Estd. 1962
"A++" Accredited by NAAC(2021)
With CGPA 3.52

SHIVAJI UNIVERSITY, KOLHAPUR - 416 004, MAHARASHTRA
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शिवाजी विद्यापीठ, कोल्हापूर - ४१६ ००४,महाराष्ट्र
दूरध्वनी - ईपीएबीएक्स - २६०९०००, अभ्यासमंडळे विभाग दुरध्वनी ०२३१—२६०९०९३/९४

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.

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. Biotechnology (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:** Advances in Plant Biotechnology	4	4	4	80$	32	3	20	8	1
	3	**CCS-303:** Fermentation Technology-I	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**	Number of lectures and credit shall be as specified on SWAYAM MOOC								
SEMESTER-IV (Duration- Six month)											
CGPA	1	**CC-401:** Animal Tissue Culture	4	4	4	80$	32	3	20	8	1
	2	**CCS-402A:** Advances in Genomics and Proteomics	4	4	4	80$	32	3	20	8	1
	3	**CCS-403:** Bioinformatics	4	4	4	80$	32	3	20	8	1
	4	**DSE-404A:** Nanobiotechnology **OR** **DSE-404B:** Fermentation Technology-II	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:** Gardening and Nursery Management Techniques	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)

• Student contact hours per week : **32** Hours (Min.)	• Total Marks for M.Sc.-II : **1200**
• Theory and Practical Lectures : **60** Minutes Each	• Total Credits for M.Sc.-II (Semester III & IV) : **48**
• 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	• 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 • ***Separate passing is mandatory for Theory, Internal and Practical Examination***
• **Requirement for Entry at Level 9:** **Completed all requirements of the relevant Post Graduate Diploma (Level 8) in Diploma in Biotechnology**	
• **Exit at Level 9:** Students will exit after Level 9 with **Master's Degree in Biotechnology** 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 programme.

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

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Syllabus for

Master of Science (M.Sc.)

In

Biotechnology

(Under Science Faculty)

Part II

(Subject to modifications to be made time to time)

Syllabus to be implemented from 2022-2023

MSc. Biotechnology Part II Syllabus

SEMESTER III

CC 301 : Genetic Engineering

CCS 302 : Advances in Plant Biotechnology

CCS 303 : Fermentation Technology-I

DSE 304 : Immunology

CCPR 305 : Laboratory Course
AEC 306 : Mandatory Non-CGPA compulsory Ability Enhancement Course
EC 307 : Non-CGPA Elective Course
(SWMMOOC) : Food Microbiology and Food Safety

SEMESTER IV

CC 401 : Animal Tissue Culture
CCS 402A : Advances in Genomics and Proteomics
OR
CCS 402 B : Microbial Fermentation Technology

CCS 403 : Bioinformatics
DSE 404 A : Nanobiotechnology
OR
DSE 404 B : Fermentation Technology– II
OR
CCPR 405 : Laboratory Course and Dissertation (Project)
SEC 406 : Mandatory Non-CGPA compulsory Skill Enhancement Course
GE 407 : Generic Elective: Gardening and Nursery management techniques'

	SEMESTER III	
	CC 301: Genetic Engineering	**60 Hrs**
Unit I	**Basics Of Recombinant DNA Technology** 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. Labeling of DNA:Nick translation, random priming, radioactive and non-radioactive probes, use of Klenow enzyme, T4 DNA polymerase, bacterial alkaline phosphatase, polynucleotide kinase.	**15 Hrs**

	Hybridization techniques: Northern, Southern, Western and Colony hybridization, Fluorescence in situ hybridization, Restriction maps and mapping techniques, DNA fingerprinting, chromosome walking & chromosome jumping. DNA-Protein Interactions: Electro mobility shift assay, DNase I footprinting, methyl interference assay.	
Unit II	**Cloning Vectors** 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/bacculo& retroviral vectors. Expression vectors; pMal, GST, pET-based vectors Baculovirus and *Pichia* vectors system. Applications: His-tag, GST-tag, MBP-tag etc. Restriction proteases, intein-based vectors. Inclusion bodies, methodologies to reduce formation of inclusion bodies.	**15 Hrs**
Unit III	**Cloning Methodologies** 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. 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. Cloning and expression in yeasts (Saccharomyces, Pichia etc.), animal and plants cells, methods of selection and screening, cDNA and genomic cloning, expression cloning, yeast two hybrid system, phage display. 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.	**15 Hrs**
Unit IV	**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. **Applications**	**15 Hrs**

	Sequencing methods: Enzymatic DNA sequencing, Chemical sequencing of DNA, principle of automated DNA sequencing, NextGene DNA sequencing Methods (SOLiD, Ilumina and pyrosequencing), RNA sequencing,Chemical Synthesis of oligonucleotides. 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. 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. 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.	

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. Goedel, 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: Advances in Plant Biotechnology	60 Hrs
Unit I	**Plant protection:** Diseases of field, vegetable, orchard and plantation crops of India and their control; causes and classification of plant diseases; principles of plant disease control biological control of diseases; seed health testing, Integrated pest management-concepts and components; host plant resistance-biological control of insect pests; genetic manipulation of insects for their control; pesticides, their formulation, classification and safe use; behavioural methods; insect growth regulators; biotechnological approaches in IPM	**15 Hrs**
Unit II	**Secondary metabolites:**Concept of secondary metabolites, their applications in agriculture and health industry.*In vitro* production of secondary metabolites: introduction to secondary metabolism, significance of cell differentiation, selection, downstream processing, influence of culture conditions on accumulation of secondary metabolites, immobilization of cells for enhanced production of secondary products, biotic and abiotic elicitation. Different techniques involved in isolation, purification and characterization of useful secondary metabolites from cultured cells	**15 Hrs**
Unit III	**Transgenic techniques in plant biotechnology:** introduction of foreign gene into plants, basics of tumor formation, hairy root culture and its uses, features of Ti &Ri plasmid, mechanism of DNA transfer, role of virulence gene, use of reporter gene, multiple gene transfers, vector less or direct DNA transfer, particle bombardment, electroporation, microinjection, chloroplast transformation. Applications of plant transformation for enhancing resistance to pests, productivity & performance, nutritional value, modification of ornamental plants, bioengineered food, edible vaccines, plantibodies, biopharming.	**15 Hrs**
Unit IV	**Functional Food:** What is functional food? Functional food from plant sources, safety issues. Algal and Moss biotechnology: Biotechnological importance of algae, Growth in laboratory, algal farming, Techniques involved in algae biotechnology, Genetic engineering of algae for enhanced production of industrially important products, Biotechnology involving *Cyanobacteria*. Biofuels.Synthetic Biology: Introduction and applications in PTC	**15 Hrs**

Suggested Readings

1. Slater, Plant Biotechnology, OUP
2. H.E Street(ed): Tissue culture and Plant science, Academic press,London, 1974
3. M.K.Sateesh, Biotechnology-5 Animal cell biotechnology Immune biotechnology Plant biotechnology New Age Int Publishers,2003
4. Concepts in Biotechnology D. Balasubramaniam, Bryce, Dharmalingam, Green, Jayaraman Univ. Press, 1996

	CCS 303 : Fermentation Technology-I	**60 Hrs**
Unit I	**Upstream Processing** Microbial cell growth, kinetics and stoichiometry, various methods for growth measurement, strain improvement by mutation, genetic engineering, etc. Overproduction of metabolites, alternative carbon and nitrogen sources and their composition. Development of innocula for industrial fermentation, design of industrial production media. Alternate metabolic routines for utilization of carbon sources with their regulation and inter-linkage especially for glucose and hydrocarbons, preservation and maintenance of microbes.	**15 Hrs**
Unit II	**Fermentation** Design of fermenter, construction materials, various sterilization techniques for solid, liquid and gases, aeration and agitation, foam, auxillaryequipments. Control of various parameters – online and offline monitoring, rheological properties of fermenter, role of computer in fermenter operation.	**15 Hrs**
Unit III	Batch, fed-batch, continuous fermentation and solid state fermentation. Effluent treatment, scale up and scale down. Types of fermenters, process economics, fermentation economics.	**15 Hrs**
Unit IV	**Downstream Processing** Principle, methodology, instrumentation and applications of cell homogenization techniques liquid-liquid extraction centrifugation, filtration, , distillation, ultrafiltration, precipitation, adsorption chromatography, ion exchange chromatography, gel filtration and affinity chromatography in clarification, concentration, isolation and purification of various metabolites from fermented media	**15 Hrs**

Suggested Readings

1. Moo-Young M. ed. (1985) Comprehensive Biotechnology vol: I & II, Pergamon Press N.Y.
2. Ratledge C and Kristiansen B. eds. (2001) Basic Biotechnology 2nd ed. Cambridge Univ Press Cambridge.
3. Old R.W and Primose S.D (1995) Principles of Gene Manipulation 5th ed. Blackwell Scientific Pub. Oxford.
4. Bailey J.E and Ollis D.F. (1986) Biochemical Engineering Fundamentals 2nd ed. McGraw Hill Book Company, N. Delhi.
5. Aiba S, Humphrey A. E. and N. F. Millis (1973) Biochemical Engineering, 2nd Edition University of Tokyo Press, Tokyo, Japan.
6. Stanbury P.F., Whitaker A, and Hall S.J. (1997) Principles of Fermentation Technology 2 nded.Aditya Books Pvt. Ltd, N.Delhi.
7. Mukhopadhaya S.N. (2001) Process Biotechnology Fundamentals.Viva Books Pvt. Ltd. N.Delhi.
8. Rehm H.J and Reed G. (1985) Biotechnology vol. I & II. VCH, Basel.
9. Stainer R. Y. Ingrahm J. L., Wheelis M. L. and Painter P. R. (1987) General Microbiology 5th Edition, Macmillan Press Ltd. London.

	DSE 304 : Immunology	**60 Hrs**
Unit 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**
Unit 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**
Unit 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,	**15 Hrs**

	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	
Unit 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**
1.	Estimation of IAA
2.	Determination of activity of enzyme IAA oxidase
3.	Induction of beta galactosidase in *E. coli.*
4.	Assay of antibiotics and demonstration of antibiotic resistance.
5.	Isolation of organic acid and amine producers and biochemical characterization of isolated microbes.
6.	SDS page/ Native Page
7.	Isolation of Streptomycin resistant mutants.
8.	Transduction
9.	Conjugation
10.	Isolation of bacterial/fungal DNA
11.	Isolation of plasmid DNA by miniprep/midiprep

	Part B
1.	Plant tissue culture
2.	Preparation of Media
3.	Surface Sterilization
4.	Organ Culture
5.	Callus Culture, organogenesis
6.	Preparation of glasswares, plasticwares, media and fine chemicals for animal cell cultures.
7.	Culturing, maintenance and passaging of stock of animal cell cultures
8.	Anther Culture
9.	Synseed preparation
10.	Double diffusion.
11.	Dot ELISA
12.	Radial Immunodiffusion.

Suggested Readings

1. Practical Biochemistry: An Introductory Course by Fiona Frais.
2. Methods in Enzymology Vol. I by S.P.Colowick and N.O.Kaplaneds.
3. Basic Biochemical Methods 2nd ed by R.R.Alexander and J.M.Griffith
4. Biochemical Methods 2nd ed. by S.Sadasivam and A. Manickam.
5. Hawk's Physiological Chemistry ed. by Bernard L Oser.
6. A Textbook of Practical Biochemistry by David Plummer.
7. Laboratory Manual in Biochemistry by S. Jayaraman.

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

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

	SEMESTER IV	
	CC- 401: Animal Tissue Culture	**60 Hrs**
Unit I	**Animal cell culture:** Historical Background, Advantages of Tissue Culture, Control of the Environment, Characterization and Homogeneity of Samples, Economy, Scale, and Mechanization, *In vitro* Modeling of Conditions, Limitations, Expertise, Quantity, Dedifferentiation and Selection, Origin of Cells, Instability, Major Differences *In vitro,* Types of Tissue Culture, Laboratory organization: Design of ATC laboratory. Equipment's used in animal tissue culture: Laminar Airflow Hoods, CO_2 incubators, microscopes, refrigerators and deep freezers. Aseptic techniques in animal tissue culture.	**15 Hrs**
Unit II	**Biology of Cultured Cells:** The Culture Environment, Cell Adhesion, Cell Motility, Cell Proliferation, Differentiation, Cell Signaling, Energy Metabolism, Origin of Cultured Cells, Initiation of the Culture, Evolution of Cell Lines, Senescence, Transformation and the Development of Continuous Cell Lines.Animal tissue culture media: Defined Media and Supplements, Development of Media, Physicochemical Properties: pH,CO_2 and Bicarbonate, Buffering,Oxygen, Temperature,Balanced Salt Solutions,Serum, Selection of Medium and Serum, Heat Inactivation,Other Supplements	**15 Hrs**
Unit III	**Primary Culture**: Initiation of a Primary Cell Culture,Isolation of the Tissue,Types of Primary Culture, Subculture and Cell Lines, Cross-contamination and Misidentification, Mycoplasma Contamination, Naming a Cell Line, Choosing a Cell Line, Routine Maintenance, Significance of Cell Morphology, viable cell count, antibiotic free stock culture. Types of animal cell cultures: monolayes, suspension, clonal culture, mass culture, micro carrier culture (monolayer), stem cell culture (ESC).	**15 Hrs**
Unit IV	**Cell fusion methods:** Techniques involved in cell fusion, hybridoma cells: definition; preparation; properties and use of hybridoma technology. Cryopreservation, Principles of Cryopreservation, Cell banks. Cytotoxicity assay, applications of cytotoxicity assays. Culture of tumour cells, 3-D cell culture: 3-D culture in spheroids, Filter well inserts. Troubleshooting: Abnormal cell appearance, slow growth rate, microbial contaminations, poor recovery from cryopreservation.	**15 Hrs**

Suggested Readings

1. Culture of Animal Cell: R. I. Freshney (Wiley-Liss)
2. Animal Cell Culture-Practical Approach: R. W. Jhon (Masters Oxford)
3. Biotechnology: U. Satyanarayana (Books & allied Pvt. Ltd.)
4. Methods in Cell Biology (Vol. 57)- Animal Cell Culture Methods: J. P. Mathon and D. Barnes (Eds) (Academic Press).
5. Mammalian Cell Biotechnology: A Practical Approach (1991): Butler, M. (IRL Press, Oxford)

	CCS-402A: Advances in Genomics and Proteomics (CBCS)	**60 Hrs**
Unit I	**Advance nucleic acidstechniques** Instrumentation, types and applications of PFGE and PGFE.Principle, types and applications of DGGE, Types and application of Real time PCR, (quantitative and qualitative), Designing Primers and probes for RT PCR and types.RNA interference and gene silencing (si-RNA, mi-RNA) technology, various blotting techniques. Advanced techniques: CRISPR principle and applications.	**15 Hrs**
Unit II	**DNA sequencing technologies** DNA sequencing technologies: Different chemistries in DNA sequencing, Next Generation sequencing (Sanger's sequencing, SOLiD, Pyrosequencing) and applications, genomic library, EST library, cDNA library, Whole genome sequencing, Introduction to the concept of Transcriptomics and Metagenomics, Applications of Transcriptomics and Metagenomics.	**15 Hrs**
Unit III	**Phylogeny** Identification of microbial isolates by 16S rDNA amplification and sequencing, methods of study of uncultivable microbial flora from environmental sample, 16S rDNA library, 16S rRNA library, Ribosomal Database Project (RDP), The principles and applications of DNA based molecular markers. Introduction to metagenomics, its methodology and applications. DNA based molecular markers technologies: RAPD, RFLP, AFLP, SCAR, SSR, ISSR, t-RFLP. Introduction to microarray: DNA and RNA microarray, applications and techniques.	**15 Hrs**
Unit IV	**Proteomics** Principles and applications, Expressional, Structural and Functional proteomics.Separation and identification of proteins. Techniques in proteomics: HPLC, ESI, MALDI-TOF, Q-TOF, MS/MS, 2-D Gel electrophoresis.	**15 Hrs**

	Protein Microarray: Analytical protein microarray, Functional protein microarray and Reverse phase protein microarray. Protein-Protein interaction, Protein-small molecule interaction using SPR technique. Applications of protein microarray.	

Suggested Readings

1. Bernard R. Glick and Jack J. Pasternak, Molecular Biotechnology: Principles and Applications of Recombinant DNA.
2. Introduction to Bioinformatics, (Atwood, T. K. and Parry-Smith, D. J).
3. An introduction to Computational Biochemistry. (C. Stain Tsai, A JohnWiley and Sons, Inc., publications).
4. Developing Bioinformatics Computer Skills. (Cynthia Gibas and Per Jambeck).
5. Bioinformatics Methods and Applications Genomics, Proteomics and Drug Discovery. (Rastogi S. C. Mendiratta, and Rastogi P.)
6. NCBI Web site: http://www.ncbi.nlm.nih.gov
7. Molecular Cloning by Sambruk and Russel (Maniatis)

OR

	CCS- 402B: Microbial Fermentation Technology	**60 Hrs**
Unit I	**Fermentation media**: Functions of media components, media rheology and Newton's law of viscosity, optimization of medium. Gas diffusion: Oxygen and mass balance transfer relationship, factors affecting gas diffusion. Types of fermentations: Solid surface culture type, liquid surface culture, submerged fermentations.	**15 Hrs**
Unit II	**Culture:** Isolation, screening, yield improvement by changing culture techniques, strain improvement and preservation. Growth kinetics and yield kinetics.	**15 Hrs**

Unit III	**Modelling of fermentation processes:**Modelling bioprocesses, approaches and techniques of mathematical modelling. Process validation and quality assurance: a) Installation Qualification (IQ), Operational Qualification (OQ) and Performance Qualification (PQ) for laboratory instruments. b) Methods of validation and calibration of equipments c) Documentation: importance and significance d) Current Good Manufacturing Practices (cGMP) and Current Good Laboratory Practices (cGLP).	**15 Hrs**
Unit IV	**Typical fermentation processes**: Industrial production of i) Microbial enzymes ii) Bacitracin iii) Streptomycin iv) Riboflavin v) beta-carotene vi) Gibberellins vii) Surfactants	**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
3. Control of fermentation process by J.R.Leigh
4. Microbial Technology Vol. I and II by H.J.Peppler and D.Perlman. Academic Press INC

	CCS 403: Bioinformatics	**60 Hrs**
Unit I	**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.	**15 Hrs**

	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.	
Unit II	**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. **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.	**15 Hrs**
Unit III	**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. **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.	**15 Hrs**
Unit IV	**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 (EST), Tandem mass spectroscopy (MS/MS) analysis; tryptic digestion and peptide fingerprinting (PMF), profiling and diagnostics, drug target discovery. **Phylogenetic Analysis** Evolution, phylogenetic tree, methods of phylogenetic analysis; distance based and character based methods, phylogenetic analysis tool- Phylip.	**15 Hrs**

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 A: Nanobiotechnology (CBCS)	**60 Hrs**
Unit I	**Nanotechnology:** Concept, definition and history. Nano and Nature: Nanoscopiccolours (Butterfly wings), Bioluminescence (fireflies), Tribology (Gecko's Sticky Feet, Nasturtium Leaf-Lotus effect etc) in nature. The development of nanoscale science: size scale. Classification of nanomaterials: 0D,1D,2D and 3D and types of nanomaterials (QDs, QW, CNT's, Bucky Balls, Nanocompositesetc).	**15 Hrs**
Unit II	**Visualization and manipulation tools, Microscopy:** Optical, electron (SEM, TEM), SPM (STM, AFM) Optical Tweezers. Inorganic nanoparticles: chemical, physical and biological methods of inorganic nanoparticle synthesis, Biological sysnthesisof nanoparicles using bacteria, fungi and plants. Introduction to types of nanomaterials, metal nanoparticles, metal oxide nanoparticles, composites, polymer nanoparticles. .Application of inorganic nanoparticles, Biological applications of inorganic nanoparticles.	**15 Hrs**
Unit III	**Introduction to biological nanoparticles and their applications:**Exosomes, lipoproteins, ferritin, magnetite viruses. Biological nanomotors, protein assemblies: Kinesin and dynein, cilia. Bacterial flagella: structure and function; nanomotor. Ion channels: nanopores of high specificity. Bioinspirednanomaterials: DNA and peptide based. Interaction between biomolecules and nanoparticle surfaces.	**15 Hrs**

Unit IV	**Nanomedicine**: Applications of nanoscience in biology. Concept of disease, their causes, molecular and cellular progression of key diseases including infectious, inherited diseases, immunological diseases and cancer. Approaches to developing nanomedicines. Various kinds of nanosystems in use. Nanodrug delivery/administration, nano-devices for drug delivery and theranostics.Introduction to the potentials applications and challenges of nanomedicine.	**15 Hrs**

Suggested reading:

1. Nanotechnology :Technology Revolution of 21st Century by RakeshRathi, published by S. Chand.
2. Introduction to Nanoscience, by Stuart Lindsay.
3. Introduction to Nanomaterials and nanotechnology by Vladimir Pokropivny, RynnoLohmus, Irina Hussainova, Alex Pokropivny and Sergey Vlassov
4. Nanomaterials by A.K. Bandyopadhyay; New Age International Publishers.
5. Nanotechnology by Mark Ratner and Daniel Ratner, Pearson Education.
6. Nano Essentials- T.Pradeep/TMH
7. Bharat Bhusan, "Springer Handbook of Nanotechnology", springer, Newyork, 2007
8. Hari Singh Nalwa, "Encyclopedia of Nanotechnology", USA 2011
9. James A. Schwarz, Cristian I. Contescu, Karol Putyera, "Dekker encyclopedia of nanoscience and nanotechnology" CRC Press, 2004.
10. Charles P. Poole Jr. and Franks. J. Qwens (2003) Introduction to Nanotechnology. John Wiley and Sons.
11. Ehud Gazit (2007) Plenty of Room for Biology at the Bottom: An Introduction to Bionanotechnology. Imperial college Press
12. Bharat Bhushan (2007) Springer Handbook of Nanotechnology. Springer Verlag.
13. Challa S., S. R. Kumar, J. H. Carola (2006) Nanofabrication towards biomedical application: Techniques, tools, Application and impact. John Wiley and sons.
14. Robert A. FreitasJr (2003) Nanomedicine, Vol. I: Basic Capabilities.
15. Neelina H. Malsch (2005) Biomedical Nanotechnology. Taylor and Francis. CRC press.
16. Patrick Boisseau, Marcel Lahmani (2009) Nanoscience: Nanobiotechnology and Nanobiology. Springer Publishers.
17. Ralph S. Greco, Fritz B. Prinz, R. Lane Smith (Editors) (2004) Nanoscale Technology in Biological Systems. CRC Press
18. Harry F. Tibbals (2010) Medical Nanotechnology and Nanomedicine. CRC Press

OR

	DSE 404 B : Fermentation Technology– II	60 Hrs
Unit I	**Pharmaceutical Biotechnology** Manufacturing by fermentative process and uses of Solvents – Ethanol, beer, wine, rum, whisky, butanol, Organic acids – Citric acid, Acetic acid, Lactic acid, Amino acids – l-glutamic acid, l-lysine, Extracellular enzymes – Amylase, protease, lipase, Renin, Glucose isomerase, Vitamins – Vitamin B group, Extracellular polysaccharides – Xanthan, pullulan, Antibiotics – B lactam - Penicillin, Anticancer – Adriamycin, Semisynthetic antibiotics.	**15 Hrs**
Unit II	**Therapeutic proteins** : Interferron, Monoclonal Antibodies L-asparginase, Hormones – insulin, Single cell protein, Single cell oil, Bioplastics : Polyhydroxyalkonates, Biogas, Flavor enhancers – MSG, Biotrasnformation reactions, Ergot alkaloids, Flavor and fragrances	**15 Hrs**
Unit III	**Environmental Biotechnology** Bioremediation, Role of microbe in petroleum industry, Bioleaching / Biomining, Biotechnological applications of extremophiles, Waste treatment, Microbial desulphurisation of coal **Food Biotechnology** Cheese, Sauerkaut, edible mushroom, Baker's yeast	**15 Hrs**
Unit IV	**Animal Tissue Culture** Media requirements, preparation of medium and sterilization techniques. Advantages and disadvantages of natural and synthetic media. Culture methods – hanging drop, suspension and monolayer culture. Behavior and characteristics of cells in culture. Primary and established cell lines, characteristics of transformed cells. Methods of cell preservation. Organ culture – clot grid, chorioallantonic and ocular culture, Applications of animal tissue culture – vaccines, cell biology, drug testing, medical applications, etc., Stem cells and their applications in medicine and tissue engineering	**15 Hrs**

Suggested Readings

1 Moo-Young M. ed. (1985) Comprehensive Biotechnology vol: III & IV. Pergamon press. N.Y.
2 Rehm H.J and Reed G eds. (1985) Biotechnology vol: III – VIII. VCH, Basel.
3 Ratledge C and Kristiansen B eds. (2001) Basic Biotechnology 2nd ed. Cambridge Univ. Press. Cambridge.

4 Klegerman, M.E and Groves M.J. (1992) Pharmaceutical Biotechnology: Fundamentals and Essentials. Interpharm Press Ltd. Buffalo Grove IL.
5 Reed G. Ed. Prescott and Dunn's Industrial Microbiology . 4th edition CBS Pub. New Delhi.
6 Culture of Animal Cells by Ian Freshney.

	CCPR- 405: Laboratory Course and Project(120 Hrs) 200 Marks **Part A**
1.	Isolation of genomic DNA from plants/yeast
2.	Restriction digestion and analysis of DNA fragments by agarose gel electrophoresis.
3.	Establishment of Molecular markers (RAPD/RFLP).
4.	Identification of bacterial/fungal isolates by 16S rDNA/18S rDNA amplification and sequencing.
5.	Isolation of genomic DNA from environmental samples
6.	Construction of 16S rDNA library, sequencing of clones and sequence analysis.
7.	Preparation of competent cells (chemical or electro)
8.	Separation of RNA by denaturing gel electrophoresis
9.	Identification and characterization of proteins resolved on 2D PAGE
10.	Isolation and purification of chlorophyll from plant material
11.	Chemical synthesis of gold and silver nanoparticles and their characterization
12.	Preparation of nanoparticles using biological source
13.	Preparation of nanoparticles using bacterial cells/fungi/plant extract, its extracellular proteins andcharacterization
14	Preparation of various metal nanoparticles for the study of their biological activity
15	Evaluation of antimicrobial activity of metal nano particles
16	SDS PAGE gel shift assay for study of nanoparticle- biomolecule assembly
	Part B (100 Marks)
	Research Project

Suggested readings

1. Practical Biochemistry: An Introductory Course by Fiona Frais.
2. Methods in Enzymology Vol. I by S.P.Colowick and N.O.Kaplaneds.
3. Basic Biochemical Methods 2nd ed by R.R.Alexander and J.M.Griffith
4. Biochemical Methods 2nd ed. by S.Sadasivam and A. Manickam.
5. Hawk's Physiological Chemistry ed. by Bernard L Oser.
6. A Textbook of Practical Biochemistry by David Plummer.
7. Laboratory Manual in Biochemistry by S. Jayaraman.
8. Developing Bioinformatics computer skills – Cynthia Gibas and Per Jambeck
9. An introduction to Computational Biochemistry- C. Stan Tsai John Wiley and Sons, Inc.
10. publications.
11. Microsystems and nanotechnology, Springer, by Z. Zhou, Z. L. Wang and L. Lin
12. Charles P. Poole Jr. and Franks. J. Qwens (2003) Introduction to Nanotechnology. John Wiley and Sons.
13. Bharat Bhushan (2007) Springer Handbook of Nanotechnology. Springer Verlag.

	SEC 406 : Mandatory Non-CGPA compulsory Skill Enhancement Course	**30 Hrs**
Unit I	Syllabus and nature of paper will be opted as per committee decision.	**15 Hrs**
Unit 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.	**'Gardening and Nursery management techniques'**	**2**	**IV**	**Masters in any stream**

Unit No.	**Topics**	**No. of Lectures/Hours**
	Introduction of nursery and gardening Soil and its preparation, Plant Propagation- Introduction, Definition, types (Natural and Artificial)	

I	Study of Nurseries - Definition and types with suitable examples of Plants, Annuals, Perennials, climbers, shrubs and trees. Establishment of Nursery, Gardening Techniques**,** Cultivation Practices – Cultivation of Vegetables (Onion, Tomato, Brinjal) Disease and Pest management	**15 L**
II	**Practical demonstration** Study of different tools and equipment's used Garden and Nursery, Preparation of soil mixture and demonstration, Study of propagation methods, Preparation of Vertical Garden, Hanging Baskets, Study of fertilizers etc.	**15 L**