



**MAHATMA GANDHI UNIVERSITY  
KOTTAYAM**

**B.Sc. BIOTECHNOLOGY**

**SCHEME AND SYLLABUS  
AND COMPLEMENTARY COURSES OFFERED BY THE  
BIOTECHNOLOGY DEPARTMENTS**

**AS PER THE NEWLY INTRODUCED C.B.C.S PROGRAMME  
2016**

## **Members of B. Sc. Biotechnology Expert Committee**

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**THE ELIGIBILITY CRITERIA FOR ADMISSION TO B.Sc.  
BIOTECHNOLOGY**

**A pass in plus 2 or equivalent - Biology as a subject or vocational higher secondary, Biological, paramedical or agriculture etc. can be fixed as eligibility for admission.**

## Theory

Scheme for B.Sc. (Biotechnology) Programme							
Sem	Course category	Title with course code	Hours per week		Credits	Marks	
			T	P		Internal	External
<b>I</b>	Common 1	English	5	-	4	20	80
	Core1	BT1CRT01 Basic Life Sciences	5	-	4		
	Core 2	BT1CRT02 Elementary Chemistry	5	-	4		
	Compl.-1	Biochemistry-1	2	-	2		
	Compl.-2	Microbiology-1	2	-	2		
Total			19		16		
<b>II</b>	Common 2	English	5	-	4	20	80
	Core 3	BT2CRT03 Cell Biology	4	-	4		
	Core 4	BT2CRT04 Genetics	4	-	4		
	Core 5	BT2CRT05 Evolutionary Biology & Environmental science	2	-	1		
	Compl.-3	Biochemistry-2	2	-	2		
	Compl.-4	Microbiology-2	2		2		
Total			19		17		
<b>III</b>	Core 8	BT3CRT06 Immunology	5	-	4	20	80
	Core 9	BT3CRT07 Biostatistics and Computer application	5	-	4		
	Core 10	BT3CRT08 Advances in Biotechnology	4	-	3		
	Comp.-7	Biochemistry-3	2	-	2		
	Compl.-8	Microbiology-3	2	-	2		
Total			18		15		

## Theory

Sem	Course category	Title with course code	Hours per week		Credits	Marks	
			T	P		Internal	External
IV	Core11	BT4CRT09 Molecular Biology	5	-	4	20	80
	Core12	BT4CRT10 Enzymology	4	-	4		
	Core 13	BT4CRT11 Biophysics and Bioinformatics	4	-	3		
	Compl.9	Biochemistry-4	2	-	2		
	Compl.10	Microbiology-4	2	-	2		
Total			17	-	15		
V	Core 16	BT5CRT12 Recombinant DNA technology	5	-	4	20	80
	Core17	BT5CRT13 Industrial Biotechnology	6	-	4		
	Core 18	BT5CRT14 Animal Biotechnology	6	-	4		
	Core 19	BT5GET01 Generic elective Paper (A/B/C)	3	-	3		
Total			20		15		
VI	Core20	BT6CRT15 Plant Biotechnology	5	-	4	20	80
	Core21	BT6CRT16 Environmental Biotechnology	5	-	4		
	Core22	BT6CBT01 Choice Based Course (A/B/C)	5	-	4		
	Core25	BT6PRP01 Project and viva voce	-	5	4		
Total			15	5	16		

## Practicals

Sem	Course category	Title with course code	Hours per week		Credits	Marks			
			T	P		Internal	External		
<b>I &amp; II</b>	Core 6	BT1CRP01 Basic Biology and Chemistry Practical	-	2	2	20	80		
	Core 7	BT2CRP02 Practical- Cell Biology	-	2	2				
	Compl.-5	Practical Biochemistry-1	-	4	2				
	Compl.-6	Practical Microbiology-1	-	4	2				
Total			-	12	8				
<b>III &amp; IV</b>	Core 14	BT3CRP03 Practical-immunology and Biostatistics	-	3	3				
	Core 15	BT4CRP04 Practical Molecular biology and Enzymology	-	4	3				
	Compl.-11	Practical Biochemistry-2	-	4	2				
	Compl.12	Practical Microbiology-2	-	4	2				
Total			-	15	10				
<b>V &amp; VI</b>	Core 23	BT5CRP05 Practical-Recombinant DNA technology and Industrial Biotechnology	-	5	4				
	Core24	BT6CRP06 Practical Environmental Biotechnology and Plant Biotechnology		5	4				
Total			-	10	8				

### **Generic elective paper**

BT5GET01A- Tissue culture techniques

BT5GET01B - Biotechnology for sustainable development

BT5GET01C - IPR and patents

### **Choice based Course**

BT6CBT01A - Bioinformatics

BT6CBT01B - Nanotechnology

BT6CBT01C - Diseases and Diagnostic Biotechnology

## SEMESTER -I

### Core 1 - BT1CRT01 BASIC LIFE SCIENCES

**Total hours of instruction: 90**

**Hours/ week: 5**

**Credit : 4**

#### **Module 1: 45Hrs**

Nutrition-digestive system, mechanism of digestion-enzymes, absorption -carbohydrate, lipid and proteins, storage and mobilization of food reserves , respiration, respiratory system - mechanism, Hb - structure and function, regulation, lymphatic system, lymph - functions excretion - structure of kidney and nephron, glomerular filtration, urine-normal and abnormal constituents, nervous coordination.

#### **References:**

1. Physiology - Guyton
2. Animal Physiology - M.S.Sebastian
3. Medical Physiology- Mahapatra
4. Foundation course in Biology- Agarwal, Ane books.

#### **Module II: 15 Hrs**

Theories on embryology, spermatogenesis, oogenesis, fertilization, morula blastula, fatemap

#### **References:**

1. A manual of Developmental biology - VijayakumarNair.K and Jeorge .P.V, Acadamia Publication, Javahar Nagar, TVM- 41
2. Developmental Biology- Muller, Springer, Netherlands
3. Chordate embryology, - P.S. Varma and V.K.Agarval, S Chand and Co.& Ltd

#### **Module III: 15 Hrs**

Absorption and transport of water, macro and micro nutrients, transpiration, Photosynthesis, plant movements, photoperiodism, vernalisation

#### **References:**

1. Text Book of Plant Physiology - V Verma
2. Fundamentals of Plant Physiology - V.K.Jain



#### **Module IV: 15Hrs**

Structure of flower, stages of flower development, androecium, gynoecium, micro and megasporogenesis, pollination and fertilization, structure of monocot and dicot embryos, polyembryoni.

#### **References:**

1. Essentials of Modern Biology - R C Sobti and VL Sharma
2. Plant Anatomy, - B. P. Pandey. S. Chand & Company Ltd. New Delhi

### **Core 2 - BT1CRT02 ELEMENTARY CHEMISTRY**

**Total hours of instruction: 90**

**Hours/ week: 5**

**Credit : 4**

#### **Module I: 24 Hrs**

Bohr atom model, Limitations, De broglie Equation, Heisenberg uncertainty principle, Schrodinger equation, Atomic orbitals. Quantum numbers and significance. Lattice energy of ionic compounds, applications, VSEPR theory, Hybridization involving s, p, d orbitals – sp, sp<sup>2</sup>, sp<sup>3</sup>, dsp<sup>2</sup>, sp<sup>3</sup>d, sp<sup>3</sup>d<sup>2</sup>. Molecular orbital theory, Hydrogen bonding in H<sub>2</sub>O, structure of water molecule, organic molecule and biomolecules, intermolecular forces, ion-dipole, dipole-dipole, dipole-induced dipole, induced dipole-induced dipole interactions.

#### **References:**

1. University General Chemistry. - C.N. R. Rao. McMillan Publication.
2. Principles of Physical Chemistry - Puri, Sharma and Pathania

#### **Module II: 22 Hrs**

Mole concept, Determination of mole wt. By gram molecular volume relationship, problems based on mole concept, Solutions, colligative properties, Methods of expressing concentrations, strength, Normality, Molarity and Molality, ppm. Standardization of solutions, pH, buffer systems, dissociation constant, pK value, Preparation of standard solution of acids and bases, problems related to acid base titrations, volumetric experiments - acidimetry, alkalimetry, permanganometry, dichrometry, iodometry.

#### **References:**

1. University General Chemistry. - C.N. R. Rao. McMillan Publication.

2. A Text Book of Physical chemistry - A.S.Negi and S.C. Anand
3. Chemistry, Second edition - Rob Lewis and Wynne Evans. Palgrave foundations

### **Module III: 24 Hrs**

Rates of reactions - various factors influencing rate of reactions - Order and molecularity - zero, first, second and third order reactions. Derivation of integrated rate equations (single reactant only), fractional life time, its relation to initial concentration of reactants for various orders, units of rate constants. Influence of temperature on reaction rates, Arrhenius equation, calculation of Arrhenius parameters, Collision theory of reaction rate.

#### **References:**

1. Principles of Physical Chemistry. - Maron and Pruton 4th Ed. Oxford and IBH Publication
2. University General Chemistry. - C.N. R. Rao. McMillan Publication.
3. Chemistry, Second edition - Rob Lewis and Wynne Evans. Palgrave foundations

### **Module IV: 20 Hrs**

Structure of organic compounds - Conformation and configuration, Rotation about carbon-carbon single bond, conformations of ethane. Isomerism, types, Geometrical isomerism, Optical isomerism: explanation with examples.

#### **References:**

1. Principles of Organic chemistry-I. Finar, ELBS
2. Principles of Organic chemistry- Puri and Sharma

## **SEMESTER 2**

### **Core 3 – BT2CRT03 CELL BIOLOGY**

**Total hours of instruction: 72**

**Hours/ week: 4**

**Credit: 4**

#### **Module I: 8Hrs.**

History and development of cell biology. Universal features of cell. Chemical components of cell. Cell theory. General organization of eukaryotic and prokaryotic cell. Evolution of eukaryotic cell. Plant cell and animal cell.

**References:**

1. The world of the Cell, 6 th Edn., Becker – Klein Smith Hardin
2. Cell and Molecular Biology, Gerald Carp, John Wiley & Sons, Inc
3. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, P S Verma, V K Agarwal.

**Module II: 17 Hrs**

Cell Membrane - Molecular models of cell membrane. Chemical composition, ultra structure - fluid mosaic model, functions - Membrane transport - active, passive, facilitated - symport, antiport. Cell-cell interaction - selectins, integrins, cadherins, cell junction - tight junction, gap junction.

**References:**

1. The world of the Cell, 6 th Edn., Becker – Klein Smith Hardin
2. Cell and Molecular Biology, Gerald Carp, John Wiley & Sons, Inc
3. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, P S Verma, V K Agarwal.

**Module III: 25Hrs.**

Nucleus-structure and function, nuclear membrane, nucleolus, chromatin-euchromatin, heterochromatin, chromosomes - structure of a typical metaphase chromosome - centromere, telomere, chromomere, satellite, nucleosome organization -histones, linker DNA, giant chromosomes, chromosome banding. Structure and functions of cell organelles - ER, Golgi complex, Ribosomes, Mitochondria, Chloroplast, Lysosome, Peroxisome. Cytoskeleton - Microtubules, Microtubular organelles, Microfilaments, Intermediate filaments.

**References:**

1. Cell and Molecular Biology, Gerald Karp, John Wiley & Sons, Inc
2. The Cell - Geoffrey M Cooper
3. Cell Biology - Smith and Wood
4. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, - P. S. Verma, V. K. Agarwal.

**Module IV: 22Hrs.**

Cell cycle - stages, Mitosis, Meiosis, Regulation of cell cycle - MPF, cyclins. Cell death - Necrosis and apoptosis. Cancer cells - characteristics of cancer cells, Cell Signaling - cyclic AMP, G protein, RTK receptors - convergence, divergence and cross talk.

**References:**

1. Principles of genetics- Snustad and A.G. Gardner, John Wiley Publication
2. Cell and Molecular Biology 8<sup>th</sup>Edn. EDP De Robertis and EMF De Robertis, Lippincott Williams and Wilkins publication.
3. Molecular Cell Biology 6<sup>th</sup>Edn. - Lodish, Berk, Kaiser, Krieger, Scott, Bretscher, Pleogh, Matsudaira. W.H Freeman and company Publication.
4. Microbiology, - Prescott, Harley and Kellin Wim C, Brown publishers.
5. Cell and Molecular Biology, - Gerald Karp, John Wiley & Sons, Inc
6. The Cell, - Geoffrey M Cooper
7. Cell Biology, - Smith and Wood
8. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, - P. S. Verma, V. K. Agarwal.
9. The world of the Cell, 6th Edn., Becker – Klein Smith Hardin

**Core 4- BT2CRT04 GENETICS****Total hours of instruction: 72****Hours/ week: 4****Credit: 4****Module I: 15hrs**

The birth of genetics, symbols and terminology, Mendel's experiments, Principle of segregation, Monohybrid cross, Principle of independent assortment, Dihybrid ratio, Dominance, Recessiveness, Codominance, Semidominance, lethal, multiple alleles, ABO blood typing, gene interactions - epistasis, pleiotropy, polygenic inheritance. Testcross, Back cross.

**References:**

1. Principles of genetics- Snustad and A. G. Gardner, John Wiley publications
2. Genetics - Strick Berger
3. Text book of genetics, - Veer Bala Rastogi
4. Genetics, - Daniel L. Hartin and Elizabeth W. John

**Module II: 25hrs**

Linkage, crossing over, sex determination - autosomes and sex chromosomes, chromosomal basis of sex determination (XX-XY, XX-XO, ZZ-ZW types) mechanism sex linked inheritance, sex influenced, sex limited gene expression, dosage compensation, extrachromosomal inheritance - mitochondria and chloroplast, Types of Mutation - Mutagens, Variation in chromosome number - euploidy, aneuploidy, polyploidy, addition,

deletion, transition, transversion, nonsense, missense mutation, Repair - Direct, reversal, base excision and nucleotide excision.

**References:**

1. Principles of genetics - Snustad and A. G. Gardner John Wiley Publications
2. Genetics - Strick Berger
3. Text book of genetics, - Veer Bala Rastogi
4. Genetics, - Daniel L. Hartin and Elizabeth W. John

**Module III: 20 Hrs**

Human genetics - Karyotype study & Pedigree analysis, Chromosomal anomalies and human disorders - autosomal anomalies - Down's syndrome and Edwards syndrome, Sex chromosome anomalies - Klinefelters syndrome, Turners syndrome, Genetic disorders - Sickle cell anaemia and phenyl ketonuria, Genetics of cancer .

**References:**

1. Principles of genetics - Snustad and A. G. Gardner John Wiley Publication
2. Genetics - Strick Berger
3. Genetics - A molecular approach - Peter. J. Russel.
4. Genetics, - Daniel L. Hartin and Elizabeth W. John
5. Human Genetics, - 2<sup>nd</sup> & 3<sup>rd</sup> Edn. S. D. Gangane.
6. Essentials of Human Genetics, - 4<sup>th</sup> Edn. S. M. Bhatnagar, M. L. Kothari and L. A. Mehta.

**Module IV: 12hrs**

Population genetics - genetic variation, allele frequencies, random mating, Hardy Weinberg equilibrium, assortive mating, genetic equilibrium

**References:**

1. Principles of genetics- Snustad and A. G. Gardner, John Wiley Publication
2. Genetics - Strick Berger
3. Text book of genetics - Veer Bala, Rastogi Publications
4. Genetics, - Daniel L. Hartin and Elizabeth W. John
5. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, - P. S. Verma, V.K. Agarwal.
6. Human Genetics, - 2<sup>nd</sup> & 3<sup>rd</sup> Edition S. D. Gangane.
7. Essentials of Human Genetics, - 4<sup>th</sup> Edn. S. M. Bhatnagar, M. L. Kothari and L. A. Mehta.

**Core 5- BT2CRT05 EVOLUTIONARY BIOLOGY AND ENVIRONMENTAL  
SCIENCE**

**Total hours of instruction: 36**

**Hours/ week: 2**

**Credit: 1**

**Module I: 8Hrs.**

History, theories on evolution, prebiotic environment and molecular evolution, origin of life, Relationship among organisms and evidences of evolution

**References:**

1. Ecology, evolution and zoogeography - Andrews and Joy
2. Evolution - Arumugham, Sara's publication

**Module II: 12 Hrs.**

Miller - Urey experiment, Darwinian's theory of evolution, natural selection, speciation, adaptive radiation, role of mutation, modern theories of evolution, micro and macroevolution, human evolution.

**References:**

1. Ecology, evolution and zoogeography - Andrews and Joy
2. Evolution - Arumugham, Sara's publication

**Module III: 10Hrs**

The components of ecosystem - producer, consumer, decomposer, abiotic components. Food chain, food web, energy flow. Biogeochemical cycles - nitrogen cycle, carbon cycle.

**References:**

1. Microbial ecology - Atlas and Bartha
2. Essential Environmental Studies - S. P. Misra, S. N. Pande, Ane Books Pvt.Ltd.
3. Ecology and environment - Sharma P.D

**Module IV: 6Hrs.**

Environmental pollution - air, soil and water pollution with suitable case studies, global warming, green house effect, acid rain, smog, hazards of nuclear fall out.

**References:**

1. Microbial ecology - Atlas and Bartha
2. Essential Environmental Studies - S. P. Misra, S. N. Pande, Ane Books Pvt. Ltd.
3. Ecology and environment - Sharma P.D
4. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, - P. S. Verma, V. K. Agarwal.
5. Ecology, evolution and zoogeography - Andrews and Joy
6. Evolution - Arumugham, Saras Publication

**Core 6 - BT1CRP01 PRACTICAL-BASIC BIOLOGY AND CHEMISTRY****Total hours of instruction: 36****Hours/ week: 2****Credit: 2**

1. Method of expressing concentration of solutions- calculations based on Normality and Molarity
2. Standardization of the concentration of acids/alkali based on volumetric titrations
3. Qualitative analysis of the organic compounds  
Tests for –Hydrocarbons, alcohol, aldehydes, ketones, aniline, amide
4. Cross section of Anther
5. Pollen tube germination
6. Demonstration of various developmental stages of chick embryo

**References:**

1. Practical Chemistry - A. O. Thomas
2. A practical guide to developmental Biology, - Melissa A. Gibbs, Oxford University Press

**Core 7- BT2CRP02 PRACTICAL- CELL BIOLOGY****Total hours of instruction: 36****Hours/ week: 2****Credit: 2**

1. Examination of different kinds of cells - Prokaryotic and eukaryotic cell
2. Blood grouping
3. Cell counting methods:
  - a) Haemocytometer: WBC, RBC

- b) Differential counting using Leishman's stain
- 4. Micrometry:
  - a) Calibration using ocular micrometer
  - b) Finding out average cell size
- 5. Squash Preparation
  - a) Study of mitotic stages
  - b) Measurement of Chromosome length.
- 7. Staining of mitochondria.
- 8. Staining of barr body.
- 9. Problems in mendelian law, linkage, population genetics

**References:**

1. Laboratory investigation in cell and molecular biology. - Allyn Bregman, 1996. John Wiley & Sons.
2. Microbiology Laboratory Manual - Cappuccino, Sherman, Pearson Education
3. A Text book of Practical Physiology - CLGhai, Jaypee Brothers Publishers (P) LTD New Delhi.
4. Medical Laboratory Technology. Procedure Manual for Routine Diagnostic Tests - Volume I, Kanai L Mukherjee; Tata McGraw - Hill publishing Company. Ltd New Delhi

## **SEMESTER – III**

### **Core 8 - BT3CRT06 IMMUNOLOGY**

**Total hours of instruction: 90**

**Hours/ week: 5**

**Credit: 4**

#### **Module I: 30Hrs**

Introduction to immunology. Innate immunity, non specific immunity. Types of immunity. Antigen, antibody. Structure and types of immunoglobulins, distribution and function. Antigen- antibody interactions and complements. Haptens and Adjuvants.

**References:**

1. Immunology - Kannan (2007), MJP Publishers, Chennai.



2. Roitt's Essential Immunology - Peter Delves, Seamus Martin, Dennis Burton, Ivan Roitt.
3. Immunology - Janis Kub, Thomas J. Kindt, Barbara A. Osborne and Richard. A. Goldsty.
4. Textbook of Microbiology, R. Ananthanarayan, C. K. Jayarampaniker.

### **Module II: 30Hrs**

Organs of immune system - primary and secondary. Cells of immunsystem. Immune response. Humeral and cell mediated immunity. MHC structure and function. Autoimmunity and hypersensitivity.

#### **References:**

1. Immunology - Kannan (2007), MJP Publishers, Chennai.
2. Roitt's Essential Immunology - Peter Delves, Seamus Martin, Dennis Burton, Ivan Roitt.
3. Immunology - Janis Kuby, Thomas. J. Kindt, Barbara A. Osborne and Richard A. Goldsty.
4. Textbook of Microbiology - R. Ananthanarayan, C.K. Jayarampaniker.

### **Module III: 15Hrs**

Transplant immunity. Immunology of malignancy. Immunohaematology. Blood groups and blood grouping. A, B, Rh antigens and antibodies, Rh typing. Bombay group

#### **References:**

1. Immunology - Kannan (2007), MJP Publishers, Chennai.
2. Roitt's Essential Immunology - Peter Delves, Seamus Martin, Dennis Burton, Ivan Roitt.
3. Immunology - Janis Kuby, Thomas. J. Kindt, Barbara A. Osborne and Richard A. Goldsty.
4. Textbook of Microbiology - R. Ananthanarayan, C. K. Jayarampaniker.

### **Module IV: 15Hrs**

Immunization. Vaccines, types and applications. Polyclonal antibodies and monoclonal antibodies.

#### **References:**

1. Immunology - Kannan (2007), MJP Publishers, Chennai.
2. Roitt's Essential Immunology - Peter Delves, Seamus Martin, Dennis Burton, Ivan Roitt.
3. Immunology - Janis Kuby, Thomas. J. Kindt, Barbara A. Osborne and Richard A. Goldsty.
4. Textbook of Microbiology - R. Ananthanarayan, C.K. Jayarampaniker.

## **Core 9- BT3CRT07 BIOSTATISTICS AND COMPUTER APPLICATION**

**Total hours of instruction: 90**

**Hours/ week: 5**

**Credit: 4**

### **Module I: 25Hrs**

Nature, application and limitation of statistics in life science. Data collection: Primary and secondary. Sampling Classification, tabulation and representation of data. Analysis of data, Measures of central tendency. Measures of dispersion. Measures of asymmetry. Correlation and regression.

#### **References:**

1. Research Methodology - Methods and techniques. - C. R Kothari
2. Fundamentals of Biostatistics. - Veer Bala Rastogi
3. Biostatistics - A foundation for analysis in the Health Sciences. - Wayne W Daniel

### **Module II: 30Hrs**

Probability theory and distribution. Binomial, Poisson and Normal. Testing of hypothesis, t-test, Chi-square test, F-test. Non parametric tests. Analysis of variance -ANOVA. Concept of ANOVA, Basic principles, ANOVA technique.

#### **References:**

1. Research Methodology- Methods and techniques. - C. R Kothari
2. Fundamentals of Biostatistics. - Veer Bala Rastogi
3. Biostatistics - A foundation for analysis in the Health Sciences. - Wayne W Daniel

### **Module III: 15Hrs**

Introduction to Computers. Low level and high level languages. Binary number system. Flow chart and programming techniques. Introduction to data structures and database concepts. Introduction to Internet and its applications.

#### **References:**

1. Computer programming. - Rajaraman V. Prentice Hall India Publication.
2. The programmer's Book of Rules. - Ladin BRC and Ledin V. Lifetime learning Publishers

#### **Module IV: 20Hrs**

Introduction to MS office software, Word processing, spread sheet and software. Computer oriented statistical techniques. Frequency table of single discrete variable Bubble sort, Computation of mean variance and Standard deviation.

#### **References:**

1. Research Methodology - Methods and techniques. - C.R Kothari
2. Fundamentals of Biostatistics. - Veer Bala Rastogi
3. Biostatistics - a foundation for analysis in the Health Sciences. - Wayne W Daniel
4. Bioinformatics. - Daniel W Mount.
5. Computer programming. - Rajaraman V. Prentice hall India Publication.
6. The programmer's Book of Rules. - Ladin BRC and Ledin V. Lifetime learning Publishers

### **Core 10- BT3CRT08 ADVANCES IN BIOTECHNOLOGY**

**Total hours of instruction: 72**

**Hours/ week: 4**

**Credit: 3**

#### **Module I: 9Hrs**

Biotechnology - Definition, Biotechnology in prehistoric times, scope, advantages, multidisciplinary nature, trends, scope of research, milestones in the development of Biotechnology, Biotechnology in India and its global trends, Major Biotechnology institutes and companies in India.

#### **References:**

1. Biotechnology - B. D Singh, Kalyan Publishers, New Delhi
2. A Text Book of Biotechnology - R. C Dubey, S Chand and Company Pub:
3. Biotechnology - U. Sathyanarayana, Books and Allied Pvt. Ltd. Kolkata.

#### **Module II: 13Hrs**

Light microscopy, Electron microscopy - SEM, TEM. Fluorescent microscopy. Fixation and staining. Cytochemical methods, Cell fractionation, Immunocytochemistry.

#### **References:**

1. Prescott/Harley/Klein's Microbiology - Joanne Willey, Linda Sherwood and Chris Woolverton.
2. Biotechnology - B. D. Singh Kalyan Publishers, New Delhi

3. A Text Book of Biotechnology - R. C Dubey, S Chand and Company Publishers.
4. Cell and Molecular Biology. 8th Edition. - EDP De Robertis and EMF De Robertis, Lippincott Williams and Wilkins Publication
5. Biotechnology - U. Sathyanarayana, Books and Allied Pvt. Ltd. Kolkata.

### **Module III: 30Hrs**

Good Laboratory Practices (GLP), Quality control in manufacturing, Good Manufacturing practices (GMP), Marketing of Biotechnological products, Impact of Biotechnology on society, Biotechnology and IPR.

#### **References:**

1. A Text Book of Biotechnology - R. C Dubey, S Chand and Company Publishers.
2. Biotechnology - U. Sathyanarayana, Books and Allied Pvt. Ltd. Kolkata.
3. Biotechnology and Ethics: A blueprint for the future, - Daniel Callahan President, Hastings Center, Center for Biotechnology, North Western University.
4. Biotechnology: Issues, Ethics and Regulation, - Tina M. Prow, Communication Specialist, Office of Agricultural Communication and Education

### **Module IV: 20Hrs**

Introduction to nanoworld, Classification of materials, application of nano crystals, DNA chip, nanobiosensors - DNA sensors, Quantum dots, applications of Nanobiotechnology in medicine and health.

#### **References:**

1. Nanobiotechnology : Concepts, Applications and Perspectives - C M Neimeyer and C. A. Mairkin, Wiley, US.
2. Biomaterial Science. An introduction to materials. - Ratner BD, Hoffman AS, Schoen FJ and Lemons JE. Elsevier, 2004.
3. Nanotechnology in Catalysis. Volume 3, - David J. Lockwood. Springer science, 2007
4. Introduction to Nanotechnology - John Wiley and Sons, 2008.
5. Nanomaterials - Synthesis, properties and applications. - A.S. Eddstein R.C. Cammarate. Institute of physics U.K, 1998
6. A Text Book of Biotechnology - R.C. Dubey, S Chand and Company Publishers.
7. Biotechnology - U. Sathyanarayana, Books and Allied Pvt. Ltd. Kolkata.
8. Biotechnology and Ethics: A blueprint for the future, - Daniel Callahan President, Hastings Center, Center for Biotechnology, North Western University.
9. Biotechnology: Issues, Ethics and Regulation, - Tina M. Prow, Communication Specialist, Office of Agricultural Communication and Education
10. Prescott/Harley/Klein's Microbiology - Joanne Willey, Linda Sherwood and Chris Woolverton.
11. Biotechnology - B.D. Singh Kalyan Publishers, New Delhi

12. Cell and Molecular Biology. 8th Edition. - EDP De Robertis and EMF De Robertis, Lippincott Williams and Wilkins publication

## **SEMESTER IV**

### **Core 11: BT4CRT09 MOLECULAR BIOLOGY**

**Total hours of instruction: 90**

**Hours/ week: 5**

**Credit: 4**

#### **Module I: 25Hrs**

History of significant discoveries in Molecular Biology, Experiments demonstrating DNA as the genetic material, RNA as genetic material, Structure of DNA and RNA, Physico - chemical properties of DNA, Organization of DNA in viral, prokaryotes and eukaryotic chromosome Cytoplasmic genome - chloroplast and Mitochondrial DNA

#### **References:**

1. Introduction to Molecular Biology - P. Paoletta; Mc. Graw Hill, New York
2. Fundamentals of Biochemistry, - J.L. Jain, Sanjay Jain, Nitin Jain, S. Chand Publishers
3. Genetics. A Molecular approach. 2<sup>nd</sup>Edn. - Peter J. Russel.
4. Principles of genetics - Snustad and A.G. Gardner, John Wiley publishers.

#### **Module II: 30Hrs**

Genes - Concept of gene, Gene structure, split genes, Structure of prokaryotic gene - operon - organization of operon. Eukaryotic genes -structure, reading frame and regulatory elements - promoters and enhancers, micro satellites, C-value paradox.

#### **References:**

1. Genetics. A Molecular approach. 2<sup>nd</sup>Edn. - Peter J Russel.
2. Principles of genetics - Snustad and A.G. Gardner, John Wiley publishers.
3. Molecular Cell Biology. 6<sup>th</sup> Edn. - Lodish. Pearson publication.

#### **Module III: 15Hrs**

DNA replication - Meselson and Stall experiment, Replication in prokaryotes and eukaryotes, Structure and function of enzymes involved in DNA replication. Transcription in prokaryotes and eukaryotes - initiation, elongation and termination, Transcription products, Types of

RNA - mRNA, rRNA, tRNA and sn RNA. Genetic code, properties of genetic code, start codon and termination codon. Wobble Hypothesis. Translation - translation of prokaryotic and eukaryotic mRNA - initiation, elongation and termination.

**References:**

1. Genetics. A Molecular approach. 2<sup>nd</sup> Edn. - Peter J Russel.
2. Principles of genetics - Snustad and A.G. Gardner, John Wiley publishers.

**Module IV: 20Hrs**

Regulation of Gene expression - Regulatory protein, promoters, activators, repressors, operon concept, positive and negative regulation, Molecular details of Lac and Trp operon, Transposable elements - IS elements, composite and non composite transposones, SINES and LINES.

**References:**

1. Molecular Biology of the gene - Watson, Baker, Ganu, Bell, Levene, Losiek (Pearson Publication)
2. Genetics. A Molecular approach. 2<sup>nd</sup>Edn. - Peter J Russel.
3. Principles of genetics - Snustad and A.G. Gardner, John Wiley publishers.
4. Principles of Genetics, - A.G. Gardner, John Wiley and Sons Publishers.

**Core12- BT4CRT10 ENZYMOLOGY**

**Total hours of instruction: 90**

**Hours/ week: 4**

**Credit: 4**

**Module I: 10 Hrs**

Enzyme nomenclature and classification. Isolation of enzymes. Extraction of soluble and membrane bound enzymes. Purification of enzymes, precipitation, dialysis, chromatography and electrophoresis, criteria for enzyme purity.

**References:**

1. Enzymes - Biochemistry, Biotechnology and Clinical chemistry - Trever Palmer, Horwood Publishers
2. Biochemistry - Donald Voet and Judith G Voet

## **Module II: 30 Hrs**

Structure and properties of enzymes, active site, specificity, specific activity, Enzyme unit, mechanism of enzyme action. coenzymes and their action, Factors affecting enzyme activity, Kinetics of enzyme substrate reactions, Michaelis - Menton equation, Lineweaver - Burk plot

### **References:**

1. Biochemistry - Donald Voet and Judith G Voet
2. Enzyme technology - M.F. Cplin and C. Burke. Cambridge University Press.

## **Module III: 30 Hrs**

Inhibition of enzymes, inhibitors, types of inhibition, Mechanism of inhibition -competitive, uncompetitive and noncompetitive and allosteric inhibition, regulation of enzyme activity.

### **References:**

1. Biochemistry - Donald Voet and Judith G Voet
2. Enzyme technology - M.F. Cplin and C. Burke. Cambridge University Press

## **Module IV: 20 Hrs**

Clinical and industrial application of enzymes, immobilization of enzymes, Biosensors, synthetic enzymes, ribozymes, abzymes, enzyme engineering

### **References:**

1. Enzymes - Biochemistry, Biotechnology and Clinical chemistry - Trevor Palmer, Horwood Publishers
2. Biochemistry - Donald Voet and Judith G Voet
3. Enzyme technology - M.F. Cplin and C. Burke. Cambridge University Press
4. Immobilization of enzymes and cells - A Rosevear, IOP publishing
5. Industrial enzymes and their application - Helmut

## **Core 13 - BT4CRT11 BIOPHYSICS AND BIOINFORMATICS**

**Total hours of instruction: 72**

**Hours/ week: 4**

**Credit: 3**

## **Module I: 30 Hrs**

Laws of thermodynamics, Role of water in living organisms, Enthalpy, entropy, free energy Basic principles and biological significance of Osmosis, diffusion, adsorption, surface

tension, colloids, radioactivity. GM counter, scintillation counter, spectroscopy - UV, visible, IR.

**References:**

1. Biophysics - Vasantha Pattabhi, N. Gautham. Kluwer Aca. Pub: Narosa Pub. House.
2. Text book of Biophysics - R.N. Roy, New central Book Agency Pvt. Ltd.
3. Biophysical Chemistry- Upadhyay.

**Module II: 15 Hrs**

Stabilizing forces in macromolecules, Protein conformation - primary, secondary, tertiary and quaternary structure, folding - chaperones, DNA conformation and Polymorphism.

**References:**

1. Biochemistry - Donald Voet & Judith G Voet: John Wiley Sons, Inc.
2. Principles of Biochemistry- Leninger

**Module III: 15 Hrs**

Introduction to Bioinformatics, Definition, history, important Biological databases and their Sequence format: NCBI, GEN BANK, EMBL, SWISSPROT, PDB, Drug bank.

**References:**

1. Bioinformatics: Sequence and Genome analysis - David W Mount, Cold Spring Harbor Lab
2. Algorithms in Bioinformatics - Benson, Ane Books

**Module IV: 12 Hrs**

Tools for global and local alignment studies, FASTA, BLAST, CLUSTAL, MUSCLE  
Applications of bioinformatics: phylogenetic analysis, homology modeling, structure prediction.

**References:**

1. Bioinformatics - sequence and genome analysis, David W Mount, Cold Spring Harbor Laboratory.
2. Biophysics - Vasantha pattabhi, N. Gautham. Kluwer Aca. Pub: Narosa Pub. House.
3. Text book of Biophysics - R.N. Roy, New central Book Agency Pvt. Ltd.
4. Biophysical Chemistry - Upadhyay.
5. Biochemistry - Donald Voet and Judith G Voet: John Wiley Sons, Inc.



6. Principles of Biochemistry – Leninger.
7. Algorithms in Bioinformatics - Benson, Ane Books

### **Core 14- BT3CRP03 Practical – Immunology and Biostatistics**

**Total hours of instruction: 52**

**Hours/ week: 3**

**Credit: 3**

1. Slide agglutination test
2. Bacterial agglutination test
3. Haemagglutination test
4. Precipitation in tube - Capillary test
5. Precipitation in gel - Immunodiffusion (Demonstration only)
6. Immunoelectrophoresis (Demonstration only)
7. Blood grouping by slide agglutination method
8. Problems in Biostatistics.
  - a. Measures of Central tendency
  - b. Chi-square test

#### **References:**

1. Diagnostic Microbiology. - Bailey and Scott, S.
2. Practical Medical Microbiology - Mackie and Mc Cartney.
3. Hand book of experimental Immunology - D.M. Weir.
4. Genetics - Strickberger.
5. Principles of Genetics - Snustad and A.G. Gardner.
6. Fundamentals of Biostatistics - Veer Bala Rastogi.

### **Core – 15 BT4CRP04 - PRACTICAL MOLECULAR BIOLOGY AND ENZYMOLOGY**

**Total Hours: 72**

**Hours / Week-4**

**Credit: 3**

1. Estimation of enzyme activity - amylase assay
2. Estimation of clinically important enzymes - SGPT, SGOT
3. Factors affecting enzyme activity
  - effect of p H on enzyme activity

- effect of temperature on enzyme activity
- effect of metal ion on enzyme activity
- effect of inhibitors on enzyme activity

4. Immobilization of enzymes

5. DNA Isolation

6. Separation of DNA by Agarose gel electrophoresis (Demonstration only)

**References:**

1. Molecular gene cloning - Sambrook and Maniatis, Cold Spring Harbour Laboratory.
2. Practical Biochemistry - David Plummer
3. Practical Skills in Biomolecular sciences - Rob Reed, Dand Holmes, Janathan Weyers, Allan Janes, Long man England.

## **SEMESTER V**

### **Core 16- BT5CRT12 RECOMBINANT DNA TECHNOLOGY**

**Total hours of instruction: 90**

**Hours/ week: 5**

**Credit: 4**

**Module I: 20Hrs**

Introduction to genetic engineering. Steps of genetic engineering. Enzymes in genetic engineering - Restriction endonucleases, DNA ligases, Adapters, Linkers, alkaline phosphatase, polynucleotide kinase, Terminal transferase, S1 nuclease, RNAase H, DNA polI, Klenow fragment, Taq polymerase, Reverse transcriptase.

**References:**

1. Gene Cloning and DNA analysis. - T A Brown. Blackwell Publication.
2. Biotechnology - Fundamentals and applications. - S.S. Purohit and S.K. Mathur. Agrobotanica publications.

**Module II: 25Hrs**

Gene cloning vectors. Plasmid vectors - features, pUC and pBR322. Bactereophage vectors - Lambda, M13. Cosmids. Vectors for animal and plant cell. Shuttle vectors. YAC. BAC.

**References:**

1. Gene Cloning and DNA analysis. - T A Brown. Blackwell Publication.
2. Biotechnology - Fundamentals and applications. - S.S. Purohit and S.K. Mathur. Agrobotanica publications.

### **Module III: 25Hrs**

Gene transfer methods - CaCl<sub>2</sub> mediated, Electroporation, Microinjection, Lipofection. Particle Bombardment, Agrobacterium mediated gene transfer. Shotgun and cDNA cloning. Genomic library. Selection of recombinants, Colony hybridization, Marker genes, reporter genes, Insertional inactivation, Blue-white screening and Blotting techniques, Southern, Northern and Western.

#### **References:**

1. Recombinant DNA-Genes and Genomes. - James D Watson, Any A candy, Richard M.M, Jan A Witkowski. W.H. Freeman and Company Publication.
2. Biotechnology - Fundamentals and applications. S.S. Purohit and S.K Mathur, Agrobotanica publications.
3. Gene Cloning and DNA analysis. - T.A. Brown. Blackwell Publication.

### **Module IV: 20Hrs**

DNA sequencing. Chromosome walking. Application of genetic engineering - Human genome project. Recombinant insulin. Transgenic plants - Herbicide and pest resistance. BT cotton. Molecular pharming. Gene therapy.

#### **References:**

1. Principles of Gene manipulation and Genomics. - S.B. Primrose and R.M. Twyman. Blackwell Publication
2. Biotechnology - Fundamentals and applications. - S.S. Purohit and S.K. Mathur. Agrobotanica publications.
3. Gene Cloning and DNA analysis. - T.A. Brown. Blackwell Publication.
4. Recombinant DNA - Genes and Genomes. - James D. Watson, Any A candy, Richard M.M, Jan A Witkowski. W.H. Freeman and Company Publication.

## **Core 17 - BT5CRT13 INDUSTRIAL BIOTECHNOLOGY**

**Total hours of instruction: 108**

**Hours/ week: 6**

**Credit: 4**

### **Module I: 25Hrs**

Advantages of bioprocess over chemical process, Fermentation - definition, types -submerged and solid state, applications of fermentation. Industrially important microbial metabolites. Isolation, screening of industrially important microorganisms, primary and secondary screening. Methods of screening. Identification of the s elected organism. Methods of strain improvement - Mutation, Protoplast fusion and Genetic Engineering.

#### **References:**

1. Principles of Fermentation technology - Stanbury et al. Wiley publishers

## 2. Industrial Microbiology - Prescott

### **Module II: 20Hrs**

Medium designing in fermentation, Defined and undefined medium, carbon and Nitrogen sources. Precursors, inducers, inhibitors and antifoam agents. Effect of pH, temperature and salt concentration in fermentation. Optimization of the process of fermentation.

#### **References:**

1. Principles of Fermentation technology - Stanbury et al. Wiley publishers
2. Industrial Microbiology - Cassida

### **Module III: 15Hrs**

Bioreactor, typical bioreactor, Criteria for the designing of a bioreactor, parts of a bioreactor, Instrumentation of the bioreactor, types of bioreactors – Airlift fermenters, CSTR, Deep bed, Cyclone column, and Tower reactors, Mode of culturing microorganisms - Batch, continuous, fed batch culture systems. Methods of downstream processing - centrifugation, filtration and chromatographic techniques.

#### **References:**

1. Biotechnology: The biological Principles. - Trevan et al., Tata McGraw Hill Edn.

### **Module IV: 48Hrs**

Fermentative production of enzymes - amylase, protease, antibiotics - Penicillin, organic acids – glutamic acid, citric acid, amino acids, alcohol, Immobilization of microbial cells.

#### **References:**

1. Principles of Fermentation technology - Stanbury et al. Wiley publishers
2. Industrial Microbiology by Cassida
3. Industrial Microbiology by Prescott
4. General Microbiology volume 2 - Powar and Dhaginawala
5. Biotechnology: The biological Principles. Trevan et al., Tata McGraw Hill Edn.
6. Biotechnology - An introduction by Susan R Barnum, Thomsun.
7. Biotechnology: fundamentals and Applications - Purohith and Mathur, Agrobotanical Publishers, India.

## **Core 18 - BT5CRT14 ANIMAL BIOTECHNOLOGY**

**Total hours of instruction: 108    Hours/ week: 6    Credit: 4**

### **Module I: 20Hrs**

History of animal cell culture. Basic requirements of animal cell culture. Culture media - natural, synthetic and serum containing media. Role of hormones. Preparation and sterilization of media. Importance of growth factors of the serum.

**References:**

1. Animal cell culture (IIIrd edition) A practical approach. - John R.W. Masters
2. Animal Biotechnology. - R. Sasidhara.
3. Animal biotechnology - Raja - Florence Periera. Dominant publishers New Delhi. 2006.
4. In vitro cultivation of animal cells. - Open University - Netherlands. New Delhi, Butter Worth - Heinemann, 1994.

**Module II: 38Hrs**

Primary cell cultures - Anchorage dependent and anchorage independent cells secondary cell cultures - Transformed animal cells, Established/continuous cell lines. Characteristics of cells in culture. Maintenance of cell lines, commonly used animal cell lines-their origin and characteristics.

**References:**

1. Animal cell culture (IIIrd edition) A practical approach. - John R.W. Masters
2. Animal Biotechnology. - R. Sasidhara.
3. Animal biotechnology – Raja, Florence Periera. Dominant publishers New Delhi. 2006.
4. In vitro cultivation of animal cells. - Open University, Netherlands. New Delhi, Butter Worth - Heinemann, 1994.

**Module III: 25Hrs**

Cell differentiation. Stem cells. Organ culture or 3D culture. Large scale culture of cell lines - monolayer culture, suspension culture and immobilized culture. Bioreactors for large scale culture of cells. Insect and virus cell culture.

**References:**

1. Animal cell culture (IIIrd edition) A practical approach. - John R.W. Masters
2. Animal Biotechnology. - R. Sasidhara.
3. Animal biotechnology – Raja, Florence Periera. Dominant publishers New Delhi. 2006.
4. In vitro cultivation of animal cells. - Open University, Netherlands. New Delhi, Butter Worth - Heinemann, 1994.
5. Insect Cell Cultures: Fundamental and Applied Aspects. - Edited by Just M. Vlak, Cornelis D. de Gooijer, Johannes Tramper, Herbert G. Miltenburger. Kluwer Academic Publishers, New York.

**Module IV: 25Hrs**

Application of animal cell culture - Production of monoclonal antibody, Production of vaccines. Production of specific metabolites. Transgenic animals - Transgenic Mice, fish and cow. Knock-out and Knock-in Technology. Animal cell culture for medical and cancer research

**References:**

1. Animal cell culture (IIIrd edition) A practical approach. - John R.W. Masters
2. Animal Biotechnology. - R. Sasidhara.

3. Animal biotechnology – Raja, Florence Periera. Dominant publishers New Delhi. 2006.
4. In vitro cultivation of animal cells. - Open University, Netherlands. New Delhi, Butter Worth - Heinemann, 1994.
5. Insect Cell Cultures: Fundamental and Applied Aspects. - Edited by Just M. Vlak, Cornelis D. de Gooijer, Johannes Tramper, Herbert G. Miltenburger. Kluwer Academic Publishers, New York.

## **BT5GET01- Generic elective Paper -I (A/B/C)**

### **BT5GET01A -TISSUE CULTURE TECHNIQUES**

**Total hours of instruction: 90**

**Hours/ week: 4**

**Credit: 3**

#### **Module I: 10Hrs**

Construction, Design and basic requirements of both plant cell culture and animal cell culture laboratory

1. Animal cell culture (IIIrd edition) A Practical approach - John R.W. Masters.
2. Animal Biotechnology - R. Sasidhara
3. Plant tissue culture Theory and Practice - S.S Bhojwani and M.K. Razdan., Elsevier
4. Plant tissue culture - S.P. Misra.
5. Plant cell and tissue culture. - S. Narayanaswamy

#### **Module II: 35Hrs**

Plant cell culture medium - Media preparation and methods of sterilization and standardization. Surface sterilization of explants. Factors affecting plant cell culture. Callus culture

#### **References:**

1. Plant tissue culture Theory and Practice - S.S Bhojwani and M.K. Razdan., Elsevier
2. Plant tissue culture - S.P. Misra.
3. Plant cell and tissue culture. - S. Narayanaswamy

#### **Module III: 30 Hrs**

Animal cell culture medium - Media preparation and methods of sterilization. Surface sterilization of primary explants. Factors affecting animal cell culture

#### **References:**

1. Animal cell culture: A Practical approach - John R.W. Masters.
2. Animal Biotechnology - R. Sasidhara.

3. Animal biotechnology - Raja - Florence Periera. Dominant publishers, New Delhi. 2006
4. In vitro cultivation of animal cells. - Open University, Netherlands. New Delhi, Butter Worth - Heinemann, 1994.

#### **Module IV: 15 Hrs**

Animal cloning, Medical, industrial and agricultural applications of animal cell and plant cell culture.

#### **References:**

1. Animal cell culture: A Practical Approach - John R.W. Masters.
2. Animal Biotechnology - R. Sasidhara.
3. Animal biotechnology – Raja, Florence Periera. Dominant publishers New Delhi, 2006.
4. In vitro cultivation of animal cells - Open University, Netherlands. New Delhi, Butter Worth - Heinemann, 1994
5. Plant tissue culture Theory and Practice - S.S Bhojwani and M.K. Razdan., Elsevier
6. Plant tissue culture - S.P. Misra.
7. Plant biotechnology - Ignacimuthu, Oxford and IBH pub.

### **BT5GET01B - BIOTECHNOLOGY FOR SUSTAINABLE DEVELOPMENT**

**Total hours of instruction: 90**

**Hours/ week: 5**

**Credit: 4**

#### **Module I: 20Hrs**

Natural raw materials, classification, physicochemical and biological analysis, exploitation of the natural waste materials through biotechnology, preparation of nutritive and cost effective substrates for industrial application.

#### **References:**

1. Advanced Environmental biotechnology - S.K. Agarwal
2. Biotechnology: fundamentals and Applications - Purohith and Mathur, Agrobotanical Publishers, India.

#### **Module II: 20Hrs**

Chemical fertilizers - disadvantages. Biofertilizers- advantages, types. Nitrogen fixing organisms, Azospirillum, Azolla, Rhizobium, Lichens, Cyanobacterium. Mycorrhiza

#### **References:**

1. Biotechnology: fundamentals and Applications - Purohith and Mathur, Agrobotanical Publishers, India.
2. Environmental biotechnology - R.A Sharma
3. Text Book of Biotechnology - R.C. Dubey

### **Module III: 25 Hrs**

Solid waste management - Composting, types, different stages in composting, types of composting - pile, windrow composting, microorganisms in composting, temperature profile in composting, advantages of composting, vermicomposting.

#### **References:**

1. Waste water Microbiology - Gabriel Bittan
2. Text Book of Biotechnology - R.C. Dubey
3. Essentials of Biotechnology - R.C. Sobi and Suparna S. Pachauri. Ane Books

### **Module IV: 25 Hrs**

Biopesticides, biofilters, biopolymers, biofuels, biosurfactants, mushroom cultivation, biotechnology in aqua culture - development of probiotics, diagnostic probes, extraction of marine natural products through biotechnology.

#### **References**

1. Advanced Environmental biotechnology - S.K. Agarwal
2. Biotechnology - An introduction by Susan R Barnum, Thomsun Publishers.
3. Biotechnology: fundamentals and Applications - Purohith and Mathur, Agrobotanical Publishers, India.
4. Waste water Microbiology - Gabriel Bittan
5. Applied Zoology - Zoological Society of India
6. Environmental biotechnology - R.A Sharma
7. Text Book of Biotechnology - R.C. Dubey
8. Essentials of Biotechnology - R.C.Sobi & Suparna S. Pachauri. Ane Books

## **BT5GET01C -IPR AND PATENTS**

**Total hours of instruction: 90**

**Hours/ week: 5**

**Credit: 4**

### **Module I: 10 Hrs**

General guidelines for DNA research, containment facilities and biosafety practices, special guidelines in India.

#### **References:**

1. Biotechnology: An introduction - Susan R. Barnum, Thomas Books\Code publishers, U.K.
2. Industrial Microbiology - Cassida, Iviely Eastern Publishers.
3. Modern concept of Biotechnology - H.D. Kumar, Vikas Publishing house Pvt. LTD.
4. Microbial Biotechnology - Principles and application, Lee Yuan Kun, World Scientific publishers.



## **Module II: 30 Hrs**

Forms of IPR like patent, design and copyright: Patents: different types of intellectual property, patent, Introduction to patent law and conditions for patentability; Procedure for obtaining patents; Rights of a patentee; Patent infringements; Biotechnology patents and patents on computer programs; Patents from an international perspective.

### **References:**

1. Biotechnology: An introduction - Susan R. Barnum, Thomas Books\Code publishers, U.K.
2. Industrial Microbiology - Cassida, Iviely Eastern Publishers.
3. Modern concept of Biotechnology - H.D. Kumar, Vikas Publishing house Pvt. LTD.
4. Microbial Biotechnology - Principles and application, Lee Yuan Kun, World Scientific publishers.

## **Module III: 20 Hrs**

Copyright: Registration procedure and copyright authorities; Assignment and transfer of copyright, Copyright infringement and exceptions to infringement; Software copyright.

### **References:**

1. Biotechnology - An introduction, Susan R. Barnum, Thomas Books\Code publishers, U.K.
2. Industrial Microbiology - Cassida, Iviely Eastern Publishers.
3. Modern concept of Biotechnology - H.D. Kumar, Vikas Publishing house Pvt. LTD.
4. Microbial Biotechnology: Principles and application - Lee Yuan Kun, World Scientific publishers.

## **Module IV: 30 Hrs**

IPR laws: Rights/protection, infringement or violation, remedies against infringement: civil and criminal; Indian Patent Act 1970 and TRIPS; Major changes in Indian Patent system as post TRIPS effects; Contents of patent specification and the procedure for patents; (a) Obtaining patents; (b) Geographical indication; (c) WTO; Detailed information on patenting biological products; Plant breeders' and farmer's rights; Biodiversity; Budapest treaty; Appropriate case studies.

### **References:**

1. Biotechnology: An introduction - Susan R. Barnum, Thomas Books\Code publishers, U.K.
2. Industrial Microbiology - Cassida, Iviely Eastern Publishers.
3. Modern concept of Biotechnology - H.D. Kumar, Vikas Publishing house Pvt. LTD.
4. Microbial Biotechnology: Principles and application - Lee Yuan Kun, World Scientific publishers.

## SEMESTER VI

### Core 20 BT6CRT15 PLANT BIOTECHNOLOGY

**Total hours of instruction: 90**

**Hours/ week: 5**

**Credit: 4**

#### **Module I: 20Hrs**

Plant tissue culture- a historical approach. Basic requirements and setting up of a plant tissue culture lab, Tissue culture media. Media preparation. Role of growth hormones. Totipotency and cyto-differentiation, Various stages of micropropagation

#### **References:**

1. Plant tissue culture Theory and Practice - S.S Bhojwani and M.K. Razdan., Elsevier
2. Plant Breeding - B.D. Singh.
4. Plant cell and tissue culture - S. Narayanaswamy

#### **Module II: 30 Hrs**

Types of culture-Callus culture, Suspension culture and single cell culture. Somaclonal variation. Organogenesis and Embryogenesis. Artificial seeds, Meristem culture. Haploid production-ovary, ovule, anther and pollen culture.

#### **References:**

1. Plant tissue culture Theory and Practice - S.S Bhojwani and M.K. Razdan., Elsevier
2. Plant tissue culture - S.P. Misra.
3. Plant Breeding - B.D. Singh.
4. Plant cell and tissue culture - S. Narayanaswamy

#### **Module III: 20 Hrs**

Plant protoplast –isolation, culture and somatic hybridization. Cybrids and hybrids. Applications of protoplast culture.

#### **References:**

1. Plant tissue culture Theory and Practice - S.S Bhojwani and M.K. Razdan., Elsevier
2. Plant tissue culture - S.P. Misra.
3. Plant Breeding - B.D. Singh.
4. Plant cell and tissue culture - S. Narayanaswamy

#### **Module IV: 20 Hrs**

Uses of plant cell culture. Gene transfer techniques in plants, Role of *Agrobacterium* in gene transfer. Maintenance and storage of plant cell. Germplasm conservation and gene bank.

#### **References:**

1. Plant tissue culture Theory and Practice - S.S Bhojwani and M.K. Razdan., Elsevier

2. Plant tissue culture - S.P. Misra.
3. Plant Breeding - B.D. Singh.
4. Plant cell and tissue culture - S. Narayanaswamy
5. Plant biotechnology - Ignacimuthu, Oxford and IBH pub.

## **CORE 21- BT6CRT16- ENVIRONMENTAL BIOTECHNOLOGY**

**Total hours of instruction: 90**

**Hours/ week: 5**

**Credit: 4**

### **Module I: 20Hrs**

Environmental pollution- Heavy metal pollution, industrial pollution, ozone layer depletion, depletion of natural resources, Pesticide pollution, Environmental laws.

#### **References:**

1. Environmental Chemistry - Anil Kumar. De Wiley Eastern Ltd. New Delhi
2. Environmental Science: Earth as living planet - Daniel B Bottein and Edward. A. Keller, John Wiley Sons.

### **Module II: 10Hrs**

Characteristics of waste water –COD, BOD, TOC, Suspended solids, Total dissolved solids, chlorides, acidity, alkalinity. Bacteriological analysis of drinking water, presumptive, completed and confirmed tests, Coagulation, Disinfection by chlorination, Food adulteration.

#### **Reference:**

1. Microbial ecology: Fundamentals and Applications - Atlas and Bartha, Pearson Education

### **Module III: 30Hrs**

Treatment of waste water, primary, secondary and tertiary treatment. Biological treatment of waste water- aerobic methods, floc and film based processes Activated sludge process, Trickling filter process, Aerobic pond. Anaerobic process- Methanogenesis, Single and double stage reactors. Solid waste management- anaerobic treatment and land filling.

#### **Reference:**

1. Microbial Ecology: Fundamentals and Applications - Atlas and Bartha, Pearson Education

### **Module IV: 30Hrs**

Biodegradation of organic compounds. Types of reactions in biodegradation, enzymes involved in biodegradation, Biodegradation of hydrocarbons, cellulose and lignin. Molecular biology of biodegradation, catabolic plasmids.

**References:**

1. Biocatalysts and biodegradation - Lawrence P Wackett and Douglas Hersherberger. ASM Press, Washington
2. Environmental Chemistry - Anil Kumar. De Wiley Eastern Ltd. New Delhi
3. Microbial ecology: Fundamentals and Applications - Atlas and Bartha, Pearson Education
4. Biotechnology: The Science and Business - V. Mopses and R.E. Capes

**Core 22- BT6CBT01- CHOICE BASED COURSE (A/B/C)****BT6CBT01A -BIOINFORMATICS****Total hours of instruction: 90****Hours/ week: 5****Credit: 4****Module I: 15 Hrs**

Introduction to bioinformatics- definition, history, significance and applications, careers in bioinformatics , genomics, transcriptomics, proteomics

**References:**

1. Beginning Perl for Bioinformatics - James D. Tisdall; Paperback.
2. Bioinformatics: Sequence and Genome Analysis - David W Mount.
3. Bioinformatics and Molecular Evaluation - Paul G Higgs and Teresa K. Attwood, Blackwell Publishers

**Module II: 30 Hrs**

Collection and storage of database, Submission of sequences, biological databases , NCBI, EMBL, DDBJ, Genbank, PDB, Swissprot, Sequence formats- FASTA/Pearson and EMBL, Genpept, Phylip formats.

**References:**

1. Beginning Perl for Bioinformatics - James D. Tisdall; Paperback.
2. Bioinformatics: Sequence and Genome Analysis - David W Mount.
3. Bioinformatics and Molecular Evaluation - Paul G Higgs and Teresa K. Attwood, Blackwell Publishers
4. Algorithms in Bioinformatics - Benson; Anne books

**Module III: 30 Hrs**

Alignment of pairs and sequences: definition of sequence alignment- global alignment, local alignment, alignment of sequence pairs- dot matrix analysis, FASTA and BLAST, multiple sequence alignment CLUSTALW

**References:**

1. Beginning Perl for Bioinformatics - James D. Tisdall; Paperback.
2. Bioinformatics :Sequence and Genome Analysis - David W Mount.

3. Bioinformatics and Molecular Evaluation - Paul G Higgs and Teresa K. Attwood, Blackwell Publishers
4. Algorithms in Bioinformatics – Benson, Anne books

#### **Module IV: 15 Hrs**

Computational biology, Rasmol, phylogenetic analysis, homology modeling, Protein function-structure prediction.

#### **References:**

1. Beginning Perl for Bioinformatics - James D. Tisdall; Paperback.
2. Bioinformatics: Sequence and Genome Analysis - David W Mount.
3. Bioinformatics and Molecular Evaluation - Paul G Higgs and Teresa K. Attwood, Blackwell Publishers
4. Algorithms in Bioinformatics – Benson, Anne books
5. Developing Bioinformatics Computer Skills - Cynthia Gibas, Per Jambeck.

### **SEMESTER VI**

#### **CHOICE BASED COURSES**

#### **BT6CBT01B NANOTECHNOLOGY**

**Total hours of instruction: 90**

**Hours/ week: 5**

**Credit: 4**

#### **Module I: 20Hrs**

Nanotechnology-definition, advantages, applications, material science, nanomedicine, emerging trends, scope, research potential, Nanotechnology in India.

#### **References:**

1. An Introduction to materials - B.D. Ratner, A.S. Hoffman, F.J. Schoen and J.E. Lemons. Biomaterial Science. Elsevier 2004.
2. Nanomaterials and nanochemistry - C. Brechignas, P. Hoody and M. Lemani. Springer-Verlag. 2007.
3. Nanotechnology in Catalysis - David J. Lockwood. Volume 3, Springer Science, 2007.
4. Nanomaterials: Synthesis, Properties and applications. - A.S. Eddstein and R.C. Cammarate. Institute of Physics, U.K. 1998.
5. Introduction to Nanotechnology - John Wiley and Sons 2008.

#### **Module II: 30Hrs**

Nanomaterials, types, examples, nanoemulsions, poly amino acid micelles, dendrimers, albumin designing of nanomaterials, selection of nanomaterials, physicochemical and biological properties, interaction of the drug with nanomaterials

#### **References:**

1. An Introduction to materials - B.D. Ratner, A.S. Hoffman, F.J. Schoen and J.E. Lemons. Biomaterial Science, Elsevier 2004.

2. Nanomaterials and nanochemistry - C. Brechignas, P. Hoody and M. Lemani. Springer-Verlag. 2007.
3. Nanotechnology in Catalysis - David J. Lockwood. Volume 3, Springer Science, 2007.
4. Nanomaterials: Synthesis, Properties and applications. - A.S. Eddstein and R.C. Cammarate. Institute of Physics U.K. 1998.
5. Introduction to Nanotechnology - John Wiley and sons 2008.

### **Module III: 20Hrs**

Drug delivery- principle, receptor mediated endocytosis, delivering systems, method of targeting, labeling of the carrier, mechanism and site of drug action, Blood brain barrier

#### **References:**

1. An Introduction to materials - B.D. Ratner, A.S. Hoffman, F.J. Schoen and J.E. Lemons. Biomaterial Science. Elsevier 2004.
2. Nanomaterials and nanochemistry - C. Brechignas, P. Hoody and M. Lemani. Springer-Verlag. 2007.
3. Nanotechnology in Catalysis - David J. Lockwood. Volume 3, Springer Science, 2007.
4. Nanomaterials: Synthesis, Properties and applications - A.S. Eddstein and R.C. Cammarate. Institute of Physics, U.K. 1998.
5. Introduction to Nanotechnology - John Wiley and sons 2008.

### **Module IV: 20Hrs**

Targeted diseases, cancer, respiratory disorders, cardiovascular problems, diabetics, AIDS. Enhanced permeability and retention effect, applications of short interfering RNA

#### **References:**

1. An Introduction to materials - B.D. Ratner, A.S. Hoffman, F.J. Schoen and J.E. Lemons. Biomaterial Science. Elsevier 2004.
2. Nanomaterials and Nanochemistry - C. Brechignas, P. Hoody and M. Lemani. Springer-Verlag. 2007.
3. Nanotechnology in Catalysis - David J. Lockwood. Volume 3, Springer Science, 2007.
4. Nanomaterials: Synthesis, Properties and applications. - A.S. Eddstein and R.C. Cammarate. Institute of Physics, U.K. 1998.
5. Introduction to Nanotechnology - John Wiley & sons 2008.
6. Microfabrication and Nano manufacturing - Jackson MJ, Taylor and Francis, Boca Raton, 2006.
7. Peptide - derivatized biodegradable nanoparticles able to cross the blood brain barrier. - Costantino L, Gandolfi F, Tosi G, Rivasi F, Vandelli MA, Forni F (2005). J Control Release 1981: 84-96.
8. Michaelis K, Hoffmann MM, Dries S, Herbert E, Alyautdin RN, Michaelis M, Kreuter J, Langer K (2006). Covalent linkage of lipoproteins to albumin nanoparticles strongly enhances drug transport into the brain. J Pharmacol Exp Ther 3: 1246-1253
9. Zhang D, Tan T, Gao L, Zhao W, Wang. P. (2007). Preparation of azithromycin nanosuspensions by high pressure homogenization and its physicochemical characteristic studies. Drug Dev Ind Pharm 33: 569-575.
10. Nanoscience and Nanotechnology - V.S. Muralidharan and A. Subramania. Anne Book Pvt. Ltd, New Delhi.

**SEMESTER VI**  
**CHOICE BASED COURSES**

**BT6CBT01C -DISEASES AND DIAGNOSTIC BIOTECHNOLOGY**

**Total hours of instruction: 90**

**Hours/ week: 5**

**Credit: 4**

**Module I: 20Hrs**

Molecular genetics of Genetic Disorders – Chromosomal disorders – autosomal, sex chromosomal. Hemoglobinopathies - Sickle cell anemia, Beta Thalassemia. Muscular disorders - Duchenne's Muscular dystrophy. Triplet disorders - Fragile X syndrome, Huntington's disease, Myotonic dystrophy. Genetic disorders-cystic fibrosis, Alzheimer's disease.

**References:**

1. Genes in Medicine Molecular biology and human genetic disorders - Rasko, I., Downes, C.S. Springer Publication.
2. Genes and Disease - Bethesda. NCBI. [www.ncbi.nlm.nih.gov/books](http://www.ncbi.nlm.nih.gov/books)
3. Essential Medical Genetics - 5th Edition. Michael Connor, M. Ferguson Smith. Wiley Publication.

**Module II: 20Hrs**

DNA diagnostics of genetic and Chromosomal disorders. Identifying disease genes-position independent strategies, positional cloning. PCR based diagnostics. Ligation chain reaction. Southern blot diagnostics. Array based genetic profiling, Single nucleotide polymorphism. Karyotyping analysis, G-banding, FISH. Comparative genomic hybridization (CGH).

**References:**

1. Forensic DNA typing - 2nd Edn - John M Butler. Academic Press
2. Human Molecular Genetics 2 –Tom Strachen and Andrew P Read. Garland Publishers

**Module III: 20Hrs**

DNA typing- Specimen collection, acquisition processing and analysis. Paternity, Ancestry-Mitochondrial, Forensic Science-Standard STR testing, Y-STR testing, Mitochondrial sequencing, SNP testing.

**References:**

1. Genetics: A Molecular approach - 2<sup>nd</sup> Edn - Peter J Russel.

2. Molecular diagnostics for the clinical laboratarian - William B Coleman and Gregory J Tsongalis, Humana Press Publishers.

#### **Module IV: 30Hrs**

Cancer diagnostics - Spectral karyotyping, Tumor markers, Molecular testing of BRCA1 and BRCA. Viral disease diagnostics-HIV, Avian Flu, Chikungunya, Swine fever-RT-PCR, ELISA, F-Ab testing, Immunoarrays.

#### **References:**

1. Cancer Diagnostics with DNA microarrays - Steen Knudsen. Wiley Publication
2. Current Medical diagnostics and treatment - Stephen J McPhee and Maxine A Papadakis. McGraw Hill Lange Publishers
3. Emerging infectious diseases - Felissa R. Lashley, Jerry D. Durham. Springer Publishing Company.
4. Infectious disease epidemiology - Nelson. Jones and Bartlett Publishers, Inc.

### **Core 23- BT5CRP05 PRACTICAL**

#### **RECOMBINANT DNA TECHNOLOGY AND INDUSTRIAL BIOTECHNOLOGY**

**Total hours of instruction: 90**

**Hours/ week: 4**

**Credit: 3**

1. Competent cell preparation
2. Transformation of the competent cell
3. Isolation of Plasmid
4. Separation of plasmid by agarose gel electrophoresis
5. Isolation of industrially important microorganism
6. Secondary screening of industrially important microorganism
7. Fermentative production of microbial metabolites-Submerged
8. Immobilization of bacteria for metabolite production.
9. Perform screening of the amylase producing isolates from soil.

#### **References:**

1. Biotechnology: Fundamentals and applications - S.S. Purohit and S.K Mathur, Agrobotanica publications.
2. Recombinant DNA: Genes and Genomes - James D Watson, Any A candy, Richard M.M, Jan A Witkowski. W.H. Freeman and Company Publication.
3. Gene Cloning and DNA analysis - T.A. Brown. Blackwell Publication.



**Core 24 - BT6CRP06 -PRACTICAL ENVIRONMENTAL BIOTECHNOLOGY AND  
PLANT BIOTECHNOLOGY**

**Total hours of instruction: 90**

**Hours/ week: 5**

**Credit: 4**

1. Enumeration of Total number of heterotrophic bacterial population in water samples
2. Bacteriological analysis of drinking water- Presumptive, completed and confirmed tests
3. Estimation of alkalinity
4. Estimation of acidity
5. Estimation of total solids, suspended and dissolved solids
6. Estimation of Dissolved oxygen
7. Estimation of Chemical oxygen demand
8. Estimation of Biological oxygen demand
9. Preparation of medium for plant tissue culture
10. Surface sterilization of explants
11. Inoculation and callus initiation of plant tissue culture
12. Meristem culture
13. Determine the potability of provided water sample by MPN technique.

**References:**

1. Experiments in Microbiology, Plant Pathology, Tissue culture and Mushroom Cultivation - K.R. Aneja; Wishwa Prakashan, New Delhi.
2. Biotechnology Fundamentals and application - Purohit and Mathur, Agro botanical Publishers, New Delhi.
3. Practical Skill in Biomolecular Sciences - Rob Reed, David Holmes, Jonathan Weyers, Allan Jones. Logman publishers, U.K.
4. Microbiological Applications: A Laboratory Manual in General Microbiology - Harold. J. Benson, WCB publishers.
5. Plant, Cell, Tissue and Organ Culture Fundamental Methods - Gamborg and Phillips, Narosa Publishers.

**BT6PRP01 Project and viva voce**

## **COMPLEMENTARY COURSES OFFERED BY THE DEPARTMENT**

### **1. BT1CMT01 COMPLEMENTARY COURSE 1**

**(Cell Biology)**

### **2. BT1CMP01 PRACTICAL- BIOTECHNOLOGY 1**

### **3. BT1CMT02 COMPLEMENTARY COURSE 2**

**(Genetics)**

### **4. BT1CMP02 PRACTICAL - BIOTECHNOLOGY 2**

### **5. BT1CMT03 COMPLEMENTARY COURSE 3**

**(Molecular Biology and Recombinant DNA Technology)**

### **6. BT1CMP03 PRACTICAL - BIOTECHNOLOGY 3**

### **7. BT1CMT04 COMPLEMENTARY COURSE 4**

**(Plant and Animal Biotechnology)**

### **8. BT1CMP04 PRACTICAL - BIOTECHNOLOGY 4**

# **BT1CMT01 COMPLEMENTARY COURSE 1**

## **(Cell Biology)**

**Total hours of instruction: 36**

**Hours/ week: 2**

**Credit: 2**

### **Module I: 5hrs**

History and development of Cell Biology, Discovery of cell, Cell theory. General organization of prokaryotic and eukaryotic cell. Plant cells and animal cells.

#### **References**

1. The world of the Cell, 6th Edn. - Becker, Klein smith Hardin
2. Cell and Molecular Biology - Gerald Carp, John Wiley and Sons, Inc
3. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology - P S Verma, V K Agarwal.

### **Module II: 10hrs**

Cell membrane- Molecular models of cell membrane, Fluid mosaic model, Chemical composition, Functions-Membrane transport-Active, passive, facilitated-symport, antiport. Cell junction-Tight junction, gap junction.

#### **References**

1. The world of the Cell, 6th Edn. - Becker Klein, Smith Hardin
2. Cell and Molecular Biology - Gerald Carp, John Wiley and Sons, Inc
3. The Cell: a molecular approach - Geoffrey M Cooper

### **Module III: 14hrs**

Cell organelles-Nucleus,Endoplasmic reticulum, golgi apparatus, lysosomes and peroxisomes, semi autonomous organelles-mitochondria and chloroplast, Cytoskeleton - microtubules, microfilaments and intermediate filaments.

#### **References**

1. The world of the Cell, 6 th Edn. - Becker – Klein smith Hardin
2. Cell and Molecular Biology - Gerald Carp, John Wiley and Sons, Inc

3. The Cell: a molecular approach - Geoffrey M Cooper
4. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology - P S Verma, V K Agarwal.

#### **Module IV: 7hrs**

Cell cycle-Phases of cell cycle - G1, S, G2 & M. Mitosis–stages, Meiosis – stages, significance, synaptonemal complex, Regulation of cell cycle - MPF and cyclins, Cell death - Necrosis and apoptosis

#### **References**

1. The world of the Cell, 6 th Edn. - Becker – Klein smith Hardin
2. Cell and Molecular Biology - Gerald Carp, John Wiley and Sons, Inc
3. The Cell - Geoffrey M Cooper
4. Cell Biology - Smith and Wood
5. Cell and Molecular Biology, 8<sup>th</sup> Edn - EDP De Robertis and EMF De Robertis, Lippincott, Williams and Wilkins publication.
6. Molecular Cell Biology 6<sup>th</sup> Edn - Lodish, Berk, Kaiser, Kreiger. Scott, Bretscher, Pleogh, Matsudaria. W. H Freeman and company publication.
7. Principles of genetics - Snustad and A.G. Gardner, John Wiky Pub

### **BT1CMP01 PRACTICAL- BIOTECHNOLOGY 1**

**Total hours of instruction: 36**

**Hours/ week: 2**

**Credit: 1**

1. Examination of different kinds of cells-Prokaryotic & eukaryotic cell
2. Squash preparation-study of mitotic stages
3. Cell fractionation
  - a) Homogenization of tissue
  - b) Organelle specific marker for mitochondria, chloroplast.
4. Staining of mitochondria

5. Cell counting methods:

- a) Haemocytometer: WBC, RBC
- b) Differential counting using Leishman's stain

**References**

1. Laboratory investigation in cell and molecular biology - Allyn Bregman, 1996.  
John Wiley and Sons.
2. A Text book of Practical Physiology - CL Ghai, Jaypee Brothers Publishers (P) LTD  
New Delhi.
3. Medical Laboratory Technology. Procedure Manual for Routine Diagnostic Tests -  
Volume I - Kanai L Mukherjee; Tata McGraw-Hill publishing Company. Ltd New Delhi

**BT1CMT02 COMPLEMENTARY COURSE 2**

**(GENETICS)**

**Total hours of instruction: 36**

**Hours/ week: 2**

**Credit: 2**

**Module I: 5Hrs**

The birth of genetics, symbols and terminology genes, alleles, genotypes, phenotypes, Dominance, Recessiveness, Wild type, Mutant type, Test cross, Backcross , Reciprocal cross.

**References**

1. Principles of genetics - Snustad and A.G. Gardner, John Wiley pub
2. Genetics - Strick Berger
3. Text book of genetics - Veer Bala Rastogi
4. Genetics - Daniel L. Hartin and Elizabeth W. John

**Module II: 8 Hrs**

Mendelian Genetics- Mendel and his experiments, principle of segregation, monohybrid cross, principle of independent assortment, dihybrid ratio, codominance. Semidominance.

## References

1. Principles of genetics - Snustad and A.G. Gardner, John Wiky Pub
2. Genetics - Strick Berger
3. Text book of genetics - Veer Bala Rastogi
4. Genetics - Daniel L. Hartin and Elizabeth W. John

## Module III: 10 Hrs

Gene interactions-Epistasis, Pleiotropy, Polygenic inheritance- Skin colour in man, Multiple alleles-ABO Blood typing, lethal genes, Sex determination-autosomes and allosomes, chromosome basis of sex determination-XX-XY,XX-XO, Barr body and L Lyon hypothesis.

## References

1. Principles of genetics - Snustad and A.G. Gardner, John Wiky Pub
2. Genetics - Strick Berger
3. Text book of genetics - Veer Bala Rastogi
4. Genetics, Daniel L. Hartin and Elizabeth W. John

## Module IV: 13 Hrs

Linkage, crossing over- mechanism- holliday model , sex linked, sex influenced and sex limited inheritance, Chromosome- size, shape, structure and types of chromosomes, chromosome banding, giant chromosomes, extra chromosomal inheritance- mitochondria and chloroplast.

## References

1. Genetics: A Molecular approach. 2<sup>nd</sup>Edn - Peter J Russel.
2. Principles of genetics - Snustad and A.G. Gardner, John Wiky pub
3. Genetics - Strick Berger
4. Text book of genetics - Veer Bala Rastogi
5. Genetics - Daniel L. Hartin and Elizabeth W. John

## **BT1CMP02 PRACTICAL-BIOTECHNOLOGY 2**

**Total hours of instruction: 36**

**Hours/ week: 2**

**Credit : 1**

1. Micrometry:

a) Calibration using ocular micrometer

b) Finding out average cell size

2. Staining of Barr body

3. ABO Blood grouping

4. Problems in mendelian law, crossing over and linkage

## **BT1CMT03 COMPLEMENTARY COURSE 3**

**(Molecular Biology and Recombinant DNA Technology)**

**Total hours of instruction: 36**

**Hours/ week: 2**

**Credit: 2**

**Module I: 7Hrs**

Experiments demonstrating DNA as the genetic material, RNA as genetic material, Structure of DNA and RNA, Physico chemical properties of DNA, Packaging of DNA in eukaryotes - Histones and nucleosomes.

### **References**

1. Introduction to Molecular Biology - P. Paoletta; Mc. Graw Hill, New York
2. Fundamentals of Biochemistry - J L Jain, Sanjay Jain, Nitin Jain, S Chand Publishers

3. Genetics. A Molecular approach. 2<sup>nd</sup>Edn - Peter J Russel.
4. Principles of genetics - Snustad and A.G. Gardner, John Wiley Pub

### **Module II: 12Hrs**

Genes-concept of gene-introns and exons, structure of prokaryotic gene: operon, organization of operon, eukaryotic gene - structure, reading frame and regulatory elements - promoters and enhancers, Mutation – types - addition, deletion, transition, transversion, missence and nonsense. Repair - direct, reversal, Base excision and nucleotide excision repair.

#### **References**

1. Genetics. A Molecular approach. 2<sup>nd</sup> Edn. - Peter J Russel.
2. Principles of genetics - Snustad and A.G. Gardner, John Wiley pub
3. Molecular Cell Biology.6 Edn. - Lodish. Pearson publication.

### **Module III: 10Hrs**

Basics of recombinant DNA technology, restriction enzymes, steps in rDNA technology, vectors - pBR322,pUC,Lambda,M13.Ligation, Selection of recombinants - Insertional inactivation, Blue-white assay

#### **References**

1. Gene Cloning and DNA Analysis - TA Brown, Blackwell publication
2. Principles of Gene Manipulation and Genomics - SB Primrose, RM Twyman. Blackwell publication.
3. Recombinant DNA: Genes and Genomes - James D Watson, Any A Candy, Richard MM, Jan A Witkoeski. WH Freeman and Company Publication

### **Module IV: 7Hrs**

Gene transfer methods - CaCl<sub>2</sub> mediated, Electroporation, Microinjection, Genomic library and C DNA library, Southern blotting. PCR, RFLP, RAPD techniques.

#### **References**

1. Gene Cloning and DNA Analysis - TA Brown, Blackwell publication.
2. Principles of Gene Manipulation and Genomics - SB Primrose RM Twyman, Blackwell publication.



3. Recombinant DNA: Genes and Genomes - James D Watson, Any A Candy, Richard MM, Jan A Witkoeski, WH Freeman and Company Publication.

4. Gene Biotechnology - SN Jogdand, Himalaya Publication.

### **BT1CMP03 PRACTICAL - BIOTECHNOLOGY 3**

**Total hours of instruction: 36**

**Hours/ week: 2**

**Credit: 1**

1. Separation of DNA by agarose gel electrophoresis
2. Estimation of DNA
3. Estimation of RNA
4. Competent cell preparation
5. Transformation of the competent cell

#### **References**

1. Molecular Cloning: A Laboratory Manual 3<sup>rd</sup>ed. - Sambrook K.J, Fritsch E.F, Maniatis T. CHLS N.Y.
2. Practical Biochemistry 4<sup>th</sup>ed - Keith Wilson and John Walker.

### **BT1CMT04 COMPLEMENTARY COURSE 4**

#### **(Plant and Animal Biotechnology)**

**Total hours of instruction: 36**

**Hours/ week: 2**

**Credit: 2**

#### **Module I: 5Hrs**

Plant tissue culture- a historical approach. Tissue culture media. Media preparation. Role of growth hormones. Totipotency and cyto-differentiation.

## **References**

1. Plant tissue culture: Theory and Practice - S.S Bhojwani and M.K. Razdan. Elsevier
2. Plant tissue culture - S.P. Misra.
3. Plant cell and tissue culture - S. Narayanaswamy

## **Module II: 13 Hrs**

Types of culture-Callus culture, Suspension culture and single cell culture. Somaclonal variation. Organogenesis and Embryogenesis. Meristem culture. Haploid production-ovary, ovule, anther and pollen culture. Application of Plant cell culture.

## **References**

1. Plant tissue culture: Theory and Practice - S.S Bhojwani and M.K. Razdan. Elsevier
2. Plant tissue culture - S.P. Misra.
3. Plant cell and tissue culture - S. Narayanaswamy
4. Plant Breeding - B.D. Singh.

## **Module III: 5 Hrs**

History of animal cell culture, Basic requirements of animal cell culture, Culture media – types and preparation, Importance of growth factors of the serum.

## **References**

1. Animal cell culture (Third edition) A practical approach - John R.W. Masters
2. Animal Biotechnology - R. Sasidhara.
3. Animal biotechnology - Raja- Florence Periera. Dominant Publishers, New Delhi. 2006
4. In vitro cultivation of animal cells - Open University, Netherlands. New Delhi, Butter Worth - Heinemann, 1994

## **Module IV: 13 Hrs**

Primary cell cultures - Anchorage dependent and non anchorage dependent cells secondary cell cultures. Transformed animal cells, Established/continuous cell lines. Commonly used animal cell lines-their origin and characteristics. Application of Animal cell culture-vaccine production and secondary metabolites.

### **References**

1. Animal cell culture (IIIrd edition) A practical approach - John R.W. Masters
2. Animal Biotechnology - R. Sasidhara.
3. Animal biotechnology – Raja, Florence Periera. Dominant publishers New Delhi. 2006
4. In vitro cultivation of animal cells - Open University, Netherlands. New Delhi, Butter Worth-Heinemann, 1994
5. Plant tissue culture: Theory and Practice - S.S Bhojwani and M.K. Razdan. Elsevier
6. Plant tissue culture - S.P. Misra.
7. Plant cell and tissue culture - S. Narayanaswamy
8. Plant Breeding - B.D. Singh.
9. Plant Tissue Culture –Kalyan Kumar De

## **BT1CMP04 PRACTICAL - BIOTECHNOLOGY 4**

**Total hours of instruction: 36**

**Hours/ week: 2**

**Credit : 1**

1. Preparation of medium for plant tissue culture
2. Surface sterilization of various explants
3. Inoculation and callus initiation of plant tissue culture
4. Rooting and Shoot development through tissue culture
4. Hardening of the tissue cultured plant

## References

1. Experiments in Microbiology, Plant Pathology, Tissue culture and Mushroom Cultivation - K.R. Aneja; Wishwa Prakashan, New Delhi.
2. Plant, Cell, Tissue and Organ Culture Fundamental Methods - Gamborg and Phillips, Narosa Publishers.
3. Plant Biotechnology - S. Ignacimuthu, Oxford and IBH Pub.
4. Basic agricultural Biotechnology - Purohit, Kothari and Mathur, Agrobotanical Pub.
5. Laboratory investigation in cell and molecular biology - Alltyn Bergman, 1996. John Wiley and Sons.