VII SEMESTER

S. No.	Subject Name	L	P	M
Theory				
1.	Instrumental Methods of Analysis	**4**	**0**	**100**
2.	Downstream Processing in Biotechnology	**4**	**0**	**100**
3.	Bioethics and Biosafety	**4**	**0**	**100**
4.	Biopharmaceutical and Technology	**4**	**0**	**100**
5.	Elective II*	**4**	**0**	**100**
6.	Elective III*	**4**	**0**	**100**
Practicals				
1.	Instrumental Analysis Lab	**0**	**3**	**100**
2.	Downstream Processing Lab	**0**	**3**	**100**

* Elective II

Biological Spectroscopy
Molecular Modelling and Drug design
Immunotechnology

* Elective III

Bioreactor Theory
Cancer Biology
Molecular Pathogenesis

INSTRUMENTAL METHODS OF ANALYSIS

AIM

To familiarize the students with various instruments that are applied in the field of Biotechnology.

OBJECTIVES

To study in detail about the

- Flame photometry, turbidimetry and nephelometry.
- Optical instruments.
- Molecular spectroscopy.
- Thermal and X - ray methods.

UNIT I 9

BASICS OF MEASUREMENTS AND SCATTERING OF RADIATION

Classification and calibration of instrumental methods, Rayleigh scattering, Scattering of gases, Atomization, Flame atomization, Turbidimetric and Nephelometric titrations.

UNIT II 9

OPTICAL METHODS

General design, Sources of radiation, Wavelength selectors, Sample containers, Radiation transducers, Types of optical instruments, Fourier transform measurements.

UNIT III 9

MOLECULAR SPECTROSCOPY

Measurement of transmittance and absorbance, Beer's law, Spectrophotometer analysis, Types of spectrometers, UV – Visible – IR- Raman spectroscopy – Instrumentation – theory, NMR spectroscopy, X-ray photoelectron spectroscopy (XPS), Ultraviolet photo electron spectroscopy (UPS), Electron impact spectroscopy, Auger electron spectroscopy and Atomic absorption spectroscopy.

UNIT IV **9**

THERMAL METHODS

Thermo-gravimetric methods, Differential thermal analysis, Differential scanning calorimetry.

UNIT V **9**

X-RAY METHODS

The absorption of X-rays, Monochromatic X-ray sources, X-ray detectors, X-ray diffraction, X-ray fluorescence.

Total : 45 Hours

TEXT BOOKS

1. Willard and Merrit, H., 1999. Instrumental Methods of Analysis. *CBS Publishers*.
2. Chatwal and Anand. Instrumental Methods of Analysis.
3. Skoog, D., 2000. Instrumental Methods of Analysis.

REFERENCES

1. Ewing, G.W., 1989. Instrumental Methods of Chemical Analysis. *McGraw Hill Book Company*.
2. Braun, H., 1987. Introduction to Chemical Analysis. *McGraw Hill Book Company*.

DOWNSTREAM PROCESSING IN BIOTECHNOLOGY

AIM

To develop the skills of the students in the various aspects of Downstream Processing.

OBJECTIVES

To impart knowledge on

- Role of Downstream Processing in Biotechnology.
- Primary separation and Recovery processes.
- Enrichment operations.
- Product fractionation and Purification.
- Formulation of the final product and Finishing.

UNIT I 10

ROLE OF DOWNSTREAM PROCESSING IN BIOTECHNOLOGY

Role and importance of downstream processing in biotechnological processes, Characteristic of biomolecules and bioprocesses, Process design criteria for various classes of bioproducts (High volume, low value products and low volume, high value products), Physio-chemical basis of bioseparation processes. Cell disruption for product release – Mechanical, Enzymatic and Chemical methods. Pre-treatment and stabilization of bioproducts.

UNIT II 8

PRIMARY SEPARATION AND RECOVERY PROCESSES

Cell disruption methods for intracellular products, Removal of insolubles, Biomass (and particular debris) Separation techniques, Flocculation and sedimentation, Centrifugation and filtration methods.

UNIT III 9

ENRICHMENT OPERATIONS

Adsorption, Liquid – Liquid extraction, Aqueous two phase extraction, Membrane separation – Ultra filtration and reverse osmosis, Dialysis, Precipitation of proteins by different methods, *In situ* product removal, Integrated bioprocessing.

UNIT IV **10**

PRODUCT FRACTIONATION / PURIFICATION

Chromatography – Principles, Instrument and practice, Adsorption, Reverse phase, Ion exchange, Size exclusion, Hydrophobic interaction, Bioaffinity and pseudo affinity chromatographic techniques, Electrophoretic Techniques (all electrophoretic techniques including capillary electrophoresis)

UNIT V **8**

FINAL PRODUCT FORMULATION AND FINISHING OPERATION

Crystallization, Drying and lyophilization in final product formulation.

Total : 45 Hours

TEXT BOOKS

1. Product Recovery in Bioprocess Technology. 1990. *BIOTOL Series*, *VCH*.
2. Asenjo, J.M., 1993. Separation Processes in Biotechnology. *Marcel Dekker Inc*.
3. Belter, P.A., Cussler, E.L. and Wei – Houhu, 1988. Bioseparations – Downstream processing for Biotechnology. *Wiley Interscience Publications*.
4. Jenkins, R.O., 1992. Product Recovery in Bioprocess Technology – Biotechnology by Open Learning Series. *Butterworth – Heinemann*.
5. Sivasankaran. Bioseparation.

REFERENCES

1. Wankat, P.C., 1990. Rate Controlled Separation. *Elsevier*.
2. Better, P.A. and Cussler, E., 1985. Bioseparation. *Wiley*.
3. Janson, J.C. and Ryden, L., 1989. Protein Purification – Principles, High Resolution Methods and Applications. *VCH Publication.*
4. Scopes, R.K., 1994. Protein Purification – Principles and Practice. *Narosa Publication*.

BIOETHICS AND BIOSAFETY

AIM

To create awareness in Biosafety and ethical issues in Biotechnological process.

OBJECTIVES

At the end of the course the students will have a thorough knowledge on

- Biosafety guidelines and management.
- Patent system and IPR.
- Bioethics and Socioeconomic impacts.
- Ethical issues on GMOs.

UNIT I 9

INTRODUCTION TO BIOSAFTEY

Biosafety regulation and guidelines, Public acceptance issues for biotechnology – Case studies, Experimental protocol approvals, Levels of containment, Problems of biologically active biotechnology products, The Cartagena protocol on the Biosafety and Biosafety management.

UNIT II 10

PROTECTION OF BIOTECHNOLOGICAL INVENTIONS

Objectives of patent system, Basic principles and general requirements of patent law, Biotechnological inventions and patent law, Legal development, Patentable subjects and protection in biotechnology, The patentability of microorganisms, Intellectual Property Rights and World Trade Organization (WTO) regime, Consumer protection and IPR, IPR and Plant genetic resources, Plant Breeders Right, IPP, WIPO, GAAT, TRIPs.

UNIT III 8

BIOTECHNOLOGY AND BIOETHICS

Definition and concepts : Bioethics and nature, Bioethics and gender bias, Theology, Bioethics and National and International legislation /Law, The ethical issues on legal and socioeconomic impacts of biotechnology.

UNIT IV **9**

BIOETHICS AND HUMAN

Personhood, Bioethical issues in reproduction, Abortion, Population explosion and control, Assisted reproduction, AIDS, Egg donation, Prenatal screening and sex selection, Cloning, Ethical issues on life and death, Voluntary euthanasia and physician assisted suicide, Organ donation and transplantation.

UNIT V **9**

BIOETHICS AND NEW GENETICS

Ethical issues on genetically engineered organisms and genetically modified foods, Ethical issues on new genetics – Human genome project, Gene therapy, stem cell research, National resource allocations.

Total : 45 Hours

TEXT BOOK

1. Beler, F.K., Crespi, R.S. and Straus, T. Biotechnology and Patent Protection. *Oxford and IBH Publishing Co.,* New Delhi.
2. Singh, K. Intellectual Property Rights on Biotechnology. *BCIL*, New Delhi.
3. Smith, J.E., 2004. Biotechnology. 3rd Edn., *Cambridge University Press*.
4. Singh, B.D., 2002. Biotechnology. 2nd Edn., *Kalyani Publishers.*
5. Dubey, R.C., 2006. A Text Book of Biotechnology. *S. Chand and Co. Ltd.*

REFERENCES

1. Edmund G. Seebauer and Robert L Barry, 2001. Fundamentals of Ethics for Scientists and Engineers. *Oxford University Press*, Oxford.
2. Cartagena Protocol on Biosafety, January, 2000.
3. Traynor, P.L., 2000. Biosafety Management. *Virginia Polytechnic Institute Publication*.
4. Howell, Joseph, H. and William F. Sale, 1995. Life Choices : A Hasting Center Introduction to Bioethics. *Georgetown University Press*, Washington, D.C.
5. Veatch and Robert M., 2000. The Basics of Bioethics. *Prentice Hall*, Upper Saddle River, New Jersey.

BIOPHARMACEUTICAL TECHNOLOGY

AIM

To make the students understand about the various concepts involved in the development of drugs and its manufacture in Biopharmaceuticals.

OBJECTIVES

To impart knowledge on

- Drugs ands Therapeutic agents.
- Drug action and metabolism.
- Process of Manufacturing drugs.
- Preparation, Preservation and Quality testing of drugs.
- Biopharmaceuticals.

UNIT I 9

INTRODUCTION

Pharmaceutical industry and development of drugs, Types of therapeutic agents and their uses, Economics and regulatory aspects.

UNIT II 9

DRUG ACTION, METABOLISM AND PHARMACOKINETICS

Mechanism of drug action, Physico-chemical principles of drug metabolism, Radioactivity, Pharmacokinetics.

UNIT III 8

MANUFACTURE OF DRUGS, PROCESS AND APPLICATIONS

Types of reaction process and special requirements for bulk drug manufacture.

UNIT IV 10

PRINCIPLES OF DRUG MANUFACTURE

Compressed tablets, Dry and wet granulation, Slugging or direct compression, Tablet presses, Coating of tablets, Capsule preparation, Oral liquids – Vegetable drugs – Topical applications, Preservation of Drugs, Analytical methods and other tests used in drug manufacture, Packing techniques, Quality management, GMP.

UNIT V **9**

BIOPHARMACEUTICALS

Various categories of therapeutics like Vitamins, Laxatives, Analgesics, Contraceptives, Antibiotics, Hormones and Biologicals.

Total : 45 Hours

TEXT BOOKS

1. Gareth Thomas, 2000. Medicinal Chemistry. An introduction. *John Wiley*
2. Katzung, B.G., 1995. Basic and Clinical Pharmacology. *Prentice Hall of Intl.*

REFERENCES

1. Leon Lachman, 1986. Theory and Practice of Industrial Pharmacy. 3rd Edn., *Lea and Febger*.
2. Remington, 1991. Pharmaceutical Science. *Mark Publishing and Co*.

INSTRUMENTAL ANALYSIS LAB

AIM

To make the students specialised in handling the various instruments of Biotechnological processes.

OBJECTIVES

- At the end of this course, the student would have learnt about the Spectroscopy, Nephelometry and Chromatography. This will be helpful in doing some specialised projects.

1. Validating Lambert – Beer's law using $KMnO_4$.
2. Precision and Validity in an experiment using Absorption spectroscopy.
3. Finding the Stoichiometry of the Fe (1,10 Phenanthroline Complex) using Absorption spectroscopy.
4. Finding the pKa of 4 Nitrophenol using Absorption spectroscopy.
5. UV spectra of Nucleic Acid.
6. Estimation of Alizarin Aluminium complex, limits of detection.
7. Estimation of Al^{3+} concentration using Alizarin in the spectrometer.
8. Estimation of Sulphate by Nephelometry.
9. Estimation of trace elements by Flame photometer.
10. Experiments on
    a. pH Meter
    b. Conductivity meter
    c. Turbidity meter.
11. Estimation of Dissolved oxygen.
12. Operating principles of IR spectrum of Hydrocarbons (Demo).
13. Operating principles of TGA, DSC and DTA (Demo).
14. Operating principles of NMR and ESR (Demo).

DOWNSTREAM PROCESSING LAB

AIM

To develop hands on training in the various techniques used in Downstream Processing.

OBJECTIVES

- At the end of this course, the student would have learnt about techniques like Solid-liquid separation, Cell disruption, High resolution purification, Product polishing. These experiments will enable the students to have a deeper understanding about the techniques.

1. Solid-Liquid Separation – Centrifugation, Micro filtration.
2. Cell Disruption Techniques – Ultra sonication, French Pressure Cell.
3. Cell Disruption Techniques – Dyno Mill – Batch and Continuous.
4. Precipitation – Ammonium Sulphite Precipitation.
5. Ultra Filtration Separation.
6. Aqueous Two Phase Extraction of Biologicals.
7. High Resolution Purification – Affinity Chromatography.
8. High Resolution Purification – Ion Exchange Chromatography.
9. Product Polishing – Gel Filtration Chromatography.
10. Product Polishing – Spray Drying, Freeze Drying.