd edition, Cold spring harbor laboratory press, New York.
2. DNA Cloning : A practical approach D.M. Glover and D.B. Hames, RL Press, Oxford, 1995
3. Molecular and cellular methods in Biology and Medicine, P.B. Kaufman, W. Wu , D. Kim and L.J. Cseke, CRC Press Florida 1995
4. Methods in Enzymology Guide to Molecular Cloning Techniques, Vol. 152 S.L. Berger and A. R. Kimmel, Academic Press Inc, San Diego, 1996
5. Methods in Enzymology Gene Expression Technology, Vol. 185D. V. Goeddel, Academic Press Inc, San Diego, 1990
6. DNA Science: A First Course in Recombinant Technology, D. A. Mickloss and G. A Freyer, Cold Spring Harbor Laboratory Press, New York, 1990
7. Molecular Biotechnology, 2nd Ed. S. B. Primrose, Blackwell Scientific publishers, Oxford, 1994
8. Milestones in Biotechnology, Classic Papers on Genetic Engineering, J. A. Davis and W. S. Reznikoff, Butterworth-Heinemann Boston 1992
9. Route Maps in Gene Technology, M. R. Walker, and R. Rapley, Blakwell Science, Oxford, 1997
10. Genetic Engineering : An Introduction to Gene Analysis and Exploitation in Eukaryotes, S. M. Kingsman, Blackwell Scientific Publications, Oxford, 1998

11. An Introduction to Genetic Engineering, 3rd Edition. Desmond S. T. Nicholl, Cambridge University press, 2008.
12. Gene Cloning and Manipulation, 2nd Ed. Cristopher Howe, Cambridge University Press, 2007.

	CCS-302: Microbial Diversity and Extremophiles	60 Hrs
Credit I	Microbial Ecology: Basic ecological principles, Ecosystems, Habitats, Ecological niches, microbial community, Population dynamics and ecosystem management, mathematical definitions and suitable examples of microbe-microbe interactions, microbe-plant interactions and microbe – animal interactions.	15 Hrs
Credit II	Microbial taxonomy: Brief study on: Algae: Classification, distribution, structure, nutrition and metabolism, reproduction, importance of Algae. Fungi; Classification, distribution, structure, nutrition and metabolism, reproduction, importance of Fungi. Protozoa ; Classification, nutrition, morphology, reproduction, of protozoa. Viruses; .General properties, classification and reproduction of viruses. Viroids and virusoids, Prions.	15 Hrs
Credit III	Study of types of Microbes with examples: Concept of autotrophy, Photosynthetic bacteria- Green sulphur bacteria, cyanobacteria classification characteristics of each class, Methanogens- class of Archeabacteria methanogens types and their classification, Methanotrophs- concept and classification, Nitrogen fixing bacteria- Concept of diazotrophy, Classification of N ₂ fixing bacteria as free living and symbiotic and their characteristics. Extremophiles: Concept, adaptation, habitat and significance of Acidophilic bacteria, Halophilic bacteria and Thermophilic bacteria.	15 Hrs
Credit IV	Microbial interactions with abiotic components and their applications: Other microbial interactions and its controls, with certain abiotic components of environment like wood, plastic, paints, rubber, pesticides, toxic heavy metals, etc.: Biodeteriorations, Bioremediations, Biotransformations and Biomagnifications and their significance with respect to environment and biodiversity. Role of microbes in secondary and tertiary recovery of petroleum.	15 Hrs

Suggested Readings:

1. Extremophiles (2000) By B.N.Johari, Springer Verlag
2. Microbial Diversity (1999) By D. Colwd, Academic press

3. Microbial Ecology (1979) By J.M. Lynch and N.J.Poole, Blackwell Scientific Publications, Oxford.
4. Introduction to Modern Virology (2001) eds.: N.J.Dimmock and K.N.Leppard, Blackwell Scientific Publications, Oxford.

	CCS-303: Pharmaceutical Microbiology	60 Hrs
Credit I	Introduction to chemotherapeutic agents: History and development of chemotherapeutic agent, Properties of antimicrobial agents, Types of chemotherapeutic agents – Synthetic, Semisynthetic, Natural. Antibiotics: Types of antibiotics with their mode of action; antibacterial, antifungal, antiviral, antiprotozoal	15 Hrs
Credit II	Antibiotic resistance and development of new therapeutics: Development of antibiotic resistance, Mechanism of antibiotic resistance, Antimicrobial Peptides: History, properties, sources, mode of action, application. Phage therapy: introduction to phages, lytic cycle, types of phages involved in phage therapy Plant based therapeutic agents.	15 Hrs
Credit III	Sterilization and Microbial spoilage of pharma products: Microbial contamination spoilage and hazard: Sources of contamination, factors affecting survival and growth, breakdown of active ingredient and general formulations. Principles of sterilizations with respect to pharmaceutical industries. Methods of sterilizations: Steam, dry heat, Radiation, Gaseous and Filtration	15 Hrs
Credit IV	Preservation of Pharma Products: Principles of preservation: objectives of preservation, the ideal preservative, rational development of a product preservative system etc. Antimicrobial preservatives and their properties: antimicrobial activity, factors affecting antimicrobial activity, preservative monographs. Preservative stability and efficacy. methods of Preservative evaluation and testing	15 Hrs

Suggested Readings:

1. Pharmaceutical Microbiology – Edt. by W.B.Hugo & A.D.Russell Sixth edition. Blackwell scientific Publications
2. Prescott's Microbiology 8th Edition by Willey, Joanne, Sherwood, Linda, Woolverton, Chris.
3. Pharmaceutical Microbiology by Ashutosh Kar

	DSE-304 : Immunology	60 Hrs
Credit I	Immunology – fundamentals and anatomy of immune system A) Immunity – Innate and acquired immunity. Components of innate and acquired immunity. B) Antigen, Haptens, adjuvants, mitogens. Antibodies – structure, functions. C) The anatomy of the immune response: - Cells and organs of immune system. Regulation of immune response – Humoral and Cell mediated response.	15 Hrs
Credit II	Immunity to infection A) Antigen processing and presentation, MHC, complement system, T & B cell activation. B) Bacterial, viral, protozoal and parasitic infections with reference to (Diphtheria, influenza virus, malaria and helminthes) with specific representative examples of each group. C) Vaccines – Active and passive immunization, DNA vaccines, multivalent subunit vaccines, synthetic peptide vaccines.	15 Hrs
Credit III	Clinical Immunology A) Hypersensitivity: - Type I, II, III, and IV reactions. Autoimmunity – organ specific and systemic autoimmune diseases. Treatment of autoimmune diseases. B) Transplantation and tumor immunology: - Graft rejection, tissue typing, immunosuppressive therapy and clinical transplantation. Tumor antigens, cancer immunotherapy. C) Immunodeficiency diseases - Phagocytic, humoral, cell mediated deficiencies and SCID. AIDS- causes, syndrome, diagnostic tools, treatment and development of vaccine	15 Hrs
Credit IV	Immunotechnology A) Antigen antibody interactions – Principles, types and applications of agglutination, precipitation, complement fixation, viral neutralization, immunodiffusion, immunoelectrophoresis, ELISA and RIA. B) Monoclonal antibodies – Hybridoma technology and various cellular technologies. C) Automation in immunological techniques – auto analyzers used in immunology, FACS etc.	15 Hrs

Suggested readings:

1. Kuby : Immunology; RA Goldsby, Thomas J. Kindt, Barbara A. Osborne.
2. Immunology by Roitt I. M., Brostoff J. and Male D. Gower medical publishing London.
3. Fundamentals of immunology 4th ed., Paul 1999, Lippencott Raven.

	CCPR-305: Laboratory Course (120 hrs) 200 Marks
Part A	<ol style="list-style-type: none"> 1. Screening of antibiotic producers- crowded plate technique 2. Screening of organic acid producers & amine producers 3. Screening of Amylase, Protease & Lipase producers 4. Screening of Vitamin producers 5. Enrichment and isolation of pesticide resistant bacteria from soil 6. Isolation of thermophilic bacteria from soil 7. Isolation of acidophilic and alkalophilic bacteria from soil 8. Isolation of psychrophilic bacteria from soil 9. Isolation of halophilic and halotolerant bacteria 10. Determination of effective dilution of the given disinfectant to disinfect tables & vessels 11. Determination of effective dilution of the given disinfectant for effective disinfection of skin. 12. Determination of preservative effect of the given preservative 13. Determination of potability of the given water sample from microbiological point of view. 14. Estimation of heterotrophic bacterial count of the given sample. 15. Isolation of lysozyme from egg. 16. Staining Protocols: <ol style="list-style-type: none"> a) Grams Staining b) Endospore Staining c) Negative staining d) Flagella staining e) Capsule staining
Part B	<ol style="list-style-type: none"> 1. Fermentative production of gluconic acid. 2. Bioassay of streptomycin. 3. Fermentative production of wine 4. Maintenance and handling of cultures. 5. Standard Plate count 6. IMViC Test 7. MPN 8. Replica Plate technique 9. Rapid identification methods of bacteria 10. Production of citric acid by <i>Aspergillus niger</i> 11. Transformation 12. Conjugation 13. ELISA and Widal 14. Western blot. 15. Transduction 16. Protoplast fusion

	AEC-306 : Mandatory Non-CGPA compulsory Ability Enhancement Course	30 Hrs
Credit I	Syllabus and nature of paper will be opted as per committee decision.	15 Hrs
Credit II		15 Hrs

	EC (SWMMOOC) 307 : Non-CGPA Elective Course Food Microbiology and Food Safety	
Credit I	Syllabus and nature of paper will be opted as per swayam portal.	
Credit II		

SEMESTER IV

	CC-401: Quality Management and IPR	60 Hrs
Credit I	Quality Assurance: Introduction of quality assurance, GMP for: building (premises) for manufacture of drugs, Packaging material, Personnel, hygiene, sanitation, waste and disposal. Quality assurance and regulatory aspect for: import, export, manufacture and sale of drug and formulation clinical and nonclinical testing, animal trials. Records and documents: Records related to products release, Quality review, and Quality audits. Complaints and recalls.	15 Hrs
Credit II	Quality Control : Definition - Quality control basics. Quality control for: all instruments, clothing's, packing, processing line. Quality control of processes and products: pharmaceutical products including sterile injectibles, non injectibles, ophthalmic preparations and implants modified release products (controlled release, sustained release products, etc), parenterals.	15 Hrs
Credit III	Quality Management in pharmaceutical: Production Management and Documentation: ICH, ISO 9000 series, total quality management, validation for tablets and parenterals, practice of WHO GMP. Industrial Safety: Industrial hazards and their prevention, fire, accidents, mechanical and electrical equipments, industrial effluent testing. Drug stability: Solution stability, solid stability, parameters for physical stability testing, protocol for physical stability testing program, accelerated studies and shelf life assignment.	15 Hrs
Credit IV	Economics and intellectual property rights in pharma industries: Entrepreneurship, Financing R&D capital and market outlook. IP, BP, USP. Government regulatory practices and policies, FDA perspective. Reimbursement of drugs and biologicals, legislative perspective. Rational drug design. intellectual property rights, Introduction to patents,	15 Hrs

Suggested Readings:

1. Quality control in the Pharmaceutical Industry - Edt. by Murray S.Cooper Vol.2. Academic Press New York.
2. Sidney H Willing, Murray M, Tuckerman. Williams Hitchings IV, Good manufacturing of pharmaceuticals (A Plan for total quality control) 3rd Edition. Bhalani publishing house Mumbai.

3. Quality Assurance of Pharmaceuticals- A compedium of Guide lines and Related materials Vol I & II, 2nd edition, WHO Publications, 1999.
4. Good laboratory Practice Regulations – Allen F. Hirsch, Volume 38, Marcel Dekker Series, 1989.
5. The International Pharmacopoeia – vol I, II, III, IV & V - General Methods of Analysis and Quality specification for Pharmaceutical Substances, Expedients and Dosage forms, 3rd edition, WHO, Geneva, 2005

	CCS-402: Fermentation Technology and Process Designing	60 Hrs
Credit I	Microbial growth and fermentation: Microbial Growth and its measurement, fermentation media: composition, rheology and optimization, Gas diffusion: oxygen uptake and mass transfer, Strain improvement: isolation, preservation and strain improvement of industrially important microorganisms.	15 Hrs
Credit II	Fermenter design and process involved in fermentation: Fermenter design: materials and auxillary equipments of fermenter used in aeration, agitation and fermentation, sterilization methods of solid liquid and air media. Fermentation process control: Knowledge Based System (KBS), Genetic Algorithm (GA), Artificial Neural networks(ANN). Flux Control Analysis and Biosensors. Modeling of fermentation process.	15 Hrs
Credit III	Types of fermentation and process development: Types of fermentation Batch, fed-batch and continuous fermentation and their yield and growth Kinetics. Fermentation economics, Scale up and scale down, downstream processing. Effluent treatment of industrial waste: physical, chemical and biological methods.	15 Hrs
Credit IV	Microbial fermentations: Production of Microbial Enzymes, organic acids, amino acids. Fermentative production of Penicillin, Bacitracin, Streptomycin. Microbial production of Vit B12, Riboflavin, β -Carotene	15 Hrs

Suggested Readings:

1. Fermentation Microbiology and Biotechnology by M. El-Mansi and C. Bryce
2. Principles of Fermentation Technology by Whitekar, Stanbury and Hall Modelling and
3. Control of Fermentation Processes by J.R. Leigh
4. Microbial Technology, Microbial Processes, Second Edition/Volume I by H. J. Peppler, D. Perlman

	CCS-403: Bioinformatics	60 Hrs
Credit I	<p>Proteomics: Protein Sequence Databases and Analysis Protein sequence information, Primary protein sequence databases, Secondary protein sequence databases, Pair-wise sequence alignment, gaps, gap-penalties, scoring matrices, PAM250, BLOSUM62, local and global sequence alignment, multiple sequence alignment, physicochemical properties using ExPASy, Useful programme; Clustal W.</p> <p>Proteomics; Strutural Databases, Protein Structure Prediction Structural databases; Protein Data bank (PDB), Nucleic Acid Data Bank (NDB), Molecular modeling Data Bank (MMDB). Homology modeling, three-dimensional structure prediction, protein folding and functional sites.</p>	15 Hrs
Credit II	<p>Genomics: Nucleotide Sequence Databases And Analysis Human Genome project (HGP); rough and final draft of HGP, goals of the HGP, genomics. Nucleotide Sequence databases: GenBank, EMBL, DNA Data Bank of Japan (DDBJ). Restriction enzymes, REBASE, Polymerase chain reaction, primer designing, Next Generation Sequencing, application of BioEdit.</p> <p>Genomics: Gene Identification Genome information and special features, coding sequences (CDS), untranslated regions (UTR's), cDNA library, expressed sequence tags (EST), 16S rDNA gene sequencing. Approaches to gene identification; masking repetitive DNA, database search, codon-bias detection, detecting functional sites in the DNA. Internet resources for gene identification. Construction of maps, genetic map, physical map, BLAST.</p>	15 Hrs
Credit III	<p>Structural Biology Ribose-ring puckering, RNA folding, Ramachandran plot, prediction of α-helix, β-sheet, and 3_{10}-helix, loop modeling, 3-D structure validation, molecular docking, protein-ligand interactions, biophysical aspects of proteins and nucleic acids.</p> <p>Molecular Modeling Functions of molecular modeling. Molecular mechanics, force field, potential energy functions, energy minimization methods, single point calculations, full-geometry optimization, conformational search, , molecular dynamics simulations, molecular modeling packages.</p>	15 Hrs
Credit IV	<p>Microarrays Concept of microarrays; spotted arrays, oligonucleotide arrays, Applications of microarray technology. Tools and Techniques in proteomics; Isotope Coded Affinity Tags (ICAT), Mass spectroscopy for protein analysis, MALDI-TOF, Electrospray ionization (ESI), Tandem mass spectroscopy (MS/MS) analysis; tryptic digestion and peptide fingerprinting (PMF), profiling and diagnostics, drug target discovery.</p>	15 Hrs

	Phylogenetic Analysis Evolution, phylogenetic tree, methods of phylogenetic analysis; distance based and character based methods, phylogenetic analysis tool-Phylip.	
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Suggested Readings:

1. Introduction to Bioinformatics, (Atwood, T. K. and Parry-Smith, D. J).
2. An introduction to Computational Biochemistry. (C. Stain Tsai, A John Wiley and Sons, Inc., publications).
3. Developing Bioinformatics Computer Skills. (Cynthia Gibas and Per Jambeck).
4. Bioinformatics Methods and Applications Genomics, Proteomics and Drug Discovery. (Rastogi S. C. Mendiratta, and Rastogi P.)
5. Bioinformatics, Sequence and Genome Analysis by David Mount, Cold Spring Harbor Laboratory Press, NY, 2004.
6. NCBI Web site: <http://www.ncbi.nlm.nih.gov>

	DSE-404: Medical Microbiology	60 Hrs
Credit I	Virulence: Invasion of pathogens through the different immunological barriers of human body. Establishment of infection. Role of portal of entry of the pathogen. Antigenic variations and virulence. Microbial toxins and super antigens. Carriers of infections. Epidemiology of certain diseases like urino-genital infections, upper respiratory tract infections, dermatological infections and gastro intestinal tract infections. Loss of virulence by many pathogens on subculturing on artificial media.	15 Hrs
Credit II	Epidemiology: Spread of certain infections in a population. Concept of epidemic, endemic and pandemic spread. Role of socioeconomic conditions in spread of disease. Epidemiological methods- descriptive, analytical and experimental epidemiology. Measurement of infection rate.	15 Hrs
Credit III	Chemotherapy: Development of drug resistance amongst pathogens – antibiotic resistance mechanisms. Disease management methods. Different prophylactic and therapeutic methods in control of infections.	15 Hrs
Credit IV	Clinical Microbiology: Collection and transportation of pathological samples with special reference to samples like Cerebro Spinal Fluid (CSF), Sputum samples, Urine samples and swabs. Certain cultural techniques for pathogens like Dermatophytes, Salmonella, Meningococcus, Leptospira, Mycobacterium, Vibrio, Plasmodium spp, Wucheria bancrofti, and Ascaris lumbricoides. Rapid methods of identification of infection like ELISA, FAT, RIA and Western Blot techniques.	15 Hrs

Suggested reading:

1. Introduction to Microbiology by Prescott, Harley, Klein
2. Medical Microbiology by Ananthanaryan
3. Medical Microbiology by Dey and Dey

	CCPR- 405: Laboratory Course and Project (120 Hrs) (200 Marks)
Part A	<ol style="list-style-type: none">1. Environmental Monitoring : Air Sampling,2. Identification of bacteria using Specialized media3. Microbial Limit Test4. To determine MIC of various antibiotics.5. Sterility testing by Bacillus stearothermophilus6. Sampling of pharmaceutical products (syrups, suspensions, creams and ointments, ophthalmic preparations) for microbial contamination and load.7. Determination of phenol coefficient8. ELISA test9. AMES Test10. LAL test/ BET11. Documentation for in process and finished products.12. Detection of adulteration in common food.13. Detection of afla toxin in food and feed.14. Chemical analysis of food – pH, benzoate, sorbate and colour.15. Microbiological –MPN, Resazurin. Chemical – pH, fat, protein, sugar and ash,16. Physical – sp. gravity, different solid, test for grading of milk.17. Platform test in dairy industry – COB, alcohol precipitation, titrable Acidity test,18. Quantitative phosphatase test.19. Using RasMol through command line.20. Pair-wise sequence alignment.21. Multiple sequence alignment.22. Introduction of BioEdit.23. Construction of three-dimensional model by using SPARTAN.24. Model Building and Energy minimization.25. Molecular Docking and Drug designing
Part B	Research Project (100 Marks)

	SEC-406 : Mandatory Non-CGPA compulsory Skill Enhancement Course	30 Hrs
Credit I	Syllabus and nature of paper will be opted as per committee decision.	15 Hrs
Credit II		15 Hrs

GE-407: Mandatory Non-CGPA Generic Elective Course

Sr. No.	Generic Elective Title of the paper	Credits assigned to the paper	Semester for which course is offered	Eligibility
1.	Basics of Microbiology	2	IV	Masters in any stream

	GE-407: Basics of Microbiology	30 Hrs
Credit I	Introduction to Microbiology: Origins of Microorganisms, differences between eukaryotic and prokaryotic cells, Types of microorganisms, Beneficial and harmful activities of microorganisms. Bacterial cell structure and its physiology. Microbial growth: growth curves, Bacterial nutrition, Culture media	15
Credit II	Techniques in Microbiology: Pure culture techniques: streak plate, pour plate, spread plate, Microscopy. Isolation of aerobic and anaerobic bacteria, Control of microorganisms: different methods such as physical and chemical, disinfection, antimicrobial test. Stains and staining techniques: definition and types of stains, monochrome and Gram staining	15

Suggested readings:

1. Introduction to Microbiology by Prescott, Harley and Keim
2. Microbiology by Pelczar