Shikshan Haach Dharma
Shri. SAPD Jain Pathashala's
(Jain Minority Institute)

Walchand College of Arts & Science, Solapur

Autonomous College

(Affiliated to P.A.H. Solapur University, Solapur)

Name of Faculty: Science & Technology

New Choice Based Credit System

M.Sc. Part-II

Subject: Biotechnology

With Effect from: 2022-23

M. Sc. Biotechnology Sem.-III and IV (syllabus structure-M.Sc. II Biotechnology) w. e. f. 2022-23

Semester	Code	Title of the Paper	Semester Examination			L	T	P	Credits
			Theory ESE	IE	Total				
Sem-III		**Hard Core**							
	HCT3.1	Industrial and Environmental Biotechnology	80	20	100	4	--	--	4
	HCT3.2	Genetic Engineering	80	20	100	4	--	--	4
		Soft Core (Any one)							
	SCT 3.1	Plant Biotechnology	80	20	100	4	--	--	4
	SCT 3.2	Cancer Genetics and Animal Cell culture							
		Open Elective (Any one)							
	OET 3.1	Computational Structure Biology and Drug Designing	80	20	100	4	--	--	4
	OET 3.2	Advanced Pharmaceuticals	80	20	100	4	--	--	4
		Seminar/Tutorial/ Industrial Visit/Field Tour	---	25	25	--	1	--	1
		SWAYYAM MOOCs/NPTL /Skill based course-Institute or University/Internship/Apprenticeship							4
	HCP3.1	Practical Course HCP3.1	40	10	50	--	--	04	2
	HCP3.2	Practical Course HCP3.2	40	10	50	--	--	04	2
	SCP 3.1/3.2	Practical Course SCP 3.1/3.2	40	10	50	--	--	04	2
	OEP 3.1/ 3.2	Practical Course OEP 3.1/ 3.2	40	10	50	--	--	04	2
	Total for Semester-III		**480**	**145**	**625**	**--**	**--**	**--**	**29**
Sem-IV		**Hard Core**							
	HCT4.1	Animal Biotechnology and Stem Cell technology	80	20	100	4	--	--	4
	HCT4.2	Advanced analytical Techniques	80	20	100	4	--	--	4
	HCT4.3	Research Methodology and Intellectual property Rights (IPR)	80	20	100	4	--	--	4
		Soft Core (Any one)							
	SCT4.1	Medical Biotechnology and Bio-nanotechnology	80	20	100	4	--	--	4
	SCT4.2	Advanced Pharmacognosy	80	20	100	4	--	--	4
		Seminar/Tutorial/ Industrial Visit/ Field Tour	---	25	25	--	1	--	1
	Total for Semester-IV		**480**	**145**	**625**	**--**	**--**	**--**	**25**
	PRACTICALS/PROJECT WORK								
	MP 4.1	Major Project	160	40	200	--	--	8	8
	M. Sc I year				**1250**				**50**
	M. Sc II year				**1250**				**54**
	Grand Total				**2500**				**104**

** L = Lecture T = Tutorials P = Practical
** IE=Internal Examination
** ESE= End Semester Examination
** 4 Credits of Theory = 4 Hours of teaching per week
** 2 Credits of Practical = 4 hours per week
** HCT = Hard core theory
** SCT = Soft core theory
** HCP = Hard core practical
** SCP = Soft core practical
** OET = Open elective theory
** OEP = Open elective practical

Walchand College of Arts and Science (Autonomous) Solapur
M. Sc. Biotechnology- Part - II Syllabus w. e. f. from – 2022-23
Semester- III- Theory

HCT -3.1 Industrial and Environmental biotechnology

Teaching Hours- 60 **Total credits- 4**

About the course

The Course is designed to obtain knowledge on wide-ranging topics related to applications of biotechnology in industries. To learn about bioprocess technology and its applications and get familiar with enzymes and microbes used for industrial purposes. To learn the environment protection Act and Law related to environmental biotechnology to understand the basic principles involved in waste water management, Bioremediation & microbial leaching.

Unit No	Title and Chapters	Lectures
Unit-I	**Introduction to bioprocess engineering** Introduction to bioprocess, Bioreactors: design, types (Air lift, Bubble column, Packed bed, fluidized bed, Photobioreactor), sterilization. Fermentation medium: formulation and sterilization. Air sterilization. Types of fermentation processes: (Batch, fed batch, continuous, submerged,and solid state). Isolation and preservation of industrially important microorganisms. Microbial growth kinetics. Applications of Computer in bioprocess engineering.Measurement and control of bioprocess parameters	**(14)**
Unit-II	**Upstream process** Industrial production of chemicals: Ethanol, Organic acids (citric acid, acetic acid and gluconic acid). Solvents (glycerol, acetone), Antibiotics (Penicillin, Streptomycin and Tetracycline), Amino acids (lysine and glutamic acid). Vitamin (B12), Single cell protein. Fermented food products (Bread, Idli, Dairy products and Alcoholic beverages).	**(10)**
Unit-III	**Downstream process** Introduction, Solid liquid separation (flotation, flocculation, sedimentation, filtration and centrifugation), Cell lysis (physical, chemical and biological methods), Concentration (Evaporation, solvent extraction, membrane filtration, precipitation and adsorption) Purification by chromatography, Formulation (dehydration, crystallization and use of stabilizing agents). Distillery and pharmaceutical industrial Effluent treatment (Physical, chemical and biological methods).	**(10)**
Unit-IV	**Scope of Biotechnology in Environmental protection** Energy sources (Conventional & Nonconventional). Environment protection Acts: Environmental laws, Environmental policies. UN declaration. Environmental protection and conservation. Environmental Impact Assessment, Eco-planning and Sustainable Development.	**(10)**
Unit-V	**Bioremediation** Biotechnology for clean environment: Biomaterials as substitutes for non-degradable materials (bioplastics, biofuel, bioinsecticide, and biofertilizer), Heavy Metal Pollution and impact on environment.	**(10)**

	Metal microbe interactions: Molecular mechanisms for heavy metal tolerance (Biosorption, bioaccumulation, bioassimilation, bioprecipitation, bioleaching, and biotransformation). Bioindicators (Bacteria, plant and animal) and biosensors for detection of pollution, Air Pollution Control, Solid Waste Management (Hazardous & non-hazardous). Xenobiotics, Biological Detoxification of PAH.	
Unit-VI	**Bioremediation by using Genetically modified organisms** Introduction, Mechanism of genetic modification, GM plants and microbes for bioremediation.	**(06)**

Reference Book:

1. Sullia S. B & Shantharam S: (1998) General Microbiology, Oxford & IBH Publishing Co.Pvt. Ltd.
2. Glaser A.N &Nilaido. H (1995) Microbial Biotechnology,W.H Freeman & Co.
3. Prescott & Dunn (1987) Industrial Microbiology 4th Edition, CBS Publishers& Distributors.
4. Prescott & Dunn (2002) Industrial Microbiology, Agrobios (India) Publishers.
5. Crueger W. & Crueger A. (2000) A text of Industrial Microbiology, 2nd Edition, PanimaPublishing Corp.
6. Stanbury P.F, Ehitaker H, Hall S.J (1997) Priciples of Fermentation Technology., AdityaBooks (P) Ltd. S.N.Jogdan (2006) Industrial Biotechnology, Himalaya Publishing House
7. Amann, R.I. Stromley, J. Stahl : Applied & Environmental Microbiology
8. Dash : Concepts of Ecology
9. Chattergy : Environmental Biotechnology
10. Varma & Agarwal : Environmental Biology
11. B.K. Sharma : Environmental Chemistry
12. Peavy & Rowe : Environmental Pollution
13. Asthana & Asthana : Environment Problems & Solution

Learning outcomes:

After successfully completing this course, the students will be able to:

- Scientific industrial biotechnology and applications of microbes and enzymes used in industry.
- Environment protection regulations and source of environmental pollutions.
- Environmental pollution and its remediation measure The capability to apply avalanched discipline in wastewater management

HCT 3.2: GENETIC ENGINEERING

Teaching Hours- 60; **Total credits- 4**

About course

The course is formulated to familiarize the students with the basic concepts in genetic engineering.

To acquaint the students to versatile tools and techniques employed in genetic engineering and recombinant DNA technology. To appraise them about applications genetic engineering.

Unit No.	Title and Chapters	Lectures
Unit-I	**Enzymes in Genetic Engineering** Exonucleases, Endonucleases, Restriction Endonucleases –Classification & Properties.DNA Manipulating Enzymes - Nucleases, DNA Polymerases, RNA Polymerases, Reverse Transcriptase. Nucleic Acid modifying enzymes - Ligases, Alkaline Phosphatases, , Kinases.	**(10)**
Unit-II	**Vectors in Genetic Engineering** Properties & Structure of Plasmids, Cosmids, Phagemids, BAC, YAC.Structure and properties Bacteriophages (λ and M13), Yeast vector, animal and plant viruses, Baculovirus, Mammalian and shuttle vectors.	**(10)**
Unit-III	***In vitro* construction, screening and Isolation of rDNA Molecules** Construction of rDNA Molecules - Isolation of Vector and donor DNA and its purification; Assembly of gene of interest and vector DNA.: Construction Genomic library and cDNA library. Screening of Recombinant Cell –Indirect Screening, Colony hybridization, Immuno- Screening. Molecular Probes - Genomic DNA probes, synthetic oligonucleotide probes, methods of labeling probes	**(10)**
Unit-IV	**Molecular Markers and Transformation Methods** Techniques in Genetic Engineering: Chromosome walking, Molecular markers: Restricted Fragment Length Polymorphism (RFLP), Random Amplified Polymorphic DNA (RAPD), Amplified Fragment Length Polymorphism (AFLP). DNA sequencing: Maxam's and Gilbert's method, Sanger's dideoxy method, Automated and pyrosequecing. PCR and its types (Real time, Reverse transcriptase). Transformation methods: Methods of direct transformation - microinjection, particle bombardment, electroporation, $CaCl_2$	**(10)**
Unit-V	**Genome editing** Origins of CRISPR, CRISPR Knockout and Knockin, CRISPR Editing, CRISPR Screens, CRISPR-Based application	**(08)**
Unit-VI	**Applications of genetic engineering** Detection and Diagnosis of Genetic diseases (sickle-cell anaemia, and Cystic fibrosis) and infectious diseases (Malaria and *Trypanosoma cruzi).* Gene therapy- *ex vivo, in vivo*, DNA marker technology in plants, DNA fingerprinting, Production of recombinant products: insulin and, Hepatitis-B recombinant vaccine, Synthesis of Human Interferon. GE in Plants**:** Insect- resistant plants, Herbicide-resistant plants, salt stress tolerant plants, Modification of food plants taste (Sweetness); GE in animals - Transgenic sheep and mice	**(12)**

Reference Books:

1. Sambrook J, Fritsch E. F. and Maniatis (1989) Molecular cloning, vol. I, II, III, 2nd 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
3 Methods in Enzymology Guide to Molecular Cloning Techniques, Vol. 152 S.L. Berger and A.R. Kimmel, Academic Press Inc, San Diego, 1996
4. Methods in Enzymology Gene Expression Technology, Vol. 185D. V. Goedel, Academic Press Inc, San Diego, 1990.
5. Molecular Biotechnology, 2nd Ed. S. B. Primrose, Blackwell Scientific publishers, Oxford, 1994
6. Milestones in Biotechnology, Classic Papers on Genetic Engineering, J. A. Davis and W. S.Reznikoff, Butterworth-Heinemann Boston 1992
7. Route Maps in Gene Technology, M. R. Walker, and R. Rapley, Blakwell Science, Oxford,1997
8. Genetic Engineering: An Introduction to Gene Analysis and Exploitation in Eukaryotes, S.M. Kingsman, Blackwell Scientific Publications, Oxford, 1998.

Learning outcomes:

- The students will have knowledge of tools and strategies used in genetic engineering.
- Understanding of applications of recombinant DNA technology and genetic engineering. from academic andindustrial perspective.
- Can use and apply the knowledge of genetic engineering in problem solving and in practice

SCT 3.1: PLANT BIOTECHNOLOGY

Teaching Hours- 60 **Total credits- 4**

About Course

The course designed to learn about basic techniques in plant tissue culture, Micro propagation and other type of hybridizationtechniques. Also used to know about genetic transformation in plant and techniques about gene delivery. Enhance knowledge about applications of plant biotechnology in molecular farming.

Unit No.	Title and Chapters	Lectures
Unit-I	**Plant physiology and basic techniques in plant tissue culture** Plant Nutrition: Microelements and micronutrients in plant metabolism, Functions & Deficiency diseases. Plant Hormones: Types & Mechanism of Action. Role of Hormones in growth of Plants. Lab setup of Plant Tissue Culture laboratory, Tissue culture Media. Initiation and Maintenance of callus & Suspension culture, single cell clones	**(09)**
Unit- II	**Micropropagation** Organogenesis, Somatic Embryogenesis, Synthetic seeds. Shoot tip culture/Auxiliary bud culture, Rapid clonal propagation. Acclimatization of Plants. Embryo Culture & Embryo Rescue. Soma clonal Variations/In vitro mutagenesis. Selected successful examples of Plants of Diverse Origin using Tissue Culture technology,Rescue of endangered Plants.	**(09)**
Unit-III	**Protoplast culture, Anther Culture And Cryopreservation** Protoplast Isolation, Culture, Fusion, Selection of Hybrid Cells and Regeneration of Hybrid Plants, Symmetric and Asymmetric hybrids. Anther, Pollen and Ovary culture for production of Haploid Plants and Homozygous lines. Cryopreservation, Slow growth & DNA Banking for germ plasm Conservation	**(11)**
Unit-IV	**Plant Transformation Technology** Basics of Tumor formation, Hairy root, features of Ti & Ri Plasmid and their uses, Mechanism of DNA transfer role of Virulence gene, Binary vectors, Use of 35s & other promoters, genetic markers, viral vectors & their applications. Multiple gene transfers: vector less or direct DNA transfer, Use of reporter gene, Particle bombardment, electroporation, Microinjection, transformation in monocots, Transgene stability & gene silencing in Plant transformation.	**(13)**
Unit- V	**Applications of Plant Biotechnology** Metabolic engineering & Industrial products, Industrial enzymes, Biodegradable plastics, Therapeutic proteins: lysozomal enzymes, Antibodies and edible vaccines. Purification strategies, oleosin partitioning technology. Agriculture Diseases resistant plants. Biotic& Abiotic stress resistant plants, Enhancement of nutritional value of crop Plants & molecular farming.	**(13)**
Unit-VI	Plant secondary metabolites Plant secondary metabolites, Biosynthesis and applications**.**	**(05)**

Reference Books:

1. An introduction to Plant Tissue Culture 2nd edn. Razdan, M. K, Science Publishers, USA.
2. Textbook of plant biotechnology, Chawala P.K.2002, Oxford & IBH, New Delhi.
3. Bhojwani, S. S. and M. K. Razdan 1996.Plant Tissue Culture:Theory and Practice, Elsevier Pub.
4. Chrispeels, M. J. 2002. Plant Tissue Culture: Genetical Aspects. Jones and Bortlett Publishers, International.
5. Chopra V. L. et al 1999. Applied Plant biotechnology. Science Publishers Inc.
6. Verpoorte, R. and A.W. Alfermann (Eds) 2000.Metabolic Engineering of plant secondar.

Learning outcomes

- After successfully completing this course, the students will be able to understand different hybridization techniques and basicsof embryogenesis.
- They will be able to learn about different gene delivery techniques.

SCT 3.2: CANCER GENETICS AND ANIMAL CELL CULTURE

Teaching Hours- 60 **Total credits- 4**

About the course

The course allows, to study the stem cell and its use as regenerative medicine as well as study the molecular level of cancer development and progression. The course also includes, study the diagnosis and treatment for cancer.

Unit No	Title and Chapters	Lectures
Unit-I	**Introduction to Cancer Biology:** Cancer cell vs. Normal cell; Hallmarks of cancer cell; Cell cycle - Regulation of Cell cycle and Tumor suppressor genes (pRb, P53, BRCA, Gene encoding CDK inhibitors); Oncogenes and Proto-Oncogenes; Factors activating proto-oncogene to oncogene (Tumor Virus; Physical and Chemical Carcinogene); Introduction to Epigenetics, Epigenetics in cancer.	**(10)**
Unit-II	**Cancer Progressions:** Apoptosis mechanism, Apoptotic Pathways; Metastasis (Clinical significances of invasion, Metastatic cascade, Basement membrane disruption); Theory of invasion (Proteinases and tumour cell invasion; Angiogenesis and its sequence of events in detail.	**(10)**
Unit-III	**Diagnostic and Treatment:** Methods of diagnosis - Chemotherapy, Radiation Therapy, Immunotherapy- use of immunotoxins in cancer therapy, retroviral drugs, Anti- angiogenic Drug; Drugs based on Epigenetics (Acetylation of Histones and Methylation of DNA).	**(08)**
Unit-IV	**Stem Cell and Technology:** Basics, Properties and Classification. Types of Stem cells – Hematopoietic Stem Cells, Mesenchymal Stem Cells, Embryonic Stem Cells, Fetal Stem Cells, Stem cells from adult organs. Isolation, Culture and Characterization protocols, Extra Cellular Matrices.	**(10)**
Unit-V	**Regenerative Medicine:** Tissue Engineering and Transplantation Technique, Immuno isolation Techniques , Modes of Cell and Tissue Delivery, Regeneration of Bone and Cartilage, Islet Cell transplantation and Bioartificial Pancreas, Bioprinting of Organs and Tissues, Types of Stem Cells used in Gastrointestinal , Liver, Pancreas, Kidney, Heart, Spinal Cord and Lung Regeneration, Stem Cells in Eye Diseases and Disorders.	**(15)**
Unit-VI	**Cancer prevention and control in India:** Magnitude of the problem, epidemiology (tobacco, diet), cancer of the head, neck, stomach, large intestine. Cancer in women (breast, uterine cervix), cancer prevention and treatment strategies for India, primary prevention and screening programs, treatment facilities. .	**(07)**

1. The Biology of Cancer, Robert Weinberg, Garland Science; 2 edition;2010
2. King R.J.B., Cancer Biology, Addision Wesley Longmann Ltd, U.K., 1996.
3. Ruddon.R.W., Cancer Biology, Oxford University Press, Oxford, 1995.
4. Bishob J. A. 1982, Retrovirus ,Cancer genes, Advances in Cancer Research.
5. Vogel F. Chemical mutagenesis Spinger and Verlag.
6. Sanberg A. A. 1980, The Chromosome in Human Cancer And Leukemia

7. Stich H. F. Carcinogens and Mutagens in EnvironmentCRC press.
8. R. Lanza, J. Gearhartet al (Eds), Essential of StemCell Biology. (2009), Elsevier Academic press.
9. R. Lanza and I. Klimanskaya, Essential Stem Cells Methods. (2009)
10. J. J. Mao, G. Vunjak-Novakovic et al (Ed): Translational Approaches in Tissue
11. Engineering & Regenerative Medicine 2008, Artech House, INC Publications.
12. Robert Lanza et al. Principles of Tissue Engineering, 3rd Edition. Academic Press; 3 edition (August 21, 2007)
13. Cherian Varghese, "Cancer prevention and control in India", 50 years of cancer control in India, published by Ministry of Health and Family Welfare under cancer control program (May 2019)

Learning outcomes:

After completion of this course students understand basic aspects of

- Cancer pathology, epigenetic and somatic genetic changes in tumors.
- Students become familiar with basic principles and applications of cell culture
- Students will also learn about the different types of stem cells.

OET 3.1 COMPUTATIONAL STRUCTURE BIOLOGY AND DRUG DESIGNING

Teaching Hours- 60 **Total credits- 4**

About Course

The course is to prepared to familiarize the students with the basic concepts structural and pathwayDatabases. It also gives students to understand the basics of molecular interaction in various diseases as well as principles of drug discovery and drug development.

Unit No.	Title and Chapters	Lectures
Unit-I	**Introduction to Structural and Pathway Databases:** Introduction to structural data, Challenges of Structural bioinformatics, exploring the structural databases such as Protein Data Bank (PDB) at RCSB, CSA, PDBe Resources, KEGG, Biocarta, BioCyc and Human Pathway Database (HPD).	(10)
Unit-II	**D Structure Prediction Methods** Types of secondary structure, Importance of 3^{10} helix and loops, Introduction to Statistical methods of Chou- Fasman, Garnier Osguthorpe- Robson method, Neural network method, Position specific scoring matrices, Motifs and domains, folds and protein folding, functional sites prediction, protein folding classes. Predicting transmembrane helices, Importance and Prediction of solvent accessibility regions.	(10)
Unit-III	**Homology Modeling** Introduction to homology modeling, Steps of Homology modeling, SWISS MODEL and Modeller, Fold recognition and Threading, Structure validation by Various tools (Qmean, Rampage, Procheck, Verify3D	(10)

	servers), Types of RNA structure, RNA structure prediction methods, Ramchandran plot analysis, architectures and topologies of protein and DNA using molecular visualization software.	
Unit-IV	**Molecular interaction**: Molecular interaction; protein-protein, protein-DNA, Protein- Lipid, Protein- Ligand, Protein-Carbohydrate, DNA-Drug interaction, Metalloproteins.	**(10)**
Unit-V	**Drug Discovery and Drug designing** Natural products, drugs, principles of drug development, Drug discovery, mutation in drug targets, automated drug design, structure based and ligand based drug design methods, combinatorial chemistry, Virtual Screening, Pharmacophore, QSAR, developing lead library, pharmacodynamics and pharmacokinetics, *in silico* ADMET properties, molecular docking programs-AUTODOCK, SwissDock, and Argus Lab, clinical trials, FDA approval.	**(10)**
Unit-VI	**Molecular Simulation** Introduction to Molecular Dynamics (MD)Simulation, Monte Carlo (MC), Quantum mechanics/molecular mechanics (QM/MM), Force field (FF), Energy Minimization, MD simulation in drug discovery & lead optimization, software for MD Simulation-GROMACS, NAMD, AMBER and CHARMM. Future Prospects and Challenges.	**(10)**

Reference Books:

1. Wilkins, M.R., Williams, K.L., Appel, R.D., Hochstrasser, D.F. (Editors) 1997
2. Proteome Research: New Frontiers in Functional Genomics. Springer Verlag BerlinHeidelberg.
3. Baxevanis, A.D. and Francis Ouellette, B.F. 2004 Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. Second Edition, Wiley.
4. Graur, D. and Li, W-H. 2000 Fundamentals of Molecular Evolution. Sinauer Ass.,USA.
5. Essential Bioinformatics, Jin Xiong
6. Rastogi S. C., Mendiratta. N., Rastogi. P. 2005 Bioinformatics methods and application,Genomics, Proteomics, and Drug Discovery.

Learning outcomes:

- Upon successfully completing this course the students could be able to explain which type of data is availablefrom the most common public databases like (UniProt, Protein Data Bank, CATH, SCOPE, PDBe servers).
- Acquiring theoretical and practical knowledge of drug development.

OET 3.2: ADVANCE PHARMACEUTICALS

Teaching Hours- 60 **Total credits- 4**

About Course

The course allows to study Physical pharmaceutics and to understand the concepts of Dissolution. It also includes study Surfactant System and Polymer science. It also makes aware of Stability studies for students.

Unit No.	Title and Chapters	Lectures
Unit-I	**Physical pharmaceutics covering the following aspects** Introduction to Advance Pharmaceuticals, Solids: Particle characterization by size, shape and surface of individual particle and for contacted particle. Handling of solids, pharmaceutical granulation, compression and compaction properties of binary mixtures, lubricant sensitivity. Characterization of granules and compacts.	**(14)**
Unit-II	**Dissolution** Theory of dissolution, concept of drug release. Dissolution test apparatus: different designs, factors affecting dissolution rate. Dissolution of different dosage forms: solids, suspensions, topicals, suppositories and controlled release systems. Enhancement of dissolution rate.Solid dispersions: Types, methods of preparation, selection of carrier, characterization and applications.	**(12)**
Unit-III	**Surfactant System** Phase behavior of surfactant in binary and ternary systems. Factors affecting phase behavior; Micellization; micelle structure, shape, size factors affecting CMC and micelle size, thermodynamics and kinetics of micelle formation. Pharmaceutical aspects of Solubilization, Solubilization in non-aqueous system, interactions with polymers, and oppositely charged species. Hydrotrophy in pharmaceuticals, surfactants in emulsions and suspensions. Biological implications of surfactants; Effect on: dissolution of drugs, permeability of membranes, drug absorption, antibacterial activity. Cyclodextrin inclusion complexes and co-solvents	**(14)**
Unit-IV	**Polymer science** Types and applications of polymers, polymerization reactions, methods of polymerization. Characterization of polymers, thermodynamics of polymer solutions.	**(10)**
Unit-V	**Stability studies** Kinetics activation energy calculations, accelerated stability studies. Factors responsible for destabilizationof pharmaceutical products and techniques to improve, shelf-life calculations. Physical testing of solution, suspension, emulsion, aerosol, powder, tablet and sustained release products	**(12)**
Unit-VI	**Rheology** Newtonian system, law of flow, kinematic viscosity, effect of temperature, thixotropy in formulation, determination of viscosity, capillary and deformation of solids.	**(08)**

Reference Books:

1. Martin, P. Bustamante and A. H. Chun; Physical Pharmacy; Waverly.
2. D. M. Parikh; Handbook of Pharmaceutical Granulation Technology; Marcel Dekker.
3. G. Alderborn and C. Nystrom; Pharmaceutical Powder Compaction Technology; Marcel Dekker
4. H. G. Brittain; Physical Characterization of Pharmaceutical solids; Marcel Dekker.

5. Lieberman, Rieser and Banker; Pharmaceutical Dosage Forms; Disperse system; Marcel Dekker
6. N. G. Stanley – Wooed; Enlargement and compaction of particle solids; Butterworths.

Learning outcomes:

After completion of this course students understand basic aspects of

- Students can understand Physical pharmaceutics.
- Students will understand concepts of Dissolution.
- Students can be enriched with knowledge of Surfactant System.
- Students can acquaint Polymer science and Stability studies

M. Sc. part II- Sem III –PRACTICALS

	PRACTICAL COURSE HCP 3.1: INDUSTRIAL & ENVIRONMENTAL BIOTECHNOLOGY 2- Credits
1.	Necessity and procedure of writing SOPs for instruments/equipment's to be used in scale up and/or large scale production.
2.	Culturing and characterization of microorganisms used in Dairy and Bakery.
3	Culturing and characterization of fungi/actinomycetes used in pharmaceutical industry.
4	Production and estimation of organic solvents: Ethanol/Acetone/Butanol/Glycerol.
5	Production and estimation of Alcoholic beverages: Beer/Wine.
6	Production and estimation of Phenylalanine/L-lysine/ Vitamin B12.
7	Preservation of industrial microorganisms (short term and long term).
8	Degradation of xenobiotic/textile dye by using bacteria/fungi.
9	Determination of COD for the given effluent sample.
10	Determination of BOD for the given effluent sample.
11	Any suitable practicals conducted by the department with respect to the concerned course(maximum two practical's).
12	Study of phytoremediation of industrial waste by using any suitable plant.

	PRACTICAL COURSE HCP 3.2: GENETIC ENGINEERING 2-Credits
1.	Isolation of Genomic DNA from blood/hair.
2.	Isolation of Ti plasmid DNA.
3	Transformation of *E. coli.*
4	In vitro DNA ligation.
5	Restriction Fragment Length Polymorphism (RFLP).
6	Random Amplified polymorphic DNA (RAPD).
7	Preservation of industrial microorganisms (short term and long term).
8	Southern blotting and hybridization.
9	DNA amplification by gradient.
10	Demonstration of Reverse transcriptase PCR (Demo).
11	Isolation of bacteriophage from given sample.
12	Any suitable practicals conducted by the department with respect to the concerned course(maximum two practicals).

	PRACTICAL COURSE SCP 3.1: PLANT BIOTECHNOLOGY 2-Credits
1.	Aseptic culture techniques for establishment and maintenance of cultures.
2.	Preparation of solutions and media in plant tissue culture laboratory.
3	Surface sterilization of different types of explants.
4	Callus induction and culture.
5	Anther and ovule culture.
6	Embryo culture.
7	Protoplast isolation and culture.
8	Protoplast fusion techniques.
9	*In vitro* rooting and acclimatization.
10	Synthetic seed preparation.
11	Cell Suspension culture.
12	Any suitable practicals conducted by the department with respect to the concerned course(maximum two practicals).

	PRACTICAL COURSE SCP 3.2: CANCER GENETICS AND ANIMAL CELL CULTURE 2-Credits
1.	DNA amplification by PCR
2.	Reporter gene assay (b- Gal).
3.	DNA Fingerprinting: Using RAPD techniques.
4.	Aseptic Transfer technique in animal Cell Culture.
5.	Preparation of Balanced Salt Solution and pH standards for animal cell culture.
6.	Trypsinization methods in animal cell culture – A. Warm Trypsinization B. Cold Trypsinization
7.	Chick Embryo Culture/Lymphocyte Culture.
8.	Synthetic seed preparation.
9.	Any suitable practical's conducted by the department with respect to the concerned course(maximum two practical's).
10.	Visit to cancer research center/laboratory

PRACTICAL COURSE OEP 3.1: COMPUTATIONAL STRUCTURE BIOLOGY AND DRUG DESIGNING	2 Credits
1.	Accessing to structural Databases and Data retrieval using RCSB PDB, CSA, and PdbSum.
2.	Structural classification using CATH and SCOP resources.
3.	Secondary structure prediction using SOPMA and GOR.
4.	Homology modeling by SWISSMODEL/Modeller 9V2.
5.	Model Validation using RAMPAGE or PROCHECK.
6.	Prediction of protein-protein.
7.	Prediction of protein-DNA/protein-ligand interactions.
8.	Drugbank database and Chembank database.
9.	Design of ligands using ACD lab/Chemsketch and Development of lead library.
10.	High throughput screening for drug like molecules using *in silico* ADMET Properties.
11.	Docking studies using AUTODOCK and HEX.
12.	Any suitable practical's conducted by the department with respect to the concerned course (maximum two practical's).

PRACTICAL COURSE OEP 3.2 ADVANCED PHARMACEUTICALS	2 Credit
1.	To determine solubility of given drug sample at room temperature.
2.	To determine density of given liquid sample.
3.	To determine surface tension of given liquid sample.
4.	To determine CMC of given liquid surfactant.
5.	To determine particle size and size distribution by using optical microscopy/microscopy method.
6.	To determine rheological properties for liquid sample.
7.	To demonstrate accelerated stability studies of a formulation.
8.	Isolation, purification and characterization of natural products.
9.	To visit the drug manufacturing/characterization unit.
10.	Any suitable practical's conducted by the department with respect to the concerned course (maximum two practical's).

Learning Outcome

After completion of above practical course, students will be able to:

- Perform lab scale production of commercial important fermentation products.
- Perform and apply the genetic engineering technology in various field, which include DNA isolation, fragmentation, mapping for disease diagnosis and their treatment.
- Perform *In-silico* analysis of various drugs and its pharmaceutical importance.
- Perform and understand principles of volumetric and electrochemical analysis.
- Perform different methods of plant tissue culture and its application in conservation and production of new economically important traits.

*As a part of self learning mode students have to acquire 4 credits compulsorily other than routine credits mentioned in the syllabus structure. It also mandatory for the students to submit the certificate from competent authorities in the stipulated time. It is the whole responsibility of the students with consultation of mentor to complete the course for successful acquiring 4 credits. Department will monitor the progression of the course completion of the students by assigning the responsibility to the concerned faculty as a mentor. It is also suggested that the students opting for internship or apprenticeship (should be of 60 hrs duration) will be allowed to join and complete the assignment

preferably during winter and summer vacation. If the duration is extended, the institute may allow the students to complete the assignment with prior permission from the head of the institution/competent authorities and the absentees from the host institute may be compensated by allowing the students to join during holidays of the working period. During the completion of self learning course at the time of semester III in emergency or exceptional case students are allowed to continue and complete in the IV semester.

Students have the options to select any one or two from **SWAYYAM/MOOCs/NPTEL /Skill based course-Institute or University/Internship/Apprenticeship.**

M. SC. BIOTECHNOLOGY, SEMESTER-IV

HCT 4.1: ANIMAL BIOTECHNOLOGY AND STEM CELL TECHNOLOGY

Teaching Hours- 60 **Total credits- 4**

About Course

This course paper is allowing students to introduce the principles, practices and applications of animal culture and stem cell technology. It also includes study of concept of Animal tissue culture, animal genomics, genetic transformation and molecular breeding of animals. This paper provide students with a theoretical and practical understanding of production of transgenic animals.

Unit No.	Title and Chapters	Lectures
Unit-I	**Introduction, history of animal cell culture and cell culture media** Introduction, importance, history of cell culture development, tissue culture techniques-primary and secondary culture, suspension culture, cell lines, hybridoma technology, Culture of lymphocyte, epithelial cell, stem cell and induced pluripotent stem (iPS) cells. Different types of cell culturemedia, growth supplements, serum free media, balanced salt solution, other cell culture reagents. Culture of different tissues and organ and their applications, animal cell culture for the production of vaccine.	**(10)**
Unit-II	**Characters of cells and behavior** Behavior of cells in culture, Mechano-chemical regulation of cell behavior, division, their growth pattern, metabolism of estimation of cell number. Bioreactor Design, Scaling up the cell culture to large scale/industrial level production, Microscale patterning of cells and their environment, Three- Dimensional Scaffolds.	**(10)**
Unit-III	**Concept of cell line and transgenic animal** Development of cell lines, characterization and maintenance of cell lines, cryopreservation, common cell culture contaminants. Culture of cells for production of various biological products, Concepts of transgenic animal technology; strategies for the production of transgenics and knock out animals–significance in biotechnology. Stem cell cultures in production of transgenic animals	**(10)**
Unit-IV	**Stem Cells – Basics, Properties and Classification** Introduction and types of Stem cells – Hematopoietic Stem Cells, Mesenchymal Stem Cells, Embryonic Stem Cells, Fetal Stem Cells, Stem cells from adult organs- Characteristics, Isolation, Culture and Characterization protocols. Three-Dimensional Cell Culture, Extra cellular matricesmorphogenesis and tissue engineering.	**(10)**
Unit-V	**Tissue Engineering and Transplantation Techniques** : Immunoisolation Techniques, Modes of Cell and Tissue Delivery, Regeneration of Bone and Cartilage, Islet Cell transplantation and Bioartificial Pancreas, Bioprinting of Organs and Tissues,Types of Stem Cells used in Gastrointestinal, Liver, Pancreas, Kidney, Heart, Spinal Cord and Lung Regeneration, Stem Cells in Eye Diseases and Disorders.	**(12)**
Unit-VI	**Biotechnology in wildlife preservation and conservation** Introduction, Development and use of advanced reproductive techniques for wild Species conservation, Artificial insemination with fresh or frozen-thawed semen, Embryo transfer, ART in birds, amphibians, and fish, Germplasm cryopreservation	**(08)**

	and genome resource banking efforts, bridging the gap between technology and animal conservation.	

REFERENCE BOOKS:

1. I.M. Butley. Anaimal Cell Culture and Technology. Second edition, Taylor and Francis
2. Freshney RI. 2005. Culture of Animal Cells. Wiley Liss.
3. Portner R. 2007. Animal Cell Biotechnology. Humana Press.
4. R. Lanza, J. Gearhart et al (Eds), Essential of Stem Cell Biology. (2009), Elsevier Academicpress.
5. R. Lanza and I. Klimanskaya, Essential Stem Cells Methods. (2009), Academic Press
6. J. J. Mao, G. Vunjak-Novakovic et al (Ed): Translational Approaches in Tissue Engineering &Regenerative Medicine 2008, Artech House, INC Publications.
7. Robert Lanza et al. Principles of Tissue Engineering, 3rd Edition. Academic Press; 3 edition(August 21, 2007)
8. Stein et al. Human Stem Cell Technology and Biology: A Research Guide and LaboratoryManual.Wiley-Blackwell; 1 edition (January 4, 2011)
   Lanza et al. Handbook of Stem Cells, Two-Volume Set: Volume 1-Embryonic Stem Cells;Volume 2-Adult & Fetal Stem Cells (v. 1).Academic Press (September 28, 2004).
9. Biotechnologies for wildlife fertility preservation, Pierre Comizzoli
   Smithsonian Conservation Biology Institute, National Zoological Park, Washington,DC

Learning outcomes:

Upon successful completion of this subject, students should:

- Be able to gain fundamental knowledge in animal cell culture and cell culture media and theirapplications.
- Be able to describe gene transfer technologies for animals and animal cell lines.
- Be able to describe Tissue Transplantation Techniques

HCT 4.2: ADVANCED ANALYTICAL TECHNIQUES

Teaching Hours- 60 **Total credits- 4**

About Course
This course provides an adequate knowledge of the principles, instrumentation and applications of common analytical techniques. It also helps to scientific understanding of analytical techniques and detail interpretation of results.

Unit No.	Title and Chapters	Lectures
Unit-I	**Microscopy & Centrifugation :** Introduction; Optical principles of Microscopy; **Types of Microscopes** -simple and compound, Inverted, Phase-contrast, Fluorescence microscope; Advanced Microscopy- Scanning electron Microscopy, Transmission electron Microscopy and Confocal Microscopy. **Centrifugation:** Small bench top centrifuges, High speed refrigerated centrifuges, analytical ultracentrifuge.	**(10)**
Unit-II	**Chromatographic techniques**: **Chromatography:** Introduction and types of chromatography: **Plane** – Paper and TLC, **Column Chromatography**- Principle, procedure and applications of Adsorption, Affinity, Gel Permeation, Ion Exchange, Gas Liquid chromatography (GLC), High Performance Liquid Chromatography (HPLC), Gas Chromatography-Mass Spectrometry (GCMS), Liquid Chromatography-Mass Spectrometry (LCMS).	**(10)**
Unit-III	**Electrophoresis and Blotting Techniques:** **Electrophoresis:**Basic principle of electrophoresis; Factors affecting electrophoretic mobility; Support Media. **Types of electrophoresis -** Theory & Applications of Paper, Starch gel, Agarose, Cellulose Acetate, Native PAGE, SDS-PAGE, Isoelectric focusing,2-D gel electrophoresis (2-D PAGE), Pulse field gel electrophoresis (PFGE), Blotting Techniques: Southern, Northern, Western blotting.	**(12)**
Unit-IV	**Spectroscopic techniques:** **Spectroscopy:** Introduction; Properties of electromagnetic radiation. Instrumentation & Applications of Colorimetry, UV Spectroscopy, VIS. Spectroscopy, Atomic Absorption Spectroscopy, Atomic Emission Spectroscopy, X-ray spectroscopy, IR Spectroscopy, Raman Spectroscopy, Nuclear Magnetic Resonance Spectroscopy, Mass Spectroscopy, Circular dichorism spectroscopy, ORD, MALDI TOF.	**(12)**
Unit-V	**Radioisotope techniques**: **Radioactivity:** Nature of Radioactivity (atomic structure, stability and radiation, types of radioactive decay, radioactive decay energy, rate of radioactive decay, units of radioactive decay, interaction of radioactivity with matter), Isotope, **Detection & Measurement of Radioactivity -** A) **Methods Based on Gas Ionization**- Ionization Chamber, Proportional Counters, GM Counters. **B) Methods Based on Excitation**- Solid and Liquid Scintillation counting. Applications of Radioisotopes in Biology, Safety measures.	**(10)**
Unit-VI	**Biomedical instruments** Introduction to Biomedical instruments, working principle and operation of ECG, EEG, Ultrasound, CT scan, MRI.	**(06)**

REFERENCE BOOKS:

1. Keith Wilson and John Walker. Practical Biochemistry- principles and techniques; Cambridge University press, London, UK.
2. David T Plummer, Tata McGraw- Hill publishing company limited, McGrqw office, New Delhi.
3. Kothari C.R., 2nd Edition, 2004. Research methodology- methods and techniques. New Age International (P) limited publishers, New Delhi.
4. P.K. Sharma-Instrumental methods of chemical analysis
5. Upadhyay. Upadhyay and Nath- Biophysical chemistry, Himalaya publication.
6. Brigan L. Williams- A Biologist's guide to principle and techniques of practical biochemistry.
7. R.S. Khandpur-Handbook of Biomedical Instrumentation, Tata McGraw Hill.

Learning outcomes:

Upon successful completion, students will have the knowledge and skills to:

- Explain the theoretical aspects of key analytical techniques and instruments used in different biological areas.
- To understand the strength and limitations of techniques and creative use of techniques for problem solving

HCT 4.3: RESEARCH METHODOLOGY AND INTELLECTUAL PROPERTY RIGHTS (IPR)

Teaching Hours- 60 **Total credits- 4**

About Course

The above course allow students to identify an appropriate research problem in their interesting domain which help them understand the actual problem and to solve it. Preparation of a research project report is important skill will be covered by this course. It helps to understand the law of patent and copyrights as well as the Adequate knowledge on IPR.

Unit No.	Title and Chapters	Lectures
Unit-I	**Research:** Definition, Importance and Meaning of Research, Objectives, Characteristics, Types of Research. Steps in Research; Identification, Selection and Formulation of Research Problem, Research Design, Formulation of Hypothesis.	**(12)**
Unit-II	**Sampling Techniques theory & Parametric Tests**: Sampling theory, Types of Sampling, Steps in Sampling, Sample Size, Advantages and limitations.Collection of Data: Primary Data, Secondary Data, Data Collection Methods, Relevance, Limitations and Cautions, **Parametric Tests**: T-test, Z-test, ANOVA (F-test) and Chi-square tests.	**(10)**
Unit-III	**Thesis and Manuscript writing:** **Thesis writing:** Abstract, Introduction, Materials and Methods, Results and Discussion, Summary and Conclusion, References (IMRAD). **Manuscript writing:** Author instructions, modes of paper communication, criteria for publication. Computer and internet application in Research (Search engines). Presentation of a scientific Paper, Preparation of Oral Presentation and Poster Presentation for conferences. Use of Audio-Visual aids in Presentation. Concept of plagiarism, citation index, h-index, i10-index, ISSN and ISBN. Scientific proposal writing for fundingagencies (UGC, CSIR, DBT, DST, ICMR and DRDO).	**(12)**
Unit-IV	**Introduction to IPR and Patents:** Intellectual property, Protection of Intellectual property, WIPO, Forms of protection: patent, copyright, trademark, trade secrets, geographical indications. Criteria and procedure of patenting, India and PCT-Patent cooperation treaty. Patenting of biological materials with examples and case studies, IP Infringement.	**(08)**
Unit-V	**Plant breeder's right**: Traditional knowledge, Biopiracy, International Union for the Protection of New Varieties of Plants (UPOV), Breeders exemption, Plant variety protection in India. Farmer's right, advantages and disadvantages of PBR**.** Technology transfer- Introduction, types of technology transfer and Indian scenario.	**(08)**
Unit-VI	**Use of tools in Research** Methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism	**(10)**

REFERENCE BOOKS:

1. Statistical Methods by S.P. Gupta.
2. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
3. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.

4. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Publications. 2 volumes.
5. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
6. Wadehra, B.L. 2000. Law relating to patents, trademarks, copyright designs and geographical indications. Universal Law Publishing.
7. Text book of Biotechnology, P K Gupta
8. Text book of Biotechnology, B D Singh.

Learning outcomes:

After completely this paper students will learn following knowledge:

- Students will get useful information about Steps in Research and Sampling Techniques
- Students will be able to learn about Thesis and Manuscript writing.
- Students will know the importance of patents and IPR in processing their innovation

SCT 4.1: MEDICAL BIOTECHNOLOGY AND BIO-NANOTECHNOLOGY

Teaching Hours- 60 **Total credits- 4**

About Course

Medical biotechnology and bio nanotechnology course includes study of the molecular basis of microbial Diseases.

It integrated knowledge of biology, physics, and chemistry associated with nanotechnology. It provides key concept of theoretical & practical aspects regarding nanotechnology.

Unit No.	Title and Chapters	Lectures
Unit-I	**Medical biotechnology** Normal microbial flora of human body, host-microbe interactions. Infection and infectious process, routes of transmission of microbes in the body. Epidemiology, description and pathology of human diseases caused by bacteria; *Staphylococcus, E.coli, Salmonella, Pseudomonas, Vibrio cholera*, *Clostridium*, *Mycobacteria,* syphilis, Fungi: description and pathology of diseases Caused by *Aspergillus, Candida.* Protozoa: Malaria and Ameobiosis. Viruses: pathogenesis of HSV, HIV and COVID-19.	**(12)**
Unit-II	**Laboratory diagnosis** Laboratory diagnosis of common infective syndromes and parasitic, Molecular diagnosis of various diseases. Biosensors: Concept and development of biosensors- Historical perceptive. Market potential and limitations, new generations of biosensors, Biosensors in medical diagnostics. Industrial applications of biosensors.	**(10)**
Unit-III	**Chemotherapy** Principles of chemotherapy, Mode of antibiotics: Penicillin, Streptomycin, Sulfonamides, and Polymyxins Antifungal drugs (Nystatin), Antiviral agents. Problems of drug resistance and drug sensitivity, Drug resistance in bacteria (MDR bacteria). Interferon Induction of interferon, types of inducers. Inactivation of viruses - Photodynamic inactivation. Vaccination for prevention of diseases, Application of phages in therapeutics.	**(12)**
Unit-IV	**Bio-Nanotechnology:** Introduction to Nanoworld, Nanoscience and Nanotechnology- nanoparticles, Nanowires, Nanorods, Nanotubes, thin films and multilayer. Applications in nanotechnology viz. Biosensors, separation of cells and cell Organelles, environmental cleaning, drug delivery, gene therapy .	**(08)**
Unit-V	**Synthesis of nanostructures** Natural in inorganic, Natural in organism, chemical and physical methods–Sol Process, Micelle, Chemical Precipitation, Hydrothermal Method, Pyrolysis, Bio-based Protocol, Chemical Vapor Deposition, and Sputtering. Functionalization of nanoparticles for biological applications. Recent trends in bionanotechnology.	**(08)**
Unit-VI	**Characterization of Nanoparticles** Microscopic methods (Shape, Size and location) using SEM, TEM; Particles interaction with electromagnetic radiation using Spectroscopy (UV-VIS and FTIR) and Determination of composition and crystal structure of nanoparticles by XRD.	**(10)**

REFERENCE BOOKS:

1. Nanomedicine books series by Robert A. Freitas Jr. Nanomedicine Volume I: basic capabilities, Landes, Austin, Tx, 1999
2. Robert A. Freitas Jr., Nanomedicine, volume IIA: Biocompatibility Lands, Austin, Tx 2003.

3. C.Wei, Nanomedicine, An issue of medical Clinics, 91-5, Elsevier Saunders, 2007
4. D.E. Reisner, bionanotechnology: Global Prospects, CRC Press, Boca Raton, FL 2008.
5. William F.Ganong. Review of medical Physiology Text Book Volume-I Springer
6. Ethical Guidelines for Biomedical Research on Human Subjects 2000. Indian Council of Medical Research, New Delhi.

Learning outcomes:

By the end of the course, the student should be able to

- Understanding the overview of bacterial, fungal and viral infections.
- Getting the knowledge for the diagnostics and treatment of various infectious agents.
- Studying the basics of nanotechnology, synthesis, characterization and applications of variousnanoparticles in medicine, agriculture and the environment.

4.2: ADVANCED PHARMACOGNOSY

Teaching Hours- 60 **Total credits- 4**

About Course

The advanced pharmacognosy paper includes study of General Research Methodology for Pharmacognosy. It provides knowledge about Herbal drug Industry for Entrepreneurship Development as well as Herbal drug regulatory affair. It also helps to understand Information Retrieval systems of Herbal Drugs and Literature survey and Volatile oils and Dyes of commercial value.

Unit No.	Title and Chapters	Lectures
Unit-I	**General Research Methodology** Definition of research, meaning of research objective of research, types of research, Review of literature and sampling techniques.	**(10)**
Unit-II	**Herbal drug Industry** Infrastructure of herbal drug industry involved in production of standardized extracts and various dosage forms. Entrepreneurship Development. Project selection, project report, technical knowledge, plant design, layout and construction. Pilot plant scale–up techniques, case studies of herbal extracts. Formulation, production management.	**(10)**
Unit-III	**Herbal drug regulatory affairs** Basic principles of clinical studies, Stability, Safety and toxicology of herbal drugs. Adverse drug reaction in herbal drugs. Effect of herbal medicines on clinical laboratory testing. Regulation and dispensing of herbal drugs.	**(12)**
Unit-IV	**Information Retrieval systems of Herbal Drugs & Literature survey of following therapeutic groups Immunomodulators:** Withania somnifera, Centellaasiatica, Embelicaofficinalis, Ocimum sanctum. Antipeptic ulcer: Glyceriza root, *Azadirachta indica,Gingiber officinalis* Hepatoprotectives:*Silibum marianum, Phyllanthus niruri, Picrorrhiza kurroa, Andrographis paniculata* Anticancer :Taxus species, *Camptotheca acuminate* Antifertility: *Embelica ribes*, Azadirachta indica, Gossypium species Nervine Tonic: *Centella asiatica*, Acorus *calamus, Valeriana wallichi* Anti-AIDS: *Areca catechu, Thea sinensis*	**(10)**
Unit-V	**Volatile oils and Dyes** Volatile oil of commercial significance. Review of Natural sweeteners: Dyes and Pigments,Preservatives.	**(10)**
Unit-VI	**Alternative system of medicine** Basic principle involved in Ayurveda, siddha, Unaniand Homeopathy, Types of formulation used in alternative system of medicine, preparation and standardization of Aristas, asawas, Gutikas, Churnas, Lehyas and Bhasmas.	**(08)**

REFERENCE BOOKS:

1. Ayurvedic formulary of India, Govt.of India, 1962.
2. British Herbal Pharmacopoia, (vol. I, II & III) Her majestys Services, U.K.
3. Cultivation and Utilization of aromatic plants: Atal & Kapoor, RRL, Jammu
4. Cultivation and Utilization of medicinal plants: Atal & Kapoor, RRL, Jammu.
5. Drug and Cosmatic act, (with latest amendments including Ayurvedic GMP), Govt. of India.

6. Herbal Drug industry: R.D. Chudhary, Eastern Publishers, New Delhi 1996.
7. Introduction to spices, plantation crops, medicinal and aromatic plants: N.Kumar et al ,Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi,1997.
8. Pharmacognosy: Trease W.C., Evans G.E. Bailliere and Tindall, Londan, 14th edtn.
9. Research in Education : John w. Best & James V. Kahn, Practice Hall of India Pvt. Ltd., NewDelhi,1996.
10. Various journals related to medicinal plants.
11. Various journals related to spices, perfumes, food and nutrition.
12. Various Research Journals on Medicinal natural products.Wealth of India , CSIR, New Delhi (Related Volumes).

Learning outcomes:

- Students can acquainted with knowledge of general research methodology for Pharmacognosy as well as Information Retrieval systems of Herbal Drugs and Literature survey.
- Gets knowledge about opportunities as entrepreneurship in Herbal drug Industry, Volatileoils and Dyes of commercial value.
- Students can understood Regulation and dispensing of herbal drugs.

MP 4.1: PRACTICAL PAPER: PROJECT DISSERTATION AND VIVA VOCE

(200 Marks, Credits-8)

Students have to begin their projects in 3rd Semester and submit the report in4th Semester.

- Students have to select individual project under the guidance of faculty and carry out in- house or industry/institutes.
- Projects will be related to Biotechnology.
- Research out-put will be presented in the form of a dissertation. At the end of semesters students have to present their research out come in the form of oral presentation during practical examinations.
- Weightage will be given on the basis of Introduction, Objectives, Review of literature, Materials & methods, Results and discussion, Summary & Conclusions, References.

Annexure-I

Walchand College of Arts and Science Solapur
Nature of Theory Question Paper for CBCS Pattern (CHOICE BASED CREDIT SYSTEM)
Faculty of Science M.Sc.-II Biotechnology

Time: - 3 hrs Total Marks-80

Instructions:

i) All questions are compulsory
ii) Draw neat labelled diagrams wherever necessary
iii) Figures to right indicate full marks
iv) Use of log table and calculators is allowed

Q. 1 A) Multiple Choice Questions (10)

i) .....

a) b) c) d)

ii) .....

a) b) c) d)

iii) .....

a) b) c) d)

iv) .....

a) b) c) d)

v) .....

a) b) c) d)

vi) .....

a) b) c) d)

vii) .....

a) b) c) d)

viii) .....

a) b) c) d)

ix) .....

a) b) c) d)

x) .....

a) b) c) d)

Q 1. B) Fill in the blank/Definition/One sentence answer/One word answer/Give the name/Predict product/match the following (06)

i)
ii)
iii)
iv)
v)
vi)

Q.2) Solve any 'eight' of the Following (16)

a)
b)
c)
d)
e)
f)
g)
h)
i)

Q. 3-A) Attempt any 'two' of the following (10)

a)
b)
c)

Q. 3-B) Short note/solve (06)

Q.4 A) Attempt any 'two' of the following (08)

a)
b)
c)

Q. 4-B) Describe/Explain/Solve (08)

Q.5) Attempt any 'two' of the following (16)

a)
b)
c)

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Annexure-II

Walchand College of Arts and Science Solapur
Nature of Practical Question Paper for CBCS Pattern (CHOICE BASED CREDIT SYSTEM)

Faculty of Science M.Sc.-II Biotechnology

Total Marks: 40

Q.1.	Major Experiments (Options)	15
Q.2.	Minor Experiments (Options)	10
Q. 3.	Spotting/Principle Writing	05
Q.4.	Laboratory Record (Journal)	05
Q. 5:	Viva-Voce	05

Board of Studies in Biotechnology
Chairperson
Dr. N. B Patkar