III SEMESTER: HARD CORE THEORY- BOT: HCT 3.1
CELL BIOLOGY AND GENETICS

Credits-04 **Theory-64 Hrs**

***Learning Objectives**: Aim of this course is to provide students with a deep understanding of the structural and functional organization of cells and chromosomes, along with the principles of heredity and genetic variation. It focuses on the study of cell organelles, cell division, and chromosomal behavior, highlighting their significance in plant growth and development. Students will also learn the historical foundations of genetics, Mendelian laws, linkage, crossing over, and patterns of inheritance, including extranuclear heredity.*

***Course Outcome**: Course provides comprehensive knowledge of cell structure, organization, and function along with molecular mechanisms underlying cell division and chromosomal dynamics. It enables students to understand classical and modern genetics, inheritance patterns, and chromosomal aberrations. The course also develops analytical and problem-solving skills through genetic analysis and cytological interpretation, preparing students for advanced studies and research in cell biology, genetics, and molecular plant sciences.*

Unit I: Cell Theory: Historical perspective and contemporary status. Cells, Prokaryotic and Eukaryotic cells, Chemical components of biological membranes, Organization and Fluid Mosaic Model, Extracellular Structures, Eukaryotic Cell organelles, Mitochondria, Chloroplast, ribosomes and nucleus, Endoplasmic Reticulum, Golgi apparatus, Lysosomes and Peroxisomes, Membrane vacuolar system Nucleus: Structure and Function, Chromosomes and their structure, Centromere, Kinetochore complex, Centromere Proteins (CENPs), Telomeres and their role in chromosome segregation, Giant chromosomes: Polytene and lampbrush chromosomes, Karyotype and Ideogram. **16 h**

Unit II: Cell Cycle: Cell division and significance of Mitosis and Meiosis, molecular events during Cell Cycle, checkpoints, role of Cyclins and cell signalling in plants. Chromosomal aberrations: Numerical: Euploidy (Monoploidy, Haploidy and Polyploidy) Polyploidy Autopolyploidy and Allopolyploidy. Aneuploidy-Monosomy, Nullisomy and Trisomy. Structural- Deletions, Duplication (Tandem, Reverse tandem and Displaced), Translocation (Simple, Isochrome, Reciprocal, Displaced) and Inversions (Pericentric and Paracentric). Significance of chromosomal aberrations. **16 h**

Unit III: History of Science of Genetics: Definition and scope of Genetics, Pre-mendelian genetic concepts, Pre-formation, Epigenesis, Pangenesis, Inheritance of acquired characters, Germplasm theory, Heredity and Environment, Genotype and Phenotype, Heredity and Variation, Mendelism: Biography of Mendel and his experiments with pea plant. Law of segregation: Monohybrid cross, back cross, and test cross, Dominance and Recessive ness, Co-dominance and Incomplete dominance, Genetic problems related. Law of Independent Assortment: Dihybrid cross in Pea plant and Drosophila, Back cross and test cross, Genetic problems related. Applications of Mendel's principles. **16 h**

Unit IV: Linkage & crossing over- Chromosome theory of Linkage, kinds of linkage, linkage groups, types of Crossing over, mechanism of Meiotic Crossing over, kinds of Crossing over, theories about the mechanism of Crossing over, Cytological detection of Crossing over, the significance of Crossing over. Sex-linked Inheritance in Drosophila and Humans, Inheritance of sex-limited and sex influenced traits. Extranuclear inheritance- Organelle heredity (mitochondrial, chloroplast), maternal effect, Infectious heredity in *Paramecium*. **16 h**

Suggested Readings/References:

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, Keith; Walter, P., (eds) c2002: Molecular Biology of the Cell, Garland Science, New York and London.
2. Copper, G.M., & Hausman, R.E., 2004: The Cell: A Molecular Approach, 3rd ed., Sinauer Associates, Inc, Sunderland, Massachusetts.
3. Lodish, H. Berk A, Zipursky SL, et al., 2000: Molecular Cell Biology, 4th ed., W.H. Freeman, New York.
4. Brooker, R. J., 2014, *Genetics: Analysis and Principles*. 5th ed. McGraw Hill.
5. Cavalli-Sforza L.L., Piazza A., Menozzi P., 1994 *History and geography of genes*, Princeton University Press, Princeton, NJ.
6. Cummings, M. R., 2014, *Human Heredity: Principles and Issues*. West Publishing Company.
7. Fisher, R.A., 1918. *The correlation between relatives on the Supposition of Mendelian Inheritance*. Transactions of the Royal Society of Edinburgh, 52: 399–433.
8. Gardner E. J. M. J. Simmons and D.P. Snustad, 2006, *Principles of Genetics*. 8th edition. John Wiley & Sons. INC. New York.
9. Griffiths A J F, H. J. Muller, D. T. Suzuki, R. C. Lewontin, and W. M. Gelbart, 2015.*An introduction to genetic analysis*. 11th ed. W. H. Freeman. New York.
10. Merell, D.J. 1975, *Introduction to Genetics*, W.W. Norton & Company Inc., New York.
11. Nelson and Cox, 2005, *Principles of Biochemistry* W.H. Freeman and Company, New York, 2005, pp.296-298.
12. Simmons S. 2006, *Principles of genetics*, 4th Edition, John Wiley & Sons (Asia) Pte Ltd. New Jersey.
13. Strickberger M. W., 2012, *Genetics*. Mac Millan Publishing Co. New York.
14. Sturtevant, A. H. 1965, *A History of Genetics*. Harper and Row, New York.
15. Tamarin, R H., 2009, *Principles of Genetics*. McGraw-Hill.

PRACTICALS
BOT: HCP-3.1. CELL BIOLOGY AND GENETICS

1. Methods of fixing and staining (Acetocarmine, Aceto-orcein and Feulgen)
2. Study of mitosis *(Allium / Maize)*
3. Study of meiosis *(Tradescantia / Chlorophytum / Allium)*
4. Determination of chromosome number at mitotic metaphase and diakinesis /metaphase I of meiosis.
5. Study of mitotic index in root meristematic tissue of *Allium cepa*
6. Preparation of Karyotype analysis in *Allium cepa*
7. Polytene chromosome in Chironomus larvae *j* Fruit flies
8. Observation of mutant flies of *Drosophila*
9. Determination of mono, dihybrid and test cross ratios

10. Problems from Mendelian linkage, Quantitative genetics and population genetics
11. Linkage problems - 3-point test cross
12. Preparation of permanent slides
13. Models/ Charts/ Photographs related to cytologist and geneticist.

III SEMESTER: HARD CORE THEORY- BOT: HCT-3.2
MOLECULAR BIOLOGY

Credits-04 **Theory-64 Hrs**

***Learning Objectives**: This course aims to provide a thorough understanding of the molecular basis of heredity and gene expression. It focuses on the structure, organization, and replication of genetic material, the processes of transcription and translation, and mechanisms regulating gene activity in both prokaryotes and eukaryotes. Students will also learn about mobile genetic elements and their role in genome evolution, genetic variation, and biotechnology applications.*

***Course Outcome**: Course provides in-depth knowledge on molecular mechanisms of DNA replication, transcription, and translation, along with gene regulation in prokaryotic and eukaryotic systems. It enables students to understand how genetic information is stored, expressed, and controlled. The course also offers insights into transposable elements and their biotechnological uses, preparing students for advanced research in molecular genetics, genomics, and biotechnology.*

Unit I: Nature of genetic material: Nucleic acid as genetic material; the primary and secondary structure of DNA and RNA; Organization of the Genetic material in prokaryotes and eukaryotes; mitochondrial and chloroplast DNA organization; Replication of DNA: Patterns of replication-experiments of Messelson's and Stahl, Cairns, Tailor, enzymes and proteins of DNA, replicating machinery, mechanism of replication-initiation, elongation and termination in prokaryotes and eukaryotes, fidelity of replication, proof reading mechanism, RNA directed DNA synthesis (reverse transcription). **16 h**

Unit II: Expression of Genome: Transcription- RNA polymerase-types, structure and function mechanism of transcription-initiation, elongation and termination in prokaryotes and eukaryotes. Post transcriptional modifications-RNA processing, capping, polyadenylation, splicing, alternate splicing, exon, shuffling, structural organization of m-RNA, t-RNA and r-RNA, m-RNA transport; Translation: t-RNA identity, amino acylation of t-RNA, amino acyl synthetase, the genetic code, deciphering of genetic code, degeneracy and Wobble hypothesis, enzymes, mechanism of translation-initiation, elongation and termination, proof reading, translational inhibitors, post translational modifications of proteins. **16 h**

Unit III: Gene regulation in prokaryotes: Cis regulatory factors-promoters, enhancers, operators, silencers-trans regulatory factors, transcription factors, regulation at transcription initiation operon concept Lac-operon, positive and negative control, Trp-operon, attenuation, ribosomal proteins as translational repressors, ribo switches, regulation in lytic and lysogenic cycle, induction and maintenance; Gene regulation in eukaryotes: Transcription activators, transcriptional repression, gene silencing by modification of histone

and DNA (Deacylation and methylation), regulation after initiation of transcription, translational controls, RNA interference, m-RNA localization during development. **16 h**

Unit IV: Transposable elements: Prokaryotic transposons, discovery, structure of IS elements, composite transposons, phage μ eukaryotic transposable elements- transposons discovery, AC-DS elements in maize, cpm/en elements in snapdragon, P elements in Drosophila, retro transposons -retroviruses and retro transposons, copia and Ty elements, mechanism of transpositions, uses of transposons-as genetic markers, mutagens, transposon tagging for gene isolation and vectors for transformation. Cell communication/Cell signaling: signaling molecules, receptors, cell signaling with reference to plant systems. Gene isolation and characterization through PCR, RAPD, RFLP, AFLP, SSR markers. **16 h**

Suggested Readings/References:

1. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Rafi, Keith Roberts, and Peter Walter. 2008. Molecular biology of the cell, 5th ed., Garland science, Taylor & Francis Group, LLC, 270 Madison Avenue, New York NY f 0016, USA.
2. Alberts, B., Bray, D., Lewis, J, Raff, M., Roberts, K and Watson, J.D. 1999. Molecular biology of the cell. Garland Publishing, Inc., New York
3. Kleinsmith, L.J. and Kish, V.M. 1995. Principles of Cell and Molecular Biology 2nd Edition Harper Collins College Publishers, New York, USA.
4. Lodish, H. Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell,J. 2000. Molecular Cell Biology 4th ed. W.H. Freeman and Co. New York, USA
5. Malaciniski, G.M. and Freidfelder, D. 1998. Essentials of Molecular Biology 3rd ed. Jones and Bartlet Publishers, Inc., London.
6. Gunning, B.E.S. and Steer, M.W.1996. Plant Cell Biology; Structure and Function. Jones and Bartlett Publishers, Boston, Massachusetts.
7. Harris, Nand Oparka, K.J. 1994. Plant Cell Biology A Practical Approach. IRL Press, Oxford University Press, U.K.
8. F.M. Ausubel, R. Brent, R.E. Kingston, D.D. Moore, J.G. Seidman, J.A. Smith, K. Struhl, (Current Edition) (2005). Current Protocols in Molecular Biology.
9. B.B. Buchanan, W. Gruissem and R.L. Jones. USA (2000). Biochemistry and Molecular Biology of Plants. Ed. ASPP Press.
10. T.A. Brown, 2000. Essential of Molecular Biology, Vol-I & 2 Oxford University Press.
11. James D. Watson, Tania, A. Baker, Stephen, P. Bell, Alexander, Gannm, Michael Levine.2004. Molecular Biology of the gene. 5th Edition, Pearson Education.
12. Philip M Gilmartin and Chris Bowle.2002. Molecular Biology of Plants. Vol 1 & 2 Oxford University Press.

PRACTICALS
BOT: HCP-3.2. MOLECULAR BIOLOGY

1. Isolation of DNA from prokaryotes
2. Isolation of DNA from eukaryotes
3. Quantification of DNA
4. Electrophoretic Separation of DNA
5. Cultivation of *E. coli.*
6. Isolation and estimation of protein from seeds.
7. Separation of protein by SDS-PAGE.
8. Isolation of RNA from plants.

III SEMESTER: HARD CORE THEORY- BOT: HCT-3.3
PLANT PHYSIOLOGY AND METABOLISM

Credits-04 **Theory-64 Hrs**

Learning Objectives: *This course aims to help students understand how plants function at the physiological and biochemical levels. It focuses on water relations, mineral nutrition, photosynthesis, respiration, and the role of plant hormones in growth and development. Students will also explore mechanisms behind flowering, seed germination, dormancy, senescence, and the physiological adaptations of plants to environmental stress.*

Course Outcome: *Course provides a detailed understanding of plant functions, including water transport, nutrient uptake, photosynthesis, and hormone regulation. It enables students to comprehend how internal and external factors influence plant growth and productivity. The course also imparts knowledge on stress physiology, flowering behavior, and regulatory mechanisms that control plant development under changing environmental conditions.*

Unit I: Water and life: Physical chemical properties of water. Water Potential and its components, Aquaporins Diffusion, osmosis, absorption (SPAC), Ascent of sap, Essential macronutrients and micronutrients: Role, deficiency and toxicity, Methods of study and use of nutrient solutions, Chelating agents, Biological membrane: Structure and Function, Chemical properties of soil (pH and soil nutrient status) Soil as a nutrient reservoir and transport of ions across cell membrane (passive absorption), Active absorption, Mineral nutrient uptake (mechanism), Phloem transport, Phloem loading, Phloem unloading, Source-sink relationship, Auxins-history of discovery, biosynthesis and mechanism of action. **16h**

Unit II: Photosynthesis: Significance of Photosynthesis, Ultrastructure of Chloroplast and photosynthetic pigments, Photosynthesis in C3 and C4 plants, Photosynthetic light and dark reactions, Photophosphorylation and Photorespiration. Factors affecting photosynthesis and measurement, Transpiration: Its importance and factors affecting transpiration, Mechanism of opening and closing of stomata, biological nitrogen fixation, regulation of nitrogen fixation, nitrate reduction and ammonia assimilation. **16h**

Unit III: Phytohormones: Auxin - history of discovery, biosynthesis and mechanism of action, Gibberellins- history of discovery, biosysnthesis and mechanism of action; Cytokinins- history of discovery, biosysnthesis and mechanism of action, Abscisic acid- history of discovery, biosysnthesis and mechanism of action, Ethylene- history of discovery, biosynthesis and role in plant growth and development. Bioassay of Auxins, Cytokinins and Gibberellins, Bioassay of Abscisic acid and Ethylene, Brassinosteroids: discovery, chemical nature, bioassay and physiological roles, Jasmonic acid: discovery, chemical nature, bioassay and physiological roles. **16h**

Unit IV: Plant Response: Development of flower as a modified shoot, Physiology of flowering, Flowering and photoperiodism (Short-day, Long-day and Day-neutral plants), Seed dormancy (types) and seed germination, Growth: phases and kinetics, Flowering plants: annuals, biennials and perennials, Senescence- mechanism and role, Leaf abscission and

senescence, Plant movements, Leaf adaptations to water stress, Morphological and anatomical responses of plants to water, Physiological responses of plants to water stress.

16h

Suggested Readings/References:

1. Taiz, L. and Zeiger, E. (2010) Plant Physiology. 5th ed., Sinauer Associates, Inc., Sunderland
2. Walsh, C. T. (1979) Enzymatic reaction mechanisms, Freeman, New York.
3. Birkla, B. J. and Pantanjo, (1996) Physiology of ion transport across the tonoplast of higher plants: Ann. Rev. Plant Physiol. 47, 159-184.
4. Clayton R K (1992) Photosynthesis- physical mechanisms and chemical patterns: (Cambridge Univ Press).
5. Brown T.A. (2006): "Gene Cloning and DNA Analysis: An Introduction", 6th ed., Wiley-Blackwell Scientific, John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichster, West Sussex, UK.
6. David L. Nelson and Michael M. Cox Lehninger: "Principles of Biochemistry", 6th ed., W.H. Freeman and Company.
7. Edwin F. George, Michael A Hall and Geert-Jan De Klerk (2007): "The Components of Plant Tissue Culture Media I: Macro- and Micro-Nutrients".
8. S. B. Agrawal and M. Agrawal (Eds): "Environmental Pollution and Plant Responses", Lewis Publishers, Boca Raton, USA, 2000
9. Schreiber, Lukas (2010): "Transport Barriers Made of Cutin, Suberin and Associated Waxes", in Trends in Plant Science, Volume 15, Issue 10, 546 – 553.
10. Varalakshmi D, Lakshmi N and Guruprasad K. N.: "Physiological changes in soybean cv JS-71-05 after the exclusion of UV-A and UV-B from solar radiation", in Indian. J. Plant Physiology, 602-606, 2003.

PRACTICALS

BOT: HCP-3.3. PLANT PHYSIOLOGY AND METABOLISM

1. Estimation of proteins in seeds by Lowry's method.
2. Estimation of the activity of lipase in seeds,
3. Quantitative estimation of carbohydrates by Benedict's and DNS method.
4. Estimation of total fat content in seeds
5. Demonstration of experiments on growth hormones.
6. Determination of water potential of tissue by plasmolytic/gravimetric method.
7. Quantitative estimation of calcium by EDTA method.
8. Study of Kranz anatomy in C4 plant leaves.
9. Quantitative estimation of Chl a, Chl b and total chlorophyll in plant tissues.
10. Study of absorption spectrum of plant chlorophylls.
11. Determination of diurnal fluctuation in TAN of CAM plants.
12. Demonstration experiment on growth hormones/effect of red and far-red light on seed germination.

III SEMESTER: SOFT CORE THEORY- BOT: SCT-3.1
GENETIC ENGINEERING

Credits-04 **Theory-64 Hrs**

***Learning Objectives**: This course aims to introduce the fundamental principles and tools of recombinant DNA technology. It covers restriction enzymes, cloning vectors, gene transfer methods, PCR, molecular markers, and blotting techniques. Students will also learn about transposons, mutation mechanisms, and applications of genetic engineering in research, healthcare, and agriculture.*

***Course Outcome**: Course provides comprehensive knowledge on the concepts and applications of genetic engineering. Students gain hands-on understanding of molecular tools used for DNA manipulation, cloning, and gene transfer. It also enhances understanding of genome analysis, transgenic development, and molecular techniques essential for research, biotechnology, and crop improvement.*

Unit I: Genetic engineering- Introduction to Genetic Engineering: Concepts and scope of genetic engineering. Milestones in Recombinant DNA Technology. Importance of gene manipulation in future perspectives. Tools in Genetic Engineering: Enzymes in genetic engineering- Restriction endonucleases- types and action, All DNA modifying enzymes. Cloning vectors: Plasmids isolation and purification- Ti Plasmid, pBR322, pUC- series. Phage vectors-M13 phage vectors, Cosmids- Types, Phasmids or Phagemids, Shuttle vectors-types. YAC and BAC vectors, Lambda phage vectors, Lambda phage DNA as a vector. Cloning vectors and expression vectors. **16 h**

Unit II: Gene Transfer Methods: *Agrobacterium* mediated genetic transformation; Transfer of genes using physical delivery methods; Poly ethylene glycol mediated and Liposome mediated DNA uptake; Micro injection and Micro projectile bombardment. Trans genes and Transgenic plants: Marker genes; Reporter genes. Practical applications of *Agrobacterium*-mediated genetic transformation. **16 h**

Unit III: Blotting techniques: Southern, Northern and Western blotting; DNA Libraries: Construction of genomic library and c-DNA library; Transposable elements: Prokaryotic transposons- Insertion and composite sequences; Applications of transposons in research and health care system. Mutation: Molecular basis of spontaneous and induced mutations and their role in evolution. The genetic manipulation of herbicide resistance: The use of herbicide in modern agriculture, Strategies for engineering herbicide resistance, The environmental impact of herbicide-resistant crops. The genetic manipulation of pest resistance: GM strategies for insect resistance. The *Bacillus thuringiensis* approach to insect resistance, The Copy Nature Strategy, Insect resistant crops and food safety. **16 h**

Unit IV: The Improvement of crop yield and quality: The genetic manipulation of fruit ripening, engineering plant protein composition for improved nutrition, The genetic manipulation of crop yield by enhancement of photosynthesis. Molecular Farming/Pharming: Metabolic engineering of plants. Carbohydrates and lipids, Molecular farming of proteins,

Economic consideration of molecular farming. Future prospects for GM crops: The current state of transgenic crops, Concerns about GM crops, the regulations of GM crops and products. **16 h**

Suggested Readings/References:

1. Principles of gene manipulation- An introduction to genetic engineering: Bold R W and Primerose S B (Black Well, London)
2. Plant Cell Culture- A practical Approach: Dixan R A and Ganzales R A (1994).
3. Hand Book of Plant Cell Culture vol.-1: Evans et al., (Macmillan, New York 1983)
4. Plant Cell, Tissue and Organ Culture Fundamental method: Gambarg O L and Phillips (Naraosa, New Delhi 1996).
5. Introduction to plant tissue culture 2nd edition: Razdhan M K (Oxford & IBH, New Delhi 2003).
6. Applied and Fundamental Aspects of Plant cell, tissue and organ culture: Reinert J and Bajaj Y P S (Narosa, New Delhi 1988).
7. Plant Secondary Metabolites: Shukla Y M, Dhruve J J, Patel N J, Bhatnagar R, Talati J G and Kathiria K B (New India, New Delhi 2009).
8. Cell culture and somatic cell genetics of plants vol.-II: Vasil I K (Academic, INC. New York 1985)
9. Introduction to plant biotechnology: Chawla, H. S. (IBH, New Delhi 2002)

PRACTICALS

BOT: SCP-3.1. GENETIC ENGINEERING

1. Amplification of DNA using PCR technique
2. Isolation of genomic DNA from bacteria/plants
3. Quantification of DNA
4. Purification of DNA by agarose gel electrophoresis.
5. Genetic transformation using *Agrobacterium tumefaciens*.
6. Study of Vectors
7. Preparation of competent *E. coli* cells. Bacterial transformation and recovery of plasmid clones.
8. Gene cloning in plasmids, analysis of recombinant plasmids.
9. DNA amplification by PCR, RT-PCR
10. Analysis of DNA and RNA and Protein by Southern and Northern and Western blotting.

III SEMESTER: SOFT CORE THEORY- BOT: SCT-3.2
BIOENERGY AND BIOFUELS

Credits-04 **Theory-64 Hrs**

***Learning Objectives**: The course aims to provide a comprehensive understanding of bioenergy, renewable resources, and sustainable energy production. It focuses on the fundamentals of biomass, biofuels, and microbial energy systems, along with the technologies involved in biomass conversion and biofuel generation. Students will also learn about algal biofuels, microbial fuel cells, and the environmental, economic, and policy aspects of bioenergy systems.*

***Course Outcome**: Course provides detailed knowledge on both the basic and applied aspects of bioenergy and renewable resources. It equips students with an understanding of biomass conversion processes, biofuel production technologies, and the role of microbes and algae in sustainable energy generation. The course also helps students evaluate the environmental impact, sustainability, and future prospects of bioenergy, preparing them for research and innovation in renewable energy and bioresource management.*

Unit I: Fundamentals of Bioenergy and Renewable Resources: Introduction to bioenergy and its significance in global energy security; renewable and non-renewable energy sources; biomass as a renewable energy resource; classification of biofuels- first, second and third generation; energy crops and lignocellulosic biomass; composition of biomass- cellulose, hemicellulose and lignin; photosynthetic energy conversion; overview of conventional and modern bioenergy systems. **16 h**

Unit II: Bioconversion of Biomass and Biofuel Production Technologies: Principles and methods of bioconversion of biomass to energy; pretreatment, hydrolysis, and fermentation processes; production of bioethanol from sugar, starch and lignocellulosic feedstocks; biobutanol and biodiesel production from plant and microbial sources; anaerobic digestion and methanogenesis for biogas production; role of microorganisms- bacteria, yeast, algae; metabolic engineering and strain improvement for enhanced biofuel production. **16 h**

Unit III: Algal Biofuels and Microbial Energy Systems: Cultivation of microalgae for biodiesel, biohydrogen, and biogas; factors affecting growth and lipid accumulation; harvesting techniques; biochemical pathways for hydrogen and lipid production; microbial fuel cells (MFCs) and bio-electrochemical systems; integrated biorefineries for multiple product generation; environmental sustainability of microbial energy systems. **16 h**

Unit IV: Sustainability, Applications and Future Prospects: Life cycle assessment of biofuels and carbon footprint analysis; environmental, economic and social implications of bioenergy production; land use, food security, and biodiversity issues; global and Indian bioenergy initiatives and government policies; emerging trends and next-generation biofuels- algal biodiesel, biohydrogen, synthetic fuels; integration of bioenergy into circular and green economy. **16 h**

Suggested Readings/References:

1. Demirbas, A. (2011). *Biofuels: Securing the Planet's Future Energy Needs.* Springer.
2. Pandey, A., Larroche, C., Ricke, S. C., Dussap, C. G., & Gnansounou, E. (Eds.). (2011). *Biofuels: Alternative Feedstocks and Conversion Processes.* Academic Press.
3. Kuila, A., & Sharma, V. (Eds.). (2020). *Lignocellulosic Biomass Production and Industrial Applications.* Wiley.
4. Sulaiman, F., & Yusoff, S. (2019). *Biomass Energy Conversion Technologies.* Springer Nature.
5. Logan, B. E. (2008). *Microbial Fuel Cells.* John Wiley & Sons.
6. Li, Y., & Hu, H. (Eds.). (2021). *Algal Biofuels: Recent Advances and Future Prospects.* Springer.
7. Kothari, D. P., Singal, K. C., & Rakesh, R. (2011). *Renewable Energy Sources and Emerging Technologies.* PHI Learning.
8. Singh, A., & Olsen, S. I. (Eds.). (2011). *Towards a Sustainable Bioeconomy: Principles, Challenges, and Perspectives.* Springer.
9. Pandey, A., et al. (2019). *Sustainable Bioenergy: Advances and Impacts.* Elsevier.
10. Abbasi, S. A., & Abbasi, N. (2010). *Renewable Energy Sources: Their Impact on Global Warming and Pollution.* PHI Learning.

PRACTICALS

BOT: SCP-3.2. BIOENERGY AND BIOFUELS

1. Estimation of moisture and ash content in biomass.
2. Determination of cellulose, hemicellulose, and lignin content in biomass.
3. Production of bioethanol from sugarcane molasses using yeast fermentation.
4. Pretreatment and enzymatic hydrolysis of lignocellulosic biomass.
5. Biodiesel production from vegetable oil by transesterification.
6. Cultivation of microalgae for lipid production.
7. Extraction and estimation of lipids from microalgae.
8. Anaerobic digestion of biomass for biogas production.
9. Demonstration of microbial fuel cell (MFC) setup.
10. Calculation of energy output and carbon savings from biofuels.

III SEMESTER: OPEN ELECTIVE THEORY-OET-3.1
MEDICINAL PLANTS

Credits-02 **Theory-32 Hrs**

***Learning Objectives**: This course introduces students to medicinal plants, their uses in traditional systems of medicine, classification of crude drugs, and commercial significance of key plants such as Rauwolfia, Catharanthus, Withania, Tinospora, Centella, and Emblica. It also covers ethno-botany, medicinal and nutritive values of food plants and mushrooms, and herbal remedies for common human ailments.*

***Course Outcome**: Upon completion of this course students will be able to identify and classify medicinal plants and crude drugs, understand the role of ethno-botany, and explain the therapeutic and nutritional value of plants. They will be capable of describing herbal remedies for metabolic, circulatory, respiratory, nervous, reproductive, and general health disorders, and applying this knowledge in research, herbal medicine, and healthcare practices.*

Unit I: Introduction: Medicinal Plants-Basic concepts and their uses in Ayurveda, Tibetan, Unani, Siddha and Homoeopathic system of medicines; Classification of crude drugs; Study of medicinal plants and their commercial significance of *Rauwolfia, Catharanthus, Withania, Tinospora, Centella,* and *Emblica*. Ethno-botany and ethno-medicine: Importance of ethno-botany and ethno-medicine in modern health care system; Methods of collecting traditional information and knowledge on medicinal plants. **16 h**

Unit II: Medicinal value of food plants: A few examples- cereals, pulses, spices, fruits, vegetables and wild food plants; Medicinal and nutritive values of mushrooms. Herbal remedies: Plants used for treatment of blood circulation, respiratory, urinary intestinal, nervous disorders, diabetics, cancer, jaundice, skin, and hair ailments. Plants in gynecological disorders and infertility. Plants used as general tonics. **16 h**

Suggested Readings/References:

1. Indian Medicinal Plants: Kirtikar K R and Basu B D (1932).
2. Indian Materia Medica vol. I & II: Nadkarni A K (1954).
3. Ayurvedic drugs and their plant sources: (Oxford & IBH, New Delhi).
4. Pharmacognosy: G E and Evans W L (12th edn, Baillie Tindal, London 1983).
5. Some controversial drugs in Indian Medicine: Vaidya B Chaukamba (Oriental Varanasi 1982).
6. Natural Products: Mann J, Davidson R S, Hobbs J B, Benthorpe D V and Longman (Scientific, Essex).
7. The Chemotaxonomy of Plants: Smith P M, Edward Arnold (London 1976).
8. Hand Book of Medicinal Plants: Prajapati, Purohit, Sharma and Kumar. (Source Book, Agrobios, India 2007).
9. Phytochemical methods: Harborne J, Ed Chapman & Hall (London 1984).

10. Ethno-botany and Medicinal Plants of Indian Subcontinent: Maheshwari J K (Scientific, India 2000).
11. A Hand Book of Medicinal plants-A complete Source Book: Prajapati *et al.* (Agrobios, Jodhpur, India 2003).
12. Compendium of Medicinal Plants vol. I & II. CDIR (Lucknow Publication & Information Directorate, New Delhi 1991).