I SEMESTER

CYTOLOGY AND GENETICS- BTY-131

Total hours -60

Paper objective

In this paper the students are made to learn the structures and purposes of basic components of prokaryotic and eukaryotic cells. Students get an idea about how these cellular components perceive the environmental signal and respond to them in the language of signal transduction. They also learn the cellular components underlying mitotic and meiotic cell division. The genetics chapters make them appreciate the flow of inherited characters form one generation to other. They can in turn apply their knowledge of cell biology and genetics to selected examples of changes or losses in cell function.

CYTOLOGY
Total hours: 30

Unit I **1hr**

Cell as a basic unit of life, Prokaryotic and eukaryotic cell

Unit II **14 hrs**

Cellular Organelles: Endplasmic reticulam, Golgi complex, Mitochondria, Chloroplast, Ribosomes, Lysosomes, Peroxisomes, Nuclear (Nuclear envelope with nuclear pore complex, nucleolus, nucleplasm and chromatin). Vacuole, Crytosol and Cytoskeletal structures (Microtubles, Microfilaments and Intermediate filaments) Extracellular matrix.

Unit III **9 hrs**

Transport across Cell Membranes and Receptors: Structure of Plasmamembrane, Passive & Active transport, permeases, sodium potassium pump, Ca2+ ATPase pumps, lysosomal and vacuolar membrane ATP dependent proton pumps; uniport, symport, antiport, transport into prokaryotic cells(porins); Endocytosis and exocytosis; Receptor-mediated endocytosis; Autocrine, paracrine and endocrine models of action; Cytosolic, nuclear and membrane bound receptors, examples of receptors

Unit IV **7hrs**

Ion Channels and Signal Transduction: Types of Ion-channels; Ligand-gated and Voltage-gated ion channels; Ion channel defects; Actin, myosin, excitation - contraction coupling, relaxation; Second messengers - cAMP, Inositol phosphates, DAG, cGMP, G proteins, Ca; Protein kinases, serine – threonine kinases, TNF receptor families

Unit V **4hrs**

Cell Division and Cell Cycle: Types of cell division (mitosis & meiosis); details of cell cycle, cancer, programmed cell death

GENETICS

Unit VI **4 hrs**

Chromosomes: Discovery, morphology and structural Organization - centromere, secondary construction, telomere, chromonema, euchromatin and heterochromatin, chemical composition. Ultrastructure: Nucleosome model of chromosome. Special types of chromosomes; Salivary gland and Lampbrush chromosomes Karyotype in man.

Unit VII **2 hrs**

Mendelism: Mendel's work, laws of heredity, Test cross, Incomplete dominance and simple problems

Unit VIII **5 hrs**

Interaction of Genes:

Supplementary factors; Comb pattern in fowls

Complementary genes; Flower colour in sweet peas

Multiple factors – Skin colouir in human beings

Epistasis: Plumage colour in poultary

Multiple allelism: Blood groups in human beings

Unit IX **2 hrs**

Sex Determination in Plants and animals: Concepts of allosomes and autosomes, XX-XY, XX-XO,ZW-ZZ, ZO-ZZ types

Unit X **4 hrs**

Linkage and Crossing Over: Coupling and repulsion hypothesis, Linkage in maize and Drosophilea, Mechanism of crossing over and its importance, Chromosome mapping – Linkage map in maize.

Unit XI **6 hrs**

Chromosomal Variations and mutations: A General account of structural and numerical aberrations. Inherited disorders - allosomal (Klinefelter syndrome and Turner's syndrome), Autosomal(Down syndrome and Cri-Du-Chat syndrome) Chromosomal evolution of wheat. Types of mutation: spontaneous and induced, Mutagens: Physical and chemical.

Unit XII **2 hrs**

Cytoplasmic Inheritance

Plastid inheritance in Mirabilis, petite characters in yeast and kappa particles in paramecium.

Reference

1. Alberts Bruce, Johnson Alexander, Lewis Julian .Molecular Biology of the Cell. Routledge (Taylor & Francis).London:2007
2. Karp Gerald. A Cell and Molecular Biology: Concepts and Experiments. JHON WILEY&SONS.USA: 2008
3. Geoffery. M. Copper, Hausman.E.Robert. The Cell: A Molecular Approach, 5Edn. ASM Press.2006
4. Sadava David E.Cell Biology: Organelle Structure And Function. CBS Publishers and Distributors. India: 2009
5. Gupta M L Cell Biology: Fundamentals And Applications Agrobios (india) 2003
6. Russell Peter J,Cecie Paul E Starr, Wolfe Stephen L, Mcmillan Breverly . Cell and Molecular Biology. Brooks/cole California.USA. 2009
7. De Robertis. Cell And Molecular Biology. 8 Edn. Lippincott. North America : 2006
8. Gupta R K. Cell And Molecular Biology. Rastogi Publications.India

9. Gardner. E. J, Simmons. M. J and Snustad. D. P. Principles Of Genetics, 8th edition Wiley India Ltd, Delhi. 2006.
10. Lodish. H, Berk. A, Matsudaira. P, Kaiser. C. A, Krieger. M, Scott. M. P, Zipursky. L and Darnell. J. Molecular Cell Biology, 6th edition. W.H. Freeman & Company. 2007.
11. Hartl Daniel L., Jones Elizabeth W. Genetics: Analysis Of Genes And Genomes. Jones & Bartlett Publishers. USA: 2005

CYTOLOGY AND GENETICS BTY-151

1. Use of Micrometer and calibaration, measurement of onion epidermal cells and yeast	**2 units**
2. Cell division : Mitotic and meiotic studies in grasshopper testes, onion root tips	**4 units**
3. Chromosomes: Mounting of polytene chromosomes	**2 units**
4. Buccal smear – Barr bodies	**1 unit**
5. Karyotype analysis in man– Normal and Abnormal – Down and Turner's syndromes	**2 units**
6. Simple genetic problems	**1 unit**
7. Isolation of chloroplasts	**1 unit**
8. Vital staining of mitochondria	**1 unit**
9. Blood smear – differential staining	**1 unit**

REFERENCE

1. Genetics: Laboratory Investigations- Robert L. Hammersmith, Thomas R. Mertens
2. Redei P.George. Genetics manual: Current theory, concepts, Terms. World scientific Publishing Co. Ltd. 1999

II SEMESTER

MICROBIOLOGY AND BIOSTATISTICS BTY 231

Total hours 60 Hrs

Paper objective

The paper surveys bacteria, viruses, fungi, and protozoa, as well as their growth characteristics and morphology. This course guides the students to learn appropriate microbiology laboratory techniques that will be useful in subsequent courses. This course fulfills the basic knowledge in microbiology for those students who wish to pursue career in allied health fields and other technical programs. Biostatistics portions will introduce the students to clinical research and imparts knowledge on applied statistics. This course will prepare them to critically read and understand the research literature in biology.

MICROBIOLOGY

Total hours: 40

Unit I **4hrs**

Introductory Microbiology: Definition and history of microbiology, contributions of Antony van Leeuwenhoek, Louis Pasteur, Robert Importance and scope of Microbiology as a modern Science .Branches of microbiology. Classification and nomenclature of Microorganisms

Unit II **7hrs**

Microbial Techniques: Microscope – Light, Phase contrast, Fluorescence & Electron: Stains and staining techniques - Gram's, acid fast, capsular, flagellar and endospore staning. Methods of Sterilization; Physical and Chemical control of microorganisms.

Unit III **5hrs**

Structure of bacteria –shape, flagella ,endospore and capsule, structure based on staining reaction (Gram positive and Gram negative bacteria), extreme environment.

Unit IV

General Account of Viruses **4hrs**

Viruses – Structure and classification, Plant Viruses – CaMV, Animal viruses – Hepatitis B Herpes Simplex Virus, Bacteriophages

Unit V **6hrs**

Eukaryotic microorganisms: Salient features, classification and reproduction of fungi, mycoplasma and algae

Unit VI **10hrs**

Physiology and biochemistry of microbes: Nutrition (Photo-autotrophs, Chemo-autotrophs), Parasitism, Saprophytism, Mutualism and Symbiosis, Commensalisms, endozoic microbes) - Respiration: EMP, HMP and ED Pathways, Bacterial photosynthesis: Photosynthetic apparatus in prokaryotes, Photophosphorylation. Nitrogen metabolism(nitrogen fixation)

Unit –VII **4hrs**

Pathogenic Microorganisms

A. Bacterial diseases of man – Tetanus, Tuberculosis, Pneumonia and Cholera

B. Viral diseases: AIDS (HIV)

C. Parasite: Entamoeba and Malaria.

BIOSTATISTICS

Total hours: 20

Unit VIII **3hrs**

Importance and application: Tabulation and classification of data, Frequency distribution and Graphical distribution of data

Unit IX **4hrs**

Measures of central tendencies: Mean, Median, Mode and their properties

Unit X **4hrs**

Measures of Dispersion

Mean deviation, Variance, Standard deviation and coefficient of Variation

Unit XI **3hrs**

Hypothesis testing: Student T and Chi-square test

Unit XII **6hrs**

Probability and Distribution: Concepts and problems on probability. Binomial, Poisson, Normal Distribution and their applications

REFERENCES

1.Johri R.M. Text Book of Microbiology. Sonali Publications India: 2004

2. MartinKO. J. M and Madigan M.T. BROCK'S BIOLOGY.11 Edn. Pearson Prentice Hall.USA: 2006

3. Sharma .K. Manual of microbiology tools and techniques. 2 Edn. Ane books India: 2007.

4. Purohit S .S. A Text Book of Microbiology. Agrobios. India:2006

5. Kamal. Microbiology : A Text Book International Books & Periodicals Supply Service. India: 1995

6. Michael Krieg, Pelczar J.Microbiology Tata Mcgraw Hill 1998

7. Tortota, Funke, Case. An introduction microbiology. 9 Edn. Pearson Education 2008

8. Prescott Lansing, Harley John and Klein Donald. Microbiology. 4 Edn .Mcgraw Hill 1999

9. Daniel.Wayne W. Biostatistics: A Foundation for Analysis in the Health Sciences, 9th Edition Wiley USA 2008

10. Arora PN, Malhan P, Biostatistics. Himalaya publishing house. Mumbai: 2006

MICROBIOLOGY PRACTICALS BTY 251

1. Safety measures in microbiology laboratory	**1unit**
2. Cleaning and sterilization of glass ware	**1 unit**
3. Study of instruments: Compound microscope, Autoclave, Hot air oven, pH meter, Laminar airflow and centrifuge	**1 unit**
4. Staining Techniques: Simple, Negative staining, Gram staining, Endospore staining and fungal staining.	**4 units**
5. Media preparation: Nutrients agar, MRBA and Nutrient broth	**2 units**
6. Isolation of bacteria and fungi from soil, air, and water – dilution and pourplate methods	**2 unit**
7. Estimation of microorganisms – Total Count (Haemocytometer)	**1 unit**
8. Antibiotic sensitivity test	**1 unit**
9. Biochemical tests IMViC test	**1 unit**
10. Study of Rhizobium from root nodules of legumes	**1 Unit**

Reference

1. Laboratory Experiments in Microbiology - by Ted R. Johnson, Christine L. Case-Addison-Wesley (2006)

2. Microbiology: A Laboratory Manual - by James G. Cappuccino, Natalie Sherman- Addison-Wesley (2007)

III SEMESTER
MOLECULAR BIOLOGY - BTY 331
TOTAL HOURS: 60 hours

Paper objective
This module aims to provide students with an indepth understanding of the basic concepts of molecular biology. The structural and functional aspects of basic biomolecules such as DNA, RNA and protein and the mechanisms of DNA replication, transcription, translation and gene regulation will be dealt with. The course facilitates the students to have a strong understanding of the molecular basis of life and the underlying genetic principles

Unit I **3hrs**
Introduction to molecular biology: Molecular basis of life, Experimental Proof for DNA and RNA as genetic material.

Unit II **11 hrs**
Nucleic Acids and Structure of Prokaryotic and Eukaryotic gene: Structure and functions of DNA, Watson and Crick model of DNA, forms for DNA (A,B, C, D and Z DNA), physical, chemical and spectroscopic properties of DNA, topoisomerases and DNA supercoiling, Structure and functions of RNA, Types of RNA – mRNA, tRNA, rRNA, snRNA. Structure and functions of RNA, Ribozymes - significance. Monocistronic and polycistronic genes, C value paradox, genetic code - properties and Wobble hypothesis.

Unit III **8 hrs**
DNA Replication: Prokaryotic DNA replication – Structure and function of DNA Polymerases and other enzymes, initiation, elongation and termination. Eukaryotic DNA replication – Enzymes and proteins involved in replication, initiation, elongation and termination. Telomere replication and its significance. Models of DNA replication: Theta model and Rolling circle model. Inhibitors of DNA replication

Unit IV **8 hrs**
DNA Repair and DNA Recombination in prokaryotes: DNA damage: DNA lesions, oxidative damage, alkylation, UV damage. Repair mechanisms - Mismatch repair, photoreactivation, excision repair, SOS repair. Transformation – Tatum and Lederberg's experiment, Conjugation – F+ and F- strains, Hfr strains. Transduction - Lytic and lysogenic life cycles of bacteriophage, generalized and specialized transduction

Unit V **8 hrs**
Transcription in prokaryotes and Eukaryotes: Mechanism - initiation, elongation and termination, promoters and RNA polymerase, transcription factors, Post transcriptional modifications of eukaryotic mRNA- polyA tailing, splicing, capping.

Unit VI **7 hrs**
Translation: Mechanism of translation in prokaryotes and eukaryotes, post translational modifications of proteins- glycosylation, protein folding.

Unit VII **8 hrs**

Regulation of Gene expression: Regulation of Gene expression in Prokaryotes – Operon concept (lac and trp), Regulation of Gene expression in Eukaryotes - transcriptional activation, galactose metabolism in yeast.

Unit VIII **3 hrs**

Extra nuclear DNA and Insertional elements: Gene organization and expression in mitochondria and choloroplast, functions, significance, role in evolutionary studies. Transposable elements – classes, transposons in bacteria, maize and drosophila, retrotransposons, LINEs and SINEs, transposons and mutations

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References:

1. Glick, B.T and Pastermak J.J. Molecular Biotechnology: Principles and application of recombinant DNA, ASM press, Washington D.C.1998.
2. Howe.C. Gene Cloning and Manipulation, Cambridge University Press, USA.1995.
3. Lewin, B., Genes VIII. Oxford University Press. New York. 2003.
4. Lodish. H, Berk. A, Matsudaira. P, Kaiser. C. A, Krieger. M, Scott. M. P, Zipursky. L and Darnell. J. Molecular Cell Biology, 6th edition. W.H. Freeman & Company. 2007.
5. Turner. P, Mclennan. A, White. R. H and Bates. A.D. Instant Notes in Molecular Biology, 3rd edition. Taylor & Francis Books India Pvt Ltd. 2005.
6. Karp. G. Cell & Molecular Biology, 3rd Edition, John Wiley & Sons Inc.2002
7. Gardner. E. J, Simmons. M. J and Snustad. D. P. Principles Of Genetics, 8th edition Wiley India Ltd, Delhi. 2006.
8. Rastogi. V. B. Fundamentals of Molecular Biology. Ane Books India, New Delhi. 2008.
9. Paul. A. Text book of Cell and Molecular Biology. 2nd edition, Books and Allied Pvt Ltd, Kolkata. 2007.
10. Freifelder. D and Malacinski. G. Essentials of Molecular Biology.3rd edition, Jones & Bartlett Publishers. 1998.

MOLECULAR BIOLOGY PRACTICALS - BTY351

1	Estimation of DNA by DPA method	1 unit
2	Estimation of RNA by Orcinol method	1 unit
3	Osmotic lysis of RBC	1 unit
4	Detergent lysis of RBC	1 unit
5	Separation of plant pigments by Paper chromatography (ascending, descending and circular).	2 units
6	Separation of plant pigments by Thin layer chromatography	1 unit
7	Extraction and estimation of protein from animal source (goat liver/muscle) by salt precipitation & Organic solvent method	2 units
8	Extraction and estimation of protein from plant source (Green gram/Pea) by salt precipitation & Organic Solvent method.	2 units
9	Polyacrylamide Gel Electrophoresis (PAGE)- Instrumentation	1 unit
10	Agarose gel electrophoresis of DNA- Instrumentation	1 unit

References

1. Sambrook *et al*. Molecular Cloning: A Laboratory Manual. 3rd edition. Volumes I, II & III Cold spring Harbor Laboratory Press, New York, USA. 2002.
2. Sadasivam.S and Manickam.A.Biochemical Methods, 2nd Edn, New Age Internatiopnal Publishers Ltd. Delhi. 1996.

IV SEMESTER
GENETIC ENGINEERING- BTY 431
TOTAL HOURS: 60 hours

Paper objective

The aim of this course is to provide an introduction to recombinant DNA technology. It helps the students to understand how the principles of molecular biology have been used to develop techniques in recombinant DNA technology. The objective of the course is to familiarize the student with the basic concepts in genetic engineering - enzymes, cloning vehicles, gene libraries, analysis and expression of the cloned gene in host cell and understand ethical issues and biosafety regulations. It gives emphasis to practical applications of genetic engineering tools in the field of health care. At the end of the course the student will have enough background of recombinant DNA technology essential for taking up projects in the field of Biotechnology.

Unit I **1 hr**

Introduction to Genetic Engineering: Brief history, advantages and disadvantages of Genetically Modified Organisms.

Unit II. **8 hrs**

Tools for genetic engineering: Restriction enzymes – function, classification, restriction modification system. DNA ligases –types and function. DNA modifying enzymes- functions. Gene cloning vectors – Plasmids, bacteriophages, cosmids, phagemids, YACs, and BACs.

Unit III **5 hrs**

Creation of recombinant DNA: *In vitro* construction of recombinant DNA molecules – (pBR 332, pUC 18) Isolation of insert and & vector DNA, creation of r-DNA.

Unit IV **7 hrs**

Transformation of r-DNA: Transformation of recombinant DNA molecules into target host Organisms - Calcium chloride mediated, Electroporation, Biolistic gun, lipofection and microinjection.

Unit V **8 hrs**

Gene Libraries and screening techniques: Selection of recombinant host cells – Immunological screening and colony and plaque hybridization, dot blot hybridization, chromosome walking Construction of genomic and cDNA libraries, selection of vectors.

UnitVI **4 hrs**

Expression of cloned DNA: Protein production by foreign DNA in the host bacteria *E. coli*, cloning in pET vectors, eukaryotic vectors- Baculovirus based vectors, mammalian viral vectors.

Unit VII

Molecular Biology Techniques: **18 hrs**

Electrophoretic techniques – Agarose gel electrophoresis, Polyacrylamide gel electrophoresis (PAGE) - Native PAGE and SDS PAGE – gel casting and running, troubleshooting.

PCR and Site directed mutagenesis: Polymerase chain reaction (PCR) - Basic principle, methodology, types of PCR- Inverse PCR, Hot start PCR, RT PCR, Real time PCR, RAPD, RFLP and AFLP. Mutagenesis – principle, types, applications

Nucleic acid sequencing – Maxam Gilbert method, Sanger's dideoxy method, automated DNA sequencing, applications, DNA Fingerprinting - principle, applications in forensics, paternity testing

Blotting techniques – Southern and Northern blot, probe preparation – radioactive and chemiluminiscent methods, hybridization technique, labeling (Random primer labeling, Nick Translation), washing, autoradiography. Western Blot, hybridization, Sandwich and dot ELISA.

Unit VIII **9 hrs**

Applications of r-DNA techniques, Biosafety issues and environmental significance: Production of recombinant proteins (Insulin), recombinant vaccines (Hepatitis B), hormones (Human growth hormone), Diagnostic kits, Gene therapy – types, applications, ethical issues. Environmental significance of genetically modified microbes, plants and animals, release of GMOs, factors affecting biodiversity, invasiveness, and gene flow, possible influences of transgenic crops on non-target organisms, international treaties/agreements in biosafety, public perception and outreach in biosafety.

References

1. Glick, B.R & Pasternak J.J .Molecular Biotechnology, Principles and Applications of Recombinant DNA, American Society for Microbiology, Washington D.C. 2003.
2. T. A. Brown. Gene Cloning and DNA Analysis: An Introduction, Wiley Blackwell Publishers.2001.
3. Nicholl. D. S. T. An Introduction to Genetic Engineering. Cambridge University Press. 1994.
4. Old. R.W.and Primrose, S.B. 5th Edn. Principles of Gene manipulation: An introduction to genetic engineering, 3rd edition, Black well Scientific Publications.1994.
5. Paul. A. Text book of Cell and Molecular Biology. 2nd edition, Books and Allied Pvt Ltd, Kolkata. 2007.
6. Lewin B. Genes VIII, Oxford University Press, New York. 2003.
7. Christopher H. Gene cloning and Manipulating, Cambridge University Press.1995.
8. Watson .J. D, Baker. T. A, Bell. S. P, Gann. A. N, Levine. M and Losick. R. Molecular biology of the gene**,** 5th edition, Cold Spring Harbor Laboratory Press. 2003.

GENETIC ENGINEERING PRACTICALS -BTY 451

1. Isolation of genomic DNA from bacteria, plant and animal tissue	3 units
2. Isolation of plasmid DNA (*E. coli*) by alkaline lysis method	2 units
3. Restriction digestion of DNA	2 unit
4. Ligation of restricted DNA	2 units
5. Separation of DNA by Agarose Gel Electrophoresis	1unit
6. Separation of proteins by SDS PAGE	1 unit
7. Transformation of pUC vector in to *E.coli*,	2 unit
8. Screening for recombinants	2 units

References

1. Sambrook *et al* . Molecular Cloning Molecular Cloning: A Laboratory Manual. 3rd edition. Volumes I, II, & III Cold spring Harbor Laboratory Press, New York, USA.2002.
2. Naik. G.R. Introduction to Basic Molecular Biology Techniques. Himalaya Publishing House, Mumbai. 2004

V SEMESTER

ANIMAL CELL CULTURE AND PLANT TISSUE CULTURE BTY-532
Total hours: 45 hours

Paper Objective:
The paper explains the concepts of animal cell and plant tissue culturing. It emphasizes on the basic tissue culture techniques and provides hands on experience in different culture methods. The course objective is to "learn by doing". Animal cell culture includes culture methods, characterization, monitoring tools such differentiation strategies. Stem cell technology has been included which describes types of stem cells, applications and ethics.

Animal Cell Culture
Total Hours: 20 hrs

Unit I **4hrs**

ntroduction and Stimulating the Natural Conditions: History and scope of animal cell and tissue culture, advantages and disadvantages of tissue culture, medium (Defined and undefined), Growth factors promoting proliferation of animal cell culture-EGF,FGF,PDGF,TGF,IL, IGF. Substrate, Gas phase

Unit II **5hrs**

Establishment of cell line and Scaling Up: Primary culture, Disaggregation of tissue (physical, chemical methods), secondary cell lines, continuous cell lines, characteristics of cell lines, Maintenance of cell lines, Measurement of cell viability-Evan's blue method, Typhan blue method, Anchorage dependent cell lines- Roux bottle, Roller bottle, Multiple array, anchorage independent cell lines- Stirred bioreactor, airlift bioreactor, immobilized bioreactor

UnitIII **5hrs**

Organ culture and Invitro fertilization: Culture techniques- Plasma Clot, Raft methods, Agargel, Grid method. Tissue engineering-artificial skin, artificial cartilage, Introduction invitro fertilization of farm animals, Induction of superovulation, Preparation and collection of oocytes, Preparation of spermatozoa, Invitro fertilization and development, Embryo transfer & its advantages.

Unit IV **4hrs**

Embryonic stem cell: Definition and importance, Properties of stem cell, Embryonic stem cell culture, stimulation of embrtonic stem cells to differentiate,Therapeutic Adult stem cells, Source, Differentiation, Similarities beteen adult and Embryonic stem cells applications, Bioethics.

Plant tissue culture.
Total hours : 25 hrs

Unit V **4hr**

Introduction and Invitro culture conditions - Totipotency of Plant cells, Terms and Definitions, Historical development of tissue culture.**:** Nutrient media, Growth regulator(Auxin, cytokinis,and gibberellins),Aseptic techniques-Sterilisation & Disinfection, Sterilisation of media, Air sterilization, Explant preparation.

Unit VI **5hrs**

Single Cell and Suspension culture – Techniques; Filter paper raft nurse technique, Bergmann technique, Microchamber technique, applications., Isolation of single cell from Organ(Mechanical method, Enzymatic method),Subculturing of Suspension Cultures,Types of Suspension Culture, Culture medium for Cell suspensions, Synchronisation of Suspension Cultures, Viability of Cultured cells(Reduction of Tetrazolium salts, Fluoresence Diacetate method, Evan's Blue Method.(4 hrs)

Unit VII **8hrs**

Invitro Culture Techniques: Invitro fertilization , Type of Explant, Culture of Ovary and ovule, Factors affecting Invitro pollination, Applications of Invitro fertilization. Organ culture, Anther culture-Technique of Androgenesis, Factors Influencing Anther Culture, Haploids from Isolated Microspore, Application of Haploids in Plant breeding. Embryo Culture-Types of Embryo Culture, Nutritional Requirements, Applications of embyoculture. Endosperm culture\Triploid production- Source material, Nutrient media, Organogenesis, Applications in Plant improvement. Protoplast culture, Isolation of Protoplast, Viability of Protoplast, Culture of Protoplasts Protoplast,Regeneration, Applications.

Unit VIII **8hrs**

Applications of Plant Tissue Culture: Clonal Propagation of Elite species, Micro propagation, Explants for microprpagation, Advantages of micropropagation, Stages, and limitations. Somaclonal variation, Source material and Culture conditions, Molecular basis of variation, Isolation of Variants, Application in Plant Breeding. Disease-Free Plants, Methods of virus Elimination; Heat treatment, Meristem tip culture, Thermotherapy and meristem tip combo method, Other invitro Methods. Virus indexing-Sap Transmission Test, Serology, Somatic Embryogenesis, Somatic embryogenesis in Dicotyledonous Cultures, Somatic Embryogenesis in Monocotyledonous cultures, Selection of Explants, Embryo maturation and plantlet Development, Practical Applications & Artificial seeds.

References

1. Freshney Ian.Culture Of Animal Cells.John Wiley.Ne york:2006
2. Sathyanarayana .B.N.Plant Tissue Culture.I.k.international Pvt Ltd.2007
3. Razdan.M.K.Introduction To Plant Tissue Culture.India Book House Limited.2008
4. Karl-hermann, Neumann,Ashwani Kumar,Jafargholi Imani.Plant Cell And Tissue Culture - A Tool In Biotechnology.Springer.Germany:2009
5. Purohit.S.S.Plant Tissue Culture.Agrobios.India:2005
6. Narayanaswamy.S.Plant Cell And Tissue Culture.Tata Mgraw Hill:1992
7. Butler Michael,Butler Mike.Animal Cell Culture And Technology: The Basics.Bios Scientific Publishers.2004
8. John R.W.Masters.Animal Cell Culture: A Practical Approach.Oxford University Press.USA:2000

Plant tissue culture.
Practical: 15 Units

1.	Plant tissue culture lab designing, sterilization techniques.	1 unit
2.	Preparation of medium-Murashige and skoog medium, Gamborg's medium Nitsch's medium.	2 units
3.	Callus culture.	1 unit
4.	Nodule and Meristerm tip culture.	2 units
5.	Anther culture.	1 unit
6.	Protoplast isolation by enzymatic method.	2 units
7.	Protoplast fusion by chemical method.	1 unit
8.	Preparation of Artificial seeds.	1 unit
9.	Establishment of Callus suspension culture & monitoring the growth by Dry weight method.	2 units
10.	Micro propagation of *Baccopa monerii*	2 units

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References:

1. Giri.C.C.Plant Biotechnology.Practical Manual.I.k.international Pvt Ltd,2007
2. Purohit.S.S.Practical Plant Biotechnology.Agrobios.Indi:,2007
3. Dodds.H.John.Roberts.W.Louis.Experiments In Plant tissue culture.Cambridge University.USA:1995
4. Nagar.santhosh.Dr.Adhav Madhavi.Practical Biotechnology and plant tissue culture. S.chand & Co Ltd.New Delhi:2009

V SEMESTER

IMMUNOLOGY - BTY 531
TOTAL HOURS: 45hrs

Paper objective:
This paper will examine cellular and molecular aspects of the immune system. Topics include: molecular genetics and molecular structure of immunoglobulin, T cell ,B cell development and the MHC antigens; modern vaccines, functions and dysfunctions of the components of the immune system; applications of immunological technologies in modern scientific research and development. These topics will help the students to absorb most of the fundamentals in immunology and this can benefit in understanding the advanced topics of higher education.

Unit I **6hrs**
Immune System: History of Immunology, Innate Immune response and its role in protection, physiological barriers, mechanical barriers, chemical barriers. Adaptive Immune response – naturally acquired and artificially acquired immune response, humoral and cellular component of the Immune response

Unit II **6hrs**
Cells and organs of immune system: Role of different blood cells in immune system, primary lymphoid organs- thymus, bone marrow, secondary lymphoid organs- spleen, lymph node, MALT.

Unit III **7hrs**
B-cell and T-cell development: Activation of B cells and T cells- maturation, proliferation and differentiation, clonal selection, B-cell receptors, T Cell receptor, αβ T cells, γδ T cells, TCR-CD complex, Structure of TCR and its interaction with MHC-I and MHC-II peptide Complex - T cell selection
Autoimmunity.

Unit IV **7hrs**
Antigens and antibodies: Antigenicity and Immunogenicity, epitopes of B Cells and T Cells, Haptens. Elucidation of antibody structure, variable regions, constant regions, Heavy chains light regions, classification of antibodies (IgA, IgG, IgM, IgD IgE). Functions of different antibodies, generation of antibody diversity, Monoclonal antibodies-hybridoma technology

Unit V **6hrs**
Antigen-antibody interaction: Affinity and avidity, precipitation reactions- radial immunodiffusion, double immunodiffusion, Agglutination- heamagglutination, agglutination inhibition, rocket electrophoresis, radioimmunoassay, ELISA- indirect, sandwich, competitive ELISA , immunofluoroscent techniques

Unit VI **4hrs**

Major histocompatibily complex: MHC molecules and organization of their genes, Structure and function of MHC types. Antigen processing, role of MHC in antigen presentation

Unit VII **6hrs**

Hypersensitivity reactions and Complement system: History and Definition of complement proteins, functions of complement system, Classical pathway, Alternate pathway, Mannan binding lectin pathway. Definition of hypersensitivity reactions Coomb's classification of HS reactions- Immediate reactions-Type I, II, III. Delayed HS reactions-type IV.

Unit VIII **3hrs**

Vaccines and Immunization: Passive and Active immunization. Types of Vaccines with examples – Inactivated, Attenuated and sub unit vaccines.

REFERENCES:

1. Ivan Roitt. Essential Immunology. 10th Edn. Blackwell CompanyLtd. USA: 2001
2. Thomas J. Kindt, Barbara A. Osborne, Richard A. Goldsby . Kuby Immunlogy. W.H. Freeman & Company. USA: 2006
3. Davies Huw. Introductory Immunology. 1st Edn. Chapman and Hall. UK: 1997
4. Khan Falim H. The elements of Immunology. Pearson Education. 2009
5. Tizard. Immunology. 4th Edn. Cengage Learning (India Edn). 1995

IMMUNOLOGY PRACTICALS - BTY 551

1. Blood grouping	1 unit
2. Differential Count of WBC	1 unit
3. Widal Test	1 unit
4. VDRL	1 unit
5. Dot Elisa	1unit
6. Octerlouny Double Diffusion	2 units
7. Radial Immuno Diffusion	2 units
8. Rocket Electrophoresis	1 unit
9. Separation of serum from blood & precipitation of Immunoglobulin	2 units
10. Estimation of the precipitated Immunoglobulin by Biuret method	1 unit

References:

1. Frank C. Hay, Olwyn M. R. Westwood, Paul N. Nelson, Leslie Hudson. Practical Immunology. 4th Edn. Blackwell Company Ltd. 2002

2. Talwar Gupta . Hand Book of Practical and Clinical Immunology, 2 Edn. Vol. II. Cbs Publishers. India: 2009

VI SEMESTER

ANIMAL BIOTECHNOLOGY AND PLANT BIOTECHNOLOGY- BTY-632
Total hours: 45 hrs

Paper Objective
The paper describes the concepts of animal and plant biotechnology. The plant biotechnology chapters will examine the scientific and technical advances which underlie the production of genetically modified crops. Topics include: plant genome organization and gene expression, genetic manipulation to confer resistance to herbicides, pests and disease and strategies for engineering stress tolerance and the improvement of crop yield and quality. Animal biotechnology focuses on use of culturing animal cells for the production of sustainable industrial products and inexpensive drugs for medical and veterinary use. It also provides a forum for presenting and discussing current events in the field of biotechnology research.

Animal Biotechnology
Total Hours: 25 hrs

Unit I **5hrs**
Production of secondary metabolites: Expression of Cloned proteins in animal cell, High level production of transgene products in animal cells, Human growth hormone, Human insulin, Factor viii, Interferon, Tissue Plasminogen activator.

Unit II **9hrs**
Vaccines and Therapeutic Agents: Recombinant vaccines, Sub unit vaccines – Hepatitis B, Foot and mouth disease, Herpes simplex virus vaccines their production, DNA vaccines, Advantages and disadvantages RNA vaccine, Production of viral vaccine, Recombinant vaccine against vaccinia virus. Monoclonal antibodies, Creation of hybridoma cells, Production of Monoclonal Antibodies, Large scale production, Human monoclonal antibodies, Genetic engineering strategies for monoclonal antibodies, Human-mouse antibodies, Advantages and limitations of monoclonal antibodies

Unit III **6hrs**
Transgenic Animals: Objective of Gene Transfer, Gene construction, methods-Retroviral Vector method , DNA microinjection method, Engineered embryonic stem cell method, Detection of transgenes, Transgenic mice and their applications, Human mice, Alzheimer's mouse, Onco mouse, Knock out mouse, SCID mouse, Dolly-Transgenic Sheep, Animal bioreactors and their Importance.

Unit IV **4hrs**
Gene therapy: Approaches for gene therapy, Ex vivo gene therapy, In vivo gene therapy, Antisense Therapy, gene therapy for Adenosine deaminase, Hemophilia, Familial hyper Cholesterolemia.

Plant Biotechnology
Total Hours : 20 hours

Unit V **6hrs**

Genetic engineering in plants: Gene construction, vectors for transgenic plants-Plasmid vectors, Plant virus vectors, Transformation Techniques-*Agrobacterium* mediated gene transfer, Direct gene method), Integration of transgene, Selection Markers\Reporter genes**.** Hybridization & Cybridization – Protoplast isolation, Protoplast fusion, Slection of hybrids & Cybrids, Applications.

Unit VI **4hrs**

Suppression of endogenous genes: Antisense gene approach, Co-suppression of genes, Terminator gene technology

Unit VII **6hrs**

Transgenic crops with new traits: Herbicide tolerance, Insect and Disease resistance, Nutrient quality (golden rice), Post harvest quality traits. Plant derived Vaccines, Edible vaccines, Recombinant and subunit vaccines, Status of Plant derived Vaccines.

Unit VIII **4hrs**

secondary metabolites: Introduction, Mass Production of Plant secondary metabolites using Suspension culture,& Immobilised Plantcells, Statergies to improve the production of secondary metabolite, Production of Carotenoids, Capsaiicin, Anthocyanin.

References:

1. Mheta Varun.Applied Biotechnology.Campus Publisher.Colarado: 2008
2. Mheta Varun.Plant Biotechnology.Campus Publisher.Colarad:, 2009
3. Keshavachandran R.,Peter K.V.Plant Biotehnology.University Press. 2008
4. Slater.A.Plant Biotechnology.Oxford University Press. 2007
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7. Chirikijian Jack.G.Biotechnology Theory and Techniques.Cbs Publishers. 2009
8. Ranga M.M.Animal Biotechnology.Agrobios.India:2008
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11. Butler.M.Animal Cell Culture and Technology.Bios Scientific Publishers. 2004

PRACTICAL IS REPLACED BY:

- BTY 652 –Internal project is taken up by student.
- Students have to present the project report.

VI SEMESTER

BIOPROCESS ENGINEERING & ENVIRONMENTAL BIOTECHNOLOGY - BTY 631
TOTAL HOURS: 45 hours

Paper objective

This paper covers important topics in the development, production, recovery, and analysis of products produced by biotechnology. The course traces the path of a biological product from the cell through the production facility, the final processing, and formulation. It discusses the growth characteristics of the organisms used to produce biological compounds, the techniques used in product recovery and purification analysis The course emphasizes the use of Good Laboratory Practices (GLP) in these analyses. The environmental biotechnology portions includes the serious environmental issues of the society and discusses the solutions to these problems using biotechnology

Bioprocess Engineering
Total Hours: 25 hours

Unit I **4hrs**

Bioreactors: Construction, Design & Operation: Definition of a Bioprocess. An over view of bioprocesses with their various components. Bioprocess operation & their global impact. Components of the fermenters & their specifications, types of fermentors- conventional stirred tank reactors, types of impellers, aeration, temperature regulation, pH monitoring, antifoaming agents, airlift fermentors, bubble up fermentors, fluidized bed fermentors, packed bed fermentors, tower reactors, drum reactors, photobioreactors

Unit II **6hrs**

Strain improvement and Media: Need for strain development, Isolation of microbes (isolation from unusual habitats, mutant selection (antibiotic resistance, anti-metabolite selection, auxotrophic selection), Genetic recombination methods in strain improvement. Media for large-scale processes & their optimization: types of media, synthetic and crude substrates, Constituents of media, Design of media, costing of media. Principles of Media Sterilization, Batch & Continuous sterilization techniques

Unit III **6hrs**

Fermentation and Enzyme technology: Solid substrate fermentation, submerged fermentation-batch fermentation, fed-batch fermentation, semi-continuous fermentation, continuous fermentation, microbial growth in relation to substrate in all the above types. Fermentation based on type of product formation- type I, II, III. Fermentation process- inoculum preservation, inoculum build up, pre-fermentation, product fermentation, recovery.

Types of enzyme immobilization- Adsorption, Covalent binding, Entrapment, encapsulation. Properties of immobilized enzymes (K_m, K_s, cycle time half life). Applications of industrial enzymes in leather, textile, baking, detergent industries.

Unit IV **4hrs**

Product Recovery & Down Stream Processing in Fermentation & Bioprocess Technology: Solid-liquid separation (Flocculation, Filtration, Centrifugation), Cell disruption (Physcal, chemical and enzymatic), Extraction, Precipitation, Distillation, Evaporation, Chromatographic separation, Adsorption, Concentration, formulation- Lyophilization, spray drying.

Unit V **5hrs**

Microbial production of products and quality analysis: Classification of metabolic products- Primary, secondary and bioconversion products. Production of alcoholic beverage (Beer), amino acid (glutamic acid), antibiotic (penicillin) single cell protein, single cell oil. Quality Control, Quality assurance, Standard Operating Procedures (SOP) & Good Manufacturing Practices (GMP)

Environmental Biotechnology
Total Hours: 20 hours

Unit VI **5hrs**

Alternate sources of fuels: Conventional fuels and their environmental impact, Modern fuels– Advantages over conventional fuels. Methanogenic bacteria, Biogas, Microbial hydrogen Production, gasohol, biodiesel

Unit VII **10hrs**

Bioremediation and Bioleaching: Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents. Degradation of lignin and cellulose using microbes. Phytoremediation. degradation of pesticides and other toxic chemicals by micro-organisms, degradation of aromatic, chlorinated hydrocarbons and petroleum products. Treatment of municipal waste and Industrial effluents using microbes. Enrichment of ores by microorganisms (Gold, copper, and Uranium)

Unit VIII **5hrs**

Integration of genetic engineering & applied microbiology in Agriculture: Uses of genetically engineered microbes in Agriculture- biofertilizers (rhizobium, mycorrhiza), nif gene cloning, biopesticides BT gene (cry gene) technology

References:

1.Whittaker & Stanbury. Principles of Fermentation Technology . 2nd Edn. Butterworth Heinemann Press. 1998

2. Pauline Doran. Bioprocess Engineering Principles. Academic Press. 1995

3. Zhong, Jian-Jiang. Biomanufacturing. Springer-Verlag Heidelberg. New York: 2004

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5. David A. Mitchell, Nadia Krieger. Solid-state fermentation bioreactors: Fundamentals of design and operation. Springer. Germany: 2006
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BIOPROCESS ENGINEERING & ENVIRONMENTAL BIOTECHNOLOGY -BTY 651

PRACTICALS

1.Growth curve study- Bacteria and yeast	2units
2. Production of primary and secondary metabolite (one organic acid and one antibiotic)	2 units
3. Estimation of the fermentation products by titration method	1 unit
4. Biomass production (*Aspergillus niger* and *Spirulina*)	2 units
5. Production of beverages (wine)	1unit
6. Immobilization of yeast in calcium alginate /Sodium alginate	1 unit
7. Determination of the activity of immobilized yeast cell	1 unit
8. Bacterial examination of water by MPN method	2 units
9. Estimation of BOD	1 unit
10. VAM staining	1 unit
11. Visit to research institute or industry	1 unit

References:

1. Chellapandi. P. Laboratory Manual in Industrial Biotechnology. 2007

2. Harrigan. Industrial Biotechnology: Training Manual. Delmar Pub