TUMKUR UNIVERSITY B. Sc., BIOTECHNOLOGY SYLLABUS (CBCS)

Structure of B.Sc., Degree Course:

The B.Sc. Degree course is three year course consisting of six semesters. Each semester is of 18 weeks duration, excluding examination period. In Biotechnology, there shall be eight theory papers and six practical. Each theory paper will consist of 60 hrs (I to IV Semester) and 45 hrs (V and VI semester) of instruction. Each practical will consist of 9 to 15 experiments.

B.Sc. Programme: Course Matrix for semester I-IV

Sl no	Course No. in Sem	Title of the paper	Type of instruction &hrs per week/ Course	Credits	Hrs of Exam (SEE) per course/ Sem	Max. Marks for IA/ Course/ Sem	Max. Marks for SEE per Course/ Sem	Max. Marks per Course/ Sem
1	1.3	Cell biology and Genetics	T 4	4	3	10	90	100
2	1.4	Cell biology and Genetics - *Practical-I*	P 4	2	3	-	50	50
3	2.3	Microbiology &Biostastistics	T 4	4	3	10	90	100
4	2.4	Microbiology &Biostastistics– *Practical-II*	P 4	2	3	-	50	50
5	3.3	Biochemistry and Biophysical Techniques	T 4	4	3	10	90	100
6	3.4	Biochemistry and Biophysical Techniques*Practical-III*	P 4	2	3	-	50	50
7	4.3	Molecular Biology and Bioinformatics	T 4	4	3	10	90	100
8	4.4	Molecular Biology and Bioinformatics *Practical-IV*	P 4	2	3	-	50	50
Open Elective								
9		Biotechnology and Human Welfare and/or Nanobiotechnology	T-2/P-4	2	3	-	50	50

B.Sc. Programme: Course Matrix for semester V /VI

Sl no	Course Number inSem	Title of the paper	Type of instruction & hours per week/ course	Credits	Hours of Exam(SEE) per course/sem	Max. Marks for IA/ Course/ Sem	Max. Marks for SEE per course/ Sem	Max. Marks per course/ Sem
1	**5.1**	Genetic Engineering	**T 3**	**3**	**3**	**10**	**90**	**100**
2	**5.2**	Immunology	**T 3**	**3**	**3**	**10**	**90**	**100**
3	**5.3**	Genetic Engineering, Immunology Practical-V/VI	**P 6**	**3**	**3**	**-**	**100**	**100**
4	**6.1**	Plant and Animal cell technology	**T 3**	**3**	**3**	**10**	**90**	**100**
5	**6.2**	Industrial and Environmental biotechnology	**T 3**	**3**	**3**	**10**	**90**	**100**
6	**6.3**	Plant and Animal cell technology & Industrial and Environmental biotechnologyPractical-VII/VIII	**P 6**	**3**	**3**	**-**	**100**	**100**

SEMESTER – I

1.3 Cell Biology and Genetics — Hours: 60

Unit -1. Cell Surface Architecture — 08 Hrs

Discovery of cell, The Cell theory, Ultrastructure of a eukaryotic cell (plant and animal cell), Ultra structure of cell wall and Plasma membrane-Fluid Mosaic model, Unit Membrane model, Sandwich model, Plasmodesmeta, Ionic channels, Voltage gated channels; Gap junctions and tight junctions

Unit – 2. Cellular Organelles — 16 Hrs

Ultra Structure and functions of cell organelles – Cytosol and Cytoskeletal structures, Endoplasmic reticulam, Golgi complex, Mitochondria, Chloroplast, Ribosomes, Lysosomes, Peroxisomes, Nucleus-Structural Organization of chromosomes- Ultra stucture, Nucleosome model, folded-fibremodel, Special types of chromosomes; Salivary gland and Lamp brush chromosomes, , Cell cycle, cell division (mitosis and meiosis), Cell Motility, Cell Senescence and Programmed Cell Death.

Unit 3. Principles of Genetics — 16 Hrs

Mendals Experiments and Principles of inheritance, Co-dominance and Incomplete dominance, multiple allels (ABO blood groups), Multi- factorial inheritance (Skin colour in Man), Interaction of genes (Supplementary factors; Comb pattern in fowls) Complementary genes (Flower colour in sweet peas) Epistasis: Plumage colour in poultry, Sex Determination in Plants and animals (Concepts of allosomes and autosomes, XX-XY, XX-XO, ZW-ZZ, ZO-ZZ types), Cytoplasmic

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

Unit: 4 Linkages and Crossing Over **06 Hrs**

Coupling and repulsion hypothesis, Linkage in maize and Drosophila, Mechanism of crossing over and its importance, Chromosome mapping – Linkage map in maize.

Unit 5. Mutation **10 Hrs**Types: spontaneous and induced, Mutagens: Physical and chemical, Mutation at the molecular level. Mutations in plants, animals, and microbes for economic benefit of man, General account of structural and numerical aberrations, detection of mutations (Ame's Test).

Unit-6: **Human Genetics** **04 Hrs**

Karyotype in man, inherited disorders - Allosomal (Klinefelter syndrome and Turner's Syndrome), Autosomal (Down syndrome and Cri-Du-Chat syndrome), Pedigree analysis

1.4 – Cell Biology and Genetics (Practical)

1. Use of Micrometer and calibration, measurement of onion epidermal cells
2. Mitotic and meiotic studies in grasshopper testes, onion root tips and flower buds
3. Chromosomes: Mounting of polytene chromosomes
4. Karyotype analysis – Man and Onion, Man – Normal and Abnormal – Down and Turner's syndromes, Genetic problems
5. Isolation of chloroplasts and mitochondria
6. Vital staining of mitochondria
7. Blood grouping
8. Blood smear – differential staining
9. Study of drosophila life cycle, mutants (Eye colour mutations in drosophila)
10. Study of Barr bodies

*EACH STUDENT IS REQUIRED TO SUBMIT 4 PERMANENT SLIDES (2- MITOSIS & 2-MEIOSIS)

SEMESTER II

2.3 Microbiology and Biostatistics **Hours: 60**

Unit 1. Introduction and Scope of Microbiology **12 Hrs**

Definition and history of microbiology, contributions of Antony van Leeuwenhoek, Louis Pasteur, Robert Koch, Alexander Fleming. Importance and scope of Microbiology as a modern Science, Branches of microbiology, five kingdom and three domain classification of microorganisms.Microscopy**:** Construction and working principles of different types of microscopes – Compound,

Dark field, Phase contrast, Confocal, Fluorescence and Electron Microscope (Scanning and Transmission)

Unit 2. Microbial Techniques **10 Hrs**

Sterilization: Principles and Applications of Physical Methods. Autoclave, Hot air oven, laminar airflow, Seitz filter, Sintered glass filter, and membrane filter. Radiation Methods: UV rays and Gamma rays. Chemical Methods: Alcohol, Aldehydes, Phenols, Halogens and Gaseous agents. Isolation of microorganisms, types of streaking, serial dilution, pour, spread plate and exposure plate methods. Stains and Staining Techniques: Principles of staining, Types of stains – simple stains, structural stains and Differential stains

Unit 3. Prokaryotic microorganisms **15 Hrs**

Concept of microbial species and strains, classification of bacteria based on – morphology (shape and flagella), nutrition, Chemotaxanomy, genetic method and extreme environment, molecular phylogeny. Bacterial diseases of man – Tetanus, Tuberculosis, Pneumonia and Cholera. Microbial Metabolism: Bacterial Photosynthesis: Photosynthetic apparatus in prokaryotes, Photophosphorylation & Dark reaction. Respiration: EMP, HMP and ED Pathways, Kreb's cycle, Oxidative Phosphorylation.

Unit 4. General Account acellular organisms **08 Hrs**

Viruses – Structure and classification, Plant Viruses –TMV, CaMV, Animal viruses – Hepatitis B, HIV, Bacteriophages- Lamba, T4 Phage, Viroid- Potato spindle tuber viroid, Prions- CJD, Kuru, BSE

Unit 5. Eukaryotic microorganisms **08 Hrs**

Salient features, classification, reproduction and economic importance of Protozoa algae and fungi. Fungal and protozoal diseases of plants and animals.

Unit 6. Biostatistics **07 Hrs**

Data types, Tabulation and classification of data, Frequency distribution and Graphical representation of data, Measures of central tendencies: Mean, Median, Mode and their properties, Measures of Dispersion: Mean deviation, Variance, Standard deviation and coefficient of Variation, Different models of data presentation with special reference to biological samples, Chi square test, student T test, introduction to SPSS analysis with examples etc.,

2.4 Microbiology (Practical)

1. Study of Compound microscope, Autoclave, Hot air oven, pH meter, Laminar Air flow and centrifuge.
2. Preparation of different types of media (Simple, complex and differential media).
3. Staining Techniques: Simple, Negative staining, Gram staining, Endospore staining and fungal staining
4. Isolation of bacteria and fungi from soil, air, and water –streaking, serial dilution and pour plate methods
5. Counting of microorganisms – Total Count (Haemocytometer)
6. Antibiotic sensitivity test, MIC,
7. Biochemical tests – starch hydrolysis, catalase, oxidase & gelatin liquefaction
8. Study of Rhizobium from root nodules of legumes
9. VAM
10. Isolation and identification of *E. coli*

SEMESTER III

3.3 Biochemistry and Biophysical techniques **Hours: 60**

Unit 1. Carbohydrates **05 Hrs**

Structure, Properties, Classification and functions

Unit 2. Lipids **05 Hrs**

Structure, Properties, Classification and Functions

Unit 3. Amino acids and Proteins **10 Hrs**

Structure, Properties, Classification and functions of amino acids and proteins. Structural organizations of proteins (primary, secondary, tertiary and quaternary structures) reverse turns and Ramachandran plot.

Unit 3. Enzymes **15 Hrs**

Introduction, classification, Enzyme kinetics-Importance of enzyme kinetics, Factors affecting enzyme reactions (Temp, pH, ions, changes in structure of proteins) Michaelis-Menton equation derivation, Line-Weaver Burk Plot, merits and demerits. Enzyme inhibition – reversible inhibition (competitive, uncompetitive and non competitive), irreversible inhibition, allosteric enzyme activity, co-enzymes and co-factors

Unit 4 Nucleic acids **05 Hrs**

Structure, Properties, classification, and functions of Nucleic acids. Nature of genetic materials, structure of purine, pyramidine and nucleotides

Unit 5. Vitamins and Hormones **05 Hrs**

Structure, Properties, classification, and functions of Vitamins and Hormones

Unit 6. Biophysical techniques **15 Hrs**

Solutions, pH and buffers: Theory of water ionization and its purity (kW), pKa&pKb acids and bases, Derivation of Henderson-Hasselbalch equation and its significance. Buffers: Criteria for selection of buffers, Types of buffers, Buffers in Biological systems and their mechanism of action.

Analytical techniques: Principles and applications of Chromatography (Paper, thin-layer, column and GLC), Centrifugation (RPM and G, Ultracentrifugation), Spectroscopy (UV-Visible, X-ray crystallography, IR, NMR, mass, ESR), Isotopes **and Radioactivity:** Radioactivity, decay laws, Isotopes in Biological studies (Metabolic and physiological tracer studies), GM counters & Scintillation counting.

3.4 – Biochemistry and Biophysical techniques (Practical)

1. Estimation of reducing sugars- Glucose, Maltose and lactose by DNS, H J and Somoji's Methods
2. Estimation of lipids
3. Estimation of Amino acids.
4. Estimation of protein by Biuret method and Lowry's method
5. Assay of enzymes activity – Amylase / Protease
6. Estimation of Nucleic acids
7. Estmation of Vitamins
8. Preparation of Buffers-: Tris-Buffer, Citrate-Buffer and Phosphate-Buffer 9.Separation of Sugars, Lipids, amino acid, and Nucleic acids by TLC
10. Estimation of inorganic phosphate by Fiske-Subba row method.

SEMESTER IV

4.3 Molecular Biology and Bioinformatics — Hours: 60

Unit 1: Introduction to Molecular Biology — 10 hrs

Scope and History. Central Dogma of Molecular Biology. Structure of DNA-Nucleoside, Nucleotide, Base pairing, Base stacking, Double Helix, features of Watson and Crick model, major and minor groove, Supercoiling- twist, writhe and linking number. Forms of DNA- A, B, Z. Structure and function of mRNA, rRNA, tRNA. Secondary structures in RNA

Unit 2: DNA Replication and Repair — 10 hrs

Types and functions of DNA polymerases in Prokaryotic and Eukaryotic replication. Proof reading activity, 5'→3' exonuclease and endonuclease activity, topoisomerase activity, Telomeric DNA replication and Plasmid Replication-theta model, strand displacement model and rolling circle model. DNA Repair- Nucleotide excision repair, base excision repair, mismatch repair, photoreactivation, recombination repair and SOS repair.

Unit 3: Transcription — 10 hrs

Structure of prokaryotic and eukaryotic gene, structure and function of the promoters in mRNA, rRNA, tRNA genes. RNA polymerases in prokaryote and eukaryote, types and function. Transcription of mRNA, rRNA, and tRNA genes in Prokaryote and eukaryote. Post transcriptional processing of mRNA – 5'capping, splicing (including different types), polyadenylation and RNA editing.

Unit 4: Translation — 10 hrs

Genetic code and Wobble hypothesis. Translation in prokaryote and eukaryote. Post translational modifications. Principles protein sorting and targeting into endoplasmic reticulum, mitochondria, chloroplast, and nucleus.

Unit 5: Gene Regulation and Recombination — 10 hrs

Principles of gene regulation- activators, co-activators, suppressors, co-suppressors, moderators, silencers, insulators, enhancers. Operon-*lac* operon, *trp*operon, recombination in prokaryotes- transformation, conjugation and transduction. Plasmids and their types, plasmid copy number and incompatibility, Episomes. Transposable elemets (insertion sequence and transposons, Integrons and Antibiotic Resistant genes), iRNA, siRNA, microRNA

Unit 6: Bioinformatics **10 hrs**

Introduction to bioinformatics, Concept and structure of databases, Introduction to the human genome project and components of the genome. Introduction to the gateway sites (NCBI, EMBL and DDBJ) Types of nucleic acid sequences–Genebank: Protein Data Bank (PDB) –in the context of protein structural biology, Introduction to sequence analysis, significance, motif analysis and phylogenic comparisons Concept and methods of sequence comparisons in general: FASTA, BLAST and CLUSTALW, pairwise sequence comparison, Scoring matrices, Gap Penalties, Global Alignment, Local Alignment, Introduction to -omics.

4.4: Molecular Biology and Bioinformatics– Practical

1. Estimation of DNA by DPA method.
2. Estimation of RNA by Orcinol method.
3. Isolation of chromosomal DNA from animal tissues, plant and Bacteria.
4. Isolation of plasmid DNA.
5. Bacterial transformation
6. Extraction and estimation of protein from animal goat liver/muscle soured by salt precipitation, Organic solvent method.
7. Extraction and estimation of protein from animal or plant source (Green gram/Pea) by salt precipitation & Organic solvent method.
8. Protein separation by Polycrylamide Gel Electrophoresis (PAGE)
9. Nucleic acid (DNA/RNA) separation by agarose gel electrophoresis
10. Sequence alignment (FASTA, BLAST)
11. ROS MOL

SEMESTER V

5.1 – Genetic Engineering **Hours: 45 Hours**

Unit 1. Tools for genetic engineering **07 hrs**

Restriction enzymes and its types, DNA ligases, Reverse transcriptase, Gene cloning vectors and its types, *in vitro* construction of recombinant DNA molecules (pBR 322, pUC 19), Artificial chromosomes.

Unit- 2. Transformation techniques **06 hrs**

Calcium chloride, Electorporation, microinjection, and biolistic methods. Screening and selection of recombinant host cells –marker genes, biochemical and Immunological screening and colony hybridization

Unit 3. Principles of Cell-based DNA Cloning-Genomic DNA and cDNA cloning **07 hrs**

Unit 4. Expression of cloned DNA in prokaryotes and eukaryotes **05 hrs**

Unit 5. **Gene engineering techniques** **10 hrs**

Hybridization- Principles and applications, Amplifying DNA, Cloning and its importance, Primers,
probes DNA and Protein microarrays. Introduction to proteomics, genomics and metabalomics

Unit 6. Application of r-DNA technology **10 hrs**

Production of Insulin, Production of recombinant vaccines – Heptitis – B, Production of GM foods and crops, Ethics and safety of GMO's

SEMESTER V

5.2 Immunology **Hours: 45 Hrs**

Unit 1. History and scope of Immunology **05 hrs**

Types of Immunity- Innate and Acquired immunity. Humoral, Cell Mediated Immunity, Cell and oragns of immune reponses and their functions

Unit 2. **Antigens and Antibodies** **10 hrs**

Antigens-Types, haptens, epitopes, adjuvants, and Factors influencing antigenicity, Antigen processing and presentations. Antibodies- Structure, types, properties and functions of immunoglobulins.. Production of antibodies (Poly and Monoclonal)

Unit 3. Complement system and MHC molecules **10 hrs**

Components of complement system and complement pathways. Types of MHC molecules and their functions

Unit 4. Antigen- Antibody reactions **10 hrs**

In vivo and *In vitro* reactions – Precipitation, agglutination, Immunoelectrophoresis, Labelled antibody (RIA, ELISA and Immunofluroscent techniques).

Unit 5. Hypersensitivity and its types **10 hrs**

Unit 6. Immunization- herd/community, Passive and Active immunization, immunization schedules. Types of Vaccines – Inactivated, Attenuated and Recombinant vaccines – Peptide and DNA Vaccines

5.3 Genetic Engineering/ Immunology Practical-V/VI

1. Isolation of genomic DNA from bacteria, plant and animal source
2. Isolation of plasmid DNA from *E. coli*
3. PCR
4. Restriction digestion of plasmid DNA
5. Separation of DNA by Gel Electrophoresis
6. SDS-PAGE
7. Replica plating
8. Transformation
9. Blood grouping
10. Differential Count of WBC
11. Widal Test
12. VDRL test
13. ELISA – Demonstration
14. Dot Elisa
15. Octerlouny Double diffusion (ODD)
16. Rocket immunoelectrophoresis
17. Separation of serum and plasma from the blood
18. Precipitation of Immunoglobulins by ammonium sulphate

SEMESTER VI

6.1 – Plant and Animal cell technology Hours: 45

Unit 1. Plant tissue culture 08 hrs

In vitro methods in plant tissue culture, aseptic Techniques. Types of nutrient media and use of growth regulators (Auxins, Cytokininis and Gibberellins).*In vitro* fertilization – Ovary and Ovule culture. Micropropogation of elite species.Organ Culture – Anther, Embryo and Endosperm culture and their applications.

Unit 2. Protoplast Culture 08 hrs

Isolation, regeneration and viability test, somantic hybridization, methods of protoplast fusion – chemical and electro fusion, practical application of somantic hybridization and cybridization. Somaclonal variation and their significance. *In vitro* production of secondary metabolites – Techniques and significance.

Unit 3. Transgenic plants 08 hrs

Technique of transformation – biological(Agrobacterium mediated), physical and chemical methods. Applications of transgenic plants. Edible vaccines. Role of tissue culture in agriculture, horticulture and forestry

Unit 4. Animal cell culture 08 hrs

Media and its components - Primary Culture – Cell lines, and cloning disaggregation of tissue, isolation of tissue, enzyme disaggregation, and mechanical disaggregation. Secondary Culture – transformed animal cells and continious cell lines. Growth factors – Promting proliferation of animal cells EGF, FGF, PDGF, IL-1, IL-2, NGF and erythropoietin.

Unit 5. Transgenic animals 08 hrs

Transfection of animal cell lines. Selectable Makers and Transplantaion of Cultural Cells.Expression of Cloned proteins in animal cell – Expression vector, over production and dowm stream processing of the expressed proteins.Production of Vaccines in animal Cells. Production and Applications of monoclonal antibodies. Production of transgenic animals

Unit 6. Biotechnology and Intellectual property rights: 05 hrs

Patents, trade secrests, copyright, trademark, Geographical indications, WIPO, TRIPS. Procedure involved in patenting biotechnological inventions.

SEMESTER VI

6.2 – Industrial and Environmental Biotechnology Hours: 45 Hrs

Unit 1. Introduction to industrial Biotechnology 08 hrs

Basic principles of fermentation technology, Screening and Isolation of Microorganisms, maintainance of strains improvement (Mutant selection, Recombinant DNA methods).

Unit 2. Fermentation technology 10 hrs

Fermentation Media, Natural and synthetic Media. Fermenters and its operation, Type of Fermentation Solid State, submerged fermentation and continious fermentation, Immobilized enzyme and cell bioreactors, Process Development – Shake flask fermentation, Downstream processing (DSP), Distingration of cells, Separation, Extraction, Concentration and purification of products

Unit3. :Production of Microbial and plant products 08 hrs

Microbial production of Alcohol, Antibiotic, enzymes, SCP, SCO, Vitamin, xanthan gum and Polyhydroxyalkonoides (PHA). Food additives – Safforn and Capasicin

Unit 4. Introduction to Enviornmental Biotechnology 06hrs

Modern fuels- Biofuels (Biogas, Microbial hydrogen Production, Gasohol). Bioremediation and its types, Bioleaching. Biofertilizers and its types, Biopesticides

Unit 5. GMO's and Environment 05 hrs

Environmental significance of genetically modified microbes, plants and animals

Unit 6. Waste manangement 08 hrs

Treatment of municipal waste and Industrial effluents, solid waste manangement (Composting and Vermi composting)

6.3: Plant & Animal cell tech.gy/Industrial & Environmental biotech. Practical-VII/VIII

1. Preparation of culture media (plant and animal)

2. Production of Callus and suspension Culture
3. Plant Protoplast Isolation
4. Plant propogation through Tissue culture (shoot tip and Nodal culture)
5. Planting and Maintenance of Medicinally important plants and its medicinal importance (1 student, 2 Plants compulsory)
6. Preparation of Synthesis seeds
7. Anther Culture
8. Trypsinization of animal tissue 9. Animal cell culture of trypsinized cells
10. Preparation of wine.
11. Production and Estimation of Alcohol by specific gravity method
12. Algal and fungal culture – Spirulina, Agaricus, Yeast and Apergillus
13. Production and Estimation of citric acid from Aspergillus culture. 14. Production and Estimation of lacatic acid
15. Immobilization of yeast cells.
16. Immobilisation of invertase
17. MPN test
18. Vermi Composting
19. Biopesticides assay

Open Elective: Biotechnology and Human Welfare

Hours 30

UNIT I **8 Hrs**

Definition and introduction to biotechnology, branches and scope of biotechnology, developmental stages of biotechnology. Types of living organisms- cellular and acellular.

UNIT II 8 Hrs

Industry: Protein engineering: enzyme and polysaccharide synthesis, activity and secretion, Alcohol and antibiotic production. Production of industrially impartment products: amino acids, Proteins, vitamins, SCP. Agriculture: N2 fixation: Plant diseases and transfer of resistance genes to plants; interaction between plants and microbes; qualitative improvement of livestock.

UNIT III 8 Hrs

Environments: Xenobiotics and their degradation; Superbug, agricultural wastes and their management, development of biodegradable polymers such as PHB. Waste as a source of energy and food.

UNIT IV **3 Hrs**

Health: e.g. new generation diagnostics and therapeutic agents, recombinant vaccines. Gene therapy, diagnostics, human genome project and ELS1. ABO system of blood grouping.

UNIT V3 Hrs

Forensic science: Solving violent crimes such as murder and rape; solving claims of paternity and theft etc. using various methods of DNA finger printing.

Open Elective: Nanobiotechnology

Hours 30

Unit 1: Introduction to Nanobiotechnology **8 hours**

Introduction to nanotechnology, Development of Nanobiotechnology, Nanomaterial in biotechnology - nanoparticles, quantum dots, nanotubes and nanowires etc., Applications of molecular recognition elements in nanosensing of different analytes

Unit 2: Properties and Characterizations: **8 hours**

Optical (UV-Vis/Fluorescence), X-ray diffraction, Imaging and size (Electron microscopy, light scattering, Zetapotential), Surface and composition (ECSA, EDAX, AFM/STM etc)

Vibrational (FT-IR and RAMAN), SERS, Magnetic, Electrical and Electrochemical

Unit 3: Applications of Nano-Materials in Biosystems **8 hours**

Proteins - Lipids - RNA and DNA, Protein Targeting - Small Molecule/Nanomaterial - Protein

Interactions, Nanomaterial-Cell interactions-Manifestations of Surface Modification (Polyvalency)

Unit 4:Nanomaterials and Diagnostics/Drug Delivery and Therapeutics **3 hours**

MRI, Imaging, Surface Modified Nanoparticles, MEMS/NEMS based on Nanomaterials, Peptide/DNA Coupled Nanoparticles, Lipid Nanoparticles For Drug Delivery

Unit 5: Nanomaterials and Toxicity Evaluation **3 hours**

Definition and scope, Acute and chronic toxicity, selective toxicity, does sysnergism and antagonism, Cytotoxicity, Genotoxicity, *In vivo* tests/assays etc.