| BTE-301 | Recombinant DNA Technology (B.Tech. Biotechnology Semester V ) | | | | | | |
|---|---|---|---|---|---|---|---|
| Lecture | Tutorial | Practical | Credit | Major Test | Minor Test | Total | Time |
| 3 | - | - | 3 | 75 | 25 | 100 | 3 Hrs. |
| Purpose | To familiarize the students with the concepts and tools of Genetic Engineering | | | | | | |
| Course Outcomes | | | | | | | |
| CO1 | Learner will know about different tools used for Genetic Engineering | | | | | | |
| CO2 | Students will be able to understand the fingerprinting methods | | | | | | |
| CO3 | This unit will enable the students to understand different types of mutation | | | | | | |
| CO4 | Students will be able to learn how to produce biomolecules by using RDNA tech | | | | | | |

## UNIT I

1. **Tools of Recombinant DNA:** Restriction endonucleases. DNA/ RNA Modifying enzymes: Methylase, Alkaline phosphatase, Terminal deoxy nucleoside acetyl transferase,T4 Polynucleotide kinase. Blunt end ligation,Linkers Adapters,DNA labeling and detection.
2. **Cloning and Expression Vectors:** Plasmid, Cosmids, Bacteriophages, Phagemids as vectors. Binary and shittle vectors. Creating and screening a gene library cDNA library. Genetic transformation of prokaryotes. Basic strategies for cloning. Cloning DNA sequences encoding eukaryotic proteins. Selection of cloned genes.Vectors for cloning large pieces of DNA.

## UNIT II

3. **Chemical synthesis, sequencing and amplification of DNA:** Chemical synthesis of DNA. DNA sequencing techniques. PCR. Analysis of eukaryotic DNA by chromosomal walking. Southern and Northern Blotting. Western Blotting. *In situ* hybridization.

4. **Isolation of cloned genes:** Probes to locate clones and related genes. Identification and isolation of tissue specific cDNA. Procedures to analyze proteins encoded by cDNA clones.

## UNIT III

5. **DNA markers**: RFLP. RAPD and DNA fingerprinting.

6. **Study of gene functions:** Directed mutagenesis. Identification of mutant clones. Use of PCR to construct genes encoding chimeric proteins.

7. Mutagenesis-gateway to gene function and protein engineering.

## UNIT IV

8. **Application of recombinant DNA in biotechnology:** In medicine and Industry: Production of small biomolecules: Production of insulin, human growth hormone and its variants. Hepatitis-B virus vaccine. Tailoring antibodies for specific applications. Biopolymers production. Heterologous Protein Production in Prokaryotes and Eukaryotes
9. Marshalling recombinant DNA to fight AIDS.

**Text Books:**

1. Recombinant DNA 2nd Edition. Watson, James D. and Gilman, M. (2001) W.H Freeman and Company, New York.
2. Molecular Biotechnology: *Principles Application of Recombinant DNA* 2nd Edition. Glick, B. R. and Pasternak, J. J. (1998) ASM press Washington DC.
3. Genetic Engineering. Ahluwalia, K. B. (2002) New Age International (P) Ltd.
4. An Introduction to Genetic Engineering 2nd edition Desmond Nicholl S.T. (2002) Cambridge University Press.
5. Genetic Engineering: *An introduction to Gene analysis and exploitation in eukaryotes*. Kingsman and Kingsman (1998) Blackwell Scientific Publication, Oxford.
6. DNA cloning: *A Practical Approach.* Glover and Hames (2001) Oxford University Press.

| BTE-303 | BIOPROCESS ENGINEERING (B. Tech. Biotechnology Semester V) | | | | | | |
|---|---|---|---|---|---|---|---|
| **Lecture** | **Tutorial** | **Practical** | **Sessional** | **Theory** | **Total** | **Time** | **Credit** |
| **3** | **-** | **-** | **25** | **75** | **100** | **3 Hrs.** | **3** |
| **Purpose** | **To introduce the basics of Bioprocess Engineering to the students for applications in Biotechnology** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO1** | **Introduce the fundamentals of Bioprocess Engineering.** | | | | | | |
| **CO 2** | **To make the students aware of the importance of formulation of culture media and sterilization of process fluids** | | | | | | |
| **CO 3** | **To introduce the concept of configuration and different types of bioreactors** | | | | | | |
| **CO 4** | **To make aware of the applications of Bioprocess Engineering to non-conventional Biological Systems** | | | | | | |

## UNIT-I

1. **Introduction to Bioprocess Engineering**. History and Scope of Bioprocess Engineering. Basic concepts and approaches used in Bioprocess Engineering. Microbial growth Kinetics. Bioprocesses: Regulatory Constraints. Steps in Bioprocess development. Major products of biological processing.
2. **Basics of Bioprocess Engineering**. Introduction to Heat Transfer, Mass Transfer and Diffusion Concepts. Material and Energy Balances in a macroscopic view point. Variables, dimensions and units. Dimensionally Homogenous and non-homogenous equations. Standard conditions and ideal gases.

## UNIT II

3. **Formulation of Fermentation Media**. Principles of microbial nutrition. Formulation of culture media. Factors influencing the choice of various carbon and nitrogen sources. Growth factors and precursors in fermentation media. Antifoaming and antifoam agents.
4. **Sterilization of Process fluids**. Kinetics of thermal death of cells and spores. Design of batch and thermal sterilization. Sterilization of air and filter design. Radiation and chemical sterilization.

## UNIT III

5. **Design of Bioreactors**. Basic objective of fermenter design, aseptic operation & containment, body construction, agitator and sparger design, baffles, stirrer glands and bearings. Process parameters and measurement techniques: measurement of temperature, pressure and pH, DO, foam etc.; flow rate of liquid and gases; Automation (processes computerization). Validation of Fermentor

6. **Configuration and Types of Reactors**: Ideal and non-ideal reactors. Batch, plug flow reactor (PFR), continuous stirred tank reactor (CSTR), Fluidized bed reactor, air lift fermenter, and mechanical design of bioreactors.
7. **Choosing the Cultivation Method.** Modifying Batch and Continuous Bioreactors. Immobilized cell systems. Solid-state Fermentations and its applications. Rheology of fermentation fluids. Various approaches to scale-up including regime analysis and scale-down.

**UNIT IV**

8. **Applications of Bioprocess Engineering to non-conventional Biological Systems**. Bioprocess considerations in using animal and plant cell cultures. Use of Genetically Engineered Microorganisms in Bioprocess development.

**Text Books-**


1. Shuler, M. L. and Kargi, F. 2002. Bioprocess Engineering-Basic Concepts. Prentice Hall India, New Delhi.
2. Doran, P. M. 2013. Bioprocess Engineering Principles. Elsevier.
3. Mukhopadhyay, S. N. 2012. Process Biotechnology-Theory and Practice. The Energy and Resources Institute, New Delhi/


**Reference Books-**


1. Ward, O.P. 1991. Bioprocessing. New York
2. Nostrand, R. V., Belter, P.A., Cussler, E. L. and Hu, W. S. 1988. Bioseparations-Downstream Processing for Biotechnology.
3. Lydersen, K. B., D'elia, N. A. and Nelson, K. L. 1994. Bioprocess Engineering: Systems, Equipments and Facilities. John Wiley and Sons, New York.

| BTE-305 | Downstream Processing (B.Tech. Biotechnology Semester V ) | | | | | | |
|---|---|---|---|---|---|---|---|
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3** | **75** | **25** | **100** | **3 Hrs** |
| **Purpose** | **To familiarize the students with the Downstream Processing** | | | | | | |
| **Course Outcomes** | | | | | | | |
| CO1 | Students will become familiar to upstream and downstream processing | | | | | | |
| CO2 | Students known about cell disintegration and primary methods of separation in DSP | | | | | | |
| CO3 | Students will develop knowledge to Emerging separation techniques | | | | | | |
| CO4 | Students will develop focus on different examples of DSP | | | | | | |

**UNIT –I**

1. **Introduction:** History and scope of downstream processing in biotechnology, problems, requirement of purification. Overview of a bioprocess including upstream and downstream processing., physicochemical basis of bioseparation

**UNIT – II**

2. **Cell disintegration:** Separation of particulate by centrifugation, settling, sedimentation, decanting and micro filtration. Primary isolation methods including solvent extraction and sorption.
3. **Purification methods:** Precipitation, electrophoresis, electro dialysis and various kinds of chromatography.

**UNIT – III**

4. **Emerging separation techniques: I**mmobilization, reverse osmosis, super critical fluid extraction evaporation, super liquid extraction and foam based separation. Separation of intracellular, extracellular, heat and photosensitive materials.

**UNIT – IV**

5. **Downstream processes and effluent treatment:** Applications of Unit Operations in Downstream with special reference to membrane separations & extractive fermentation, anaerobic and aerobic treatment of effluents. Typical examples effluent disposal in process industries.

**Text books**

1. Biochemical Engineering fundamentals 2nd ed. Bailey J. E. and Ollis D. F. (1986) MacGraw Hill, New York.

2. Principles of fermentation technology, Stanbury, P. F. and Whitaker, A. (1984), Pergamonpress.

3. Unit Operation of Chemical Engineering 6th ed. McCabe, W. L; Smith J. C and Harriott P. (2000). MacGraw Hill, New York

**Reference Books**

1. Bioseparation: Downstream Processing for Biotechnology. Belter, P. A.; Cussler E. L. and Hu W. S. (2003) John Wiley & Sons. OXFORD.

**2.** Bioseparations Science and Engineering, Harrison R.G.; Todd P.; Rudge S.R. and Petrides D.P. (2003). Oxford Press.

**Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus.**

| BTE-307 | Healthcare Biotechnology (B.Tech. Biotechnology Semester V ) | | | | | | |
|---|---|---|---|---|---|---|---|
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time(H)** |
| **3** | **-** | **-** | **3.0** | **75** | **25** | **100** | **3** |
| **Purpose** | **To Learn the use of biotechnology in the area of healthcare and diagnosis** | | | | | | |
| **Course Outcomes** | | | | | | | |
| CO1 | **To understand the fundamental of diagnostics** | | | | | | |
| CO2 | **To understand the use of therapeutics agents in healthcare.** | | | | | | |
| CO3 | **To understand the diagnosis in molecular level.** | | | | | | |
| CO4 | **To understand advanced techniques in molecular diagnostics.** | | | | | | |

## Unit I

**Introduction to diagnostics in Heathcare Biotechnology:** Different methods to daignose bacterial and parasitic infection. Signal amplification system. FACS. Assay development evalution and validation. Reagent formulation and their self life evalution.

Production of antibody in *E.coli.* Regulatory aspect of therapeutic proteins and approaches for producing HIV therapeutics agents.

## Unit II

**Therapeutics Agents in Pharmaceutical and Enzymes:** Human Interferons, Human Growth Hormone, Tumor Necrosis factos, Dnase I, Alginate Lyase, Phenylalanine Ammonia Lyase and alpha-Antitrypsin.

**Nucleic Acid as Therapeutic Agents:** Antisense RNA, Ribozymes, Interfering RNAs and Antibody Genes.

## Unit III

**DNA Diagnostics:** Radioactive and non radioactive nucleic acid hybridisation. DNA fingerprinting and RAPD as diagnostic tools.

**Vaccines:** Subunit Vaccines for herpese simplex virus and Foot-and-Mouth Disease. Genetic Immunization by DNA vaccine. Attenuated and vector vaccines.

## Unit IV

**Molecular Diagnosis of Genetic Disorder:** Diagnosis before onset of symptoms and identification of carriers of heredity disorder. Significance in prenatal diagnosis. PCR/OLA Procedures for diagnosis heredity disease caused by mutation without affecting restrictions sites. Genotyping with FISH and related techniques. Detection of mutation.

**Text Books:**

**1.** Moloecular Biotechnology: Principles and Applications of Recombinant DNA. 3rd Edition. Glick Bernard R.and Pasternak Jack J. (1998), ASM Press washington DC.

**2.** Kuby's immunology, 5th Edition. Goldsby, R A., Kindt, T.Jand Osborne B.A.(2003). W. H. Freeman and company, New york.

**Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus.**

| BTE-307L | Recombinant DNA Technology Lab(B. Tech. Biotechnology Semester V ) | | | | | | |
|---|---|---|---|---|---|---|---|
| Lecture | Tutorial | Practical | Credit | Minor Test | Practical (Major Test) | Total | Time |
| - | - | 3 | 1.5 | 40 | 60 | 100 | 3 Hrs |
| Purpose | To learn the experiments of Recombinant DNA Technology | | | | | | |
| Course Outcomes | | | | | | | |
| CO1 | The students will be able to digest, ligate and amplify the DNA | | | | | | |
| CO2 | The students will learn how to design primers | | | | | | |
| CO3 | The students will learn about protein expression | | | | | | |
| CO4 | Students will learn techniques of DNA extraction and its analysis | | | | | | |

**LIST OF EXPERIMENTS**

1. Target selection
2. Strategy for cloning
3. Primer design
4. Isolation of genomic DNA
5. Gene amplification by PCR
6. Ligation of desired gene sequence
7. Transformation
8. Verification of cloned DNA
9. Induction of expression
10. Verification of protein expression

**References Book:**

1.Molecular Cloning – A laboratory manual 3rd Edition Vol. 1-3. Sambrook J. and Russell D.W. (2001) Cold Spring Harbor laboratory Press, New York
2. Molecular Biology-Principles and Practices. Singh, N. and Siwach, P. Luxmi Publications, Delhi

| BTE-309L | Fermentation and Downstrean Processing LAB (B.Tech. Biotechnology Semester V ) | | | | | | |
|---|---|---|---|---|---|---|---|
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Practical (Major Test)** | **Minor Test** | **Total** | **Time** |
| **-** | **-** | **3** | **1.5** | **60** | **40** | **100** | **3 Hrs.** |
| **Purpose** | **To familiarize the students with different Downstream Processing techniques** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO1** | **Students will learn how to optimized the fermentation conditions** | | | | | | |
| **CO2** | **Students will learn different chromatography used in DSP** | | | | | | |
| **CO3** | **Students will work on purification of antigen** | | | | | | |
| **CO4** | **Students will work on cell lysis by different methods** | | | | | | |

**Note**: A college should offer 70% of the below listed experiments. The remaining 30% experiments may be modified by college according to facilities available

**LIST OF EXPERIMENTS**

1. **Study of factors affecting bioprocesses in submerged fermenters** (pH, O2, Temperature, Foam, Ingredients)

**2. Purification of bacterial protein**

a) Cell lysis by different methods.

b) Cell debris separation by different methods.

c) Column purification

I. Separation by Molecular weight.

II. Separation by charge.

III. Separation by metal affinity.

IV. Separation by Receptor-Ligand affinity.

d) Dialysis

e) Crystallization

f) Lyophilization

**3. Purification of O-PS**

a) Cell lysis

b) Harvesting of cells

c) Purification of O-PS antigens

**References:**

1. Biophysical Chemistry: Principles & techniques 2nd Edition. Upadhyay, A.; Upadhyay, K. and Nath, N. (2002) Himalaya Publication House, New Delhi.

2. Bioprocess Engineering: Systems, Equipment & facilities. Eds. Lydersen K.B.; D'elia N.A. and Nelson K.L. (1994) John Wiley & Sons, New York.
3. Physical Biochemistry 2nd Edition. Friefelder D. (1983) W.H. Freeman & Co., USA.
4. Physical Biochemistry: Principles & applications. Sheehan David (2000) John Wiley & Sons Ltd. New York.
5. Bioseparations- Downstream processing for biotechnology. Belter, P.A.; Cussler, E.L. and Hu, W.S. (1988) John Wiley and Sons, New York.
6. Encyclopedia of Bioprocess Technology: Fermentation, biocatalysis and bioseparation Vol. 1-5. Eds. Flickinger M.C. and Drew S.W. (1999) John Wiley & Sons, New York.

| MC-903 | Essence of Indian Traditional Knowledge (B.Tech. Biotechnology Semester V ) | | | | | | |
|---|---|---|---|---|---|---|---|
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **0** | **0** | **100** | **0** | **100** | **3 Hrs.** |
| **Purpose** | **To familiarize the students with Indian Traditional Knowledge** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO1** | **Students will learn the importance of Holistic Life Style.** | | | | | | |
| **CO2** | **Students will learn about Indian perspective of modern scientific world.** | | | | | | |
| **CO3** | **Students will learn about cultural Heritage of India.** | | | | | | |
| **CO4** | **Students will learn about holistic health care system** | | | | | | |

Unit I

Basic structure of Indian Knowledge System: अा दशिव4ा -४वेद,४उपवेद(आयुव ंद, धनुव ंद,गNव ंवेद, 3थ पÆ शआद) ६वेद ाेंग(शाि¶ा , क¾,शान7ª,ा करण, ¾ा शातष, छांद) ४उप ड्ग(धम ंि ™, मीम ाेंस , पुर ण, तक ंि ™)

Unit II

Modern Science and Indian Knowledge System−Yoga and Holistic Healthcare−Case studies

Indian philosophical traditions, Indian linguistic Tradition,

Unit III

Indian artistic tradition.Course Contents−Philosophical Tradition (सव ंदि ंन)-¾ा य, वैि ेशापक,स ाेंस, य ग, मीम ाेंस , वेद ाेंत, च व ,जाैन,बा \−Indian Linguistic Tradition (Phonology, morphology, syntax andsemantics)−

Unit IV

Indian Artistic Tradition -शाच7कल , मूशात ंकल , व ™ाुकल , 3थ पÆ, सांगीत,नृÆएवांस शाहत्य−

**References books**

Knowledge traditions and practices of India, CBSE Publication•V. Sivarama krishnan (Ed.), Cultural Heritage of India-course material, Bharatiya Vidya Bhavan, Mumbai. 5th Edition, 2014 •

Swami Jitatmanand, Modern Physics and Vedantharatiya Vidya Bhavan

•Swami Jitatmanand, Holistic Science and Vedantharatiya Vidya Bhavan •Fritzof Capra,

Tao of Physics •Fritzof Capra,

The Wave of life •VN Jha (Eng. Trans.), Tarkasangraha of Annam Bhatta, International Chinmay Foundation, Velliarnad,Arnakulam •

Yoga Sutra of Patanjali, RamakrishnaMission,Kolkata •

| BTE-304 | Plant Biotechnology (B.Tech. Biotechnology Semester VI ) | | | | | | |
|---|---|---|---|---|---|---|---|
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3** | **75** | **25** | **100** | **3 Hrs.** |
| **Purpose** | **To familiarize the students with the concepts of tissue culture and transgenic plants** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO1** | **Students will learn about different types of tissue culture techniques** | | | | | | |
| **CO2** | **Students will be able to understand about male and female tissues used for culturing** | | | | | | |
| **CO3** | **Students will learn about different gene transfer methods** | | | | | | |
| **CO4** | **Learner will be able to understand about transgenic plants and products** | | | | | | |

## UNIT I

**Introduction**: Cyto and organogenic differentiation. Types of culture: seed, embryo, callus, organ, cell and protoplast culture. Secondary metabolites, their production and applications.

**Micropropagation**: Axillary bud proliferation, meristem and shoot tip culture, bud culture, organogenesis, embryogenesis, advantages and disadvantages of micropropagation.

**In Vitro haploid production**: Androgenic methods: anther culture, microspore culture, factors effecting and organogenesis. Significance and use of haploids, ploidy level and chromosome doubling, diplodization. Gynogenic haploids: factors effecting gynogenesis, chromosome elimination techniques for production of haploids in cereals.

## UNIT II

**Protoplast Isolation and fusion:**Methods of protoplast isolation, protoplast development, somatic hybridization, identification and selection of hybrid cells, cybrids, potential of somatic hybridization, limitations.

**Somaclonal variation:** Nomenclature, methods, causes applications and disadvantages. Gametoclonal variation.

**Germplasm storage and Cropreservation**: Methods, cryoprotectants, pretreatment, freezing, storage, thawing, slow growth cultures, DNA clones, Advantages and disadvantages

## UNIT III

**Plant Growth Promoting bacteria**: Nitrogen fixation, nitrogenase, hydrogenase, nodulation, Growth promotion by free-living bacteria

**Gene transfer in plants:** Transient and stable gene expression, marker genes, selectable markers, chimeric gene vectors.

**Gene transfer methods:** Agrobacterium, viruses and transposable elements. Vectorless or direct DNA transfer: Physical, chemical and imbibation methods of gene transfer.

## UNIT IV

**Transgenics in crop improvement:** Resistance to biotic stresses- insect, virus and disease (fungus and bacterium) resistance, herbicide resistance. Development of stress and senescence-tolerance – Oxidative stress, salt stress and fruit ripening. Transgenics for : improved quality, longer life, flower color and shapes, for male sterility, for terminator seed. Trangenic plants as bioreactors: production of carbohydrates, lipids, vitamins and minerals, biodegradable plastics, peptides, proteins and edible vaccines. Commercial transgenic crops.

**Text Books:**

1. Introduction to Plant Biotechnology 2nd edition. Chawla, H.S. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi
2. Molecular Biotechnology: Principles and Applications of recombinant DNA. Glick, B. R. and Pasternak J. J. (1998) ASM press, Washington DC.
3. Plant Tissue culture: Theory and Practice. Bhojwani, S.S. and. Razdan M.K (1996) Elsevier Science, Netherlands.

**Reference Books:**

1 Handbook of Plant Biotechnology, Vol. I and II. By Paul Christou and Harry Clee. John Wiley and Sons, Ltd.
2. Improving Plant draught, salt and freezing tolerance by gene transfer of a single stress-inducible transcription factor. (1999) *Nature Biotechnology 17(3):* 287-291. Kasuga, M., Q. Liu, et al.
3. Heterologous expression of *Arabidopsis* phytochrome B in transgenic potato influences photosynthetic performance and tuber development.(1999) *Physiology***120,** (1):73-81. Thiele, A., Herold M., et al.
4. Exploiting the full potential of disease-resistance genes for agricultural use. Curr Opin Biotechnol. 2000 Apr;11(2):120-5. Review Rommens CM, Kishiore GM
8. Directed molecular evolution in plant improvement. Curr Opin Plant Biol. 2001 Apr;4(2):152- 156. Review. Lassner M, Bedbrook J.

**Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus**

| BTE- 306 | Animal Biotechnology (B.Tech. Biotechnology Semester VI ) | | | | | | |
|---|---|---|---|---|---|---|---|
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3.0** | **75** | **25** | **100** | **3 Hrs.** |
| **Purpose** | **To introduce the students with basics of Animal Biotechnology.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO1** | **Basic concepts of animal cell culture.** | | | | | | |
| **CO2** | **To understand the concept of Reproductive Biotechnology.** | | | | | | |
| **CO3** | **To learn the concepts of Molecular biological techniques for rapid diagnosis of genetic diseases.** | | | | | | |
| **CO4** | **To learn the theoretical aspects of Transgenic animals Methodology.** | | | | | | |

## UNIT I

**Introduction and Scope of Animal Biotechnology**. History and scope of animal cell culture; Cell culture media and reagents, culture of cells, tissues and organs, establishment of cell culture, continuous cell lines, suspension cultures, application of animal cell culture for *in vitro* testing of drugs

## UNIT II

**Reproductive Biotechnology:** Artificial insemination, super ovulation, In *Vitro* fertilization and embryo transfer. Cryopreservation of cell lines and animal germplasm (i.e. semen, ovum and embryos). DNA bar coding.

## UNIT III

Molecular biological techniques for rapid diagnosis of genetic diseases and gene therapy. Transfection. Establishment of immortal cell lines, expression of mammalian genes in prokaryotic and eukaryotic systems. Extinction of gene function by antisense RNA and DNA. Brief account of gene silencing.

## UNIT IV

Transgenic animals Methodology: Retroviral vector method, DNA microinjection method and engineered embryonic stem cell method. Cloning by nuclear transfer. Yeast artificial chromosome transgenesis.

**Text Books:**

1. Principles of Gene Manipulations 6th edition. Primrose S.B.; Twyman, R. and Old B. (2002) Blackwell Publishing.
2. Molecular Biotechnology: Principles and Applications of recombinant DNA 2nd Edition. Glick, B. R. and Pasternak J. J. (1998) ASM press, Washington DC.
3. Animal Cell Biotechnology : Spier, R.E. and Griffiths J.B. (1988) Academic press.

**References:**

1. Living resources for Biotechnology, Animal cells. Doyle, A.; Hay, R. and Kirsop, B.E. (1990) Cambridge University Press, Cambridge.
2. Animal Biotechnology. Murray Moo-Young (1989) Pergamon Press, Oxford.
3. Introduction of Aquaculture Landau Matthew (1991) John Wiley & Sons, New York.
4. Lincoln PJ & Thomson J. 1998. *Forensic DNA Profiling Protocols*. Humana Press.
5. Gordon I. 2005. *Reproductive Techniques in Farm Animals*. CABI.
6. Culture of Animal Cells – a manual of basic techniques 4th Edition. Freshney, R. I. (2000) John Wiley & Sons, New York.

**Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus**

| BTE-308 | Food Biotechnology (B.Tech. Biotechnology Semester VI ) | | | | | | |
|---|---|---|---|---|---|---|---|
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3** | **75** | **25** | **100** | **3 Hrs** |
| **Purpose** | **To familiarize the students with various aspects of Food Biotechnology** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO 1** | **Student to learn the method of fermentation and know about fermented foods and fermentation industries.** | | | | | | |
| **CO 2** | **To learn the development of novel food and food ingredients**. | | | | | | |
| **CO 3** | **Able to understand various methods of preservation** | | | | | | |
| **CO 4** | **Student will learn about monitoring of food quality and packaging techniques**. | | | | | | |

## UNIT I

1. **Introduction to human nutrition**; Nutritive values of foods; Basal metabolic rate

2. **Food Fermentation Technology**: Food as substrate for microorganisms: Classification of foods. Scope and development of fermented products, important fermented foods and beverages, Significance of fermentation. Food Fermentation Industries, Methods of waste disposal from various food industries

## UNIT II

3. **Novel Food and Food Ingredients**: Low calorie sweeteners, food supplements, food colorings, probiotics.

4. **Neutraceuticals:** Sources, Types, Significance, role of nutraceuticals in prevention and control of diseases.

## UNIT III

5. **Food Spoilage**: Factors affecting spoilage- Intrinsic and extrinsic factors affecting microbial growth in foods: Intrinsic factors (Nutrient contents, pH, moisture contents/water activity, Antimicrobial substances), Extrinsic factors (relative humidity, temperature, gaseous atmosphere).

6. **Methods of food preservation**- Thermal processing, Cold preservation, Chemical preservatives & food dehydration, Use of Radiations for food preservation. Preservation by fermentation: curing and pickling.

## UNIT IV

7. **Monitoring of food quality** - HACCP.

8. **Packaging of Food:** Need for packaging, Containers for packaging (glass, metal, plastics and aluminium foil). Types of Packaging- Primary, Secondary and Tertiary; Flexible Packaging, Biodegradable Packaging.

**Text Books:**

1. Microbiology 5th Edition. Prescott, L.M.; Harley, J.P. and Klein, D.A.(2003) McGraw Hill, USA

2. Food Microbiology: Fundamentals and Frontier 2nd Eds. Ed. Beuchat, Doyle & Montville. (2001). Blackwell Synergy.

3. Food Microbiology. Frazier, W.C. and Westhoff, D.C. (2010) Tata Mc-Graw Hill, New Delhi.

4. Modern Food Microbiology. Jay, J.M. (1996) CBS Publishers and Distributors, New Delh

5. Foods: Facts and Principles. (2012) N. Shakuntala Manay and M. Shadakshara Swami. New Age International (P) Ltd, Publishers

**Reference Books:**

1 Biotechnology: Food Fermentation Vol. I & II. Eds. Joshi, V.K. & Pandey, A. (1999) Educational Publishers and Distributers, Kerala.

2 Biotechnological Strategies in Agroprocessing. Eds. Marwaha S.S & Arora, J.K. (2003)

3. Ray, Bibek.(1996). Fundamental Food Microbiology .CRC Press.

Food Microbiology 2nd ed, Adam, M. R. and Moss (2003) Panima Pub, New Delhi.

**Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus**.

| BTE-310 | Environmental Biotechnology& Engineering (B.Tech. Biotechnology Semester VI ) | | | | | | |
|---|---|---|---|---|---|---|---|
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3** | **75** | **25** | **100** | **3 Hrs** |
| **Purpose** | **To introduce the students with role of environmental biotechnology in pollution control** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **COI** | **The students will be able to understand the microbiology and biochemistry of waste water treatment** | | | | | | |
| **COII** | **The students will learn different methods for waste water treatment using bioreactors** | | | | | | |
| **COIII** | **The students will understand the concept of bioremediation and its applications** | | | | | | |
| **CO IV** | **Students will know novel and biotechnological methods for waste treatment and pollution control** | | | | | | |

## UNIT – I

1. **Role of Biotechnology in Environment Protection:** Introduction and current status of biotechnology in environment protection, pollution control and waste treatment.
2. **Classification and Characterization of Waste:** Physicochemical characteristics of waste material, Waste Material suitable for biological treatment, Estimation of COD and BOD.

## UNIT II

3. **Biological Treatment of Waste: I**mpact of pollutants on biotreatment, Recommended Effluent treatment methods. Use of packaged microorganisms and genetically engineered organisms.
4. **Treatment of Industrial Effluent: A**erobic biological treatment, anaerobic biological treatment. Pulp and paper mill effluent, dye effluent, distillery effluent etc.
5. **Removal of Pollutants using plants and microbes:** Phytoaccumulation, Phytovolatilization, Phytoabsorbtion, Rhizofilteration**,** role and significance of microbes .

## UNIT III

6. **Bioremediation :** Definition, Types of bioremediation. Bioaugmentation, Biostimulation Applications of bioremediation, Biomarkers, Biosensors.

7. **Biotechnology for Hazardous Waste Management :** Xenobiotic compounds, recalcitrant and hazardous waste, Biodegradation of xenobiotics.

## UNIT IV

8. **Solid Waste Management :** Incineration, Composting, Biogas Plant**.**
9. **Restoration of degraded lands :** Development of stress tolerant plants, use of mycorrhizae and microbes for improving soil fertility. Organic farming and Vermitechnology,
10. **Novel Methods for Pollution Control :** Aiming for biodegradable and ecofriendly products.

**Text Books**


1. 1. Environmental Biotechnology. Jogland, S.N. (1995) Himalaya Publishing House, New Delhi.
2. 2. Environmental Biotechnology: Bhattacharya and Banerjee ( 2007) Oxford University Press.
3. 2. Comprehensive Biotechnology (Vol. 1-4) Young Murray Moo (Ed.) 1985 Elsevier Sciences.


**References Books:**


4. 1. Waste water Engineering Treatment, Disposal and Reuse. Metcalf & Eddy (1991) McGraw Hill.
5. 2. Biochemical Engineering Fundamentals 2nd ed. Bailey, J. E. and Ollis, D. F. (1986) MacGraw Hill. New York


**Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus.**

| HM-902 | Business Intelligence & Entrepreneurship (B.Tech. Biotechnology Semester VI ) | | | | | | |
|---|---|---|---|---|---|---|---|
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3** | **75** | **25** | **100** | **3 Hrs** |
| **Purpose** | **To introduce the students with role of environmental biotechnology in pollution control** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **COI** | **Students will be able to understand who the entrepreneurs are and what competences needed to become an Entrepreneur** | | | | | | |
| **COII** | **Students will be able to understand insights into the management, opportunity search, identification of a Product; market feasibility studies; project finalization etc. required for small business enterprises** | | | | | | |
| **COIII** | **Students can be able to write a report and do oral presentation on the topics such as product identification, business idea, export marketing etc.** | | | | | | |
| **CO IV** | **Students be able to know the different financial and other assistance available for the establishing small industrial units** | | | | | | |

## UNIT -I

**Entrepreneurship :** Concept and Definitions; Entrepreneurship and Economic Development; Classification and Types of Entrepreneurs; Entrepreneurial Competencies; Factor Affecting Entrepreneurial Growth – Economic, Non-Economic Factors; EDP Programmes; Entrepreneurial Training; Traits/Qualities of an Entrepreneurs; Manager Vs. Entrepreneur, Entrepreneurial challenges.

## UNIT -II

**Opportunity / Identification and Product Selection:** Entrepreneurial Opportunity Search &Identification; Criteria to Select a Product; Conducting Feasibility Studies; Sources of business ideas, Marketing Plan : Conducting of Marketing Research, Industry Analysis, Competitor analysis, market segmentation and positioning, building a marketing plan, marketing mix, launching a new product; export marketing, Methods of Project Appraisal, Project Report Preparation; Specimen of Project Report; Project Planning and Scheduling using Networking Techniques of PERT / CPM.

## UNIT -III

**Small Enterprises and Enterprise Launching Formalities :** Definition of Small Scale; Rationale; Objective; Scope; SSI; Registration; NOC from Pollution Board; Machinery and Equipment Selection , Role of SSI in Economic Development of India; major problem faced by SSI,MSMEs – Definition and Significance in Indian Economy; MSME Schemes, Challenges and Difficulties in availing MSME Schemes.

## Unit -IV

**Role of Support Institutions and Management of Small Business :** DIC; SIDO; SIDBI; Small Industries Development Corporation (SIDC); SISI; NSIC; NISBUD; State Financial Corporation SIC; Venture Capital : Concept, venture capital financing schemes offered by various financial institutions in India.

**Special Issues for Entrepreneurs**: Legal issues – Forming business entity, requirements for formation of a Private/Public Limited Company, Entrepreneurship and Intellectual Property Rights: IPR and their importance. (Patent, Copy Right, Trademarks) , Case Studies-At least one in whole course.

**Note:**

• Case studies of Entrepreneurs – successful, failed, turnaround ventures should be discussed in the class.

• Exercises / activities should be conducted on 'generating business ideas' and identifying problems and opportunities.

• Interactive sessions with Entrepreneurs, authorities of financial institutions, Government officials should be organized

**Suggested Readings:**


1. "Entrepreneurship development small business enterprises", Pearson, Poornima M Charantimath,2013.
2. Roy Rajiv, "Entrepreneurship", Oxford University Press, 2011.
3. "Innovation and Entrepreneurship",Harper business- Drucker.F, Peter, 2006.
4. "Entrepreneurship", Tata Mc-graw Hill Publishing Co.ltd new Delhi- Robert D. Hisrich, Mathew J. Manimala, Michael P Peters and Dean A. Shepherd, 8th Edition, 2012
5. Enterpreneurship Development- S.Chand & Co.,Delhi- S.S.Khanka 1999
6. Small-Scale Industries and Entrepreneurship. Himalaya Publishing House, Delhi –Vasant Desai 2003.
7. Entrepreneurship Management -Cynthia, Kaulgud, Aruna, Vikas Publishing House, Delhi, 2003.
8. Entrepreneurship Ideas in Action- L. Greene, Thomson Asia Pvt. Ltd., Singapore, 2004.


**Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus**

| BTE-312 L | Animal Cell Culture Lab (B.Tech. Biotechnology Semester VI ) | | | | | | |
|---|---|---|---|---|---|---|---|
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Minor Test** | **Practical (Major Test)** | **Total** | **Time** |
| **-** | **-** | **3** | **1.5** | **40** | **60** | **100** | **3 Hrs** |
| **Purpose** | **To learn the Practical Aspects of Animal cell Culture lab** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO1** | **Learning of Sterilization Techniques used in Animal cell culture Lab** | | | | | | |
| **CO2** | **Learning of Preparation of reagents and media for cell culture.** | | | | | | |
| **CO3** | **Students will learn Quantification of cells** | | | | | | |
| **CO4** | **Students will learn Cryopreservation of cell primary cultures and cell lines** | | | | | | |

**LIST OF EXPERIMENTS:**

1. Packing and sterilization of glass and plastic wares for cell culture.
2. Preparation of reagents and media for cell culture.
3. Primer culture technique chicken embryo fibroblast.
4. Secondary culture of chicken embryo fibroblast.
5. Quantification of cells by trypan blue exclusion dye.
6. Isolation of lymphocytes and cultivation of lymphocytes
7. Study of effect of toxic chemicals on cultured mammalian cells
8. Study of effect of virus on mammalian cells.
9. Cryopreservation of cell primary cultures and cell lines.

**Text Books:**

1. Culture of Animal Cells – a manual of basic techniques 4th Edition. Freshney, R. I. (2000) John Wiley & Sons, New York.

**References:**

1. Animal Cell Biotechnology. Spier, R. E. and Griffiths, J. B. (1988) Academic Press.
2. Living resources for biotechnology: Animal Cells. Doyle, A.; Hay, R. and Kirsop, B. E. (1990) Cambridge University Press.
4. Portner R. 2007. Animal Cell Biotechnology. Humana Press.

| BTE-314 L | Plant Cell Culture Lab (B.Tech. Biotechnology Semester VI ) | | | | | | |
|---|---|---|---|---|---|---|---|
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Minor Test** | **Practical (Major Test)** | **Total** | **Time** |
| **-** | **-** | **3** | **1.5** | **40** | **60** | **100** | **3 Hrs** |
| **Purpose** | **To learn the Practical Aspects of Plant cell Culture lab** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO1** | **Student will learn basic sterilization and nutrient media preparation technique.** | | | | | | |
| **CO2** | **Student will able to propagate rare and endangered plant species through direct and indirect methods** | | | | | | |
| **CO3** | **To study somaclonal variations and somatic cell embryogenesis** | | | | | | |
| **CO4** | **To study fidelity of in vivo and in vitro grown cell culture and applications.** | | | | | | |

**List of Experiments**

1. Laboratory set up for plant cell tissue culture.
2. Preparation of culture media, Nutrients stock solutions and chelating agents.
3. Handling and sterilization of plant material.
4. Establishment of callus culture using different explants.
5. Inoculation and subculture for mass propagation of callus.
6. Callus development stages for somatic embryogenesis.
7. Direct plant regeneration from axillary nodes and nodal tissues.
8. Seed culture on MS media.
9. Isolation of plant genomic DNA using CTAB method.
10. Agrobacterium mediated gene transfer method for gene transfer.
11. Study of fidelity in direct and indirect method of culture (Somaclonal variations).
12. Application of using Plant cell culture in human scenario.

**References**

1. Plant Tissue Culture- Theory and Practice. Bhojwani ,S.S. and Rajdan ,M.K. (1996).Elsevier, Amsterdam.

| BTE-316 L | Food and Environmental Biotechnology Lab (B.Tech. Biotechnology Semester VI) | | | | | | |
|---|---|---|---|---|---|---|---|
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Minor Test** | **Practical (Major Test)** | **Total** | **Time** |
| **-** | **-** | **3** | **1.5** | **40** | **60** | **100** | **3 Hrs** |
| **Purpose** | **To learn the practical aspects of food and environmental biotechnology** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO1** | **Students will microbiologically analyze different food samples.** | | | | | | |
| **CO2** | **Students will learn to test the quality of water, waste water and milk** | | | | | | |
| **CO3** | **Students will learn the technique of isolation and purification of bacteria from contaminated soil** | | | | | | |
| **CO4** | **Students will explore the vermicomposting plant and learn the technique of vermicomposting and biogas formation** | | | | | | |

**List of LABORATORY EXPERIMENTS**

**(Any 10 experiments will be conducted depending upon the availability of chemicals and instruments)**

**A. Food Biotechnology:**

***1.*** Estimation of proteins in different food samples.
2. Microbiological analysis of food samples.
3. Estimation of viscosity in different liquids .
4 Testing of Milk and Milk Products- Testing the adulterants present in milk.
5. Assay of Vitamin c in juices.
6. Determination of pH and Moisture in food sample
7. Analysis of carbohydrates in various food products

**B. Environmental Biotechnology:**

8. Qualitative analysis of water/waste water:
9. Bacterial analysis of waste water.
10. Determination of hardness, alkalinity, Electrical conductivity, chlorides and pH.
11. Determination of soluble phosphates.
12. Determination of BOD and DO contents.
13. Decolourization of industrially important dyes by microbes.
14. Isolation of resistant Bacteria from soil containing pollutants .
15. Visit to Vermicomposting Plant .

**Text Books:**

**1.** Microbiology- A laboratory manual. 4th edition. Cappuccino J. and Sheeman N. (2000) Addison Wesley, California.
**2.** Environmental Microbiology – A Laboratory Manual Pepper. I.L.; Gerba, C.P. and Brendecke, J.W.(1995) Academic Press, New York.

**Reference Books:**

1. Microbiology. Pelczar Jr., M.J.; Chan, E.C.S. and Krieg, N.R. (1993) Tata McGraw Hill, New Delhi

2. Experiments in Microbiology, Plant Pathology and Biotechnology. 4th Edition. Aneja, K.R.

(2003) w Age International Publishers, New Delhi**.**

3. Manual of Industrial Microbiology and Biotechnology. 2nd Edition. Ed. Arnold L. Demain and Julian E. Davies (1999) ASM Press Washington D.C.

| OEC-BT-302 | Nano Biotechnology (B.Tech. Biotechnology Semester VI ) | | | | | | |
|---|---|---|---|---|---|---|---|
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3.0** | **75** | **25** | **100** | **3 Hrs.** |
| **Purpose** | **To familiarize the students about different aspects of Nano Biotechnology.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO1** | **Students will learn about Nano biotechnology and different characterization techniques** | | | | | | |
| **CO2** | **Students will be able to understand about basics of BioMEMS and different advancements in sensors** | | | | | | |
| **CO3** | **Students will learn about different types of nanomaterials** | | | | | | |
| **CO4** | **Students will have clear idea about different applications of nanotechnology in life science** | | | | | | |

**UNIT-I**

1. **Introduction to Nanotechnology:** Definition of Nano biotechnology, A brief history of the Super small, Bottom-up versus top-down, discussion on nanofabrication, nanolithography, Nano biotechnology, Structure property relations in materials, materials characterization techniques, microelectronic fabrication, scanning tunneling and atomic force microscopy, Biomolecule-surface interactions, DNA microarrays.

**UNIT-II**

2. **BioMEMS**: Introduction and overview, biosignal transduction mechanisms. Electromagnetic transducers: basic sensing mechanisms, basic actuating mechanisms. Case studies in biomagnetic sensors. Mechanical transducers: basic sensing mechanisms, basic actuating mechanisms. Case studies in microfluidic devices. Chemical transducers: basic sensing mechanism, basic actuating mechanism, ultimate limits of fabrication and measurement. Recent developments in BioMEMS.

**UNIT-III**

3. **Nanomaterials:** Buckyballs and buckytubes, fluidics, manufacturing, diagnostics and sensors, nanobiosensors, Fullerenes, Carriers, Dendrimers, nanoparticles, membrane/matrices, nanoshells, quantum dot nanocrystals, nanotubes and hybrid biological/ inorganic devices.

**UNIT-IV**

4. **Applications of nanotechnology in the life science:** Leading applications of nanobiotechnology: drug delivery. Bioavailability, sustained and targeted release, nanorobots. Benefits of nano drug delivery. Drug delivery using nanocrystals, drug discovery using Resonance Light Scattering (RLS) technology, rapid ex-vivo diagnostics, benefits of nano-imaging agents, nanoscale biosensors, nanosensors, nanosensors as diagnostics, nanotherapeutics

**References Books**

1. Unbounding the future by K Eric Drexler, C.Pelerson, G.Pergamit Willaim Marrow and Company, 1993

2. Biological molecules in Nanotechnology By Stephen Lee and Lynn M Savage, 2004

3. Nanotechnology By mark Ratner and Dan Ratner, Prentice Hall, 2005.

| OEC-BT-318 | Introduction to MEMS (B.Tech. Biotechnology Semester VI ) | | | | | | |
|---|---|---|---|---|---|---|---|
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3** | **75** | **25** | **100** | **3 Hrs.** |
| **Purpose** | **To familiarize the students with the Basics of MEMS system.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO1** | **The students will be able to understand the operation of Micro and Nano scale devices** | | | | | | |
| **CO2** | **Able to learn about applications and technologies used to fabricate MEMS.** | | | | | | |
| **CO3** | **Able to analyze the simple devices using relevant mechanical/electrical engineering principles.** | | | | | | |
| **CO4** | **Able to build simple system.** | | | | | | |

## UNIT -I

**Introduction**: micro- and nano-scale size domains; scaling of physical laws; MEMS materials and processes; MEMS devices and applications

## UNIT -II

**Introduction to Submicron Technology**: semiconductor materials; photolithography; doping; thin film growth and deposition; CVD and Ion Implantation, metallization; wet and dry etching; silicon micromachining; metal MEMS processes; submicron optical lithography; electron beam lithography; soft lithography and printing.

## UNIT-III

**MEMS Sensors and Actuators**: mechanics including elasticity, beam bending theory, membranes/plates; micro actuators based on various principles, electrostatic, electromagnetic, piezoelectric and SMA; actuator applications e.g. inkjet, electrical and optical switching; physical sensors e.g. acceleration, strain, flow; chemical sensors.

## UNIT-IV

**Microfluidics:** transport in micro-channels; microfluidic components (filters, mixers, valves, and pumps) Bio-Nano (Materials and processes for BioMEMS, Applications: µTAS, Biochips)

**Reference Books**

Foundations of MEMS, Chang Liu, Prentice Hall (2006)

Fundamentals of Micro fabrication, Marc Madou, CRC (2002)

Introduction to BioMEMS – Albert Folch, CRC (2012)

**Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus**

| OEC-BT-320 | Non-Conventional Energy Resources (B.Tech. Biotechnology Semester VI) | | | | | | |
|---|---|---|---|---|---|---|---|
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | 3 | **75** | **25** | **100** | **3 Hrs** |
| **Purpose** | **To familiarize the students with the Basics of Non –Conventional Energy Resources.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO1** | **The students will be able to explain the classification of NCES** | | | | | | |
| **CO2** | **Able to learn about different aspects of solar energy** | | | | | | |
| **CO3** | **Able to understand the different aspects of wind energy.** | | | | | | |
| **CO4** | **Able to learn about principles of ocean thermal energy conversion** | | | | | | |

## UNIT – I

Statistics on conventional energy sources and supply in developing countries, Definition Concepts of NCES, Limitations of RES, Criteria for assessing the potential of NCES. Classification of NCES – Solar, Wind, Geothermal, Bio-mass, Ocean Energy Sources, comparison of these energy sources.

## UNIT – II

Solar Energy-Energy available form Sun, Solar radiation data, Solar energy conversion into heat, Flat plate and Concentrating collectors, Mathematical analysis of Flat plate collectors and collector efficiency, Principle of Natural and Forced convection, Solar engines-Stirling, Brayton engines, Photovoltaic, p-n junction, solar cells, PV systems, Stand-alone, Grid connected solar power satellite.

## UNIT – III

Wind energy conversion, General formula -Lift and Drag- Basis of wind energy conversion: Effect of density, frequency variances, angle of attack, and wind speed. Windmill rotors Horizontal axis and vertical axis rotors. Determination of torque coefficient, Induction type generators- working principle.

## UNIT – IV

Introduction, wave motion, wave energy and power, wave patterns, devices, the causes of tides, enhancement of tides flow power, tidal range power, world range power sites, problems.

Principles of Ocean Thermal Energy Conversion (OTEC), heat exchangers, pumping requirements, other practical considerations, introduction to geothermal energy, geophysics, dry rock and hot aquifer analysis, harnessing geothermal resources, problems.

**Reference/Text Books:**


1. B.H KHAN, "NON-Conventional Energy Resources, McGraw Hill
2. D.Y. Goswami, F. Kreith and J.F. Kreider, "Principle of Solar Engineering", Taylor and Francis, 2000.
3. Sukhatme S.P., "Solar Energy", Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1994.
4. J.F. Kreider, F. Kreith, "Solar Energy Handbook", McGraw Hill, 1981
5. J.A. Duffie and W.A. Beckman, "Solar Engineering of Thermal Processes", John Wiley, 1991.


**Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus**

| OEC-BT-322 | Introduction to Art and Aesthetics (B.Tech. Biotechnology Semester VI ) | | | | | | |
|---|---|---|---|---|---|---|---|
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **3** | **75** | **25** | **100** | **3 Hrs.** |
| **Purpose** | **To familiarize the students with the Basics of Philosophy of Art and Aesthetics.** | | | | | | |
| **Course Outcomes** | | | | | | | |
| **CO1** | **The students will be able to explain importance of art in human life.** | | | | | | |
| **CO2** | **Able to explain the concept of aesthetics and beauty.** | | | | | | |
| **CO3** | **Able to explain the concept of taste and Kant's theory of taste.** | | | | | | |
| **CO4** | **Able to understand the concept of interpretation of literature.** | | | | | | |

## UNIT-I

**Introduction:** Definition of Art? History and nature of the fine arts and the production of art. Different types of arts. Importance of arts in Human life. The modern system of the Art. Expression of art. Languages of Arts. Key issues in philosophy of art.

## UNIT –II

**Aesthetics**: Definition, nature and historical development of Aesthetics experience, what is beauty? Restoration of Beauty. The concept of Sublime and the experience of nature. Origin of idea of beautiful. Importance of environmental aesthetics.

## UNIT-III

**Taste and aesthetics:** Concept of Taste, relationship between taste and aesthetics, Kant's theory of Taste, Hume's standard of Taste, depiction and nature of representation in pictures and photographs, transparent picture.

## UNIT-IV

**Deception**: Philosophical view, concept of music and emotional expression. Production and interpretation of literature, concept of black aesthetics, relationship between politics and black art. An aesthetics adventure.

**References Books:**

Kristeller, P. O. [1951,78] 'The Modern System of the Arts' selections reprinted in *Aesthetics: A Comprehensive Anthology*. (S. M. Cahn & A. Meskin Eds.). Malden, MA: Blackwell, (2008). pp. 3-15.

Abell, C. (2012) 'Art: What it Is and Why it Matters', *Philosophy and Phenomenological Research*, 85(3), pp. 671–691.

Carrol, N. (2006) 'Aesthetic Experience: A question of Content' in Kieran, M.

*Aesthetics and the Philosophy of Art*. Malden, MA: Blackwell. pp.

Costelloe, T. M. (2013). *The British Aesthetic Tradition: From Shaftesbury to Wittgenstein*. Cambridge: Cambridge University Press.

Guyer, P. (2005). The Origins of Modern Aesthetics: 1711-1735 *Values of Beauty: Historical Essays in Aesthetics* (pp. 3-36). Cambridge: Cambridge University Press.

**Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus**

**BS-141 Biology**

| BT | Biology | | | | | | |
|---|---|---|---|---|---|---|---|
| Lecture | Tutorial | Practical | Credit | Major Test | Minor Test | Total | Time Hrs. |
| 2 | 1 | - | 3 | 75 | 25 | 100 | 3 |
| Purpose | To familiarize the students with the basics of Biology and Biotechnology | | | | | | |
| Course Outcomes | | | | | | | |
| CO1 | Introduction to Living world, Cell & Organisms. | | | | | | |
| CO2 | Introduction to Biomolecules and Biocatalyst | | | | | | |
| CO3 | Introduction of basic Concept of Genetics & immune system | | | | | | |
| CO4 | Introduction of basic Concept of Genetic Engineering, Biochemistry & Role of Biology in Different Fields | | | | | | |

## Unit – I

**Introduction to living world:** Concept and definition of Biology; Importance of biology in major discoveries of life Characteristic features of living organisms; Cell ultra-structure and functions of cell organelles like nucleus and endoplasmic reticulum. Difference between prokaryotic and eukaryotic cell. Difference between animal and plant cell.

**Classification of Organisms**: Classify the organisms on the basis of Cellularity Unicellular and Multicellular organisms. Energy and Carbon Utilization- Autotrophs, Hetrotrophs and Lithotrops. Nitrogen Excretion:- Ammonotelic, Uricotelic and Ureotelic. Habitat- Acquatic & Terrestrial.

## Unit-II

**Introduction to Biomolecules:** Definition, general classification and important functions of carbohydrates, lipids, proteins, nucleic acids & Enzymes.

**Enzymes as Biocatalysts:** General characteristics, nomenclature and classification of Enzymes. Effect of temperature, pH, enzyme and substrate concentrations on the activity of enzymes. Elementary concept of and coenzymes. Mechanism of enzyme action.

## Unit-III

**Genetics:-**Mendel's laws of inheritance. Variation and speciation. Concepts of recessiveness and dominance. Genetic Disorders: Single gene &Multiple genes disorders in human.

**Human Traits**: Genetics of blood groups, Diabetes Type I & II.

**Role of immune system in health and disease**: Brief introduction to morphology and pathogenicity of bacteria, fungi, virus, protozoa beneficial and har mful for human beings.

## Unit-IV

**Concepts of Genetic Engineering:** Definition; Tools used in recombinant DNA Technology: Enzymes, Vectors & Passenger DNA.

**Catabolism:** Glycolysis and Krebs cycle, Photosynthesis:- Light and Dark Reaction. Concept of Exothermic and endothermic reactions

**Role of Biology:** Role of Biology in Agriculture, Medicine, Forensic science, Bioinformatics, Nanotechnology, Bio-MEMS and Biosensors.

**Text Book:**

1. Introduction to Biotechnology, By Deswal & Deswal, Dhanpat Rai Publications N.A
2.Campbell, J. B. Reece, L. Urry, M. L. Cain and S. A. Wasserman, "Biology: A global approach", Pearson Education Ltd, 2014.
3. E. E. Conn, P. K. Stumpf, G. Bruening and R. H. Doi, "Outlines of Biochemistry", John Wiley and Sons, 2009.
D. L. Nelson and M. M. Cox, "Principles of Biochemistry", W.H. Freeman and Company, 2012.
4.G. S. Stent and R. Calendar, "Molecular Genetics", Freeman and company, 1978.

**Note: The paper setter will set the paper as per the question paper templates provided**

**Suggested Books:**

1. Molecular Biology of cell, 4th ed. Alberts, Bruce et al. Garland Science Publishing, New York.
2. Microbiology. Pelczar Jr., M.J.; Chan, E.C.S. and Krieg, N.R. Tata McGraw Hill, New Delhi.
3. Lehninger: Principles of Biochemistry, 3rd edition, by David L. Nelson and M.M. Cox. Maxmillan/ Worth publishers.
4. Genetics by Snusted& Simmons.
5. Molecular Biotechnology: Principles Application of Recombinant DNA. Glick, B. R. and Pasternak, J. J. ASM press
Washington DC.
6. Kuby's Immunology, Goldsby, R A,.Kindt, T.J, Osborne, B.A.(2003) W. H. Freeman and company, New York.
7. Recombinant DNA 2nd Edition. Watson, James D. and Gilman, M. (2001) W.H Freeman and Company, NewYork

**Bachelor of Technology (Biotechnology)**
**Credit-Based**
SCHEME OF STUDIES/EXAMINATIONS
**Semester – VI**

| S. No. | Course No. | Course Title | Teaching Schedule | | | | Credits | Allotment of Marks | | | | Duration of Exam (Hrs.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Hours/ Week | | Major Test | Minor Test | Practical | Total | |
| 1 | OEC-II | | 3 | 0 | 0 | 3 | 3.0 | 75 | 25 | 0 | 100 | 3 |
| 2 | BTE-304 | Plant Biotechnology | 3 | 0 | 0 | 3 | 3.0 | 75 | 25 | 0 | 100 | 3 |
| 3 | BTE-306 | Animal Biotechnology | 3 | 0 | 0 | 3 | 3.0 | 75 | 25 | 0 | 100 | 3 |
| 4 | BTE-308 | Food Biotechnology | 3 | 0 | 0 | 3 | 3.0 | 75 | 25 | 0 | 100 | 3 |
| 5 | BTE-310 | Environmental Biotechnology& Engineering | 3 | 0 | 0 | 3 | 3.0 | 75 | 25 | 0 | 100 | 3 |
| 6 | HM-902 | Business Intelligence & Entrepreneurship | 3 | 0 | 0 | 3 | 3.0 | 75 | 25 | 0 | 100 | 3 |
| 7 | BTE-312 | Animal Cell Culture Lab | 0 | 0 | 3 | 3 | 1.5 | 0 | 40 | 60 | 100 | 3 |
| 8 | BTE-314 | Plant Cell Culture Lab | 0 | 0 | 3 | 3 | 1.5 | 0 | 40 | 60 | 100 | 3 |
| 9 | BTE-316 | Food & Environmental Biotechnology Lab | 0 | 0 | 3 | 3 | 1.5 | 0 | 40 | 60 | 100 | 3 |
| | | **Total** | **18** | **0** | **9** | **27** | **22.5** | **450** | **270** | **180** | **900** | |

**Note:** All the students have to undergo 4-6 weeks industrial training after VI semester and it will be evaluated in VII semester.
The students should select two open Elective Courses (OEC) from the following list.
**The course of both Program Elective and Open Elective will be offered at 1/3rd strength or 20 students (whichever is smaller) of the section.**

| Course No. | OEC-II | | Course No. | OEC-II |
|---|---|---|---|---|
| OEC-BT-302 | Nano Biotechnology | | OEC-BT-322 | Introduction to Arts & Aesthetics |
| OEC-BT-318 | Introduction to MEMS | | MOOC-2 | Anyone MOOC through SWAYAM |
| OEC-BT-320 | Non Conventional Energy Resources | | | |

## SEMESTER- Ⅱ

| S. No. | Course Code | Subject | L | T | P | Total | Minor* Test | Major Test | Practical | Cr. | Duration of Exam (Hrs.) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | MTBT-102 | Drug Discovery and Development | 3 | - | - | 3 | 40 | 60 | | 3 | 3 |
| 2 | MTBT-104 | Medical Biotechnology | 3 | - | - | 3 | 40 | 60 | | 3 | 3 |
| 3 | * | Program Elective-III | 3 | - | - | 3 | 40 | 60 | | 3 | 3 |
| 4 | ** | Program Elective-IV | 3 | - | - | 3 | 40 | 60 | | 3 | 3 |
| 5 | MTBT-118 | Molecular Techniques Lab | | - | 4 | 4 | 40 | | 60 | 2 | 3 |
| 6 | MTBT-120 | Advanced Molecular Techniques. Lab | - | - | 4 | 4 | 40 | | 60 | 2 | 3 |
| 7 | # MTBT-122 | Mini Project | - | - | 4 | 2 | 100 | - | - | 2 | 3 |
| 8 | *** | Audit Course-II | 2 | | | 2 | 100 | | | 0 | 3 |
| | **Total** | | **14** | | **12** | **24** | **340** | **240** | **120** | **18** | **3** |
| | | | | | | | **700** | | | | |

| *Program Elective -III | | **Program Elective -IV | |
|---|---|---|---|
| **Course No.** | **Subject** | **Course No.** | **Subject** |
| MTBT-106 | Metabolic Engineering | MTBT-112 | Biomedical Equipments |
| MTBT-108 | Biofuel Technology | MTBT-114 | Gene Therapy and Gene Editing |
| MTBT-110 | Advanced Industrial Biotechnology | MTBT-116 | Metagenomics |

| *** Audit Course - II | |
|---|---|
| MTAD-102 | Constitution of India |
| MTAD-104 | Pedagogy Studies |
| MTAD-106 | Stress Management by Yoga |
| MTAD-108 | Personality Development through Life Enlightenment Skills. |

#4**. Mini project:** During this course the student will be able to understand the contemporary/emerging technologies for various processes and systems. During the semester, the students are required to search/gather the material/information on a specific topic, comprehend it and present/discuss the same in the class. He/she will be acquainted to share knowledge effectively in oral (seminar) and written form (formulate documents) in the form of report. The student will be evaluated on the basis of viva/ seminar (40 marks) and report (60 marks).

**Note:** 1.The course of program elective will be offered at 1/3rd or 6 numbers of students (whichever is smaller) strength of the class.

2. *** Along with the credit course, a student may normally be permitted to take audit course, however for auditing a course; prior consent of the course coordinator of the course is required. These courses shall not be mentioned for any award/calculation of SGPA/CGPA in the DMC. A certificate of successful completion of the audit course will be issued by the Director/Head of institution.

3. Students be encouraged to go to Industrial Training/Internship for at least 6-8 weeks during the summer break with a specific objective for Dissertation Part–I (MTBT-203). The industrial Training/Internship would be evaluated as the part of the Dissertation Part–I (with the marks distribution as 40 marks for Industrial Training/Internship and 60 marks for Dissertation work).