Name of faculty: Science	**Department:** Biotechnology
Program: M.Sc. Genetics	**Type:** Theory + Practical
Subject: DSC-5 Proteomics	**Semester:** 3
Credit: 04 + 02	**Total learning hours:** 60

Pre-requisites: Knowledge about:

- Gene Expression and Regulation
- Molecular Biology Techniques
- rDNA Technology
- Instrumentation and Techniques

Course description:

The goal of this course is to deliver information about proteomics a science conventionally named as protein chemistry. This subject is vast as the proteome of any given individual is dynamic and ever changing hence difficult to study. But this course helps to decipher the methods to study the proteins and their relationship in relevance to genomics and transcriptomics. Lastly the course delivers knowledge about ongoing projects and databases for studying proteomics and metabolomics.

Student learning outcome:

On completion of course students will be able to:

- Understand techniques for knowing the structure of proteins.
- Get acquainted with different global proteomic projects ongoing for developing understanding of and about proteome and their implications that can be applied at par to human welfare.
- Explain the functional interactions of proteins and metabolism, thus understand the interplay of proteins in metabolic processes at a given moment.

Unit-1 Introduction to Proteomics: (5h)

1.1. Proteomics-the Subject
1.2. Proteome and Genome
1.3. Transcriptome and Proteome
1.4. Proteins and Proteome

Unit-2 Tools for Studying Proteomics-I: (8h)

2.1 Overview of Proteomic Analysis and Selection of Protein Separation Methods
2.2 Extraction of Protein from Biological Systems
2.3 Protein Separation Techniques (SDS PAGE, 2D-PAGE, IEF, HPLC)
2.4 Tandem LC Approaches

Unit-3 Tools For Studying Proteomics and their Applications -II: (8h)

3.1. Digestion of Proteins (Use of Proteases, Chemicals, in Gel Digestions)

3.2. Mass Spectrometry
3.3. Peptide Mass Fingerprinting
3.4. Tandem Mass Spectrometry

Unit-4 Identification of Proteins: (7h)
4.1 Identification with MS Data
4.2 Software Tools for Identification
4.3 SALSA algorithm
4.4 Structural proteomics (NMR and X-Ray Crystallography)

Unit-5 Functional Proteomics: (10 h)
5.1 Functional Annotation of Protein
5.2 Protein Microarray
5.3 Studying Protein Interactions (Genetic Approaches, Methods Based on Comparative Genomics, Library Based Screening Methods-Phage Display, Yeast Two-Hybrid System and Bait & Prey Matrix)
5.4 Protein Interaction Maps

Unit-6 Metabolomics: (8h)
6.1 Introduction to Metabolomic Studies
6.2 Levels of Metabolite Analysis
6.3 Analytical Methodology for Metabolomics
6.4 Sample Selection and Sample Handling
6.5 Databases Aids in Metabolomics Data Sets

Unit-7 Proteomic Projects: (7h)
7.1. Human Proteome Project and HUPO
7.2. C-HPP (Chromosome centric Human Proteome Project)
7.3. PRIDE
7.4. PeptideAtlas Project

Unit-8 Applications of Proteomics: (7h)
8.1. Proteome Mining.
8.2. Comparative Proteomics
8.3. Epitope Mapping
8.4. Protein Microarray Technologies

References:

- Primrose, S. B., Twyman, R. M., (2006). *Principles of Gene Manipulation and Genomics*. Malden, MA: Blackwell PubISBN:1-4051-3544-1
- Campbell, A. M., & Heyer, L. J. (2003). *Discovering Genomics, Proteomics, and Bioinformatics*. San Francisco: Benjamin Cummings.ISBN:0-8053-4722-4
- Brown, T. A. (2006). *Genomes* (3rd Ed.). New York: Garland Science Pub.ISBN:0 8153 4138 5
- Walker J, Rapley, R. Molecular Biomethods Handbook, 2nd Ed., Humana Press; 2008. ISBN:978-1-60327-374-9
- Liebler, D. C. (2002). Introduction to Proteomics: Tools for the New Biology. Totowa, NJ: Humana Press.ISBN:0-89603-991-9

Research articles:

- Paik, Y. K., Jeong, S. K., Omenn, G. S., Uhlen, M., Hanash, S., Cho, S. Y., ... & Hancock, W. S. (2012). The Chromosome-Centric Human Proteome Project for cataloging proteins encoded in the genome. Nature biotechnology, 30(3), 221-223.
- Legrain, P., Aebersold, R., Archakov, A., Bairoch, A., Bala, K., Beretta, L., ... & Omenn, G. S. (2011). The human proteome project: current state and future direction. Molecular & cellular proteomics, 10(7), M111-009993.
- Omenn, G. S., Lane, L., Overall, C. M., Corrales, F. J., Schwenk, J. M., Paik, Y. K., ... & Deutsch, E. W. (2018). Progress on identifying and characterizing the human proteome: 2018 metrics from the HUPO human proteome project. Journal of proteome research, 17(12), 4031-4041.
- Vizcaíno, J. A., Côté, R. G., Csordas, A., Dianes, J. A., Fabregat, A., Foster, J. M., ... & Hermjakob, H. (2012). The PRoteomics IDEntifications (PRIDE) database and associated tools: status in 2013. Nucleic acids research, 41(D1), D1063-D1069.
- Desiere, F., Deutsch, E. W., King, N. L., Nesvizhskii, A. I., Mallick, P., Eng, J., ... & Aebersold, R. (2006). The peptideatlas project. Nucleic acids research, 34(suppl_1), D655-D658.

Practicals:

1. Extraction of protein from biological source bacteria/plant/animal cells.
2. Retrieval of protein data from protein databases.
3. Demonstration of Mass Spectrometry analysis of protein.

Name of faculty: Science	**Department:** Biotechnology
Program: M.Sc. Genetics/ Medical Biotechnology	**Type:** Theory + Practical
Subject: DSC-6 Genetic Disorders and Counseling	**Semester:** 3
Credit: 04 + 02	**Total learning hours:** 60

Course description:

The purpose of this course is to explicate the information about the genetics that play a central role in having a well synchronized biological systems and how defects or problematic working of the same may lead to abnormalities which may recur inheritably in several generations of organisms. It explains the basis of developing such abnormalities –known as genetic disorders, the factors that influence occurrence of such disorders. This course discusses certain representative cases of such genetic disorders and how different techniques can help to recognize and relate causes to these disorders. Lastly it also covers various counselling skills so that the patients and families can be counselled by trained persons to recover, deal and lead a life with such disorders, what can be done to obstruct these genetic changes from expressing further in familial generations.

Student learning outcome:

On completion of course students will be able to:

- Understand the basics of genetics and patterns of inheritance.
- Explain factorial variations in genetics and influences of the same in developing diseases or disorders.
- Understand and relate the genetic variations with respective representative genetic disorders and their etiology.
- Discuss the basic techniques to diagnose and imply the diagnostic data to case history, thereby deciphering the molecular cause of the disorder.
- Learn fundamental skills of counselling, that will help them in professional areas related to genetic counselling.
- Through case studies at the end of course, they will be able to fully understand the applicability of counselling in different cases of genetic disorders.

Unit-1 Introduction to Genetic Disorders, Genetics and Pattern of Inheritance: (8 h)

1.1. Introduction to Diseases and Disorders, Types of Genetic Disorders
1.2. Classical Mendelian Genetics
1.3. Modern Genetics (Extensions of and Deviations from Mendelian Genetic Principles)
1.4. Immunogenetics
1.5. Mitochondrial Inheritance

Unit-2 Mechanisms of Disease: (8 h)

2.1 History of Medical genetics
2.2 Principles of Disease
2.3 Genetic Causes of Human Malformations
2.4 Environmental Influence on Human Malformations
2.5 Mitochondrial Mutations
2.6 Developmental Biology and Birth Defects

Unit-3 Genetic Disorders –I (Introduction, Causes and Treatment): (7 h)

3.1. Down Syndrome
3.2. Fragile X Syndrome
3.3. LHON (Mitochondrial Disorder)
3.4. Cystic Fibrosis (Respiratory Syndrome)
3.5. Thalessemias (Haematological Disorder)

Unit -4 Genetic Disorders-II: (7 h)

4.1 SCID (Immunologic Disorders)
4.2 Type-II Diabetes (Endocrinological Disorders)
4.3 Obesity (Metabolic Disorders)
4.4 Alzheimer (Mental and Behavioural Disorder)
4.5 Duchenne Muscular Dystrophy (Neuromuscular)

Unit-5 General Techniques for Survey: (8 h)

5.1 Screening v/s Diagnostic Tests
5.2 Genetic Assessment (History, Examination, Investigation, Diagnosis)
5.3 Pedigree Analysis Through History and Bayesian Theory
5.4 Cytogenetic Analysis (Banding Patterns, FISH, DNA Probes)
5.5 Carrier Screening
5.6 Prenatal Diagnosis

Unit-6 Fundamentals for Counselling: (7 h)

6.1 Definition of Counselling
6.2 Principles, Components and Goals of Counselling
6.3 Model of Counselling (WICHE Model)
6.4 Variables Affecting Counselling Skills and Counsellor's Skills
6.5 Risk Assessment in Genetic Counselling
6.6 Maintaining Genetic Information

Unit-7 Basic Skills for Specific Counselling: (8 h)

7.1. Preparation for Counselling (Academic Preparation, Practical Skills, Interviewing Techniques etc.)

7.2. Counselling Relationship and Counselling Process (The Set Up, Skills for Communications, Stages of Counselling Process)
7.3. Methods of Counselling (Individual, Group, Family and Marriage Counselling)
7.4. Counselling for Stem Cell Preservation and Stem Cell Therapy
7.5. Counselling for Infertility and ART
7.6. Counselling for Genetic Disorders and Risk of Recurrence

Unit -8 Case Studies for Genetic Disorders and Counselling: (7 h)

8.1. Fragile X Syndrome (Lipton Family)
8.2. Down's Syndrome (Howard Family)
8.3. LHON (Fletcher Family)
8.4. Breast Cancer (Wilson Family)
8.5. Alzheimer Disease (Yamomoto Family)
8.6. Diabetes Type-2 (Zuabi Family)

References:

- Rimoin D., Connor J. M, Pyeritz R., Korf B., (2002) Emery and Rimoin's Principles and Practice of Medical Genetics, Fourth Edition, Churchill Livingston (Elsevier Science Ltd.) ISBN: 9780443064340
- Read A., Donnai D. (2011), New Clinical Genetics Second Edition. Scion Publishing Ltd. ISBN:1-904842801
- Gardner A. and Davies T., (2012), Human Genetics Second Edition. Scion Publishing Ltd. ISBN:978-81-309-1364-3
- Jones R.,(2012) Basic Counselling Skills A Helper's Manual 3rd Edition, SAGE publications.ISBN:978-8132109990
- Rao S. N. And Sahajpal P., (2014) Counselling and Guidance, 3rd Edition, McGraw Hill Education (India) Pvt. Ltd.ISBN: 9781259005077

Practicals:

1. To perform PBLC and prepare metaphase plates; study staining and banding patterns.
2. To study karyotyping and relate with genetic disorders.
3. A Visit to Cytogenetic Diagnostic Lab./Counselling Centre/Specialized Schools.
4. Mock drill (Group of students' have to explain the path of counselling for given problem)/(Students have to perform pedigree analysis of given trait in a family)

Name of faculty: Science	**Department:** Biotechnology
Program: M.Sc. Genetics/ Medical Biotechnology	**Type:** Theory + Practical
Subject: SEC-3 Molecular Diagnostics	**Semester:** 3
Credit: 04 + 02	**Total learning hours:** 60

Pre-requisites: Knowledge about:

- Molecular Biology Techniques
- Instrumentation and Techniques

Course description:

This course aims at imparting knowledge about different diagnostic methods at molecular levels for detecting diseases/ disorders as well as to check the quality of food and food products. The methods also aim to check the probable biological warfare weapons if at all dissipated as bioterrorism. The course covers various molecular based nucleic acid detection techniques, protein detection techniques, cytogenetic testing methods, etc.

Student learning outcome:

On completion of course students will be able to:

- Understand the role of different health care institutes/centers in diagnosis.
- Learn different specialized techniques, their applications in diagnosis of microbial diseases, genetic disorders, cancers etc.
- Apply these techniques in epidemiological studies of infectious outbreaks.
- Study, learn and apply various oncological markers used for cancer diagnosis.
- Understand the regulatory laws applicable for molecular diagnosis.

Unit-1 Introduction: (5 h)

1.1. Historical Perspective
1.2. Concept Of Molecular Diagnostics
1.3. Approaches For Molecular Diagnostics
1.4. Molecular Diagnostic Industry

Unit-2 Disease and Significance of Health Care Resources: (7 h)

2.1 Nature of Disease and Understanding the Disease
2.2 Classes of Disease
2.3 Investigation of Disease
2.4 Types of Pathological Laboratories
2.5 Role of Laboratories and Hospital Tests in Diagnosis

Unit-3 Genetic Variability Leading To Disease/Disorder: (8 h)

3.1. Molecular Genetics of Disorders
3.2. Discovering Human Disease Genes
3.3. Molecular Genetics of Cancer

Unit-4 Technologies for Molecular Diagnosis: (9 h)

4.1 PCR Based Methods for Detection of Mutation
4.2 Alternative Methods for Amplified Nucleic Acid Detection
4.3 Electrophoresis in Diagnostic Laboratories
4.4 Tests for DNA Variation Detection for Disease Association
4.5 Microarray Approaches
4.6 Tests to Detect DNA Methylation
4.7 Advanced Technologies for Molecular Diagnostics (FISH, Flow Cytometry, Laser Capture Microdissection, Medical Cytogenetics)

Unit-5 Detection Techniques for Microbial Diseases: (8 h)

5.1 Traditional Methods for Microbial Typing
5.2 New Molecular Methods for Microbial Typing
5.3 Applications in Clinical Microbiology
5.4 Applications in Epidemiology

Unit-6 Detection Techniques for Genetic Disorders and Analysis of Genetic Patterns: (9 h)

6.1 Molecular Diagnosis of Common Genetic Disorders: (Cystic Fibrosis, Duchenne Muscular Dystrophy, Fragile X Syndrome, Thalassemia, Obesity)
6.2 Cytogenetics in Detection of Malignancies (Diagnostics in Cancer-Biomarkers in Cancer Detection and Prognosis, Diagnosis of Breast Cancer, Lymphoma, Leukemias)
6.3 Microarray Analysis for Complex Pattern of Genes

Unit-7 Food Diagnostics and Rapid Diagnosis of Biological Warfare: (7 h)

7.1. Conventional Tools for Food Diagnosis
7.2. Rapid Methods for Food Diagnosis
7.3. Future Technologies for Food Diagnosis
7.4. Types of Bio-warfare Agents
7.5. Methods for Detection of Bio-warfare Agents

Unit-8 Quality Control and Auditing: (7 h)

8.1. Framework
8.2. Standardization of Protocols and Standards of Test
8.3. Laboratory Developed Tests and Their Implementation
8.4. Verification of Assays
8.5. Ethical and Social Issues in Molecular Diagnostics

References:

- Rimoin D., Connor J. M, Pyeritz R., Korf B., (2002) Emery and Rimoin's Principles and Practice of Medical Genetics, Fourth Edition, Churchill Livingston (Elsevier Science Ltd.)ISBN: 9780443064340
- Gardner A. and Davies T., (2012), Human Genetics Second Edition. Scion Publishing Ltd. ISBN:978-81-309-1364-3
- Glick, B. R., Pasternak, J. J., & Patten, C. L. (2010). *Molecular Biotechnology: Principles and Applications of Recombinant DNA*. Washington, DC: ASM Press.ISBN: 978-1-55581-498-4
- Coleman, W. B., & Tsongalis, G. J. (1997). *Molecular Diagnostics: for the Clinical Laboratorian*. Totowa, NJ: Humana Press.ISBN:978-1-58829-356-5

Practicals:

1. Isolation of food(source) DNA through spin column based method.
2. ELISA for detection of HIV/Hepatitis.
3. Detection of food poisoning pathogen by PCR (Salmonella/E.coli O157:H7 PCR detection kit)
4. Demonstration of cancer diagnosis of any one cancer case study.

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.