# Punyashlok Ahilyadevi Holkar Solapur University, Solapur


**NAAC Accredited-2015**
**'B' Grade (CGPA 2.62)**

# Name of the Faculty: Science & Technology

**CHOICE BASED CREDIT SYSTEM**

# Syllabus: Biotechnology

**Name of the Course: M.Sc. II (Sem.– III & IV)**

**(Syllabus to be implemented from w.e.f. June 2021)**

**PUNYASHLOK AHILYADEVI HOLKAR**
**SOLAPUR UNIVERSITY, SOLAPUR**
**Syllabus for M. Sc. Biotechnology**
**M. Sc. Biotechnology Sem.-III and IV (STURCTURE) w. e. f. 2021-22**

| Semester | Code | Title of the Paper | Semester Examination | | | L | T | P | Credits |
|---|---|---|---|---|---|---|---|---|---|
| | | | Theory UA | IA | 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
** IA=Internal Assessment
** UA= University Assessment
** 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

# M. SC. –II- BIOTECHNOLOGY, SEMESTER-III

## HCT 3.1: INDUSTRIAL AND ENVIRONMENTAL BIOTECHNOLOGY 4 Credits (60 Lectures)

**Objective:**

- 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

**Learning outcomes:**

After the completion of the course the student will have overall knowledge of

- 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 waste water management

**UNIT-I: Introduction to bioprocess engineering [14]**

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). Biotransformation. Analysis of mixed microbial population. Isolation and preservation of industrially important microorganisms. Microbial growth kinetics. Applications of Computer in bioprocess engineering. Measurement and control of bioprocess parameters (Physical, chemical and biological).

**UNIT-II: Upstream process [10]**

Industrial production of chemicals: Ethanol, Organic acids (citric acid, acetic acid and gluconic acid), Solvents (glycerol, acetone, and butanol), Antibiotics (Penicillin, Streptomycin and Tetracycline), Amino acids (lysine and glutamic acid). Vitamin (B12), Single cell protein and Single cell oil. Fermented food products (Bread, Idli, Dairy products and Alcoholic beverages).

**UNIT-III: Downstream process [12]**

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).

**UNIT-IV: Scope of Biotechnology in Environmental protection [10]**

Energy sources (Conventional & Nonconventional). Environment protection Acts: Environmental laws, Environmental policies, Environmental ethics. UN declaration. Environmental protection and conservation. Environmental Impact Assessment, Eco-planning and Sustainable Development.

**UNIT-V: Bioremediation [14]**

Biotechnology for clean environment: Biomaterials as substitutes for non-degradable materials (bioplastics, biofuel, bioinsecticide, and biofertilizer), Heavy Metal Pollution and impact on environment, 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), Biotreatment of textile Effluent, Xenobiotics, Biological Detoxification of PAH.

**REFERENCE BOOKS:**


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, Panima Publishing Corp.
6. Stanbury P.F, Ehitaker H, Hall S.J (1997) Priciples of Fermentation Technology., Aditya Books (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

**HCT 3.2: GENETIC ENGINEERING** **4 Credits (60 Lectures)**

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**Objective:**

- The objective of the course is 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.

**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 and industrial perspective.
- Can use and apply the knowledge of genetic engineering in problem solving and in practice

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**UNIT-I: Enzymes in Genetic Engineering** **[10]**

Exonucleases, Endonucleases, Restriction endonucleases–classification & properties; DNA manipulating enzymes - nucleases, DNA polymerases, RNA polymerases,and reverse transcriptase; nucleic acid modifying enzymes-ligases, alkaline phosphatases, terminal transferases and kinases.

**UNIT-II: Vectors in Genetic Engineering** **[12]**

Properties & structure of plasmids, cosmids, phagemids, BAC, YAC, Bacteriophages (λ and M13), Yeast vector, animal and plant viruses, Baculovirus, Mammalian and shuttle vectors.

**UNIT-III: *In vitro* construction, screening and Isolation of rDNA Molecules** **[14]**

Construction of rDNA Molecules - Isolation of Vector and donor DNA and its purification; Assembly of gene of interest and vector DNA; Introduction to genomic library: Construction and screening of Genomic library and cDNA library. Screening of Recombinant Cell – Direct Screening, Indirect Screening, Colony hybridization, Immuno-Screening. Molecular Probes- Genomic DNA probes, cDNA probes, synthetic oligonucleiotide probes,and RNA probes, methods of labeling probes.

**UNIT-IV: Molecular Markers and Transformation Methods** **[14]**

Techniques in Genetic Engineering: Introduction; Commonly used techniques: Chromosome walking, Molecular markers: Restricted Fragment Length Polymorphism (RFLP), Random Amplified Polymorphic DNA (RAPD), Amplified Fragment Length Polymorphism (AFLP), Microarray (DNA and protein). DNA sequencing: Maxam's and Gilbert's method, Sanger's dideoxy method, Automated and pyrosequecing. PCR and its types (Inverse, Real time and Reverse transcription). Transformation methods: Methods of direct transformation - microinjection, particle bombardment, electroporation, PEG and $CaCl_2$.

**UNIT-V: Applications of genetic engineering** **[10]**

Detection and Diagnosis of Genetic diseases (sickle-cell anaemia, Thalasemia, Haemophilia and Cystic fibrosis) and infectious diseases (Malaria and TB) Gene therapy- *ex vivo, in vivo*, DNA marker technology in plants, DNA fingerprinting, Production of recombinant products: insulin and HGH; Hepatitis-B recombinant vaccine, Synthesis of Human Interferon. GE in Plants**:** Insect- resistant plants, Herbicide-resistant plants, salt stress tolerant plants, edible vaccines, Modification of food plants taste (Sweetness); GE in animals - Transgenic sheep and mice.

**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
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. Molecular Biotechnology, 2nd Ed. S. B. Primrose, Blackwell Scientific publishers, Oxford, 1994
7. Milestones in Biotechnology, Classic Papers on Genetic Engineering, J. A. Davis and W. S.Reznikoff, Butterworth-Heinemann Boston 1992
8. Route Maps in Gene Technology, M. R. Walker, and R. Rapley, Blakwell Science, Oxford,1997
9. Genetic Engineering: An Introduction to Gene Analysis and Exploitation in Eukaryotes, S.M. Kingsman, Blackwell Scientific Publications, Oxford, 1998.

**SCT 3.1: PLANT BIOTECHNOLOGY** **4 Credits (60 Lectures)**

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**Objective:**

- To learn about basic techniques in plant tissue culture, Micro propagation and other type of hybridization techniques
- To know about genetic transformation in plant and techniques about gene delivery.
- To know about applications of plant biotechnology in molecular farming.

**Learning outcomes:**

- On the completion of course student will be able to understand different hybridization techniques and basics of embryogenesis.
- They will be able to learn about different gene delivery techniques.

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**UNIT-I: Plant physiology and basic techniques in plant tissue culture [10]**

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.

**UNIT-II: Micropropagation [10]**

Organogenesis, Somatic Embryogenesis, Synthetic seeds. Shoot tip culture/Auxiliary bud culture, Rapid clonal propagation. Embryo Culture & Embryo Rescue. Acclimatization of Plants. Somaclonal Variations/*In vitro* mutagenesis Selected successful examples of Plants of Diverse Origin using Tissue Culture technology, Rescue of endangered Plants.

**UNIT-III: Protoplast culture, anther culture and cryopreservation [12]**

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 plasma Conservation.

**UNIT-IV: Plant transformation technology [14]**

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.

**UNIT-V: Applications of plant biotechnology [14]**

Commercial micro propagation. Metabolic engineering & Industrial products, Plant secondary metabolites, 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, Applications in Biodiversity conservation.

**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 secondary

metabolism, lower Academic Publisher.
7. Chawla HC (2004) – Introduction to plant biotechnology (Science Publ)
8. Davies K (Ed) (2004) – Plant pigments and their manipulation – Annual plant revies, vol 14 Blackwell Publ)
9. Altman A, Hasegawa PM (Ed) (2012) – Plant Biotechnology and agriculture. Prospects for the 21st century (Academic press).
10. Bhojwani SS. & Razdan MK (1996). - Plant Tissue Culture: Theory & Practice (Elsevier)
11. Hou CT, Shaw JF (2009) – Biocatalysis and agricultural biotechnology (CRC Press)
12. Slater A, Scott NW, Fowler MR (2008) – Plant Biotechnology: the genetic manipulation of plants (Oxford Press)
13. Vasil IK, Thorpe TA (1994) – Plant cell and tissue culture (Springer)
14. H K Das Textbook of Biotechnology 4th edition

**SCT 3.2: CANCER GENETICS AND ANIMAL CELL CULTURE** **4 Credits (60 Lectures)**

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**Objective:**

- To study the stem cell and its use as regenerative medicine.
- To study the molecular level of cancer development and progression.
- To study the diagnosis and treatment for cancer.

**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.

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**UNIT I:** **[15]**

**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

**UNIT II:** **[10]**

**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

**UNIT III:** **[10]**

**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)

**UNIT IV:** **[10]**

**Animal Cell culture:** Introduction to animal cell and tissue culture, its advantages and limitations, Applications of animal cell and tissue culture. Basic techniques in animal cell culture: Disaggregation of tissue and setting up of primary culture, established cell line cultures, maintenance of cell culture, culture media and role of serum in cell culture, organ culture.

**UNIT V:** **[15]**

**Stem cell cultures:** Biology and characterization of the cultured cells, measurement of growth, measurement of viability and cytotoxicity. Scale up of animal cell culture, cell cloning, cell synchronization and transformation. Stem cell cultures: Embryonic and adult stem cells, their isolation, culture and applications, animal cloning. Transgenic animals: Construction of transgenic animals, gene knockouts, ethical and biosafety considerations.

**Recommended Text Books:**


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.

**OET 3.1 COMPUTATIONAL STRUCTURE BIOLOGY AND DRUG DESIGNING**

**4 Credit (60 Lectures)**

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**Objective:**

- The objective of the course is to familiarize the students with the basic concepts structural and pathway Databases.
- Students will understand the basics of molecular interaction in various diseases.
- To understand the principles of drug discovery and drug development

**Learning outcomes:**

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

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**UNIT-I:Introduction to Structural and Pathway Databases: [10]**

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).

**UNIT-II:Structure Prediction Methods: [10]**

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.

**UNIT-III:HomologyModeling: [10]**

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 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: [15]**

Molecular interaction; protein-protein, protein-DNA, Protein- Lipid, Protein- Ligand, Protein-Carbohydrate, DNA-Drug interaction, Metalloproteins, Pi … Pi interactions, C-H…Pi interactions.

**UNIT-V: Drug Discovery and Drug designing: [15]**

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, DOCKING; introduction to docking method to generate new structure, tools and molecular docking programs-AUTODOCK, HEX, iGemdock, SwissDock, clinical trials, FDA approval.

**REFERENCES:**

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 Berlin Heidelberg.
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.

## OET 3.2: ADVANCE PHARMACEUTICALS 4 Credits (60 Lectures)

**Objective:**

- To study Physical pharmaceutics
- To understand the concepts of Dissolution.
- To study Surfactant System.
- To study Polymer science.
- To be aware of Stability studies.

**Learning outcomes:**

After completion of this course students understand basic aspects of

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

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**UNIT-I: Physical pharmaceutics covering the following aspects [14]**

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.

**UNIT-II: Dissolution [12]**

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.

**UNIT-III: Surfactant System [14]**

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.

**UNIT-IV: Polymer science [10]**

Types and applications of polymers, polymerization reactions, methods of polymerization and characterization of polymers, thermodynamics of polymer solutions.

**UNIT-V: Stability studies [10]**

Kinetics activation energy calculations, accelerated stability studies, factors responsible for destabilization of pharmaceutical products and techniques to improve, shelf life calculations. Physical testing of solution, suspension, emulsion, aerosol, powder, tablet and sustained release products.

**REFERENCE BOOKS:**


1. Kitahard and A. Watanabe; Electrical Phenomena at Interfaces; Marcel Dekker.
2. Martin, P. Bustamante and A. H. Chun; Physical Pharmacy; Waverly.
3. D. M. Parikh; Handbook of Pharmaceutical Granulation Technology; Marcel Dekker.
4. G. Alderborn and C. Nystrom; Pharmaceutical Powder Compaction Technology; Marcel Dekker.

5. H. G. Brittain; Physical Characterization of Pharmaceutical solids; Marcel Dekker.
6. J. T. Cartensen; Drug Stability; Marcel Dekker.
7. James J. Wells; Pharmaceutical Preformulation, Ellis Harwood Ltd.
8. Lieberman, Rieser and Banker; Pharmaceutical Dosage Forms; Disperse system; Marcel Dekker.
9. M. N. Rubinstein; Pharmaceutical Technology, Drug stability, John Wiley and sons.
10. Martin Rhodes; Principles of Powder Technology, John Wiley and sons.
11. N. G. Stanley – Wooed; Enlargement and compaction of particle solids; Butterworths.
12. P. H. List and P. C. Schmidt; Pharmaceutical Technology, CRS Press.
13. P. J. Tarcha; Polymer for Controlled Drug Delivery, CRC Press.
14. Robinson; Novel Drug Delivery Systems, Marcel Dekker.
15. Kitahard and A. Watanabe; Electrical Phenomena at Interfaces; Marcel Dekker.
16. Martin, P. Bustamante and A. H. Chun; Physical Pharmacy; Waverly.
17. D. M. Parikh; Handbook of Pharmaceutical Granulation Technology; Marcel Dekker.
18. H. G. Brittain; Physical Characterization of Pharmaceutical solids; Marcel Dekker.
19. J. T. Cartensen; Drug Stability; Marcel Dekker.
20. James J. Wells; Pharmaceutical Preformulation, Ellis Harwood Ltd.
21. Rieser and Banker; Pharmaceutical Dosage Forms; Disperse system; Marcel Dekker.
22. M. N. Rubinstein; Pharmaceutical Technology, Drug stability, John Wiley and sons.
23. Martin Rhodes; Principles of Powder Technology, John Wiley and sons.
24. N. G. Stanley – Wooed; Enlargement and compaction of particle solids; Butterworths.
25. P. H. List and P. C. Schmidt; Pharmaceutical Technology, CRS Press.

**PRATICALS**

**PRACTICAL COURSE HCP 3.1: INDUSTRIAL & ENVIRONMENTAL BIOTECHNOLOGY**

**2- Credits**

1. Necessity and procedure of writing SOPs for instruments/equipments 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 practicals)

**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. Restriction Fragment Length Polymorphism (RFLP)
5. Random Amplified polymorphic DNA (RAPD)
6. *In vitro* DNA ligation
7. Southern blotting and hybridization
8. DNA amplification by gradient/
9. Demonstration of Reverse transcriptase PCR (Demo)
10. Isolation of bacteriophage from given sample
11. 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. 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. Any suitable practicals conducted by the department with respect to the concerned course. (maximum two practicals)

**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 practicals conducted by the department with respect to the concerned course (maximum two practicals)

**PRACTICAL COURSE OEP 3.2 ADVANCED PHARMACEUTICALS**

**2 Credits**

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 practicals conducted by the department with respect to the concerned course (maximum two practicals)

*As a part of self learning mode students have to acquire 4 credits compulsorily other than routine credits mentioned in the university 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

**4 Credits (60 Lectures)**

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**Objectives:**

- The objectives of this course are to introduce students to the principles, practices and applications of animal culture and stem cell technology.
- Animal tissue culture, animal genomics, genetic transformation and molecular breeding of animals.
- Providing students with a theoretical and practical understanding of production of transgenic animals.

**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 their applications.
- Be able to describe gene transfer technologies for animals and animal cell lines.
- Be able to describe Tissue Transplantation Techniques

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**UNIT-I: Introduction, history of animal cell culture and cell culture media [14]**

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 culture media, 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.

**UNIT-II: Characters of cells and behavior [10]**

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.

**UNIT-III: Concept of cell line and transgenic animal [10]**

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.

**UNIT-IV: Stem Cells – Basics, Properties and Classification [12]**

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 matrices morphogenesis and tissue engineering.

**UNIT-V: Tissue Engineering and Transplantation Techniques [14]**

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.

**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 Academic press.
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 Laboratory Manual.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).

**HCT 4.2: ADVANCED ANALYTICAL TECHNIQUES** **4 Credits (60 Lectures)**

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**Objective:**

- To provide an adequate knowledge of the principles, instrumentation and applications of common analytical techniques.
- To provide scientific understanding of analytical techniques and detail interpretation of results.

**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

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**UNIT-I: Microscopy & Centrifugation** **[12]**

Microscopy: Introduction, Optical principles of Microscopy, Types of Microscopes - simple and compound, Inverted, Phase-contrast, Bright field, Dark field, Fluorescence microscope, Advanced Microscopy- Scanning electron Microscopy, Transmission electron Microscopy and Confocal Microscopy. Centrifugation: Small bench top centrifuges, large capacity refrigerated centrifuges, High speed refrigerated centrifuges, preparative and analytical ultracentrifuge.

**UNIT-II: Chromatographic techniques** **[10]**

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), Fast Protein Liquid Chromatography (FPLC), High Performance Liquid Chromatography (HPLC), Gas Chromatography-Mass Spectrometry (GCMS), Liquid Chromatography-Mass Spectrometry (LCMS). Chromatofocussing.

**UNIT-III: Electrophoresis and Blotting Techniques** **[14]**

**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), High Voltage, Pulse field gel electrophoresis (PFGE), Capillary Electrophoresis; Blotting Techniques: Southern, Northern, Western and Southwestern blotting.

**UNIT-IV: Spectroscopy** **[14]**

**Spectroscopic techniques:** Introduction; Properties of electromagnetic radiation. Instrumentation & Applications of Colorimetry, Nephelometry, VIS & UV Spectroscopy, Atomic Absorption Spectroscopy, Atomic Emission Spectroscopy, X-ray spectroscopy, IR Spectroscopy, Raman Spectroscopy, Nuclear Magnetic Resonance Spectroscopy, Mass Spectroscopy, Circular dichorism spectroscopy, MALDI TOF, Spectro-fluorimetry, Gamma ray spectroscopy.

**UNIT-V: Radio isotope techniques** **[10]**

**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.

**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. Khandpur R.S-Handbook of Biomedical Instrumentation, Tata McGraw Hill.

**HCT 4.3: RESEARCH METHODOLOGY AND INTELLECTUAL PROPERTY RIGHTS (IPR) 4 Credits (60 Lecture)**

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**Objective:**

- Identify an appropriate research problem in their interesting domain.
- Understand the Preparation of a research project report
- Understand the law of patent and copyrights.
- Understand the Adequate knowledge on IPR

**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 innovations.

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**UNIT-I: Research [10]**

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.

**UNIT-II: Sampling Techniques & Parametric Tests [14]**

Sampling theory, Types of Sampling, Steps in Sampling, Sample Size, Advantages and limitations. Collection of Data: Primary Data, Data Collection Methods, Secondary Data, Relevance, Limitations and Cautions, Testing of significance Mean, Proportion, Variance and Correlation, Testing for Significance of Difference between Means, Proportions, Variances and Correlation Co efficient. Chi-square tests, ANOVA.

**UNIT-III: Thesis and Manuscript writing [14]**

Abstract, Introduction, Materials and Methods, Results and Discussion, Summary and Conclusion, References (IMRAD). Preparation of Manuscript; 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 funding agencies (UGC, CSIR, DBT, DST, ICMR and DRDO).

**UNIT-IV: Introduction to IPR and Patents [12]**

Intellectual property, Protection of Intellectual property, WIPO, forms of protection- patent, copyright, trademark, geographical indications, trade secrets. Criteria and procedure of patenting, patenting biological material. Patent procedure in India and PCT-Patent cooperation treaty. Types of patenting, Patenting of biological materials with examples and case studies,IP Infringement.

**UNIT-V: Plant breeder's right [10]**

Traditional knowledge, Bio piracy, 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.

**REFERENCE BOOKS:**


1. Statistical Methods by S.P. Gupta.
2. Research Methodology, Method and Techniques by C.R. Kothari or by Santosh Gupta.
3. Research Methodology by Gurumani.
4. Text book of Biotechnology, P K Gupta
5. Text book of Biotechnology, B D Singh.

## SCT 4.1: MEDICAL BIOTECHNOLOGY AND BIO-NANOTECHNOLOGY

**4 Credits (60 L)**

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**Objective:**

- To understand the molecular basis of microbial Diseases.
- To integrate knowledge of biology, physics, and chemistry associated with nanotechnology.
- To provide key concept of theoretical & practical aspects regarding nanotechnology.

**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 various nanoparticles in medicine, agriculture and the environment.

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**UNIT-I: Medical biotechnology [14]**

**Microbial Diseases:** 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, Klebsiella, Vibrio cholera*, *Clostridium*, *Mycobacteria,* syphilis, Fungi: description and pathology of diseases Caused by *Aspergillus, Candida,.Micrococcosis,* Protozoa: Malaria and Ameobiosis. Viruses: pathogenesis of HSV, HIV and COVID-19.

**UNIT-II: Laboratory diagnosis [10]**

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.

**UNIT-III: Chemotherapy [12]**

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.

**UNIT IV: Bio-Nanotechnology [10]**

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 .

**UNIT-V: Synthesis of nanostructures [14]**

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.

**REFERENCE BOOKS:**


1. Nanomedicine books series by Robert A. Freitas Jr. NanomedicineVolumeI: 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.

## 4.2: ADVANCED PHARMACOGNOSY 4 Credits (60 Lectures)

**Objective:**

- To study General Research Methodology for Pharmacognosy.
- To understand Herbal drug Industry for Entrepreneurship Development.
- To study Herbal drug regulatory affair.
- To understand Information Retrieval systems of Herbal Drugs and Literature survey.
- To study Volatile oils and Dyes of commercial value.

**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, Volatile oils and Dyes of commercial value
- Students can understood Regulation and dispensing of herbal drugs.

**UNIT-I: General Research Methodology [10]**

Definition of research, meaning of research objective of research, types of research, Review of literature and sampling techniques.

**UNIT-II: Herbal drug Industry [12]**

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.

**UNIT-III: Herbal drug regulatory affairs [14]**

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.

**UNIT-IV: Information Retrieval systems of Herbal Drugs & Literature survey of following therapeutic groups [10]**

**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*

**UNIT-V: Volatile oils and Dyes** **[10]**

Volatile oil of commercial significance. Review of Natural sweeteners: Dyes and Pigments, Preservatives.

**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., New Delhi,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 ).

**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 in 4th 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.

**Chairman**
**(BOS In biotechnology)**