Name of Faculty: Science	**Department:** Biotechnology
Program: M.Sc. Medical Biotechnology	**Type:** Theory + Practical
Subject: DSC-5 Reproductive Biology & ART	**Semester-**9
Credit: 04 + 02	**Total Learning Hours:** 60
Course Description: This Course will make students ready with all relevant background to deal with Assisted Reproductive Technology in Humans. It will provide fundamental knowledge about key elements of reproduction & ART.	
Student Learning Outcome: After completion of this course student will be ● well informed about female & male reproductive anatomy, disorders & infertility issues ● will be able to identify need & applications of IVF ● will be skilled for sperm processing, cryopreservation, & other relevant techniques related to IVF	

Unit -1 Reproductive Anatomy & Physiology (06 hours)
1.1 Male reproductive system (gross anatomy & histology)
1.2 Female reproductive system (gross anatomy & histology)
1.3 Gametogenesis
1.4 Fertilization & Implantation Process
1.5 Menstrual & Ovarian Cycle

Unit 2 Reproductive Physiology (Including Clinical Correlates) (08 Hours)
2.1 Hormonal Mechanisms, Neuroendocrine control of reproduction and feedback mechanisms
2.2 Physiological Role & functioning of - gonadotropins, prolactin, melatonin, Estrogen, progesterone, testosterone
2.3 Physiological Role & functioning of - Inhibin B, AMH, Activin, Leptin, T3, T4, TSH, Cortisol, DHEA
2.4 Metabolic control of reproduction
2.5 Physiology of pregnancy, parturition & lactation

Unit 3 Reproductive Disorders (Any 3 in each Subtopic) (07 Hours)
3.1 Menstrual Disorders
3.2 Fertility Disorders
3.3 Pregnancy Disorders
3.4 Endocrine Disorders
3.5 Sexual differentiation & developmental abnormalities

Unit-4 Embryology (08 Hours)
4.1 Overview of Embryonic Period & Fetus
4.2 Development of male reproductive system I (Gonads, Genital ducts & glands)
4.3 Development of male reproductive system II (External genitalia, descent of testis)
4.4 Development of female reproductive system I (Gonads, genital ducts, glands)
4.5 Development of male reproductive system II (External genitalia, descent of ovaries)

Unit-5 Introduction Of IVF (05 Hours)
5.1 Historical perspective
5.2 Indications for IVF treatment (diagnosis to prognosis)
5.3 Initial investigations of the infertile couple
5.4 Overview of IVF culture systems
5.5 Overview of IVF Clinic/ Lab

Unit-6 Sperm Processing In Art (09 Hours)
6.1 Evaluation of Sperms
6.2 Sperm Preparation techniques
6.3 Sperm chromatin Assessment
6.4 Advanced sperm selection techniques & technical aspects for ICSI
6.5 Sperm recovery techniques clinical aspects

Unit-7 Oocyte & Embryo Handling In Art (09 Hours)
7.1 Oocyte retrieval, selection & in-vitro maturation in clinical setting
7.2 Preparation & evaluation of oocytes for ICSI
7.3 Morphological Embryo Assessment & Embryo selection
7.4 Assisted Hatching
7.5 Preimplantation Genetic Diagnosis (PGD)

Unit-8 Cryopreservation In Ivf (06 Hours)
8.1 Sperm Cryopreservation
8.2 Human oocyte controlled rate cooling & slow freezing
8.3 Human embryo slow freezing
8.4 Vitrification – oocyte & embryo
8.5 Managing Oocyte Bank

References

- Step by Step Protocols in Clinical Embryology & ART – Pankaj Talwar & Surveen Ghumman Sindhu, Jaypee Brothers medical Pub
- IVF Techniques for the beginners – Kuldeep Jain & Pankal Talwae, Jaypee Brothers Medical Pub.
- A practical guide to setting up an IVF Lab, Embryo culture systems & running the unit – Alex C Varghese, peter Sjoblom & K Jayaprakasan, Jaypee brothers' medical Pub
- Textbook of assisted reproductive techniques volume 1: lab perspectives by dvid Gardner, Areil Weisssman, Colin M Howles, Zeev Shoham, CRC Press, 5th Edition
- Textbook of assisted reproductive techniques volume 2: Clinical Perspectives by David Gardner, Areil Weisssman, Colin M Howles, Zeev Shoham, CRC Press, 5th Edition

Practicals
1) Visit to an IVF clinic/ Training at IVF Clinic
2) Review Poster presentation related to embryology / IVF
3) Demonstration of Sperm Washing & Sperm Abnormalities
4) Study of Menstrual Cycle of Female

Name of faculty: Science	**Department:** Biotechnology
Program: M. Sc. Biotechnology	**Type:** Theory + Practical
Subject: DSC-6 Biopharmaceutical Technology	**Semester-**9
Credit: 04 + 02	**Total learning hours:** 60
Course description: The objectives of this course are to provide students with the theory and practical experience of Biopharmaceuticals which facilitate investigation of Drug action, metabolism and development process.	
Student learning outcome: ● Able to gain basic ideas and knowledge on sources of Biopharmaceuticals. ● Able to understand clarity and an understanding of the basic idea of the drug manufacturing process. ● It will create a deep understanding of scientific and technical aspects of development, production and clinical usage of biopharmaceuticals. ● It will facilitate the students to explore job avenues, research opportunities and entrepreneurship.	

UNIT-1: PHARMACEUTICALS, BIOLOGICS & BIOPHARMACEUTICALS (6h)

1.1 Biopharmaceuticals and pharmaceutical biotechnology
1.2 History of the pharmaceutical industry
1.3 Biopharmaceuticals: Current status and future prospects
1.4 Sources of Biopharmaceuticals: E.coli, Animal and Additional System

UNIT-2: DRUG DISCOVERY & DEVELOPMENT (8h)

2.1 Drug discovery – Gene chips, Proteomics, Structural Genomic
2.2 Principles of drug metabolism
2.3 Pharmacokinetics and Pharmacodynamics
2.4 Clinical Trials and Toxicological studies

UNIT-3 PRINCIPLES OF DRUG MANUFACTURE (8h)

3.1 Compressed tablets, Dry and wet granulation
3.2Oral liquids and Injectables
3.3 Vegetable drugs, Topical applications and Preservation of Drugs
3.4 Analytical methods and other tests used in drug manufacture

Unit-4 Biopharmaceutical technologies-1(9h)

4.1 Role of manufacturing process & evaluation
4.2 Cell banking, cell revival & expression system
4.3 Case Study of Biopharmaceuticals Manufacturing: Insulin Lispro (Humalog)
4.4 Case Study of Biopharmaceuticals Manufacturing: Monoclonal Antibody

Unit-5 Biopharmaceutical technologies-2 (9h)

5.1 Formulation, Labelling and Packaging
5.2 Drug delivery: Liposome, Nasal Spray, Polymer
5.3 Drug based on RNA-i Therapeutics & Antisense Technology

5.4 Drug based on Enzyme: SuperOxide dismutase and DNAase
5.5 Testing Potency of Biomolecule (*In vitro* and *In vivo* analysis)

Unit-6 Quality assurance and quality control (9h)
6.1 Fundamental of quality assurance
6.2 Quality assurance in manufacturing
6.3 Cross contamination and product confusion
6.4 Product Release and product recall
6.5 Basic elements of Quality Management System (QMS)

Unit-7 Production facilities & Product Analysis (6h)
7.1 Basic principles of GMP compliant design & zoning concept
7.2 Clean rooms, Water for injection and waste management
7.3 Product Analysis: Detection of Contaminants
7.4 Endotoxins and other pyrogenic contaminants

UNIT-8: REGULATORY AFFAIRS (5h)
8.1 Food & Drug Administration
8.2 The investigational new drug application
8.3 Regulatory Procedure-India, EMEA, ICH
8.4 Role of regulatory affairs department

References and Textbooks: (With Author, Edition, Publishers, ISBN)

- Walsh, G., Pharmaceutical Biotechnology: Concepts and Applications. John Wiley & Sons, 2007, ISBN: 978-0-4700-1244-4
- Walsh, Gary, and Brendan Murphy, eds. Biopharmaceuticals, an Industrial Perspective. Springer Science & Business Media, 1999, 978-0-7923-5746-9
- Rang, H. P., Drug Discovery and development. Churchill Livingstone Elsevier, 2006, ISBN: 978-0-44306420-3
- Manufacturing of Pharmaceutical Proteins (from technology to Economy) by Dr.-Ing. Stefan Behme, Wiley-VCH Verlag GmbH & Co. ISBN 978-3-527-32444-6

Practicals:
1. Purification of his-tagged recombinant proteins from bacterial hosts.
2. Detection of Endotoxins in pharmaceutical products by LAL test.
3. Introduction to CDS (cleaning, decontamination and sanitization) protocols as per GLP norms.
4. Sterility testing of finished biopharmaceutical products (Injectables / freeze dried formulations).

Name of faculty: Science	**Department:** Biotechnology
Program: M. Sc. Biotechnology	**Type:** Theory + Practical
Subject: SEC-3 Industrial Biotechnology Process	**Semester**-9
Credit: 04 + 02	**Total learning hours:** 60
Course description: The objectives of this course are to provide students with the theory and practical experience of Industrial Biotechnology Process which facilitate investigation of production aspects of commodity chemicals, pharmaceuticals and fine chemicals.	
Student learning outcome: ● Understand role of industrial biotechnology in improving microbial cells as factories. ● Apply knowledge of microorganisms in commercial production of flavors, fragrance, and microbial pigment in food industry. ● Apply and get insight in to the the process for commercial production of enzyme, pharmaceutical substances and waste management. ● To apply basic biotechnological principles, methods and models to solve biotechnological tasks and understand economy.	

UNIT-1 Introduction to Industrial Biotechnology (5h)

1.1 Overview of fermentation industries with their commercial products
1.2 Strain improvement through mutation and recombination in industrial microorganisms
1.3 Integrated Strain improvement program (Precision Engineering Technology)
1.4 Biosynthetic technology.

UNIT-2 Microbes in food industry (8h)

2.1 Single Cell Protein
2.2 Microbial production of wine, beer and vinegar
2.3 Biopreservatives (Nisin), cheese, biopolymers (xanthan gum, PHB etc), Bioflavours and biopigments
2.4 Microbial production of flavors and fragrances, Pigments in textile and food industry.

UNIT-3 Process technology for the production of cell biomass and primary metabolites- (8h)

3.1 Ethanol
3.2 Acetone-butanol
3.3 Citric acid
3.4 Dextran and amino acids

UNIT-4 Production of enzymes and specialty chemicals (9h)

4.1 Production of industrial enzymes: Proteases, Amylases, Lipases, Cellulases
4.2 Whole cell biocatalysis
4.3 Applications of bioconversion, transformation of steroids and sterols;
4.4 Production of acrylamide, adipic acid, 1,2- propanediol

UNIT-5 Microbial production of pharmaceuticals (8h)

5.1 Penicillin, Cephalosporin
5.2 Production of Vitamin E, K, B2 and B12,
5.3 Glutamic acid, L-Lysine.
5.4 Transformation of non-steroidal compounds

UNIT-6 Microbial production of other bio products(10h)

6.1 Genetic engineering of microorganisms for production of non-ribosomal peptides (NRPS) and polyketides (PKS)
6.2 Anticancer drugs
6.3 Mushroom Cultivation
6.4 Production of Chemicals by Immobilized Microbial Cells

Unit-7 Bioenergy & Waste Treatment (6h)

7.1 Fuel from biomass,
7.2 Production and economics of biofuels,
7.3 Biogas, bio-refineries, Microbial Enhanced Oil Recovery (MEOR)
7.4 Microorganisms for Waste Treatment

Unit-8 Economic of Fermentation Process (6h)

8.1 Plant Design
8.2 Process Design
8.3 Case Study of Biotech Industry and Product
8.4 Experimental Designing and Fundamental process

References and Textbooks: (With Author, Edition, Publishers, ISBN)

- Wulf Cruger and Anneliese Crueger (2003), Biotechnology: A Textbook of Industrial Microbiology, Panima Publishing Corporation.ISBN- 0878931317
- Peppler and Periman Vol.-1 & 2 2nd Edition (2004) Microbial Technology; Microbial Process ISBN 81-81474-495-3
- P.F. Stansbury and A. Whitaker, Principles of Fermentation Technology: An Introduction to Current Concepts, Pergamon Press (1993)- ISBN-978-0-08-036131-4
- Satyanarayana, U. "Biotechnology" Books & Allied (P) Ltd., 2005 ISBN-8187134909

Practicals:

1. Isolation, Screening, Production and partial purification of Amylase in shake flask culture
2. Isolation, Screening, Production and purification of Citric acid using *Aspergillus species*
3. Strain improvement of Aspergillus species using physical and chemical mutagenesis process.
4. Isolation, Screening, Production and purification cellulase producing enzymes
5. Isolation, Screening, Production and partial purification of Penicillin.

Name of faculty: Science	**Department:** Biotechnology
Program: M.Sc.	**Type:** Theory + Practical
Subject: DSE-3 Forensic Biology and DNA Typing	**Semester-**3
Credit: 04 + 02	**Total learning hours: 60**

Course description:

The course provides the basic knowledge about Forensic Science and its applications. Specifically this course covers biological and molecular aspects and information used for forensic studies and to solve the crimes. The techniques used for identification and characterization of culprits or victims through diverse biological evidences are included in this course.

Student learning outcome:

On completion of course students will be able to:

- Learn the basics of forensic biology.
- Understand the collection, identification and applications of various biological evidence for solving crimes.
- Learn basic biology of DNA and its principles.
- Apply the techniques for DNA typing for forensics.

Unit-1: Basics of Forensics: (4 h)

1.1. Introduction to Forensics and its branches
1.2. Forensic biology: A subdiscipline of Forensics
1.3. History of Forensic Biology
1.4. Laboratory Services: Forensics

Unit-2: Biological Sources as Forensic Indicators: (8 h)

2.1. The Decay process of Biological Sources
2.2. Body fluids and waste products
2.2.1. Blood and Cells; Blood Typing (bloodstain pattern analysis)
2.2.2. Saliva and Semen
2.2.3. Faeces, urine and vomitus
2.3. Hair
2.4. Bone
2.5. Wounds

Unit-3: Crime Scene Investigation and Analysis of Biological Evidence: (8 h)

3.1. Protection and documentation of crime scene
3.2. Recognition and collection of biological evidence
3.3. Packaging and transportation of biological evidence
3.4. Identification and characterization of biological evidence

3.5. Crime scene reconstruction and reporting results

Unit-4: Organisms in Forensics: (9 h)

4.1. Microbes (Bacteria, Viruses, Protist And Fungi)
4.2. Plants
4.2.1. Wood and illegal trade in protected plants
4.2.2. Pollen and spores
4.2.3. Fruit, seeds and leaves
4.2.4. Secondary metabolites as drugs and poison
4.3. Invertebrates (forensic indicators and forensic information obtained-calculating death time)
4.4. Vertebrates
4.5. Collection of plant and animal material for forensic studies

Unit-5: Basics of DNA Biology: (6 h)

5.1. Basic DNA principles and structure of DNA
5.2. Chromosome, genes
5.3. DNA Polymorphisms
5.4. DNA Markers
5.5. Designating chromosomal locations

Unit-6: DNA typing: (8 h)

6.1. Introduction to DNA analysis
6.2. Historical methods for DNA typing
6.3. Sources for DNA
6.4. Sampling, collection, storage and transportation of DNA evidence
6.5. Dealing with Degraded DNA, Low copy Number DNA and Mixture of DNA samples

Unit-7: Techniques for DNA typing: (10 h)

7.1. Extraction of DNA
7.2. Quantitation and analysis of DNA evidence
7.3. Amplification of DNA
7.4. Separation and detection of DNA
7.5. STR markers and genotyping (general STR and Y-chromosome)
7.6. SNPs and other polymorphisms
7.7. VNTRs profiling

Unit-8: Applications of DNA Typing in Forensics: (7 h)

8.1. Sex chromosome haplotyping and gender identification
8.2. Mitochondrial DNA profiling (Tzar Nicholas II case)
8.3. Parentage identification
8.4. Disaster victim identification
8.5. Wildlife Crime and Forensics

References:

- Li R.,(2015) Forensic Biology (2nd Edition), CRC Press ISBN:978-1-4398-8972-5
- Butler J., (2010) Fundamentals of Forensic DNA Typing, Elsevier ISBN:9780123749994
- Gunn A., (2006) Essential Forensic Biology, John Wiley & Sons Ltd.ISBN:978-0470758038
- Jamieson A. & Bader S., (2016) A Guide to Forensic DNA Profiling, John Wiley & Sons Ltd.ISBN:978-1118751527

Practicals:

1. Extraction and characterization (spectrophotometric and gel electrophoresis) of DNA from hair/nail clipping. Or To study DNA extraction through InstaDNA card.
2. Demonstration of Crime scene investigation. Or To identify unknown remains through mitochondrial DNA study (Demonstration and theoretical case study)
3. To study diatoms for identification of location, time of year and habitat of crime involving drowning.
4. To identify blood stain through presumptive tests (Hydrogen Peroxide test/Kastle-Meyer Test).

Reference for Practical:

1. Walker P. & Wood E., (2010) Facts on File Science Experiments Forensic Science Experiments, Infobase Publishing ISBN:978-0816078042

Name of Faculty: Science	**Department:** Biotechnology
Program: M.Sc.	**Type:** Theory
Subject: DSE-3 Bioentrepreneurship	**Semester:** 3
Credit: 04	**Total Learning Hours:** 60
Course Description: This course introduces students to basic concepts of Bio- Entrepreneurship. It will also inculcate the importance, need & applications of these areas. This course will prepare the students for becoming an Entrepreneur.	
Student Learning Outcome: After completion of the course, students will be: 1)Student will be able to appreciate the importance of Bio-Entrepreneurship 2)Student will be able to exposed to different concepts needed for practical execution when they work as Entrepreneur 3) Student will gain skills useful for becoming an Entrepreneur	

Unit 1 Introduction to Entrepreneurship (08 Hours)

1.1 Definitions & Concepts -Entrepreneur, Entrepreneurship, MSMEs , Enterprise & Startups
1.2 Process of Entrepreneurship
1.3 Competencies & Skills/ Qualities of an Entrepreneur
1.4 Types of Entrepreneurs & Enterprise
1.5 Advantages & Disadvantages of Entrepreneurship

Unit 2 Biotechnology Entrepreneurship (09 Hours)

2.1 Concept of Biotechnology Entrepreneurship
2.2 Significance of the Biotechnology Entrepreneur
2.3 Biotechnology entrepreneurship versus general entrepreneurship
2.4 Essential biotechnology entrepreneurial characteristics
2.5 Backgrounds of biotechnology entrepreneurs
2.6 Fuel, Feed and Heal the world through Biotechnology Entrepreneurship: Industrial and Environmental Biotechnology, Food and Agricultural Biotechnology, Health Biotechnology.

Unit 3 Financial Management & Financial Statements (09 hours)

3.1 Approaches to managing capital & cost of capital
3.2 Working capital & cash flow planning
3.3 Financial Planning & Budgets
3.4 Statement showing financial position
3.5 Measuring & reporting financial performance
3.6 Accounting conventions & concepts

Unit 4 Project Management (07 hours)
4.1 Project: Concept & Classification
4.2 Project Formulation
4.3 Project Reporting
4.4 Project Appraisal

Unit 5 Entrepreneurial Planning & HRM (06hours)
5.1 Basic legal forms of organizations
5.2 Company formation,ownership structure & securities
5.3 Human resource & business strategies
5.4 Workforce Planning
5.5 HRM Functions

Unit 6 Case studies of Biotech Entrepreneurs (06 Hours)
6.1 Shantha Biotech: Unleashing Biotechnology in India.
6.2 Aravind Eye Hospital: Making a Dent in Global Blindness.
6.3 Centocor: Diagnostics Company on Monoclonal Antibodies.
6.4 Suguna Poultry Farm Ltd: Hard work, No compromise, No excuse.
6.5 The Surat Transformation: Urban Renewal.

Unit 7 Introduction to IPR (06 Hours)
7.1 History & Definition of IPR
7.2 Forms/ Types of IPR
7.3 Traditional Knowledge, Commercial Exploitation & Protection
7.4 Protection of Biotechnological Inventions

Unit 8 Introduction to Patent (09 Hours)
8.1 Introduction & Types of Patent
8.2 Requirements for Patenting
8.3 Procedure of Patent Application
8.4 Various types of patent applications in India
8.5 Patent Search

References:

- Bioentrepreneurship Development: A Resource Book Prepared by Biotech Consortium India Limited (BCIL), New Delhi Compiled by: Ms. Shreya Sanghvi Malik, Deputy Manager Dr. Shiv Kant Shukla, Deputy General Manage
- Biotechnology Entrepreneurship (2014) Craig Shimasaki, Academic Press, USA.
- Dynamics of Entrepreneurial Development and Management (2005) Vasant Desai, Himalaya Publishing House.

- Making Breakthrough Innovation Happen: How Eleven Indians Pulled of the Impossible (2009) Porus Mushi, HarperCollins Publishers India.
- The CII Entrepreneur Hand Book: Practical Advice for Starting a New Business (2010) Sushila Ravindranath, Westland Ltd.
- The Game Changers: 20 extraordinary success stories of Entrepreneurs (2013) Y. Modi, R. Kumar & A. Kothari, Random House Publishers India Pvt. Ltd.
- Bioethics & Biosafety by M K Sateesh ,I K International Pub. Ltd
- Biotechnology Expanding Horizons by B D Singh, Kalyani Pub.

Name of faculty: Dr. Chaulami Desai	**Department:** Chemistry
Program: M.Sc. Organic Chemistry	**Type:** Theory
Semester: III	
Subject: DSE- III - Application of Green Chemistry	
Credit: 04(T) + 02 (P)	**Total learning hours:** 60

Course description: Students shall be able to understand:

- A functional concept of the field of green chemistry.
- The 12 principles of green chemistry.
- Several real world examples where organizations used green chemistry to improve the sustainability performance of their products.

How the practice of green chemistry enhances competitiveness, innovation and faster time to market.

Student learning outcome:

At the end of the course students will be able to...understand about

- Green Chemistry is the design of chemical products and processes that reduce or eliminate the use and generation of hazardous substances.
- This course will present the fundamentals of the 12 principles of green chemistry, and explore relevant examples of their practical use in commercial applications.
- To understand the environmental consequences of chemical manufacturing and illustrate how these may be minimized.

Unit 1 Application of green chemistry in daily life (06 Hours)

1.1 Green Dry cleaning of clothes, Green Bleaching Agents, green detergents, green dyes
1.2 Eco Friendly paints & Waxes
1.3 Putting out Fires in a green way
1.4 Turning turbid water clear in a Green way
1.5 Biodegradable plastics
1.6 Computer chips
1.7 Green drugs
1.8 Solar cell, Solar water heater
1.9 Green building and construction Materials
1.10 Bleaching of paper
1.11 Reusable water Bottle
1.12 Bio Material & Green fuel
1.13 Anti foulants and other green chemicals

Unit 2 Application of green chemistry in pharmaceutical Industry. (12Hours)

2.1 Green Pharmacy: Principle
2.2 Green Catalyst & Biocatalyst used in pharmaceutical industry.
2.3 Green Solvents and it's categories:
Water, Ionic liquids & Supercritical CO_2, Other Green Solvents
2.4 Solvent free processes,
2.5 Green processes in Pharmaceutical development
2.6 Minimum Pharmacy Waste
2.7 Design pharmaceutical products for degradation
2.8 Green Resources for Drug development through Ethan botany
2.9 Eco friendly Medicinal plants & Ayurvedic preparation

Unit 3 Application of Green chemistry in Agriculture. (10Hours)

3.1 Natural product in plant protection:

3.2 Development of green chemicals for the Agriculture-Minimum Risk Pesticides

3.3 Eco friendly Pesticides & Insecticides

3.4 Renewable Feedstock from Agriculture (Biomass)

3.5 A new Role of Neem Tree in greening the Environment

3.6 Vesicular Arbuscular Mycorrhizae in green chemistry.

Unit 4 Application of Green chemistry in Industry (12Hours)

4.1 Food and flavour Industry

4.2 Paper and pulp Industry

4.3 Polymer Industry

4.4 Textile Industry

4.5 Paint Industry: Water Based paints, High solids Paints, low TiO_2 paint

4.6 Tannery Industry

4.7 Rubber Industry

Unit 5 Application of Green chemistry for achieving sustainable development (06 Hours)

5.1 Green chemistry skills

5.2 Environmentally Friendly Technologies

5.3 Renewable feedstock and raw materials,

5.4 Oleochemistry, photochemistry, bio catalysis & biotransformation, sequestration of CO_2, waste biomass as chemical feed stock,

5.5 Biodegradation of biomass to biogas & biodiesels

Unit 6 Application of Green chemistry in analytical chemistry (04Hours)

6.1 Green analytical chemistry

6.2 Electrophoresis

6.3 Micronization in separation Methods

6.4 Greener solvent for separation

Unit 7 Eco friendly technologies for clean world (06Hours)

7.1 Waste: production, problems & prevention

7.2 Environmentally Benign Technologies using green chemistry

7.3 Application of non conventional energy sources

7.4 Microwave induced & Ultrasound assisted green synthesis

Unit 8 Other Applications Of Green Chemistry (04 Hours)

8.1 Chemicals from glucose:

8.2 Polysaccharide Polymers

8.3 Application of green chemistry in organic synthesis

8.4 Greener nanoscience

References:

1. V.K. Ahluwalia & M.R. Kidwai: New Trends in Green Chemistry, 2005, Anamalaya Publishers.
2. P.T. Anastas & J.K. Warner: Oxford Green Chemistry- Theory and Practical, 1988, University Press.
3. A.S. Matlack: Introduction to Green Chemistry, 2001, Marcel Dekker.
4. M.C. Cann & M.E. Connely: Real-World Cases in Green Chemistry, 2000, American Chemical Society, Washington.
5. M.A. Ryan & M. Tinnesand, Introduction to Green Chemistry, 2002, American Chemical Society, Washington.

Laboratory Practical

1. Determination of Organic Carbon in soil sample.
2. Determination of Nitrogen in soil sample.
3. Determination of Phosphorous in soil sample.
4. Determination of BOD in industrial wastewater sample.
5. Determination of NOx in Air sample.
6. Determination of SOx in Air sample.
7. Nitration of Salysilic Acid using $Ca(NO_3)_2$ and Acetic Acid.
8. Bromination of Acetanilide using $KBrO_3$ and $(NH_4)_2Ce(NO_3)_6$.
9. Preparation of Schiff Base by Microwave Technique.
10. Determination of Blood Sugar by Folin-Wu method.
11. Determination of Blood Urea by DAM method.
12. Determination of % Purity of Brass Alloy (Copper and Zinc).

References:

1. Standard Methods for Examination of Water & Wastewater, Andrew D. Eaton, Lenore S. Clesceri, Eugene W. Rice, Arnold Greenberg, 23rd Edition, 2017, published by APHA, AWWA, WEF.
2. Official Methods of Analysis, Dr. William Harwitz, Dr. George W Latimer, 18th Edition, 2005, published by Association of Officiating Analytical Chemists (AOAC).
3. Analytical Techniques in Agriculture, Biotechnology and Environmental Engineering, A. Nag, 1st Edition, 2006, Prentice Hall of India Pvt. Ltd.
4. Laboratory Manual on Engineering Chemistry, S.K. Bhasin and Sudha Rani, 3rd Edition, Reprint 2011, Dhanpat Rai Publishing Company (P) Ltd.