**Core Subject BIOPROCESS TECHNOLOGY**

 **SEMESTER V Code: 212903501**

**6 Hrs/Week**

 **Credits 4**

 ***PREAMBLE***

* ***To gain knowledge on the gene transfer techniques in animal cells***
* ***To characterize and conserve of animal genetic resource using reproductive and molecular techniques.***
* ***To develop the clone of transgenic animals for improving the livestock productivity.***
* ***To exploit the genetic resources through modern biotechnological tools.***

**COURSE OUTCOMES (CO)**

On Successfulcompletion of the course, the student will be able to

|  |  |  |
| --- | --- | --- |
| **CO** | **Course Outcome** | **Knowledge Level(According to Bloom’s Taxonomy)** |
| **CO 1** | Understand the principle and basic requirements of fermentation technology and Assimilate knowledge on industrially important microbes | Up to K3 |
| **CO 2** | Gain the knowledge on design of fermentor and its types, Understand the importance and industrial applications of upstream processing and Basic understanding of fermentation process and types. | Up to K3 |
| **CO 3** | Apply the principles and industrial applications of best downstream processing technologies for recovery of fermentation based products | Up to K3 |
| **CO 4** | Develop the knowledge on commercial production of industrial enzymes and their application. Develop knowledge on solid state fermentation processes. | Up to K3 |
| **CO 5** | Identify knowledge on production and use of microbial products. | Up to K3 |

K1 - Knowledge K2 - Understanding K3 - Application

UNIT – I: **[18 Hrs]**

 Upstream Process: Media formulation- Media Optimization, Screening of micro organisms – Primary and secondary screening, stock culture maintenance and preservation, Strain improvement, Inoculum development, Industrial sterilization process.

UNIT – II: **[18 Hrs]**

 Fermentor/bioreactor - design and applications, Types of fermentor – Packed bed, tubular, air lift and tower fermentors, Types of fermentation – Batch, continuous, fed batch process, fermentation kinetics, Immobilization process.

UNIT – III: **[18 Hrs]**

 Down Stream Processing: Biomass separation methods – centrifugation – Precipitation – Filtration – Cell disruption – Product recovery – Liquid Liquid extraction, chromatography purification, crystallization.

UNIT – IV: **[18 Hrs]**

 Enzyme production – Recovery and purification methods – Amylase, Pectinase, Protease, Invertase, Solid state Fermentation - Merits and Demerits – Applications of industrial enzymes.

UNIT – V: **[18 Hrs]**

 Large scale production of industrial products – Ethyl alcohol Antibiotics – Penicillin and streptomycin, Organic acids – citric acid and acetic acid, Vitamins – riboflavin and cyanocobalamine, Amino acids (L–Glutamic acid and L–Lysine)

**TEXT BOOKS:**

1. Casida J.F., Industrial Microbiology, Wiley Eastern Limited, New Delhi, 1968.
2. Crueger W., and Crueger A., Biotechnology, Black – Well Scientific Publication, Oxford, 1995.
3. Patel A.H., Industrial Microbiology, Macmillan India Limited, New Delhi, 1984.
4. Stanbury P.R., Whitaker and Hall S.J., Principles of Fermentation Technology, Aditya Books Private Limited, New Delhi, 2000.

**REFERENCES:**

1. Murray Moo Young, Comprehensive Biotechnology, Vol. 1,2,3 and 4, Elsevier Science, 1985.
2. Stephen J.Hall, Principles of Fermentation Technology, Butter Worth Heinemann Publication.

**Web resources: (URLs)**

**Unit I:1.**<https://www.researchgate.net/publication/318370478_Upstream_Processes>

**Unit II:1.**<https://www.quora.com/What-are-the-different-types-of-fermenters>,

2.<https://biologydictionary.net/fermentation/>

**UnitIII:1.**<https://www.sciencedirect.com/topics/engineering/downstream-processing>

**Unit IV: 1.**<https://www.tandfonline.com/doi/abs/10.3109/07388558409082583?journalCode=ibty20>

**Unit V: 1.**<https://en.wikipedia.org/wiki/Production_of_antibiotics>

2.<http://www.biologydiscussion.com/fermentation/production-of-important-organic-acids-by-fermentation/10290>

**Pedagogy:** chalk and talk, power point presentation

**COURSE CONTENTS & TEACHING/LEARNING SCHEDULE**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Module No.** | **Topic** | **No. of Lectures** | **Content Delivery Method** | **Teaching Aids** |
| Unit -I (18Hrs) |
| 1.1 | Upstream Process: Media formulation- Media Optimization | 3 | Lecture | Black Board |
| 1.2 | Screening of microorganisms – Primary and secondary screening | 4 | Lecture | Black Board |
| 1.3 | stock culture maintenance and preservation | 2 | Lecture | Black Board |
| 1.4 | Strain improvement | 3 | Chalk & Talk | Black Board |
| 1.5 | Inoculum development | 3 | Chalk & Talk | Black Board |
| 1.6 | Industrial sterilization process. | 3 | Chalk & Talk | Black Board |
| Unit -II (18Hrs) |
| 2.1 | Fermentor/bioreactor - design and applications,  | 4 | Lecture | Black Board |
| 2.2 | Types of fermentor – Packed bed, tubular, air lift and tower fermentors, | 4 | Chalk & Talk | Black Board |
| 2.3 | Types of fermentation – Batch, continuous, fed batch process, | 5 | Chalk & Talk | Black Board |
| 2.4 | fermentation kinetics, | 3 | Chalk & Talk | Black Board |
| 2.5 | Immobilization process. | 2 | Chalk & Talk | Black Board |
| Unit - III (18Hrs) |
| 3.1 | Biomass separation methods – centrifugation  | 4 | Lecture | Black Board |
| 3.2 | Precipitation, Filtration | 3 | Lecture | Black Board |
| 3.3 | Cell disruption | 2 | Chalk & Talk | Black Board |
| 3.4 | Product recovery – Liquid-Liquid extraction | 1 | Chalk & Talk | Black Board |
| 3.5 | chromatography purification | 6 | Chalk & Talk | Black Board |
| 3.6 | crystallization | 2 | Chalk & Talk | Black Board |
| Unit – IV (18Hrs) |
| 4.1 | Enzyme production – Recovery and purification methods – Amylase, Pectinase,  | 6 | Lecture | Black Board |
| 4.2 | Enzyme production – Recovery and purification methods- Protease, Invertase | 6 | Lecture | Black Board |
| 4.3 | Solid state Fermentation- Merits and Demerits. | 3 | Lecture | Black Board |
| 4.4 | Applications of industrial enzymes. | 3 | Chalk & Talk | Black Board |
| Unit –V (18Hrs) |
| 5.1 | Large scale production of industrial products – Ethyl alcohol  | 4 | Chalk & TalkLecture | Black Board |
| 5.2 | Antibiotics – Penicillin and streptomycin,  | 4 | Chalk & Talk | Black Board |
| 5.3 | Organic acids – citric acid and acetic acid, | 4 | Chalk & Talk | Black Board |
| 5.4 | Vitamins – riboflavin and cyanocobalamine, Amino acids (L–Glutamic acid and L–Lysine | 6 | Chalk & Talk | Black Board |

**Mapping COs with POs**

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| --- | --- | --- | --- | --- | --- |
| **POs****COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** |
| **CO1** | **3** | **2** | **3** | **2** | **3** |
| **CO2** | **3** | **3** | **1** | **1** | **1** |
| **CO3** | **2** | **3** | **1** | **2** | **3** |
| **CO4** | **1** | **2** | **2** | **3** | **2** |
| **CO5** | **2** | **2** | **1** | **3** | **3** |

**3 - STRONG 2- MEDIUM 1 - LOW**

**COURSE DESIGNER: Dr. A.GANESH**

**NANOTECHNOLOGY**

**V SEMESTER**

**Core Subject Code: 212903502**

 **6 Hrs/Week**

 **Credits 4**

**Preamble:**

* **To learn the techniques of microbial growth in controlled environments.**
* **To enable students to exploit the industrially important microorganisms.**
* **To gain about various types of fermentor and fermentation process**
* **To acquire knowledge on fermentation process of organic acids, vitamins and amino acids**

**COURSE OUTCOMES (CO)**

On Successful completion of the course, the student will be able to

|  |  |  |
| --- | --- | --- |
| **CO** | **Course Outcome** | **Knowledge Level(According to Bloom’s Taxonomy)** |
| **CO 1** | Explain the fundamental principles of nanotechnology and applications of nanoparticles***.*** | Up to K3 |
| **CO 2** | Understanding the different approaches of synthesis of nanoparticles. | Up to K3 |
| **CO 3** | Getting detailed knowledge on characterization of nanoparticles by applying physics concept. | Up to K3 |
| **CO 4** | To understand how Nano biotechnology used in drug delivery system. | Up to K3 |
| **CO 5** | Acquire theoretical knowledge on the applications of Nano biosensors and Nano medicine  | Up to K3 |

K1 - Knowledge K2 - Understanding K3 – Application

UNIT – I: **[18Hrs]**

 Nanotechnology – History and basic concepts - Dimensionality and size dependent phenomena of nanoparticle; Properties and applications of Carbon nanotubes, Quantum dots, Buckyball and polymer; metal nanocomposites.

UNIT – II: **[18Hrs]**

 Synthesis of nanomaterials – Top down approach-Photolithography, Bottom up approach- self-assembly: chemical vapour deposition: physical vapour deposition – sputtering: Green synthesis of nano particles.

UNIT – III: **[18Hrs]**

 Characterization of nanoparticle- Scanning Electron Microscope – Transmission Electron Microscope – Atomic Force Microscopy- NMR and IR- spectroscopy

UNIT – IV: **[18Hrs]**

 Applications of nanobiotechnology in drug delivery - Drug targeting, Nanocarriers for drug delivery- Gold nanoparticle, Nanoshell, Nanocapsule, Liposomes, Micelles and dendrimer; Implantable drug delivery- Nanoporous membrane and biochips

UNIT – V: **[18Hrs]**

 Environmental applications of nanotechnology - Nanomaterial based biosensors, Nanomedicine- Respirocytes, Mechanical artificial red blood cells; Using DNA as a construction medium; Nanotechnology in cancer diagnosis and treatment.

**TEXT BOOKS:**

1. Richard Booker and Earl Boyson, Nanotechnology, Wiley India Pvt Ltd, Newdelhi, 2001.
2. Daniel R., Ratner M., Nanotechnology, Pearson education, 2009.
3. Lynn E. Foster., Nanotechnology, science, Innovation and opportunity, Dorling Kindersley (India) Pvt Ltd 2008, Newdelhi

**REFERENCES:**

1. RanerWaser (Ed), Nano electronics and information technology, wiley- Ych, 2nd edition, 2005.
2. Willard Merritt, Deand and Settle, Instrumental Methods of Analysis Wordsworth publishing company, 7th sub edition (Feb1998)

**Web resources:**

Unit I:

1. <https://jnanobiotechnology.biomedcentral.com/articles/10.1186/1477-3155-2-3>

<https://en.wikipedia.org/wiki/Nanotechnology>

Unit II:

1. <https://jnanobiotechnology.biomedcentral.com/articles/10.1186/s12951-018-0408-4>
2. <https://www.sciencedirect.com/science/article/pii/B9780323461429000013>

Unit III:

1. <https://en.wikipedia.org/wiki/Characterization_of_nanoparticles>

2.<https://www.sciencedirect.com/science/article/pii/B9780081005576000031>

Unit IV:

1. <https://www.azonano.com/article.aspx?ArticleID=4668>
2. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2222591/>

Unit V:

1. <https://www.researchgate.net/publication/319701714_Development_Applications_of_Nanobiosensors_for_Biomedical_Diagnosis>.
2. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5371978/>

**Pedagogy:** Chalk and Talk, Power point presentation, Animations

**COURSE CONTENTS & TEACHING/LEARNING SCHEDULE**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Module No.** | **Topic** | **No. of Lectures** | **Content Delivery Method** | **Teaching Aids** |
| Unit – I [18 Hrs] |
| 1.1 | Nanotechnology – History and basic concepts | 4 | Lecture | Black Board |
| 1.2 | Dimensionality and size dependent phenomena of nanoparticle; | 4 | Lecture | Black Board |
| 1.3 | Properties and applications of Carbon nanotubes, | 3 | Lecture | Black Board |
| 1.4 | Quantum dots, Buckyball and polymer; | 4 | Chalk & Talk | Black Board |
| 1.5 | metal nanocomposites | 3 | Chalk & Talk | Black Board |
| Unit – II [18 Hrs] |
| 2.1 | Synthesis of nanomaterials | 2 | Lecture | Black Board |
| 2.2 | Top down approach-Photolithography | 4 | Chalk & Talk | Black Board |
| 2.3 | Bottom up approach- self-assembly | 4 | Chalk & Talk | Black Board |
| 2.4 | chemical vapour deposition: physical vapour deposition – sputtering: | 4 | Chalk & Talk | Black Board |
| 2.5 | Green synthesis of nano particles. | 4 | Chalk & Talk | Black Board |
| Unit – III [18 Hrs]  |
| 3.1 | Characterization of nanoparticle- | 3 | Lecture | Black Board |
| 3.2 | Scanning Electron Microscope | 3 | Lecture | Black Board |
| 3.3 | Transmission Electron Microscope | 3 | Chalk & Talk | Black Board |
| 3.4 | Atomic Force Microscopy | 3 | Chalk & Talk | Black Board |
| 3.5 | NMR | 3 | Chalk & Talk | Black Board |
| 3.6 | IR- spectroscopy | 3 | Chalk & Talk | Black Board |
| Unit – IV [18 Hrs] |
| 4.1 | Applications of nanobiotechnology in drug delivery | 3 | Lecture | Black Board |
| 4.2 | Drug targeting, Nanocarriers for drug delivery | 2 | Lecture | Black Board |
| 4.3 | Gold nanoparticle, Nanoshell, Nanocapsule | 4 | Lecture | Black Board |
| 4.4 | Liposomes, Micelles and dendrimer | 4 | Chalk & Talk | Black Board |
| 4.5 | Implantable drug delivery | 2 | Chalk & Talk | Black Board |
| 4.6 | Nanoporous membrane and biochips | 3 | Chalk & Talk | Black Board |
| Unit – V [18 Hrs]  |
| 5.1 | Environmental applications of nanotechnology | 3 | Chalk & TalkLecture | Black Board |
| 5.2 | Nanomaterial based biosensors | 3 | Chalk & Talk | Black Board |
| 5.3 | Nanomedicine- Respirocytes, Mechanical artificial red blood cells; | 4 | Chalk & Talk | Black Board |
| 5.4 | Using DNA as a construction medium | 4 | Chalk & Talk | Black Board |
| 5.5 | Nanotechnology in cancer diagnosis and treatment | 4 | Chalk & Talk | Black Board |

**Mapping COs with POs**

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| --- | --- | --- | --- | --- | --- |
| **PO****CO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** |
| **CO1** | **3** | **1** | **2** | **1** | **1** |
| **CO2** | **3** | **2** | **1** | **3** | **1** |
| **CO3** | **2** | **1** | **1** | **1** | **1** |
| **CO4** | **3** | **3** | **1** | **1** | **2** |
| **CO5** | **2** | **1** | **1** | **3** | **3** |

**3 – STRONG 2- MEDIUM 1 - LOW**

**COURSE DESIGNER: Mr.G.PONNUDURAI**

**Core Subject GENETIC ENGINEERING Code: 212903503**

**SEMESTER V**

 **6 Hrs/Week Credits 4**

 **Preamble:**

* **To learn the techniques of microbial growth in controlled environments.**
* **To enable students to exploit the industrially important microorganisms.**
* **To gain about various types of fermentor and fermentation process**
* **To acquire knowledge on fermentation process of organic acids, vitamins and amino acids**

**COURSE OUTCOMES (CO)**

On Successful completion of the course, the student will be able to

|  |  |  |
| --- | --- | --- |
| **CO** | **Course Outcome** | **Knowledge Level (According to Bloom’s Taxonomy)** |
| **CO 1** | Have developed the role of different enzymes responsible for gene manipulation and the basic steps of gene cloning. | Up to K3 |
| **CO 2** | Understanding the different types and functions of prokaryotic and eukaryotic vectors. | Up to K3 |
| **CO 3** | Getting detailed knowledge on gene cloning strategies. | Up to K3 |
| **CO 4** | Describe the blotting techniques and gene sequencing methods. | Up to K3 |
| **CO 5** | Acquire theoretical knowledge in the gene manipulation techniques and tools, applications and safety measures of Genetic engineering. | Up to K3 |

K1 - Knowledge K2 - Understanding K3 – Application

UNIT I:  **[18 Hrs]**

Principles of genetic engineering – Nuclease – Types and applications of Exonuclease; Restriction endonuclease enzyme – role, nomenclature, Classification and application of endonuclease; DNA modifying enzymes – DNA methylase, alkaline phosphatase, polynucleotide kinase, DNA ligases, Taq DNA polymerase and Terminal transferase.

UNIT II: **[18 Hrs]**

Vectors: Properties and types – plasmid – pBR322 and PUC18, cosmid, Expression vectors, shuttle vector, lamda phage vector - insect viral vectors(Baculo virus), animal (SV40) and plant vectors (Ti plasmid based vector) and their applications.

UNIT III: **[18 Hrs]**

Cloning strategies – linkers, double linkers, adaptors and homopolymer tailing, screening and selection of recombinants – Direct selection, Insertional inactivation, plaque lifting method, Immunochemical method and Colony hybridization; Construction of genomic and cDNA libray.

UNIT IV:  **[18 Hrs]**

Blotting techniques – Southern, Northern and Western; Autoradiography; Gene sequencing methods – chemical, enzymatic and automated sequencing; Chromosome walking and jumping.

UNIT V: **[18 Hrs]**

Methods in gene manipulation – PCR, RAPD, RFLP and AFLP; DNA finger printing; Bioethics and Biosafety.

**TEXT BOOKS:**

1. Bernard R.Glick and Jack J.Pasterneck, Molecular Biotechnology, American Society for Microbiology, Canada, 2008.
2. Don–Murray C., and Walter Wilest, Gene Transfer and Repressor Protocols, Methods in Molecular Biology, Human Press, New Jerly, 1991.

**REFERENCES:**

1. Puller A., Genetic Engineering in Animals, VCH Publishers, New Delhi.
2. Old and Primrose, Principles of Gene Manipulation, 7th Edition, Blackwelt Publication.
3. Sandhya Mitra, Genetic Engineering, 9th Edition Published by Rajiv Beri for Macmillan India Ltd., 2008

**WEB RESOURCES:**

Unit I:

1. <https://en.wikipedia.org/wiki/Restriction_enzyme>
2. <https://nptel.ac.in/courses/102103013/>

Unit II :

1. [https://en.wikipedia.org/wiki/Vector\_(molecular\_biology)](https://en.wikipedia.org/wiki/Vector_%28molecular_biology%29)

Unit III:

1. <https://www.khanacademy.org/science/biology/biotech-dna-technology/dna-cloning-tutorial/a/overview-dna-cloning>
2. <https://en.wikipedia.org/wiki/Clonin>

Unit IV:

1. [https://en.wikipedia.org/wiki/Blot\_(biology)](https://en.wikipedia.org/wiki/Blot_%28biology%29)
2. <https://www.mybiosource.com/learn/southern-blotting/>
3. <https://en.wikipedia.org/wiki/DNA_sequencing>

Unit V:

1. <https://en.wikipedia.org/wiki/Genetic_engineering>
2. <https://en.wikipedia.org/wiki/Polymerase_chain_reaction>
3. <https://en.wikipedia.org/wiki/Biosafety>

**Pedagogy:** Chalk and Talk, Power point presentation, Animations

 **COURSE CONTENTS & TEACHING/LEARNING SCHEDULE**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Module No.** | **Topic** | **No. of Lectures** | **Content Delivery Method** | **Teaching Aids** |
| Unit –I (18 hrs)  |
| 1.1 | Principles of genetic engineering | 2 | Lecture | Black Board |
| 1.2 | Nuclease – Introduction  | 1 | Lecture | Black Board |
| 1.3 | Types and applications of Exonuclease | 2 | Lecture | Black Board |
| 1.4 | Restriction endonuclease enzyme – role, nomenclature, Classification and application | 5 | Chalk & Talk | Black Board |
| 1.5 | DNA methylase, alkaline phosphatase,  | 3 | Chalk & Talk | Black Board |
| 1.6 | polynucleotide kinase, DNA ligases, | 2 | Chalk & Talk | Black Board |
| 1.7 | Taq DNA polymerase and Terminal transferase. | 3 | Chalk & Talk | Black Board |
| Unit -II (18 hrs)  |
| 2.1 | Vectors: Properties and types – plasmid – pBR322 and PUC18 | 5 | Lecture | ppt |
| 2.2 | Cosmid, Expression vectors | 4 | Chalk & Talk | Black Board |
| 2.3 | Shuttle vector, lamda phage vector | 3 | Chalk & Talk | Black Board |
| 2.4 | Insect viral vectors(Baculo virus), animal (SV40) | 3 | Chalk & Talk | Black Board |
| 2.5 | Plant vectors (Ti plasmid based vector) and their applications  | 3 | Chalk & Talk | ppt |
| Unit – III (18 hrs)  |
| 3.1 | Cloning strategies | 1 | Lecture | Black Board |
| 3.2 | Linkers, double linkers, adaptors and homopolymer tailing | 4 | Lecture | Black Board |
| 3.3 | Screening and selection of recombinants | 2 | Chalk & Talk | Black Board |
| 3.4 | Direct selection, Insertional inactivation, plaque lifting method | 4 | Chalk & Talk | Black Board |
| 3.5 | Immunochemical method and Colony hybridization | 3 | Chalk & Talk | Black Board |
| 3.6 | Construction of genomic and cDNA libray | 4 | Chalk & Talk | ppt |
| Unit- IV (18 hrs)  |
| 4.1 | Blotting techniques | 1 | Lecture | Black Board |
| 4.2 | Southern, Northern and Western blotting techniques | 6 | Lecture | ppt |
| 4.3 | Autoradiography | 2 | Lecture | ppt |
| 4.4 | Gene sequencing methods – chemical, enzymatic and automated sequencing | 6 | Chalk & Talk | Black Board |
| 4.5 | Chromosome walking and jumping | 3 | Chalk & Talk | Black Board |
| Unit -V (18 hrs)  |
| 5.1 | Methods in gene manipulation  | 3 | Chalk & TalkLecture | Black Board |
| 5.2 | PCR | 3 | Chalk & Talk | Black Board |
| 5.3 | RAPD, RFLP and AFLP | 6 | Chalk & Talk | Black Board |
| 5.4 | DNA finger printing | 3 | Chalk & Talk | Black Board |
| 5.5 | Bioethics and Biosafety | 3 | Chalk & Talk | Black Board |

**Mapping COs with POs**

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| --- | --- | --- | --- | --- | --- |
| **POs****Cos** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** |
| **CO1** | **2** | **1** | **1** | **1** | **3** |
| **CO2** | **3** | **2** | **1** | **2** | **2** |
| **CO3** | **3** | **1** | **1** | **1** | **2** |
| **CO4** | **2** | **3** | **1** | **1** | **2** |
| **CO5** | **1** | **1** | **2** | **3** | **3** |

**3 - STRONG 2- MEDIUM 1 - LOW**

**COURSE DESIGNER: Mrs M.SHYAMALA**

**Core Lab LAB IN GENETIC ENGINEERING Code: 212903504**

 **SEMESTER V**

**3 Hrs/Week**

 **Credits 3**

***PREAMBLE:-***

* ***To train the students to handle the molecular techniques.***
* ***To understand principle and application of different molecular biology techniques.***
1. Isolation of genomic DNA from Plant and Animal Tissues.
2. Isolation of plasmid DNA from Bacteria.
3. Separation of DNA on agarose electrophoresis.
4. Qualitative analysis of DNA by UV spectrophotometer.
5. Restriction Digestion of DNA
6. Ligation of DNA molecules
7. Preparation of competent cells for transformation technique.
8. Transformation and screening of transformants based on blue white selection.
9. PCR (Demonstration)
10. Demonstration of Southern Blotting and RAPD
11. Industrial visit

TEXT BOOK:

Glover D.M., and Hames B.D., DNA Cloning – A Practical Approved (VL–4) LRL Press, 1995.

REFERENCES:

1. Brown T.A., Lab – Molecular Biology, Lab Fax – II – Gene Analysis, 2nd Edition, Academic Press, UK, 1998.
2. Joseph Sambrook, David N.Rusell, Joe Sambrook, Molecular Cloning: A Laboratory Manual (I–III) Cold Spring Habor Press, USA, 2001.

**COURSE DESIGNER: Mrs M.SHYAMALA**

**Elective-I MARINE BIOTECHNOLOGY Code: 212903505**

**SEMESTER V**

**5 Hrs/Week**

 **Credits 3**

**PREAMBLE**

* ***To study the fundamentals of Marine biotechnology.***
* ***To describe the role of microorganisms in the area of marine ecology.***
* ***To gain knowledge on signal molecules to control marine life***

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| **CO** | **Course Outcome** | **Knowledge Level (According to Bloom’s Taxonomy)** |
| **CO 1** | Describe the types and values of products obtained from marine organisms | Up to K3 |
| **CO 2** | Explain about the bioflims, marine polysaccharide and molecular mechanism of aquacultural pathogens | Up to K3 |
| **CO 3** | Depict the role of marine organism in bioremediation  | Up to K3 |
| **CO 4** | Give clear picture about biofouling and its controlling measures  | Up to K3 |
| **CO 5** | Illustrate the signal molecules which involve in controlling of marine life  | Up to K3 |

K1 – KNOWLEDGE K2 - UNDERSTANDING K3 - APPLICATION

UNIT – I: **[15 Hrs]**

Marine natural products - Marine organisms: an alternative source of potentiality valuable natural products - Pharmaceuticals from marine organisms: anti - cancer, diagnostic and therapeutic, bioadhesives and thermostable enzymes.

UNIT – II: **[15 Hrs]**

Marine Microbiology -Microbial biofilms; Marine polysaccharaides - biomedical and biotechnological applications - Molecular pathogenicity of aquacultural pathogens; Biochemistry, gene regulation and molecular biology of marine hyperthermophils.

UNIT – III: **[15 Hrs]**

Bioremediation - Marine pollution - Aerobic and anaerobic bioremediation in the marine environment - Marine microorganisms capable, of degrading and detoxinng chlorinated hydrocarbons and other pollutants.

UNIT – IV:  **[15 Hrs]**

Befouling and Control technology - Biofouling organisms - Problems due to biofouling - Antifouling paints and its environmental pollution - Biotechnological approach to biofouling control.

UNIT – V: **[15 Hrs]**

Receptor molecules and chemical signals that control life in ocean - Genetic engineering and ploidy manipulation to enhance growth - reproduction and development of disease resistance in aquacultural species crustaceans, molluscans, fin fishes and algae.

**TEXT BOOKS:**

1. Italy E., New Developments in Marine Biotechnology, Plenum Publication Corporation, 1998.
2. Le Gal Y., and Halvorson H.O., New Development in Marine Biotechnology, 1998.

**REFERENCES:**

1. Millton Figerman and Rachakonda Nagabhasnam, Molecular Genetics of Marne Organisms, Science Publication Inc, 1996.

**WEB RESOURCES (URLS):**

**Unit – I –** 1.<https://www.eolss.net/sample-chapters/C17/E6-58-08-05.pdf>

 2.<https://www.researchgate.net/publication/260714583_Marine_Natural_Products/link/0deec5321179fd7eda000000/download>

 3.<https://www.e-sciencecentral.org/upload/bt/pdf/bt-24-561.pdf>

 4.<https://www.researchgate.net/publication/26545730_Biomedical_Compounds_from_Marine_organisms>

**Unit–II –** 1**.**<https://download.e-bookshelf.de/download/0003/8480/65/L-G-0003848065-0002367749.pdf>

2.<https://www.researchgate.net/publication/322204505_Microbial_Biofilms_Pathogenicity_and_Treatment_Strategies/link/5ae02c38aca272fdaf8b719a/download>

**Unit–III-** 1.Bioremediation\_strategies\_for\_oil\_polluted\_marine\_.pdf

 <https://www.princeton.edu/~ota/disk1/1991/9109/9109.PDF>

**Unit–IV –**1.<http://www.vliz.be/imisdocs/publications/ocrd/224762.pdf><http://www.issg.org/pdf/publications/GISP/Guidelines_Toolkits_BestPractice/Jackson_2008.pdf>

2.<https://en.wikipedia.org/wiki/Biofouling>

**Unit–V -**1.<https://www.nap.edu/read/4979/chapter/12#150>

**Pedagogy:**  Chalk and Talk, Power point presentation

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| **COURSE CONTENTS & TEACHING/LEARNING SCHEDULE**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Module No.** | **Topic** | **No. of Lectures** | **Content Delivery Method** | **Teaching Aids** |
| Unit -I (15 Hrs) |
| 1.1 | Marine natural products | 3 | Lecture | Black Board |
| 1.2 | Marine organisms: an alternative source of potentiality valuable natural products | 4 | Lecture | Black Board |
| 1.3 | Pharmaceuticals from marine organisms: anti - cancer, diagnostic and therapeutic | 5 | Lecture | Black Board |
| 1.4 | Pharmaceuticals from marine organisms: bioadhesives and thermostable enzymes | 3 | Chalk & Talk | Black Board |
|  Unit -II (15 Hrs) |
| 2.1 | Marine Microbiology -Microbial biofilms | 3 | Lecture | Black Board |
| 2.2 | Marine polysaccharaides - biomedical and biotechnological applications | 3 | Chalk & Talk | Black Board |
| 2.3 | Molecular pathogenicity of aquacultural pathogens | 4 | Chalk & Talk | Black Board |
| 2.4 | Biochemistry, gene regulation and molecular biology of marine hyperthermophils.  | 5 | Chalk & Talk | Black Board |
| Unit -III (15 Hrs) |
| 3.1 | Bioremediation - Marine pollution | 3 | Lecture | Black Board |
| 3.2 | Aerobic and anaerobic bioremediation in the marine environment | 4 | Lecture | Black Board |
| 3.3 | Marine microorganisms capable, of degrading and detoxinng chlorinated hydrocarbons and other pollutants | 4 | Chalk & Talk | Black Board |
| 3.4 | Marine microorganisms capable, of degrading and detoxinng chlorinated pollutants | 4 | Chalk & Talk | Black Board |
| Unit -IV (15 Hrs) |
| 4.1 | Befouling and Control technology | 3 | Lecture | Black Board |
| 4.2 | Biofouling organisms | 3 | Lecture | Black Board |
| 4.3 | Problems due to biofouling | 3 | Lecture | Black Board |
| 4.4 | Antifouling paints and its environmental pollution | 3 | Chalk & Talk | Black Board |
| 4.5 | Biotechnological approach to biofouling control.  | 3 | Chalk & Talk | Black Board |
| Unit -V (15 Hrs) |
| 5.1 | Receptor molecules and chemical signals that control life in ocean | 3 | Chalk & TalkLecture | Black Board |
| 5.2 | Genetic engineering and ploidy manipulation to enhance growth | 3 | Chalk & Talk | Black Board |
| 5.3 | reproduction and development of disease resistance in aquacultural species crustaceans, molluscans | 4 | Chalk & Talk | Black Board |
| 5.4 | reproduction and development of disease resistance in aquacultural species fin fishes and algae | 4 | Chalk & Talk | Black Board |

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**Mapping COs with POs**

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| **POs****COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** |
| **CO1** | **S** |  **L**  |  **M** | **M** | **S** |
| **CO2** | **M** | **S** | **M** | **L** | **S** |
| **CO3** | **S** | **M** | **L** | **S** | **M** |
| **CO4** | **S** | **M** | **L** | **S**  | **S** |
| **CO5** | **S** | **M** | **L** | **M** | **S** |

**3 – STRONG 2 - MEDIUM 1 – LOW**

**COURSE DESIGNER: Dr. T. SIVAGAMASUNDARI**

 **MICROBIAL BIOTECHNOLOGY**

**Elective-I SEMESTER V**

 **Code: 212903506**

**5 Hrs/Week**

 Credits 3

 ***PREAMBLE***

* ***To understand the concepts in the development of genetically engineered organisms and compounds.***
* ***To describe the role of microorganisms in the area of ecology and food technology.***

**COURSE OUTCOMES (CO)**

On Successful completion of the course, the student will be able to

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| **CO** | **Course Outcome** | **Knowledge Level (According to Bloom’s Taxonomy)** |
| **CO 1** | Understand the technical aspects in the production of recombinant vaccines, designing drugs.  | Up to K3 |
| **CO 2** | Comprehensive knowledge on applications and microbial production of amino acids, insulin, interferon, polysaccharide, polyester and bioplastics. | Up to K3 |
| **CO 3** | Get detailed knowledge on waste water treatment, its different methods, bioremediation and biodegradation. | Up to K3 |
| **CO 4** | Acquire knowledge on metal leaching by microbes, MEOR, biosensor and its types. Gain knowledge on the role of microbes as biocontrol agents. | Up to K3 |
| **CO 5** | Apply the technical knowledge to develop the products of industrial and agricultural importance. | Up to K3 |

K1 - Knowledge K2 - Understanding K3 – Application

UNIT–I: **[15 Hrs]**

 Protein Engineering: Recombinant DNA vaccines - Production - Subunit, Attenuated and Vector vaccine and its applications – Drug designing- Probiotics, prebiotics and synbiotics.

UNIT-II:  **[15 Hrs]**

Metabolic Engineering –Amino acid (Tryptophan) production. Protein production in bacteria – Insulin production – Interferon production - Microbial polysaccharide and microbial polyesters – Bioplastics and its types.

UNIT–III: **[15 Hrs]**

Environmental aspects of microbial biotechnology – Sewage/Waste water treatment –primary, secondary and tertiary treatment. Bioremediation: Principle, In–situ and Ex–situ methods – Biodegradation of xenobiotics.

UNIT–IV: **[15 Hrs]**

Bioleaching of metals – direct and indirect leaching. Microbial enhanced oil recovery – Biosensor – its types and applications. Microprobes –Microbes as biocontrol agents (*Bacillus thuringiensis,* Baculovirus).

UNIT–V: **[15 Hrs]**

Microbes as food and feed for animals – Single cell protein – Biogas Production – Methane, Hydrogen –Mass production of biofertilizer -*Rhizobium*, Mycorrrhizae.

**TEXT BOOKS:**

1. Alexander N., Glazer and Hiroshi Nikaido, Microbial Biotechnology, W.H. Freeman Company, New York, 1995.
2. Bernard R.Glick, and Jack J.Pasternek, Molecular Biotechnology, 2nd Edition, ASM Press, Washington, 1997.
3. Ronald M.Atlas and Richard Bartha, Microbial Ecology, 4th Edition, Wesley Long Man Inc, 2011.

**REFERENCES:**

1. Christen J.Hurst, and Ronald L.Crawford, Manual of Environmental Microbiology, 2nd Edition, ASM Press, Washington, 2002.
2. Primrose S.B., and Twyman R.M., Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell Publishing.
3. Ronald M.Atlas, Richard Bartha, Microbial Ecology, 4th Edition, Wesley Longman, Inc, 1994.

**WEB RESOURCES: (URLs)**

Unit I:1. [http://www.biologydiscussion.com/biotechnology/vaccines/types-of- recombinant-vaccines-3-types/10080](http://www.biologydiscussion.com/biotechnology/vaccines/types-of-%20%20%20%20%20recombinant-vaccines-3-types/10080).

 2. <https://www.slideshare.net/sheetalvincent/probiotics-13663177>.

Unit II: 1.<https://pdfs.semanticscholar.org/efa2/711bb6a54a0130474d6bf2b56f67f7a70c88.pdf>.

 2. <https://www.slideshare.net/jatingarg52/bioplastic-45792097>.

Unit III:1. <http://web.iitd.ac.in/~arunku/files/CVL100_Y16/LecSep1220.pdf>.

 2. <https://www.slideshare.net/vanithagopal/bioremediation-41934065>.

Unit IV: 1.<http://depts.washington.edu/mictech/optics/sensors/week8.pdf>.

 2.<https://www.slideshare.net/ManishaG1/biocontrol-agentsinsecticidal-toxins-of-bacillus-thuringiensis>.

Unit v: 1. <https://www.britannica.com/technology/biogas>.

 2. <https://www.slideshare.net/vanithagopal/biofertilizer-40950247>.

**Pedagogy:**  Chalk and Talk, Power point presentation

**COURSE CONTENTS & TEACHING/LEARNING SCHEDULE**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Module No.** | **Topic** | **No. of Lectures** | **Content Delivery Method** | **Teaching Aids** |
| UNIT -I (15 Hrs) |
| 1.1 |  Introduction to Protein Engineering | 2 | Lecture | Black Board |
| 1.2 | Recombinant DNA vaccines Production | 2 | Lecture | Black Board |
| 1.3 | Subunit, Attenuated and Vector vaccine and its applications | 6 | Lecture | Black Board |
| 1.4 | Drug designing | 2 | Chalk & Talk | Black Board |
| 1.5 | Probiotics, prebiotics and synbiotics | 3 | Chalk & Talk | Black Board |
| UNIT -IV (15 Hrs) |
| 2.1 | Introduction to Metabolic Engineering | 2 | Lecture | Black Board |
| 2.2 | Amino acid (Tryptophan) production | 2 | Chalk & Talk | Black Board |
| 2.3 | Protein production in bacteria – Insulin production | 2 | Chalk & Talk | Black Board |
| 2.4 | Interferon production | 2 | Chalk & Talk | Black Board |
| 2.5 | Microbial polysaccharide and microbial polyesters production | 5 | Chalk & Talk | Black Board |
| 2.6 | Bioplastics and its types. | 2 |  |  |
| UNIT - III (15 Hrs) |
| 3.1 | Environmental aspects of microbial biotechnology | 3 | Lecture | Black Board |
| 3.2 | Sewage/Waste water treatment –primary, secondary and tertiary treatment | 5 | Lecture | Black Board |
| 3.3 | Bioremediation: Principle, In–situ and Ex–situ methods | 4 | Chalk & Talk | Black Board |
| 3.4 | Biodegradation of xenobiotics. | 3 | Chalk & Talk | Black Board |
| UNIT -IV (15 Hrs) |
| 4.1 | Bioleaching of metals – direct and indirect leaching | 3 | Lecture | Black Board |
| 4.2 | Microbial enhanced oil recovery | 2 | Lecture | Black Board |
| 4.3 | Biosensor – its types and applications | 4 | Lecture | Black Board |
| 4.4 | Microprobes | 2 | Chalk & Talk | Black Board |
| 4.5 | Microbes as biocontrol agents - *Bacillus thuringiensis,* Baculovirus | 4 | Chalk & Talk | Black Board |
| UNIT -V (15 Hrs) |
| 5.1 | Microbes as food and feed for animals – Single cell protein | 5 | Chalk & TalkLecture | Black Board |
| 5.2 | Biogas Production – Methane | 3 | Chalk & Talk | Black Board |
| 5.3 | Biogas Production – Hydrogen | 2 | Chalk & Talk | Black Board |
| 5.4 | Mass production of biofertilizer -*Rhizobium* | 3 | Chalk & Talk | Black Board |
| 5.5 | Mycorrrhizae biofertilizer production | 2 | Chalk & Talk | Black Board |

**Mapping COs with POs**

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| **POs****COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** |
| **CO1** | **2** |  **1**  |  **2** | **2** | **3** |
| **CO2** | **3** | **2** | **3** | **1** | **3** |
| **CO3** | **3** | **3** | **2** | **3** | **1** |
| **CO4** | **3** | **3** | **1** | **2** | **3** |
| **CO5** | **3** | **1** | **3** | **2** | **2** |

**3 - STRONG 2 - MEDIUM 1 – LOW**

**COURSE DESIGNER: Dr. T. SIVAGAMASUNDARI**

**RESEARCH METHODOLOGY**

**SEMESTER V**

**Elective:II**

 **Code: 212903507/213003507**

**3Hrs/Week**

 **Credits 3**

***Course Preamble:***

**To learn the techniques of microbial growth in controlled environments.**

* **To enable students to exploit the industrially important microorganisms.**
* **To gain about various types of fermentor and fermentation process**
* **To acquire knowledge on fermentation process of organic acids, vitamins and amino acids**

**COURSE OUTCOMES (CO)**

On Successful completion of the course, the student will be able to

|  |  |  |
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| **CO** | **Course Outcome** | **Knowledge Level (According to Bloom’s Taxonomy)** |
| **CO 1** | Develop familiarize with various kinds of research, objectives of doing research, research process, research designs and sampling. | Up to K3 |
| **CO 2** | To know the basic concept of research design and its various types | Up to K3 |
| **CO 3** | To frame the hypothesis, its types and to prepare a research report | Up to K3 |
| **CO 4** | To learn the essential basic techniques and to apply in research | Up to K3 |
| **CO 5** | Analyse the data through various statistical methods like measures of central tendency and measures of standard deviation | Up to K3 |

K1 - Knowledge K2 - Understanding K3 – Application

UNIT-I **[9 Hrs]**

Introduction – Research – Definition – Objectives – Types of research – Descriptive, Analytical, Applied, Qualitative. Quantitative, Conceptual, Empirical, Exploratory – Significance of research – Significance of research – Criteria for good research – Research process – Definition and steps of research process.

UNIT-II **[9 Hrs]**

Research design – Features of good research design – Experimental design – Informal, formal experimental designs (Brief account only) – Steps in sample design – Types of sample design – Non probability sampling, Probability sampling.

UNIT-III **[9 Hrs]**

Hypothesis – Definition – Characteristics of hypothesis – Concepts of hypothesis -Null and Alternate hypothesis – Levels of significance – Types of hypothesis – Type 1 and Type 2 – Research report – Components of research report – Steps in report writing – Role of computers in research

UNIT-IV **[9 Hrs]**

Principle and application of electrophoresis – NMR, X – Ray crystallography, Chromatography - Thin Layer Chromatography, High performance liquid Chromatography and FTIR.

UNIT-V **[9 Hrs]**

Data – Methods of collection and classification of data – Primary and Secondary data, representation of Data, Measures of central tendency: (Mean, Median and Mode) Measure of Dispersion, Standard Deviation, ANOVA – Table construction and uses.

**TEXT BOOKS:**

1. Kothari C.R., Research methodology, Willy Eastern Limited, New Delhi.
2. Gupta S.P., Statistical Methods, 9th Edition, S.Chand and Sons Publishers, New Delhi 1979.
3. Palanichamy.S and Manoharan. M, Statistical Methods for Biologists, Palani Paramount

**REFERENCES:**

1. Keith Wilson and John Walkers, Principles and Techniques of Practical Bio-Chemistry, 5th Edition, Cambridge University press, USA, 2000.
2. Palanivelu P, Laboratory Manual for Analytical Bio – Chemisty and Separation Techniques 3rd Edition, 21st century Publications, 2002.

**Web Resources: (URLs)**

UNIT I:<https://www.slideshare.net/vaisalik/types-of-research>

UNIT II:<https://www.wisdomjobs.com/e-university/research-methodology-tutorial-355/basic-principles-of-experimental-designs-11465.html>

UNIT III: <https://www.wisdomjobs.com/e-university/research-methodology-tutorial-355/what-is-a-hypothesis-11523.html>

UNIT IV:<https://courses.lumenlearning.com/suny-hccc-research-methods/chapter/chapter-4-theories-in-scientific-research/>

UNIT V: <https://courses.lumenlearning.com/suny-hccc-research-methods/chapter/chapter-4-theories-in-scientific-research/>

<https://courses.lumenlearning.com/atd-bmcc-sociology/chapter/approaches-to-sociological-research/>

**Pedagogy:** Chalk and Talk, video clip presentation

**COURSE CONTENTS & TEACHING/LEARNING SCHEDULE**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Module No.** | **Topic** | **No. of Lectures** | **Content Delivery Method** | **Teaching Aids** |
| Unit – I [9 Hrs] |
| 1.1 | Introduction – Research – Definition – Objectives | 2 | Lecture | Black Board |
| 1.2 | Types of research – Descriptive, Analytical, Applied, Qualitative. Quantitative, Conceptual, Empirical, Exploratory | 3 | Lecture | Black Board |
| 1.3 | Significance of research – Criteria for good research | 2 | Lecture | Black Board |
| 1.4 | Research process – Definition and steps of research process. | 2 | Chalk & Talk | Black Board |
| Unit – II [9 Hrs] |
| 2.1 | Research design – Features of good research design | 2 | Lecture | Black Board |
| 2.2 | Experimental design – Informal, formal experimental designs (Brief account only) | 2 | Chalk & Talk | Black Board |
| 2.3 | Steps in sample design | 2 | Chalk & Talk | Black Board |
| 2.4 | Types of sample design – Non probability sampling, Probability sampling. | 3 | Chalk & Talk | Black Board |
| Unit – III [9 Hrs]  |
| 3.1 | Hypothesis – Definition – Characteristics of hypothesis | 1 | Lecture | Black Board |
| 3.2 | Concepts of hypothesis -Null and Alternate hypothesis | 2 | Lecture | Black Board |
| 3.3 | Levels of significance – Types of hypothesis – Type 1 and Type 2 | 2 | Chalk & Talk | Black Board |
| 3.4 | Research report – Components of research report – Steps in report writing | 3 | Chalk & Talk | Black Board |
| 3.5 | Role of computers in research | 1 | Chalk & Talk | Black Board |
| Unit – IV [9 Hrs] |
| 4.1 | Principle and application of electrophoresis | 2 | Lecture | Black Board |
| 4.2 | NMR, X – Ray crystallography | 3 | Lecture | Black Board |
| 4.3 | Chromatography - Thin Layer Chromatography, High performance liquid Chromatography | 3 | Lecture | Black Board |
| 4.4 | FTIR. | 1 | Chalk & Talk | Black Board |
| Unit – V [9 Hrs]  |
| 5.1 | Data – Methods of collection and classification of data – Primary and Secondary data, | 3 | Chalk & TalkLecture | Black Board |
| 5.2 | Measures of central tendency: (Mean, Median and Mode) | 3 | Chalk & Talk | Black Board |
| 5.3 | Measure of Dispersion, Standard Deviation, | 2 | Chalk & Talk | Black Board |
| 5.4 | ANOVA – Table construction and uses. | 1 | Chalk & Talk | Black Board |

**Mapping COs with POs**

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| --- | --- | --- | --- | --- | --- |
| **POs****COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** |
| **CO1** | **3** | **2** | **1** | **1** | **1** |
| **CO2** | **1** | **2** | **3** | **1** | **3** |
| **CO3** | **3** | **1** | **2** | **1** | **1** |
| **CO4** | **1** | **1** | **2** | **3** | **1** |
| **CO5** | **3** | **1** | **1** | **1** | **3** |

**3 - STRONG 2 - MEDIUM 1 – LOW**

**COURSE DESIGNER: Mr.G.PONNUDURAI**

**BIOINSTRUMENTATION**

**SEMESTER V**

**Elective-II Code:212903508/213003508**

 **3 Hrs/Week**

 **Credits 3**

***PREAMBLE***

* ***To make students able to handle various instruments properly.***
* ***To teach students, basic principle behind working of each instrument.***
* ***To make students know advance techniques useful in identification and purification of compounds.***

**COURSE OUTCOMES (CO)**

On Successful completion of the course, the student will be able to

|  |  |  |
| --- | --- | --- |
| **CO** | **Course Outcome** | **Knowledge Level (According to Bloom’s Taxonomy)** |
| **CO 1** | Understand the technical aspects in the basic laboratory instrumentation techniques.  | Up to K3 |
| **CO 2** | Depict the knowledge on principle and applications of different chromatographic techniques and microscopic analysis. | Up to K3 |
| **CO 3** | Get detailed knowledge on electrophoretic techniques.. | Up to K3 |
| **CO 4** | Acquire knowledge on spectroscopic techniques and their applications. | Up to K3 |
| **CO 5** | Perform and analyse the knowledge on radioisotopic techniques.. | Up to K3 |

 K1 - Knowledge K2 - Understanding K3 – Application

Unit –I **[9 Hrs]**

Basic laboratory Instruments -Principle and working of pH meter, Laminar-air flow. Biosafety cabinets. Centrifugation: Types of centrifuge machines, preparative and analytical centrifuges, differential centrifugation, sedimentation velocity, sedimentation equilibrium, density gradient methods and their applications. Introduction to PCR, Gel documentation.

Unit – II **[9 Hrs]**

Chromatographic techniques and Microscopy**-**Theory, principles and applications of paper, thin layer, HPTLC, gel filtration, ion-exchange, affinity, hydrophobic, gas liquid, high pressure/ performance liquid chromatography (HPLC),

Microscopy – Dark Field and Phase contrast, Fluorescent, Electron, Atomic force microscopy.

Unit – III **[9 Hrs]**

Electrophoretic techniques -Basic principles of electrophoresis, theory and application of paper, starch gel, agarose, native and denaturing PAGE, isoelectric focusing, capillary, microchip and 2 D electrophoresis.

Unit – IV **[9 Hrs]**

Spectroscopy - Spectroscopic techniques, theory and applications of turbidometry, nephlometry, luminometry, UV-Visible, IR, NMR, Fluorescence, Atomic Absorption, CD, ORD, Mass, Raman Spectroscopy.

Unit – V **[9 Hrs]**

Radioisotopic techniques - Use of radioisotopes in life sciences, radioactive labeling, principle and application of tracer techniques, detection and measurement of radioactivity using ionization chamber, proportional chamber, Geiger- Muller and Scintillation counters, autoradiography and its applications. Dosimetry.

**TEXT BOOKS:**

1. Biochemistry. 6th Edition by Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Freeman, New York.
2. Bioinstrumentation, L.Veerakumari,1st Edition, Mjp Publications,2011.

**REFERENCES:**

1. Biochemistry. 3rd edition by Garrett, R. H. and Grisham, C. M. (2004). Brooks/Cole, Publishing Company, California.
2. Principles and Techniques of Biochemistry and Molecular Biology by Wilson Keith and Walker John (2005), 6th Ed. Cambridge University Press, New York.

**WEB RESOURCES: (URLs)**

Unit-I

1.<https://microbenotescom.webpkgcache.com/doc//s/microbenotes.com/instrumentsusedinmicrobiologylab/>

2.<https://www.labcompare.com/ClinicalDiagnostics/5140MicrobiologyEquipment/>

Unit-II

1.[https://www.khanacademy.org/science/class11chemistryindia/xfbb6cb8fc2bd00c8:ininorganicchemistrysomebasicprinciplesandtechniques/xfbb6cb8fc2bd00c8:ininmethodofpurificationoforganiccompounds/a/principlesofchromatography](https://www.khanacademy.org/science/class11chemistryindia/xfbb6cb8fc2bd00c8%3Aininorganicchemistrysomebasicprinciplesandtechniques/xfbb6cb8fc2bd00c8%3Aininmethodofpurificationoforganiccompounds/a/principlesofchromatography)

2.<https://www.sciencedirect.com/topics/earthandplanetarysciences/microscopy>

Unit-III

1.<https://microbiologynotes.org/electrophoresisoverviewprinciplesandtypes/>

2.<https://www.thoughtco.com/electrophoresisdefinition4136322>

Unit- IV

1.[https://www.sciencedirect.com/topics/earth-and-planetary sciences/spectroscopy](https://www.sciencedirect.com/topics/earth-and-planetary%20sciences/spectroscopy)

2.<https://www.slideshare.net/LOKESHPANIGRAHI/spectroscopy134933430>

Unit-V

1.<https://www.britannica.com/science/radioactiveisotope>

2.[https://www.slideshare.net/abhigiri02/radioisotope-technique-and methods](https://www.slideshare.net/abhigiri02/radioisotope-technique-and%20methods)

**Pedagogy:**  Chalk and Talk, Power point presentation

**COURSE CONTENTS & TEACHING/LEARNING SCHEDULE**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Module No.** | **Topic** | **No. of Lectures** | **Content Delivery Method** | **Teaching Aids** |
| Unit -1 [9Hrs] |
| 1.1 |  Basic laboratory Instruments -Principle and working of pH meter, Laminar-air flow. Biosafety cabinets.  | 2 | Lecture | Black Board |
| 1.2 | Centrifugation: Types of centrifuge machines, preparative and analytical centrifuges, differential centrifugation, | 2 | Lecture | Black Board |
| 1.3 | sedimentation velocity, sedimentation equilibrium, density gradient methods and their applications. | 3 | Lecture | Black Board |
| 1.4 | Introduction to PCR, Gel documentation. | 2 | Chalk & Talk | Black Board |
| Unit -2[9Hrs] |
| 2.1 | Chromatographic techniques Theory, principles and applications of paper, thin layer,  | 2 | Lecture | Black Board |
| 2.2 | HPTLC, gel filtration, ion-exchange, affinity, | 1 | Chalk & Talk | Black Board |
| 2.3 | hydrophobic, gas liquid, high pressure/ performance liquid chromatography (HPLC), | 2 | Chalk & Talk | Black Board |
| 2.4 | Microscopy – Dark Field and Phase contrast, Fluorescent, | 2 | Chalk & Talk | Black Board |
| 2.5 | Electron, Atomic force microscopy | 2 | Chalk & Talk | Black Board |
| Unit – 3 [9Hrs] |
| 3.1 | Electrophoretic techniques -Basic principles of electrophoresis, theory and application  | 3 | Lecture | Black Board |
| 3.2 | paper, starch gel, agarose, native and denaturing PAGE | 3 | Lecture | Black Board |
| 3.3 | isoelectric focusing, capillary, microchip and 2 D electrophoresis. | 3 | Chalk & Talk | Black Board |
| Unit- 4 [9Hrs] |
| 4.1 | Spectroscopy - Spectroscopic techniques, theory and applications  | 2 | Lecture | Black Board |
| 4.2 | turbidometry, nephlometry, luminometry, UV-Visible | 2 | Lecture | Black Board |
| 4.3 | IR, NMR, Fluorescence, Atomic Absorption | 3 | Lecture | Black Board |
| 4.4 | CD, ORD, Mass, Raman Spectroscopy | 2 | Chalk & Talk | Black Board |
| Unit -5 [9Hrs]  |
| 5.1 | Radioisotopic techniques - Use of radioisotopes in life sciences. | 1 | Chalk & TalkLecture | Black Board |
| 5.2 | radioactive labeling, principle and application of tracer techniques, detection and measurement | 2 | Chalk & Talk | Black Board |
| 5.3 | radioactivity using ionization chamber, proportional chamber | 2 | Chalk & Talk | Black Board |
| 5.4 | Geiger- Muller and Scintillation counters | 2 | Chalk & Talk | Black Board |
| 5.5 | autoradiography and its applications. Dosimetry | 2 | Chalk & Talk | Black Board |

**Mapping COs with POs**

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| --- | --- | --- | --- | --- | --- |
| **POs****COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** |
| **CO1** | **2** |  **1**  |  **2** | **2** | **3** |
| **CO2** | **3** | **2** | **3** | **1** | **3** |
| **CO3** | **3** | **3** | **2** | **3** | **1** |
| **CO4** | **3** | **3** | **1** | **2** | **3** |
| **CO5** | **3** | **1** | **3** | **2** | **2** |

**3 - STRONG 2 - MEDIUM 1 – LOW**

**COURSE DESIGNER: Mr. G. PONNUDURAI**

**Self Learning Course ENVIRONMENTAL BIOTECHNOLOGY Code: 218003529**

 **SEMESTER V**

 **Addl. Credits 4**

***Objectives:-***

* ***To study the fundamentals of environmental biotechnology.***
* ***To study about bioremediation of organic contaminants & toxic metals in the environment.***

***.***

UNIT – I:

 Bio–diversity: Historical and geographical causes for diversity; types of diversity – Maintenance of ecological biodiversity; collection and conservation of biodiversity; global biodiversity information system. Biochemical approaches to biomass measurement and community structure analysis.

UNIT – II:

 Phytoremediation, composting for waste management, bioventing and biosparing; bio films, biochemistry of biofilm formation; merits and demerits. Bio surfactants global environmental problems: green house effect and global warming; green house gases, measures to control green house effect; the problem of ozone; acid rain; environmental sustainability and biotechnology, beneficial – Microbes to reduce green house effect.

UNIT – III:

 Scope of marine biotechnology; biodiversity in marine ecosystem; coral diversity, seagrass, mangroove and salt masses, application of coral server in medicine, micro organisms in marine environment. UNIT – IV:

 Bioactive marine natural products: Primary and secondary bioactive metabolites of marine algae, fungi and bacteria. Isolation and assay of bioactive compounds, marine toxins.

UNIT – V:

 Algal biotechnology single cell protein, agarose, carrageen alginates. Marine enzymes sources and their applications marine lipid sources and their applications. Mass cultivation of photoautotrophic microalgae.

**TEXT BOOKS:**

1. Italy E., New Developments in Marine Biotechnology, Plenum Publication Corporation, 1998.
2. Le Gal Y., and Halvorson H.O., New Development in Marine Biotechnology, 1998.
3. Milton Figerman and Rachakonda Nagabhshanam, Molecular Genetics of Marine Organisms, Science Publication Inc, 1996.

**REFERENCES:**

1. Foster C.F., and John Ware D.A., Environmental Biotechnology, Ellis Horwood Limited, 1987.
2. John T.Cookson, Bioremediation Engineering, Design and Application, 1995.
3. Stainer R.Y., and Ingram J.L., et al., General Microbiology, M.C. Millan Publications, 1989.

**COURSE DESIGNER: Mr. T.MUTHURAYAR**

**Core Subject ANIMAL BIOTECHNOLOGY Code: 212903601**

**SEMESTER VI**

**5 Hrs/Week**

 **Credits 4**

 **PREAMBLE**

* ***To gain knowledge on the gene transfer techniques in animal cells***
* ***To characterize and conserve of animal genetic resource using reproductive and molecular techniques.***
* ***To develop the clone of transgenic animals for improving the livestock productivity.***
* ***To exploit the genetic resources through modern biotechnological tools.***

**COURSE OUTCOMES (CO)**

On Successful completion of the course, the student will be able to

|  |  |  |
| --- | --- | --- |
| **CO** | **Course Outcome** | **Knowledge Level (According to Bloom’s Taxonomy)** |
| **CO 1** | Understand the genome of animals and various gene transfer techniques in animal cells | Up to K3 |
| **CO 2** | Appreciate the basic techniques to culture animal cells and maintaining cell lines and their uses in developing biopharmaceuticals | Up to K3 |
| **CO 3** | Explicate the techniques involved in the development of transgenic animals and their applications in human healthcare | Up to K3 |
| **CO 4** | Examine the gene therapy techniques used for human genetic disorders by understanding the nature of diseases in mice models | Up to K3 |
| **CO 5** | Evaluate the stem cell therapy and analyze the patenting of commercially important products produced from transgenic animals with the proper understanding of patenting research and intellectual property rights | Up to K3 |

K1 - KNOWLEDGE K2 - UNDERSTANDING K3 - APPLICATION

UNIT – I:  **[15 Hrs]**

 Genome Organization: Animal Genome Organization. An introduction to animal viral vectors - SV40, Baculovirus and retrovirus. Gene transfer techniques in animals- Microinjection, Shotgun method and Liposome mediated gene transfer.

UNIT – II: **[15Hrs]**

 Basic cell culture techniques - primary and established cell lines, cell viability and cytotoxicity. Application of molecular markers in livestock management . Applications of animal cell culture - Mammalian cells as Bioreactors - Pharmaceutically important proteins and hormones.

UNIT – III:  **[15 Hrs]**

 Transgenic animals – Transgenic cattles, Mice, Pig, Birds, Fish and its research, Transgenesis for animal improvement – *invitro* fertilization - Artificial insemination, multiple ovulation, embryo transfer. Transgenic animals in xenotransplantaion.

UNIT – IV: **[15 Hrs]**

 Introduction to genetic disorders – Gene therapy – Somatic gene therapy, germ line gene therapy - gene replacement - gene augmentation - gene knock out and their application. Mice model for human genetic disorders –Human Genome Project.

UNIT – V: **[15 Hrs]**

 Introduction to stem cells and stem cell therapy. Intellectual property rights – types of IPR. Patenting and patenting research. Production and patenting of commercially important products from transgenic animals.

**TEXT BOOKS:**

1. Benjamin Lewin, Genes VIII, Prentice Hall, USA, 2004.
2. Prime Rose Old R.W., and SB, Principles of Gene Manipulation Black Well Science Inc, 6th Edition, Germany, 2002.
3. Winnaker E.L.X., Genes to Clones: Introduction to Gene Technology, Republic Germany, 2002.

**REFERENCES:**

1. Brown T.A., Gene Cloning, 4th Edition, Chapman and Hall Publications, USA, 2000.
2. David M., Glover and Hames B.D., DNA Cloning 1, 2, and 3, A Practical Approach, IRL Print, 1995.

**Web Resources: (URLs:)**

Unit - I: 1.<https://sydney.edu.au/science/molecular_bioscience/PHAR2811/PHARlectures/PHARlecture4/PHARlecture4DH_notes.pdf>

 2. <https://www.mybiosource.com/learn/gene-transfer-technique/>

*Unit-II :* 1.[https://iopscience.iop.org/book/978-0-7503-1347-6/chapter/bk978- 0-7503-1347-6ch1](https://iopscience.iop.org/book/978-0-7503-1347-6/chapter/bk978-0-7503-1347-6ch1)

 2. [https://microbeonline.com/animal-cell-culture-introduction-types- methods-applications/](https://microbeonline.com/animal-cell-culture-introduction-types-methods-applications/)

Unit -III:1.<https://www.biology-pages.info/T/TransgenicAnimals.html>

 2.<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4095860/>

Unit-IV: 1. <https://www.mayoclinic.org/tests-procedures/gene-therapy/about/pac-20384619> [file:///C:/Users/dell/Downloads/jsc00414.pdf](file:///C%3A%5CUsers%5Cdell%5CDownloads%5Cjsc00414.pdf)

 2.<https://annualmeeting.asgct.org/about_gene_therapy/diseases.php>

Unit-V: 1. <https://www.wipo.int/about-ip/en/>

 2.<https://www.dubaicustoms.gov.ae/en/IPR/Pages/WhatIsIPR.aspx>

 3.<https://web.ornl.gov/sci/techresources/Human_Genome/project/index.shtml>

**Pedagogy:** Chalk and Talk, Power point presentation

**COURSE CONTENTS & TEACHING/LEARNING SCHEDULE**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Module No.** | **Topic** | **No. of Lectures** | **Content Delivery Method** | **Teaching Aids** |
| Unit -I [15 Hrs] |
| 1.1 | Animal Genome Organization | 3 | Chalk & Talk | Black Board |
| 1.2 | Animal viral vectors - SV40,  | 2 | Chalk & Talk | Black Board |
| 1.3 | Baculoviral vectors | 2 | Lecture | Power point presentation |
| 1.4 | Retrovirual vectors | 2 | Chalk & Talk | Black Board |
| 1.5 | Gene transfer techniques – Microinjection  | 2 | Lecture | Power point presentation |
| 1.6 | Shot gun method | 2 | Lecture | Power point presentation |
| 1.7 | Liposome mediated gene transfer | 2 | Lecture | Power point presentation |
| Unit - II [15 Hrs] |
| 2.1 | Basic cell culture techniques  | 2 | Chalk & Talk | Black Board |
| 2.2 | Primary cell culture and established cell lines, | 2 | Chalk & Talk | Black Board |
| 2.3 | Cell viability and cytotoxicity | 2 | Chalk & Talk | Black Board |
| 2.4 | Application of molecular markers in livestock management | 2 | Lecture | Power point presentation |
| 2.5 | Applications of animal cell culture | 2 | Lecture | Power point presentation |
| 2.6 | Mammalian cells as Bioreactors | 2 | Lecture | Power point presentation |
| 2.7 | Pharmaceutically important proteins and hormones. | 3 | Lecture | Power point presentation |
| Unit - III [15 Hrs] |
| 3.1 | Transgenic animals – transgenesis -  | 2 | Chalk & Talk | Black Board |
| 3.2 | Transgenic cattles and Mice | 3 | Lecture | Power point presentation |
| 3.3 | Transgeneic Pig, Birds, Fish and its research, | 3 | Lecture | Power point presentation |
| 3.4 | Transgenesis for animal improvement – *invitro* fertilization | 2 | Chalk & Talk | Black Board |
| 3.5 | Artificial insemination, multiple ovulation. embryo transfer,  | 3 | Chalk & Talk | Black Board |
| 3.6 | Transgenic animals in xenotransplantation. | 2 | Chalk & Talk | Black Board |
| Unit - IV [15 Hrs] |
| 4.1 | Introduction to genetic disorders | 2 | Chalk & Talk | Black Board |
| 4.2 | Gene therapy – Somatic gene therapy, germ line gene therapy | 3 | Chalk & Talk | Black Board |
| 4.3 | Gene replacement - gene augmentation | 3 | Chalk & Talk | Black Board |
| 4.4 | Gene knock out and their application | 2 | Chalk & Talk | Black Board |
| 4.5 | Mice model for human genetic disorders | 3 | Lecture | Power point presentation |
| 4.6 | Human Genome Project | 2 | Lecture | Power point presentation |
| Unit - IV [15 Hrs] |
| 5.1 | Introduction to stem cells  | 2 | Chalk & Talk | Black Board |
| 5.2 | Stem cell therapy | 3 | Lecture | Power point presentation |
| 5.3 | Intellectual property rights – types of IPR | 4 | Chalk & Talk | Black Board |
| 5.4 | Patenting and patenting research. | 3 | Chalk & Talk | Black Board |
| 5.5 | Patenting of commercially important products from transgenic animals. | 3 | Chalk & Talk | Black Board |

**Mapping COs with POs**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **POs****COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** |
| **CO1** | **2** | **1** | **3** | **1** | **2** |
| **CO2** | **3** | **2** | **1** | **2** | **3** |
| **CO3** | **2** | **3** | **1** | **2** | **3** |
| **CO4** | **2** | **1** | **2** | **1** | **2** |
| **CO5** | **3** | **3** | **2** | **1** | **2** |

**3 - STRONG 2 - MEDIUM 1 - LOW**

**COURSE DESIGNER: Mr. L. ARUL YESUDOSS**

**\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***

**Core Subject PLANT BIOTECHNOLOGY Code: 212903602**

**SEMESTER V**

**5Hrs/Week**

 **Credits 4**

**Course Preamble:**

* ***To acquire knowledge on specific problems of economic importance in selected crop plants***
* ***To identify & characterize the importance of genes from crop plants & microbes***
* ***To explore the functional genomics of plant***

**Course Outcome:**

On Successful completion of the course, the students will be able to

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| --- | --- | --- |
| **CO** | **Course Outcome** | **Knowledge Level (According to Bloom’s Taxonomy)** |
| **CO 1** | Develop the basic knowledge on the applications of plant tissue culture for betterment of human life and Understand methodologies in plant tissue culture and micropropogation techniques. | Up to K3 |
| **CO 2** | Get familiarized with the plant growth hormones, selectable markers and their applications in Plant tissue culture. | Up to K3 |
| **CO 3** | Examine the plant transformation techniques, different methods of gene transfer and synthetic seed technology. | Up to K3 |
| **CO 4** | Gain the knowledge on the production of transgenic plant in relation to biotic and abiotic stresses and the commercial applications of edible vaccines. | Up to K3 |
| **CO 5** | Understand the knowledge on Agrobacterium mediated gene transfer techniques and their applications in the development of transgenic plants. | Up to K3 |

K1 - KNOWLEDGE K2 - UNDERSTANDING K3 - APPLICATION

UNIT – I: **[15 Hrs]**

Plant Genome Organisation- chloroplast and mitochondrial genome, Plant tissue culture - An Introduction, Surface sterilization of plant materials,Micropropagation, callus induction,Initiation of suspension culture.

UNIT –II: **[15 Hrs]**

 Plant hormones – Role of hormone in plant morphogenesis, Seed storage proteins, Genetic engineering in plants, Selectable markers - reporter genes and promotors used in plant vectors. Regulation of gene expression in plants.

Unit – III: **[15 Hrs]**

 Transformation of DNA to plant cells, Protoplast culture and fusion, Protein targeting, Cytoplasmic male sterility, Synthetic seed technology.

UNIT – IV: **[15 Hrs]**

 Transgenic Plants - Genetic Engineering of plants for pest resistance, herbicide and stress tolerance, resistance against plant pathogens, peptide hormones and edible vaccines in plants.

UNIT – V: **[15 Hrs]**

 Agroinfection –Agrobacterial plasmid biology and their use in genetic engineering of plants – Crown gall tumors, Plant Ti plasmid vectors for plant transformation, symbiotic nitrogen fixation, mechanism of N2 fixation.

**TEXT BOOKS:**

1. Ignacimuthu.S., Plant Biotechnology, Oxford and IBM Publishing Co., Pvt. Ltd., NewDelhi, 1997.
2. HS Chawla, Introduction to Plant Biotechnology, Science Publishers, 2nd edition, Enfield USA, 2002.
3. Bob, Buchanan, Wilhelon, Greissem and Russell Jones, Bio–Chemistry and Molecular Biology of Plants, American Society of Plant Biologies, Academic Press, USA.
4. U. Sathyanarayanaya, Biotechnology. Books & Allied Ltd (2008).

**REFERENCES:**

1. Grierson D., and Convey S.N., Plant Molecular Biology, 2nd Edition, Kluwar, Academic Press, USA, 1991.
2. Roberta H.Smith, Plant Tissue Culture, Techniques and Experiments, 2nd Edition, Elsevies Science and Technology Books, New Delhi, 2000.

**Web resources: (URLs)**

**Unit I:** 1.<https://plantbiotech.bg/en/i-want-to-know/plant-tissue-culture-and-micropropagation/>

**Unit II:** 1.<https://en.wikipedia.org/wiki/Plant_hormone>

**Unit III:** 1.<https://www.jic.ac.uk/blog/what-is-plant-transformation/>,

2.<https://www.agriquest.info/synthetic_seeds.php>

**UnitIV:**1.<https://www.researchgate.net/publication/318039006_Transgenic_plants_resistance_to_abiotic_and_biotic_stresses>

**UnitV:** 1.<https://www.mybiosource.com/learn/testing-procedures/agrobacterium-mediated-gene-transfer/>

2.<https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/symbiotic-nitrogen-fixation>

**Pedagogy:** Chalk and Talk, Power point presentation

**COURSE CONTENTS & TEACHING/LEARNING SCHEDULE**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Module No.** | **Topic** | **No. of Lectures** | **Content Delivery Method** | **Teaching Aids** |
| Unit -I [15 Hrs] |
| 1.1 | Plant Genome Organisation-  | 2 | Lecture | Black Board |
| 1.2 | Chloroplast genome  | 2 | Lecture | Black Board |
| 1.3 | Mitochondrial genome | 2 | Lecture | Black Board |
| 1.4 | Plant tissue culture - An Introduction | 2 | Chalk & Talk | Black Board |
| 1.5 | Surface sterilization of plant materials | 2 | Chalk & Talk | Black Board |
| 1.6 | Micropropagation and callus induction | 3 | Chalk & Talk | Black Board |
| 1.7 | Initiation of suspension culture | 2 | Chalk & Talk | Black Board |
| Unit - II [15 Hrs] |
| 2.1 | Plant hormones introduction | 2 | Lecture | Black Board |
| 2.2 | Role of hormone in plant morphogenesis | 3 | Chalk & Talk | Black Board |
| 2.3 | Seed storage proteins and Genetic engineering in plants | 3 | Chalk & Talk | Black Board |
| 2.4 | Selectable markers - reporter genes used in plant vectors | 2 | Chalk & Talk | Black Board |
| 2.5 | Selectable markers - promotors used in plant vectors | 2 | Chalk & Talk | Black Board |
| 2.6 | Regulation of gene expression in plants. | 3 |  |  |
| Unit - III [15 Hrs] |
| 3.1 | Transformation of DNA to plant cells | 3 | Lecture | Black Board |
| 3.2 | Protoplast culture  | 3 | Lecture | Black Board |
| 3.3 | Fusion Protein targeting | 3 | Chalk & Talk | Black Board |
| 3.4 | Cytoplasmic male sterility  | 3 | Chalk & Talk | Black Board |
| 3.5 | Synthetic seed technology. | 3 | Chalk & Talk | Black Board |
| Unit - IV [15 Hrs] |
| 4.1 | Transgenic Plants  | 2 | Lecture | Black Board |
| 4.2 | Genetic Engineering of plants for pest resistance | 3 | Lecture | Black Board |
| 4.3 | Genetic Engineering of plants for herbicide and stress tolerance | 3 | Lecture | Black Board |
| 4.4 | Resistance against plant pathogens | 3 | Chalk & Talk | Black Board |
| 4.5 | Peptide hormones  | 2 | Chalk & Talk | Black Board |
| 4.6 | Edible vaccines in plants. | 2 | Chalk & Talk | Black Board |
| Unit - V [15 Hrs] |
| 5.1 | Agroinfection–Agrobacterial plasmid biology  | 2 | Chalk & TalkLecture | Black Board |
| 5.2 | Agrobacterial plasmid uses in genetic engineering of plants  | 3 | Chalk & Talk | Black Board |
| 5.3 | Crown gall tumors  | 2 | Chalk & Talk | Black Board |
| 5.4 | Plant Ti plasmid vectors for plant transformation | 3 | Chalk & Talk | Black Board |
| 5.6 | Symbiotic nitrogen fixation  | 2 | Chalk & Talk | Black Board |
| 5.7 | Mechanism of N2 fixation. | 3 | Chalk & Talk | Black Board |

**Mapping COs with POs**

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| --- | --- | --- | --- | --- | --- |
| **POs****Cos** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** |
| **CO1** | **2** | **1** | **3** | **2** | **2** |
| **CO2** | **3** | **2** | **1** | **2** | **3** |
| **CO3** | **2** | **3** | **1** | **2** | **3** |
| **CO4** | **2** | **3** | **2** | **1** | **2** |
| **CO5** | **3** | **3** | **2** | **1** | **2** |

**3 - STRONG 2 - MEDIUM 1 - LOW**

**COURSE DESIGNER: Dr. M. DHANASEKARAN**

**Core GENOMICS AND PROTEOMICS****Code: 212903603**

**SEMESTER VI**

**5 HOURS/WEEK CREDIT: 4**

***Course preamble:-***

* ***To inculcate knowledge in transcriptomics and gene prediction of living things.***
* ***To implement the knowledge knowledge on systematic analysis, evolutionary studies, drug targeting & Drug designing using modern software tools.***

**COURSE OUTCOMES (CO)**

On Successful completion of the course, the student will be able to

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| **CO** | **Course Outcome** | **Knowledge Level (According to Bloom’s Taxonomy)** |
| **CO 1** | Describe and analyse the structural organization and sequencing of genome | Up to K3 |
| **CO 2** | Portray the expression of gene using transcriptomic techniques | Up to K3 |
| **CO 3** | Depict the structural analysis and protein expression | Up to K3 |
| **CO 4** | Illustrate the genome projects and drug mechanism | Up to K3 |
| **CO 5** | Analyse the phylogeny of organisms, metabolic pathways and evolutionary relationship | Up to K3 |

**K1 - KNOWLEDGE (REMEMBERING) K2 - UNDERSTANDING K3 - APPLICATION**

UNIT – I: **[15 Hrs]**

 Definition of genomics and proteomics – Structural organization of prokaryote and eukaryote genome – DNA sequencing methods, Conventional sequencing (Sanger, Maxam and Gilbert method),Automated sequencing and its applications.

UNIT – II: **[15 Hrs]**

 Transcriptomics – Transcript and analysis – Global gene expression analysis – Differential display analysis, Differential gene expression analysis – DNA microarray technology – Whole transcriptome analysis – SAGE (Serial Analysis of Gene Expression).

UNIT – III: **[15 Hrs]**

 Proteomics – Introduction,types.concepts of proteome analysis –Protein – Protein interaction – Yeast two hybrid system – Computational approaches to analyse protein – Mass spectrometry for proteome analysis-2D gel electrophoresis.

UNIT – IV: **[15 Hrs]**

 Human Genome: Ethics, analysis – Pharmacogenetics – Drug discovery, Target and Developments – SNP analysis.

UNIT – V: **[15 Hrs]**

 Metabolomics: Introduction, principle and applications –Phylogenomics-Terminologies-Homolog,Ortholog,Paralog and Xenolog-Phylogenetic tree analysis methods-Maximum parsimony method,Distancemethod,Maximum likelihood method.

**TEXT BOOKS:**

1. Andrew J., and Link L.D., Proteome Analysis Protocols, Human Press, New Jensey, 1998.
2. Me Chelland M., and Anthor Pardee, Expression Genetics: Accelerated and High Throughout Methods, Biotechniques Press Eaton Publishing, USA, 1999.
3. Ignacimuthu S., Basic Bioinformatics,Naroza publishing House Pvt Ltd,New Delhi,2006.

**REFERENCES:**

1. Mark Schrma, DNA Micro Arrays: A Practical Approach, Oxford University Press and Oxford England, 1999.
2. William M.R., Appel R.D., and Hrchstracsr D.F., Proteome Research: New Tronfiers in Functional Genomics: Principles and Practice, Springer Vetrlap, New York, 1997

**Web Resources: (URLs)**

**UNIT I:** <https://onlinelibrary.wiley.com/doi/full/10.1038/npg.els.0005008>

**UNIT II:** <https://en.wikipedia.org/wiki/Genomics>

**UNIT III**:

<http://www.auburn.edu/academic/agriculture/fisheries/genomics/FISH7660%202006/DNA%20marker%20review%20paper-Aquaculture.pdf>

**UNIT IV**: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2435252/>

**UNIT V**: <https://www.ncbi.nlm.nih.gov/books/NBK83754/>,

<https://link.springer.com/article/10.1007/s11568-007-9003-8>

**Pedagogy:**

Chalk and Talk, video clip presentation

**COURSE CONTENTS & TEACHING/LEARNING SCHEDULE**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Module No.** | **Topic** | **No. of Lectures** | **Content Delivery Method** | **Teaching Aids** |
| Unit -1 (15Hrs) |
| 1.1 |  Definition of genomics and proteomics. | 2 | Lecture | Black Board |
| 1.2 | Structural organization of prokaryote genome | 2 | Lecture | Black Board |
| 1.3 | Structural organization of Eukaryote genome | 4 | Lecture | Black Board |
| 1.4 | DNA sequencing method- Sanger method. | 2 | Chalk & Talk | Black Board |
| 1.5 | Maxam and Gilbert method | 3 | Chalk & Talk | Black Board |
| 1.6 | Automated sequencing and its applications.  | 2 | Chalk & Talk | Black Board |
| Unit -2 (15Hrs) |
| 2.1 | Transcriptomics – Transcript and analysis | 2 | Lecture | Black Board |
| 2.2 | Global gene expression analysis | 2 | Chalk & Talk | Black Board |
| 2.3 | Differential display analysis | 2 | Chalk & Talk | Black Board |
| 2.4 | Differential gene expression analysis | 2 | Chalk & Talk | Black Board |
| 2.5 | DNA microarray technology | 3 | Chalk & Talk | Black Board |
| 2.6 | Whole transcriptome analysis | 2 | Chalk & Talk | Black Board |
| 2.7 | SAGE (Serial Analysis of Gene Expression). | 2 | Chalk & Talk | Black Board |
| Unit – 3 (15Hrs) |
| 3.1 | Proteomics – Introduction | 2 | Lecture | Black Board |
| 3.2 | Proteomics – types. concepts of proteome analysis | 3 | Lecture | Black Board |
| 3.3 | Protein – Protein interaction  | 3 | Chalk & Talk | Black Board |
| 3.4 | Yeast two hybrid system. | 2 | Chalk & Talk | Black Board |
| 3.5 | Computational approaches to analyse protein | 1 | Chalk & Talk | Black Board |
| 3.6 | -Mass spectrometry for proteome analysis. | 2 | Chalk & Talk | Black Board |
| 3.7 | 2D gel electrophoresis. | 2 | Chalk & Talk | Black Board |
| Unit- 4 (15Hrs) |
| 4.1 | Human Genome: Ethics, analysis | 3 | Lecture | Black Board |
| 4.2 | Pharmacogenetics | 3 | Lecture | Black Board |
| 4.3 | Drug discovery | 4 | Lecture | Black Board |
| 4.4 | Target and Developments | 3 | Chalk & Talk | Black Board |
| 4.5 | SNP analysis. | 2 | Chalk & Talk | Black Board |
| Unit -5 (15Hrs)  |
| 5.1 | Metabolomics: Introduction. | 2 | Chalk & TalkLecture | Black Board |
| 5.2 | Principle and applications | 3 | Chalk & Talk | Black Board |
| 5.3 | Phylogenomics - Terminologies-Homolog, Ortholog, Paralog and Xenolog | 2 | Chalk & Talk | Black Board |
| 5.4 | Phylogenetic tree analysis methods | 2 | Chalk & Talk | Black Board |
| 5.5 | Maximum parsimony method, Distance method,Maximum likelihood method. | 6 | Chalk & Talk | Black Board |

**Mapping COs with POs**

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| --- | --- | --- | --- | --- | --- |
| **POs****Cos** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** |
| **CO1** | **3** | **2** | **1** | **1** | **2** |
| **CO2** | **2** | **1** | **3** | **2** | **1** |
| **CO3** | **2** | **2** | **1** | **1** | **3** |
| **CO4** | **1** | **3** | **1** | **2** | **3** |
| **CO5** | **1** | **3** | **2** | **3** | **1** |

**3 – STRONG 2 – MEDIUM 1 – LOW**

**COURSE DESIGNER: Mrs. P.GAYATHRIDEVI**

**Core Lab LAB IN ANIMAL CELL CULTURE AND PLANT TISSUE CULTURE**

 **SEMESTER VI Code: 212903603**

**3Hrs/Week**

 **Credits 3**

***Preamble:-***

* ***To know the handling techniques on animal and plant tissue culture***
* ***To understand the safety procedures and significance of tissue culture.***

***Animal cell culture (Virtual practical)***

1. Preparation of Animal cell culture media.
2. Primary cell culture of Mouse embryonic fibroblast.
3. Sub culture and established cell lines.
4. Cell counting and cell viability.
5. Preservation of cultured animal cells.

***Plant tissue culture***

1. Preparation of plant tissue culture media.
2. Callus induction from different plant materials
3. Isolation of chloroplast.
4. Production of synthetic seeds
5. Isolation and culture of plant protoplast

**REFERENCE BOOKS:**

1. Martin Clynes, (1998), Animal Cell Culture Techniques, Springer lab manual, 1st Ed, Springer Berlin, Heidelberg.
2. Robert H.Smith, (2000), Plant Tissue Culture: Technique and experiments, 2nd Edition, Elsevier Science and Technology, New Delhi,

**COURSE DESIGNER: Dr. M.DHANASEKARAN**

**Core Lab Lab in Bioinformatics Code: 212903606/**

 **SEMESTER VI 213003606**

**2Hrs/Week**

 **Credits 2**

**PREAMBLE:**

* ***To learn the basic methodology in Bioinformatics***
* ***To develop technological tools that help analyze biological data****.*
* ***The program aims to utilize and understand biological databases to gather, store, retrieve, manage, analyze and integrate biological data for generating new knowledge.***

1. Bioinformatics Resources: NCBI, EMBL and DDBJ.

2. Database search engines : Entrez.

3. Open access bibliographic resources and literature databases.

 a. PubMed

 b. BioMed Central

4. Sequence databases:

a. Nucleic acid Sequence databases : GenBank, EMBL, DDBJ

 b. Protein Sequence database (PIR, SWISSPROT)

 c. Genome databases at NCBI, EBI.

5. Sequence File format:

 a. Pair wise Sequence alignment tool – BLAST and FASTA.

 b. Multiple sequence alignment tools - Clustal W.

6. Polygenetic tree construction using Mega 5.

7. Protein Structural database – PDB.

8. Molecular Visualization tool – RASMOL.

**References:**

0.1 . https://www.ncbi.nlm.nih.gov.

0.2 <https://www.megasoftware.net>

0.3 <http://www.openrasmol.org>

0.4 https://www.rcsb.org

**COURSE DESIGNER: Mrs. P.GAYATHRIDEVI**

 **BIOINFORMATICS Code: 212903607/**

 **213003607**

**Elective-III SEMESTER VI**

**3 Hrs/Week**

 **Credits 3**

* ***To learn about the basics and applications of bioinformatics and also know about database.***
* ***To understand the nucleic acid sequence and protein databases.***
* ***To acquire knowledge an Sequence alignment- Tools of Analysis and unknown nucleotide sequence and evolutionary relationships***
* ***To gain the knowledge of Structural classification of protein and phylogenetic analysis of protein.***
* ***To understand the gene prediction method and tools for gene prediction and also drug design****.*

**COURSE OUTCOMES (CO)**

On Successful completion of the course, the student will be able to

|  |  |  |
| --- | --- | --- |
| **CO** | **Course Outcome** | **Knowledge Level (According to Bloom’s Taxonomy)** |
| **CO 1** | To learn about the basics and applications of bioinformatics and also know about database. | Up to K3 |
| **CO 2** | To understand the nucleic acid sequence and protein databases. | Up to K3 |
| **CO 3** | To acquire knowledge an Sequence alignment- Tools of Analysis and unknown nucleotide sequence and evolutionary relationships | Up to K3 |
| **CO 4** | To gain the knowledge of Structural classification of protein and phylogenetic analysis of protein. | Up to K3 |
| **CO 5** | To understand the gene prediction method and tools for gene prediction and also drug design. | Up to K3 |

K1 - KNOWLEDGE K2 - UNDERSTANDING K3 - APPLICATION

UNIT – I: **[9 Hrs]**

Bioinformatics - Definition, application and significance of bioinformatics in life sciences. Database- introduction, types and classification, internet, World Wide Web.

UNIT – II: **[9 Hrs]**

Nucleic acid sequence databases - Genbank, EMBL and DDBJ, Protein sequence databases – Protein Information Resource, SWISS PROT, protein structural databases – Protein Data Bank.

UNIT – III: **[9 Hrs]**

 Sequence alignment- Tools of Analysis - FASTA, BLAST, clustal W, protein visualization tools- SWISS PDB viewer, RasMol.

UNIT – IV:  **[9 Hrs]**

 Structural and classification of protein- SCOP, PROSITE and CATH, Phylogenetic analysis method - maximum parsimony, distance method.

UNIT – V: **[9 Hrs]**

Gene prediction- method and tools for gene prediction. Drug design – Structural and ligand based drug design, Lipinski rules - ADMET properties, Protein 3D structure prediction- Homology modeling - Ramachandran Plot.

**TEXT BOOKS**:

1. S. Ignacimuthu, Basic Bioinformatics, Narosa publishing house New Delhi, 2006
2. Rastogi S. C., Mendisatta N., Rastogi P., Bioinformatics methods and application, 3rd Edition, PHI learning private limited, New Delhi, 2008.

**REFERENCES:**

1. David W. Mount, Bioinformatics sequence and Genome Analysis, University of Arizona, TUCSON, CBS Publishers, Bangalore, 2001.
2. T. K. Attwood, D.J. Parry –Smith. Introduction to bioinformatics - Pearson Education (Singapore Pvt Ltd), 1999.

**WEB RESOURCES (URLs):**

Unit I:

<https://en.wikipedia.org/wiki/Bioinformatics>

<https://en.wikipedia.org/wiki/Internet>

Unit II :

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3964972/>

<https://en.wikipedia.org/wiki/List_of_biological_databases>

Unit III:

<https://en.wikipedia.org/wiki/FASTA>

<https://blast.ncbi.nlm.nih.gov/Blast.cgi>

Unit IV:

<https://spdbv.vital-it.ch/>

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3965108/>

Unit V:

<https://en.wikipedia.org/wiki/List_of_gene_prediction_software>

<https://en.wikipedia.org/wiki/Homology_modeling>.

**Pedagogy:** Chalk and Talk, Power point presentation, Animations

**COURSE CONTENTS & TEACHING/LEARNING SCHEDULE**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Module No.** | **Topic** | **No. of Lectures** | **Content Delivery Method** | **Teaching Aids** |
| **Unit -I [9 Hrs]** |
| 1.1 | Bioinformatics - Introduction, application and significance of bioinformatics in life sciences.  | 4 | Chalk & Talk | Black Board |
| 1.2 | Database- introduction, types and classification of databases  | 3 | Chalk & Talk | Black Board |
| 1.3 | Internet, World Wide Web. | 2 | Lecture | Power point presentation |
| **Unit - II [9 Hrs]** |
| 2.1 | Nucleic acid sequence databases - Genbank, EMBL and DDBJ | 4 | Chalk & Talk | Black Board |
| 2.2 | Protein sequence databases – Protein Information Resource, SWISS PROT | 3 | Chalk & Talk | Black Board |
| 2.3 | protein structural databases – Protein Data Bank.  | 2 | Chalk & Talk | Black Board |
| **Unit - III [9 Hrs]** |
| 3.1 | Sequence alignment- Tools of Analysis  | 2 | Chalk & Talk | Black Board |
| 3.2 | FASTA, BLAST, clustal W | 4 | Lecture | Power point presentation |
| 3.3 | Protein visualization tools- SWISS PDB viewer, RasMol. | 3 | Lecture | Power point presentation |
| **Unit - IV [9 Hrs]** |
| 4.1 | Structural and classification of protein | 2 | Chalk & Talk | Black Board |
| 4.2 | SCOP, PROSITE and CATH | 3 | Chalk & Talk | Black Board |
| 4.3 | Phylogenetic analysis method - maximum parsimony, distance method. | 4 | Chalk & Talk | Black Board |
| **Unit - V [9 Hrs]** |
| 5.1 | Gene prediction- method and tools for gene prediction.  | 2 | Chalk & Talk | Black Board |
| 5.2 | Drug design – Structural and ligand based drug design, Lipinski rules - ADMET properties | 3 | Lecture | Power point presentation |
| 5.3 | Protein 3D structure prediction- Homology modeling  | 3 | Chalk & Talk | Black Board |
| 5.4 | Ramachandran Plot. | 1 | Chalk & Talk | Black Board |

**Mapping COs with POs**

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| --- | --- | --- | --- | --- | --- |
| **POs****COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** |
| **CO1** | **3** | **1** | **2** | **2** | **3** |
| **CO2** | **3** | **2** | **2** | **2** | **1** |
| **CO3** | **3** | **1** | **2** | **1** | **3** |
| **CO4** | **2** | **3** | **1** | **2** | **2** |
| **CO5** | **3** | **1** | **2** | **1** | **3** |

**3 - STRONG 2 - MEDIUM 1 - LOW**

**COURSE DESIGNER: Mr. L. ARUL YESUDOSS**

**Elective -III TRANSCRIPTOMICS AND METABOLOMICS Code: 212903608/**

 **SEMESTER VI 213003608**

**3 Hrs/Week**

 **Credits 3**

**Course Preamble:**

* ***To know about existing and emerging application of transcriptomics studies.***
* ***To evaluate advantages and limitations of some analytical techniques used in transcriptomics and metabolomics studies***

**COURSE OUTCOMES (CO)**

On Successful completion of the course, the students will be able to

|  |  |  |
| --- | --- | --- |
| **CO** | **Course Outcome** | **Knowledge Level (According to Bloom’s Taxonomy)** |
| **CO 1** |  Illustrate about types, regulation and importance of transcription | Up to K3 |
| **CO 2** | Depict the gene expression and transcriptomic analysis | Up to K3 |
| **CO 3** | Elucidate the basic principles and applications of transcriptome techniques | Up to K3 |
| **CO 4** | Point up the significance of metabolomics of plant and animal | Up to K3 |
| **CO 5** | Analyse the metabolites using various techniques like Mass spectroscopy, NMR etc., | Up to K3 |

**K1 - KNOWLEDGE (REMEMBERING) K2 - UNDERSTANDING K3 - APPLICATION**

UNIT – I: **[9 Hrs]**

 Introduction to transcript, transcriptome and transcriptomics. Importance of transcription. Types of transcripts. Generation of transcriptional regulatory networks. Databases and softwares for transciptomics study.

UNIT – II: **[9 Hrs]**

 Data mining and bioinformatics software to built transcription regulatory model. High throughput genetic manipulations, Denova transcriptome analysis, gene expression profiling, noncoding RNA discovery and deletion.

UNIT – III: **[9 Hrs]**

 Techniques of transciptome analysis: mRNA isolation, cDNA synthesis, semi- quantitative/ qPCR, microarray, EST, SAGE, dot-blot, Northern blotting. Comparative transcriptome analysis techniques- Suppression, substraction, hybridization.

UNIT – IV:  **[9 Hrs]**

 Introduction to metabolism, metabolites, metabolome and metabolomics- significance of metabolomics. Key metabolic pathways in plant and animals. Metabolic profiling in phenotyping and breeding – Arabdopsis, ecotype, rice, maize, potato.

UNIT – V: **[9 Hrs]**

 Principles and procedures of metabolites extraction: Mass spectroscopy, NMR, X ray crystallography, LIF, LC-UV, CE-MS, 2D and high resolution metabolic profiling. Metabolic pathway resources: KEGG, Biocarta. Future prospective of metabolomics.

**TEXT BOOKS:**

1. Attwood T. K and Parry Smith D.J., Introduction to Bioinformatics, Peasson Education, Asia, 1999.
2. Primrose Old R.W., and S. B., principles of gene manipulation, BLackWells Science, Inc 6th Rdition, Germany, 2002.

**REFERENCES:**

1. Mark Schena, DNA microarrays: A Practical Approaches, Oxford University Press, Oxford England, 1999.

2. William M.R., Appel R.D., and Hrchstracsr D.F., Proteome Research: New Tronfiers in Functional Genomics: Principles and Practice, Springer Vetrlap, New York, 1997

**Web Resources (URLs):**

**Unit – I**

<https://nptel.ac.in/content/storage2/courses/102101007/downloads/PPT/LEC-03-PPT.pdf>

<https://nptel.ac.in/content/storage2/courses/102101007/downloads/TRANSCRIPT/LEC-03-TRANSCRIPT.pdf>

**Unit–II**

<https://www.ijcsmc.com/docs/papers/May2017/V6I5201729.pdf><https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0001717>

<https://www.eurofinsgenomics.eu/en/next-generation-sequencing/customised-solutions/transcriptome-sequencing/de-novo-transcriptome/>

**Unit–III**

<https://www.researchgate.net/publication/51667731_Transcriptome_Analysis/link/09e41502e227106162000000/download>

<https://www.researchgate.net/publication/303404667_RNA-Seq_methods_for_transcriptome_analysis_RNA-Seq>

**Unit–IV**

[https://www.cell.com/cell-metabolism/pdf/S1550-4131(07)00298-7.pdf](https://www.cell.com/cell-metabolism/pdf/S1550-4131%2807%2900298-7.pdf)<https://www.researchgate.net/publication/319677524_Metabolomics/link/5a40ebb10f7e9ba8689ee86c/download><https://web.stanford.edu/class/gene211/lectures/Lecture9_Metabolomics-Proteomics-2018.pdf>

**Unit–V**

<https://www.intechopen.com/books/molecular-medicine/metabolomics-basic-principles-and-strategies>

<https://www.researchgate.net/publication/329160885_Metabolomics_Resources_An_Introduction_of_Databases_and_Their_Future_Prospective>

**Pedagogy:**

Chalk and Talk, Power point presentation, Animations

**COURSE CONTENTS & TEACHING/LEARNING SCHEDULE**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Module No.** | **Topic** | **No. of Lectures** | **Content Delivery Method** | **Teaching Aids** |
| **Unit -I [9 Hrs]** |
| 1.1 | Introduction to transcript, transcriptome and transcriptomics. Importance of transcription. | 3 | Chalk & Talk | Black Board |
| 1.2 | Types of transcripts. Generation of transcriptional regulatory networks.  | 3 | Chalk & Talk | Black Board |
| 1.3 | Databases and softwares for transciptomics study.  | 3 | Lecture | Power point presentation |
| **Unit - II [9 Hrs]** |
| 2.1 | Data mining and bioinformatics software to built transcription regulatory model.  | 3 | Chalk & Talk | Black Board |
| 2.2 | High throughput genetic manipulations, Denova transcriptome analysis | 3 | Chalk & Talk | Black Board |
| 2.3 | Gene expression profiling, noncoding RNA discovery and deletion. | 3 | Chalk & Talk | Black Board |
| **Unit - III [9 Hrs]** |
| 3.1 | Techniques of transciptome analysis: mRNA isolation, cDNA synthesis. | 3 | Chalk & Talk | Black Board |
| 3.2 | Semi- quantitative/ qPCR, microarray, EST, SAGE, dot-blot, Northern blotting.  | 3 | Lecture | Power point presentation |
| 3.3 | Comparative transcriptome analysis techniques- Suppression, substraction, hybridization. | 3 | Lecture | Power point presentation |
| **Unit - IV [9 Hrs]** |
| 4.1 | Introduction to metabolism, metabolites, metabolome and metabolomics- significance of metabolomics.  | 3 | Chalk & Talk | Black Board |
| 4.2 | Key metabolic pathways in plant and animals.  | 2 | Chalk & Talk | Black Board |
| 4.3 | Metabolic profiling in phenotyping and breeding – Arabdopsis, ecotype, rice, maize, potato. | 4 | Chalk & Talk | Black Board |
| **Unit - V [9 Hrs]** |
| 5.1 | Principles and procedures of metabolites extraction: Mass spectroscopy, NMR, X ray crystallography, LIF. | 3 | Chalk & Talk | Black Board |
| 5.2 | LC-UV, CE-MS, 2D and high resolution metabolic profiling. | 3 | Lecture | Power point presentation |
| 5.3 | Metabolic pathway resources: KEGG, Biocarta. Future prospective of metabolomics. | 3 | Chalk & Talk | Black Board |

**Mapping COs with POs**

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| --- | --- | --- | --- | --- | --- |
| **POs****Cos** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** |
| **CO1** | **3** | **2** | **3** | **1** | **2** |
| **CO2** | **2** | **1** | **3** | **2** | **1** |
| **CO3** | **3** | **2** | **1** | **1** | **3** |
| **CO4** | **1** | **3** | **1** | **2** | **3** |
| **CO5** | **1** | **3** | **2** | **3** | **1** |

**3 – STRONG 2 – MEDIUM 1 – LOW**

**COURSE DESIGNER: Mr. L. ARUL YESUDOSS**