CBCS – MAKAUT B.Sc Biotechnology B.Sc (Hons) 140 Credit FRAMEWORK

Subject Type and Number of Subjects per Semester	Semester I	Semester II	Semester III	Semester IV	Semester V	Semester VI
CORE COURSE	2	2	3	3	2	2
GENERIC ELECTIVE SUBJECT	1	1	1	1		
ABILITY ENHANCEMENT COMPULSORY	1	1				
SKILL ENHANCEMENT COURSE			1	1		
DISCIPLINE SPECIFIC ELECTIVE					2	2
Number of paper (total credit)	4 (20)	5 (20)	5 (26)	5(26)	4 (24)	4 (24)

Total Credit- 20+26+26+20+24+24= 140

Semester-I

CORE COURSE (Credit=4+2)		ABILITY ENHANCEMENT COMPULSORY (Credit =2)		SKILL ENHANCEMENT COURSE (Credit =2)Any one		GENERIC ELECTIVE SUBJECT (Credit =6) (MOOCs)		DISCIPLINE SPECIFIC ELECTIVE (Credit =6) Any one from A group and B group	
Paper name	**Paper code**	**Paper name**	**Paper code**	**Paper name**	**Paper code**	**Paper name**	**Paper code**	**Paper name**	**Paper code**
Biochemistry and Metabolism (Theory)	BSUBTC-101	English Communication Skill Development	BSUBTA-101			MOOC Basket 1 MOOC Basket 2	BSUBTG-1		
Biochemistry and Metabolism (Lab)	BSUBTC-191					MOOC Basket 3 MOOC Basket 4			
Cell Biology (Theory)	BSUBTC-102								
Cell Biology (Lab)	BSUBTC-192								
Credit- 6+6=12		Credit- 2				Credit- 6			

Total Credit- 12+2+6=20

Semester-II

CORE COURSE (Credit=4+2)		ABILITY ENHANCEMENT COMPULSORY (Credit =2)Any one		SKILL ENHANCEMENT COURSE (Credit =2)Any one		GENERIC ELECTIVE SUBJECT (Credit =6)(MOOCs)		DISCIPLINE SPECIFIC ELECTIVE (Credit =6) Any one from A group and B group	
Paper name	**Paper code**	**Paper name**	**Paper code**	**Paper name**	**Paper code**	**Paper name**	**Paper code**	**Paper name**	**Paper code**
General microbiology (Theory)	BSUBTC-201	Introduction to Environmental Science	BSUBTA-201			MOOC Basket 1 MOOC Basket 2 MOOC Basket 3 MOOC Basket 4	BSUBTG-2		
General microbiology (Lab)	BSUBTC-291	Introduction to fundamental computer	BSUBTA-202						
Plant and Mammalian Physiology (Theory)	BSUBTC-202								
Plant and Mammalian Physiology (Lab)	BSUBTC-292								
Credit- 6+6=12		Credit- 2				Credit- 6			

Total Credit- 12+2+6=20

Semester-III

CORE COURSE (Credit=4+2)		ABILITY ENHANCEMENT COMPULSORY (Credit =2)Any one		SKILL ENHANCEMENT COURSE (Credit =2)Any one		GENERIC ELECTIVE SUBJECT (Credit =6)(MOOCs)		DISCIPLINE SPECIFIC ELECTIVE (Credit =6) Any one from A group and B group	
Paper name	**Paper code**	**Paper name**	**Paper code**	**Paper name**	**Paper code**	**Paper name**	**Paper code**	**Paper name**	**Paper code**
Genetics (Theory)	BSUBTC-301			Enzymology	BSUBTS-301	MOOC Basket 1 MOOC Basket 2 MOOC Basket 3 MOOC Basket 4	BSUBTG-3		
Genetics (Lab)	BSUBTC-391			Industrial Biotechnology	BSUBTS-302				
Chemistry I (Theory)	BSUBTC-302			Plant and animal chromosome preparation and karyotyping.	BSUBTS-303				
Chemistry I (Lab)	BSUBTC-392								
Molecular Biology (Theory)	BSUBTC-303								
Molecular Biology (Lab)	BSUBTC-393								
Credit- 6+6+6=18				Credit- 2		Credit- 6			

Total Credit- 18+2+6=26

Semester-IV

CORE COURSE (Credit=4+2)		ABILITY ENHANCEMENT COMPULSORY (Credit =2)Any one		SKILL ENHANCEMENT COURSE (Credit =2)Any one		GENERIC ELECTIVE SUBJECT (Credit =6)(MOOCs)		DISCIPLINE SPECIFIC ELECTIVE (Credit =6) Any one from A group and B group	
Paper name	**Paper code**	**Paper name**	**Paper code**	**Paper name**	**Paper code**	**Paper name**	**Paper code**	**Paper name**	**Paper code**
Immunology (Theory)	BSUBTC -401			Molecular Diagnostics	BSUBTS -401	MOOC Basket 1 MOOC Basket 2 MOOC Basket 3 MOOC Basket 4	BSUBTG-4		
Immunology (Lab)	BSUBTC -491			Plant-Microbe Interaction	BSUBTS-402				
Chemistry2 (Theory)	BSUBTC -402			Research Methodology	BSUBTS-403				
Chemistry 2 (Lab)	BSUBTC -492			Basic Forensic Science	BSUBTS-404				
Bioanalytical tools (Theory)	BSUBTC -403								
Bioanalytical tools (Lab)	BSUBTC -493								
Credit- 6+6+6=18				Credit- 2		Credit- 6			

Total Credit- 18+2+6=26

Semester-V

CORE COURSE (Credit=4+2)		ABILITY ENHANCEMENT COMPULSORY (Credit =2)Any one		SKILL ENHANCEMENT COURSE (Credit =2)Any one		GENERIC ELECTIVE SUBJECT (Credit =6) (MOOCs)		DISCIPLINE SPECIFIC ELECTIVE (Credit =6) Any one from A group and B group	
Paper name	**Paper code**	**Paper name**	**Paper code**	**Paper name**	**Paper code**	**Paper name**	**Paper code**	**Paper name**	**Paper code**
Bioprocess Technology (Theory)	BSUBTC-501							Animal Biotechnology	BSUBTD-501A
Bioprocess Technology (Lab)	BSUBTC-591							Model organism and human genome project	BSUBTD-502A
Recombinant DNA Technology (Theory)	BSUBTC-502							Medical biotechnology	BSUBTD-503A
Recombinant DNA Technology (Lab)	BSUBTC-592							Plant Biotechnology	BSUBTD-501B
								Plant secondary metabolites and Biotransformation	BSUBTD-502B
Credit- 6+6=12								Credit- 6+6=12	

Total Credit- 12+12=24

Semester-VI

CORE COURSE (Credit=4+2)		ABILITY ENHANCEMENT COMPULSORY (Credit =2)Any one		SKILL ENHANCEMENT COURSE (Credit =2)Any one		GENERIC ELECTIVE SUBJECT (Credit =6)Any one (MOOCs)		DISCIPLINE SPECIFIC ELECTIVE (Credit =6) Any one from A group and B group	
Paper name	**Paper code**	**Paper name**	**Paper code**	**Paper name**	**Paper code**	**Paper name**	**Paper code**	**Paper name**	**Paper code**
Genomics, Proteomics and Bioinformatics(Theory)	BSUBTC-601							Genetic Modification In agriculture, food and medicine	BSUBTD-601A
Genomics, Proteomics and Bioinformatics(Lab)	BSUBTC-691							Environmental Biotechnology	BSUBTD-602A
IPR, Biosafety and ethical issues(Theory)	BSUBTC-602							Project/ Dissertation	BSUBTD-681B
IPR, Biosafety and ethical issues(Lab)	BSUBTC-692								
Credit- 6+6=12								Credit- 6+6=12	

Total Credit- 12+12=24

Credits point distribution per Semester:

	Core Course [Credit=4+2]	**Ability enhancement Compulsory [Credit=2]**	**Skill Enhancement Course [Credit=2]**	**Generic elective Subject {MOOC} [Credit=6]**	**Discipline Specific Subject [Credit=6]**	**Semester Specific Total Credit**
SEM-I	[4+2]+[4+2]	2	0	6	0	20
SEM-II	[4+2]+[4+2]	2	0	6	0	20
SEM-III	[4+2]+[4+2]+ [4+2]	0	2	6	0	26
SEM-IV	[4+2]+[4+2]+ [4+2]	0	2	6	0	26
SEM-V	[4+2]+[4+2]	0	0	0	6+6	24
SEM-VI	[4+2]+[4+2]	0	0	0	6+6	24
Course Specific Total Credit	84	4	4	24	24	**140 is the Total Credit for B.Sc Biotechnology Course**

B.Sc Biotechnology Syllabus

(2020)

Department of Biotechnology

MaulanaAbulKalam Azad University of Technology (MAKAUT)

SEMESTER-I

BSUBTC-101 Biochemistry and Metabolism Credit- 4

UNIT I:

Introduction to Biochemistry: A historical prospective.

Carbohydrates:- Structural aspects – Introduction & Occurrence, Classification of Mono-, Di- and Polysaccharides, Reducing & Non-reducing Sugars, Constitution of Glucose & Fructose, Osazone formation, Pyranose& Furanose forms, Determination of ring size, Inter-conversion of monosaccharides.

Amino acids & Proteins: Structure & Function. Structure and properties of Amino acids, Types of proteins and their classification, Forces stabilizing protein structure and shape. Different Level of structural organization of proteins, Protein Purification. Denaturation and renaturation of proteins. Fibrous and globular proteins.Protein misfolding and related diseases.

UNIT II

Lipids: Structural aspects – General introduction, Classification & Structure of Simple & Compound lipids, Properties of Lipid aggregates (elementary idea), Biological membrane, membrane protein – structural aspects, Lipoproteins (elementary idea).Membrane Transport.

Nucleic acids: Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, purines & pyrimidines,. Biologically important nucleotides, Double helical model of DNA structure and forces responsible for A, B & Z – DNA, denaturation and renaturation of DNA

UNIT-III

Chemical & Enzymatic Kinetics - An introduction to enzyme; How enzyme works; Reaction rate; Thermodynamic definitions; Principles of catalytic power and specificity of enzymes, Order of reactions; Enzyme kinetics – Approach to mechanism.

UNIT IV

Carbohydrates Metabolism: Reactions, energetics and regulation. Glycolysis: Fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway and its significance, Gluconeogenesis, Glycogenolysis and glycogen synthesis. TCA cycle, Electron Transport Chain, Oxidative phosphorylation. ß-oxidation of fatty acids.

Lipid Metabolism – Structures and roles of Fatty acids &Glycerols, beta oxidation of saturated fatty acids, oxidation of unsaturated fatty acids, oxidation of odd chain fatty acids, energy yield, Ketone bodies.

Amino acid Metabolism – Amino acid breakdown (amino acid deamination, Urea cycle, metabolic breakdown of individual amino acids – glucogenic & ketogenic amino acids), amino acids as biosynthetic precursors (haem biosynthesis & degradation, biosynthesis of epinephrine, dopamine, seretonin, GABA, histamin, glutathione); biosynthesis of essential & non-essential amino acids.

Nucleotide Metabolism – biosynthesis of purine & pyrimidine (de novo& salvage pathway); degradation of purine & pyrimidine.

BSUBTC-191 (Lab) [Lab on Biochemistry and Metabolism] Credit 2

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Estimation of protein by Folin Lowry method
2. TLC separation of Amino acids /sugars
3. Determination of Iodine number of a fat
4. Estimation of RNA by Orcinol method
5. Estimation of DNA by diphenyl amine method
6. Qualitative tests for Carbohydrates, lipids and proteins
7. Testing of Blood Sugar

8. Testing of Liver Function Test (Bilirubin, SGOT, SGPT, Alkaline Phosphatase, Albumin, Globulin, Total Protein)
9. Testing of Renal Function Test (Urea, Uric acid, Creatine, Creatinine)

BSUBTC-102 Cell Biology — Credit 4

UNIT I

Basics of Cell Biology (structure & function) – Discovery of cell and Cell Theory; Comparison between plant and animal cells; cytosol, compartmentalization of eukaryotic cells, cell fractionation.Cell Membrane and Permeability: Chemical components of biological membranes, organization and Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport. Cell wall; Plasma membrane; Modification of plasma membrane and intracellular junctions; Cytoskeleton; Protoplasm; Mitochondria; Chloroplast; ER; Golgi complex;

UNIT II

Membrane Vacuolar system, cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments. Endoplasmic reticulum: Structure, function including role in protein segregation. Golgi complex: Structure, biogenesis and functions including role in protein secretion.

UNIT III

Lysosomes: Vacuoles and micro bodies: Structure and functions Ribosomes: Structures and function including role in protein synthesis. Mitochondria: Structure and function, Genomes, biogenesis. Chloroplasts: Structure and function, genomes, biogenesis Nucleus: Structure and function, chromosomes and their structure.

UNIT IV

Extracellular Matrix: Composition, molecules that mediate cell adhesion, membrane receptors for extra cellular matrix, macromolecules, regulation of receptor expression and function. Signal transduction.

Cell cycle - An overview of cell cycle; Components of cell cycle control system; Intracellular and Extra- cellular control of cell division, Programmed cell death (Apoptosis), intrinsic & extrinsic pathways of cell death, Apoptosis in relation with Cancer,

Cancer: Carcinogenesis, agents promoting carcinogenesis, characteristics and molecular basis of cancer.

BSUBTC-192 (Lab))[Lab on Cell Biology] — Credit 2

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Preparation of Mitotic Chromosome from onion root tip.
3. Preparation of Meiotic Chromosome from Rhoeo discolor or onion sp.
4. Preparation and study of polytene chromosome from Drosophila salivary gland.
5. Study of sex chromatin through preparation of Barr body from buccal epithelium .
6. Study of chromosomal aberration induced by pesticide in onion root tips.
7. Study of plasmolysis and de-plasmolysis.

Learning Resources:

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.
2. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants.American Society of Plant Biologists.
3. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH

Freeman and Company, New York, USA.
4. Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology. John Wiley and Sons.
5. Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co. Ltd.

BSUBTA-101 English Communication Skill development **Credit2**

1. Communication and communicative activities of the notions of encoder and decoder and the message and the medium.
2. Concise grammatical structures and key vocabulary for general as well as specific purpose accuracy and appropriateness in the use of English.
3. English speech sounds and sound combinations.
4. Elements of Spoken English.
5. Topic of discourse, mode of discourse and style of discourse with special reference to scientific discourse.
6. Writing notes, reports, proceedings etc.
7. Expanding and summarizing.
8. Narrating and describing.
9. Tutorial for each topic.

BSUBTG-1(1,2,3,….n): MOOCS **Credit: 6**

MOOC Basket 1
MOOC Basket 2
MOOC Basket 3
MOOC Basket 4

SEMESTER-II

BSUBTC-201 General Microbiology Credit 4

UNIT I

Overview of history of Microbiology - Biogenesis and abiogenesis Contributions of Redi, Spallanzani, Needham, Pasteur, Tyndal, Joseph Lister, Koch [Germ Theory], Edward Jenner and Flemming [Penicillin], Scope of Microbiology.

Classification of Microbes - Systems of classification, Numerical taxonomy, Identifying characters for classification, General properties and principles of classification of microorganisms Systematics of bacteria, General properties of Archae and Eubacteria.

UNIT II

Staining: Concept of auxochrome, chromophore, dyes, Mechanism of gram staining, acid fast staining, negative staining, capsule staining, flagella and endospore staining.

UNIT III

Methods of isolation: Cultivation and Maintenance of microorganisms, Concept of Sterilization - Definition of sterilization, dry and moist heat, pasteurization, tyndalization; radiation, ultrasonication, filtration. Physical and Chemical methods of sterilization; disinfection sanitization, antisepsis sterilants and fumigation. Determination of phenol coefficient of disinfectant, Chemotherapeutic agents.

UNIT III

Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria. Nutritional types [Definition and examples]. Classification on the basis of oxygen requirement.

Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways Bacterial Reproduction: Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria.

UNIT IV

Water Microbiology: Bacterial pollutants of water, coliforms and non coliforms. Sewage composition and its disposal.

Food Microbiology: Important microorganism in food Microbiology: Moulds, Yeasts, bacteria.Major food born infections and intoxications, Preservation of various types of foods. Fermented Foods (Yoghurt, cheese, Idli, Kinema).

BSUBTC-291 (Lab)|Lab on General Microbiology] Credit 2

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Sampling and quantification of microorganisms in air, soil and water.
2. Isolation of bacteria [Streak plate, spread plate, pour plate,serial dilution].
3. Identification of microorganisms from the habitats [simple staining,differential staining, acid fast staining, capsule staining, spore staining and motility]
4. Observation of morphology - shape and arrangement of cells.
5. Methods of inoculation of different microbes in selective media.
6. Microscopic measurements, micrometer (ocular and stage).
7. Enumeration of microorganism - total & viable count.

Learning Resources:-

1. Alexopoulos CJ, Mims CW, and Blackwell M. (1996). Introductory Mycology. 4

thedition.ohn and Sons, Inc.
2. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7thedition, CBS Publishers and Distributors, Delhi, India.
3. Kumar HD. (1990). Introductory Phycology. 2nd edition. Affiliated East Western Press.
4. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. 12th edition. Pearson/Benjamin Cummings.
5. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
6. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.
7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9 th edition. Pearson Education.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

BSUBTC-202 Plant and Mammalian Physiology — Credit 4

UNIT IA

Digestion and Respiration

Digestion: Mechanism of digestion & absorption of carbohydrates, Proteins, Lipids and nucleic acids.
Respiration: Exchange of gases, Transport of O2 and CO2, Oxygen dissociation curve, Chloride shift.

UNIT IB

Simple & complex permanent tissues, primary structure of shoot & root, secondary growth, growth rings, leaf anatomy (dorsi-ventral and isobilateral leaf)

UNIT IIA

Circulation

Composition of blood, Plasma proteins & their role, blood cells, Haemopoisis, Mechanism of Coagulation of blood.Mechanism of working of heart: Cardiac output, cardiac cycle, Origin & conduction of heart beat.

UNIT IIB

Plant water relations and micro & macro nutrients

Importance of water to plant life, diffusion, osmosis, plasmolysis, imbibition, guttation, transpiration, stomata & their mechanism of opening &closing.Micro& macro nutrients: criteria for identification of essentiality of nutrients, roles anddeficiency systems of nutrients, mechanism of uptake of nutrients, mechanism of food transport.

UNIT IIIA

Muscle physiology and osmoregulation

Structure of cardiac, smooth & skeletal muscle, threshold stimulus, single muscle twitch, muscle tone, isotonic and isometric contraction, Physical, chemical & electrical events of mechanism of muscle contraction.

Excretion: modes of excretion, Ornithine cycle, Mechanism of urine formation

UNIT IIIB

Carbon and nitrogen metabolism

CO_2 Capture, Photosynthesis- Photosynthesis pigments, concept of two photo systems, photphosphorylation, calvin cycle, CAM plants, photorespiration, compensation point Nitrogen metabolism- inorganic & molecular nitrogen fixation, nitrate reduction and ammonium assimilation in plants.

UNIT IVA

Nervous and endocrine coordination

Mechanism of generation & propagation of nerve impulse, structure of synapse, synaptic conduction, saltatory conduction, Neurotransmitter Mechanism of action of hormones (insulin and steroids)Different endocrine glands– Hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid and adrenals, hypo & hyper-secretions.

UNIT IVB

Growth and development

Definitions, phases of growth, growth curve, growth hormones (auxins, gibberlins, cytokinins, abscisic acid, ethylene) Physiological role and mode of action, seed dormancy and seed germination, concept of photoperiodism and vernalization.

BSUBTC-292 (Lab)[Lab on Plant and mammalian Physiology] Credit 2

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Finding the coagulation time of blood
2. Determination of blood groups
3. Counting of mammalian RBCs
4. Determination ofHaemoglobin
5. Preparation of stained mounts of anatomy of monocot and dicot root and stem.
6. Separation of photosynthetic pigments by paper chromatography.
7. Demonstration of aerobic respiration and photosynthesis

LEARNING RESOURCES

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company.
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition. John wiley&sons,Inc.
3. Dickinson, W.C. 2000 Integrative Plant Anatomy. Harcourt Academic Press, USA.
4. Esau, K. 1977 Anatomy of Seed Plants. Wiley Publishers.
5. Fahn, A. 1974 Plant Anatomy. Pergmon Press, USA and UK.
6. Hopkins, W.G. and Huner, P.A. 2008 Introduction to Plant Physiology. John Wiley and Sons.
7. Mauseth, J.D. 1988 Plant Anatomy. The Benjammin/Cummings Publisher, USA.
8. elson, D.L., Cox, M.M. 2004 Lehninger Principles of Biochemistry, 4th edition, W.H. Freeman and Company, New York, USA.
9. Salisbury, F.B. and Ross, C.W. 1991 Plant Physiology, Wadsworth Publishing Co. Ltd.
10. Taiz, L. and Zeiger, E. 2006 Plant Physiology, 4thedition, Sinauer Associates Inc .MA, USA.

BSUBTA-201: Introduction to Environmental Science Credit2

UNIT I

Introduction to environmental studies & ecosystems: Multidisciplinary nature of environmental studies: Scope and importance; what is an ecosystem? The structure and function of ecosystem, Energy flow in an ecosystem, food chains, food webs and ecological succession, forest ecosystem, grassland ecosystem, desert ecosystem, aquatic ecosystems; Levels of biological diversity such as genetic, species and ecosystem diversity; biogeography zones of India, biodiversity patterns and global biodiversity hot spots, India as a mega-biodiversity nation, endangered and endemic species of

India, threats to biodiversity, habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions, conservation of biodiversity, in-situ and ex-situ conservation of biodiversity, concept of sustainability and sustainable development.

UNIT II

Natural resources & its management and conservation: Land resources and land use change: Land degradation, soil erosion and desertification; Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations; Water: Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state); Energy resources: Renewable and non renewable energy sources, use of alternate energy sources and growing energy needs.

UNIT III

Environmental pollution & management: Environmental pollution: types, causes, effects and controls; Air, water, soil and noise pollution, Solid waste management: Control measures of urban and industrial waste. Climate change, global warming, ozone layer depletion, acid rain and their impact on human communities and agriculture. Environment Laws: Environment Protection
Act, Air (Prevention & Control of Pollution) Act, Water (Prevention and control of pollution) Act, Wildlife Protection Act, Forest Conservation Act; International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD); Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context.

UNIT IV

Environment & social issues: Human population growth: Impacts on environment, human health and welfare; Resettlement and rehabilitation of project affected persons; case studies; Disaster management: floods, earthquake, cyclones and landslides; Environmental movements: Chipko, Silent valley, Bishnois of Rajasthan; Environmental ethics: Role of Indian and other religions and cultures in environmental conservation; environmental communication and public awareness.
Learning resources

1. Carson, R. 2002. Silent Spring. Houghton Mifflin Harcourt.
2. Gadgil, M., & Guha, R. 1993. This Fissured Land: An Ecological History of India. Univ. of California Press.
3. Gleeson, B. and Low, N . (eds.) 1999. Global Ethics and Environment, London, Routledge.
4. Gleick, P. H. 1993. Water in Crisis. Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press.
5. Groom, Martha J., Gary K. Meffe, and Carl Ronald Carroll. Principles of Conservation Biology. Sunderland: Sinauer Associates, 2006.
6. Grumbine, R. Edward, and Pandit, M.K. 2013. Threats from India's Himalaya dams. Science, 339: 36-37.
7. McCully, P. 1996. Rivers no more: the environmental effects of dams (pp. 29-64). Zed Books.
8. Pepper, I.L., Gerba, C.P. &Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press.
9. Rao, M.N. & Datta, A.K. 1987. Waste Water Treatment. Oxford and IBH Publishing Co. Pvt. Ltd.
10. Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012. Environment. 8th edition. John Wiley & Sons.
11. Rosencranz, A., Divan, S., & Noble, M. L. 2001. Environmental law and policy in India. Tripathi 1992.
12. Sengupta, R. 2003. Ecology and economics: An approach to sustainable development. OUP.
13. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. Ecology, Environmental Science and
14. CSthooednThsrei,orvpNai.ctSiso..,n JG.oShibn. sCWohnai,lneLdy. P&&u bSRloiasnvhsei. nn g,
,PN.Hew. (Dedesl)h.i .2 013. Conservation Biology: Voices from

15. Wilson, E. O. 2006. The Creation: An appeal to save life on earth. New York: Norton.
16. World Commission on Environment and Development. 1987. Our Common Future. Oxford University Press.

BSUBTA-202 Introduction to Fundamental Computer **Credit-2**

Unit -I

Generation of computer: 1st to 4th generation with their characteristics .Basic concept of computer: Introduction, different components of computer, basic design of computer.

Unit-II

Introduction to operating system, Introduction to OS, different management (processor, memory, device, file),

Unit-III

Processor management-Process concept, Threads, CPU Scheduling Process scheduling, Deadlocks, Process synchronization.

Unit-IV

Memory management –Memory allocation rule, Swapping, Overlay, Paging, Demand paging ,segmentation ,virtual memory. Device management, File management.

Reference Books:

- Computer Fundamentals – by Pradeep K Sinha, Priti Sinha
- Operating System Concepts – by Abraham Silberschatz, Peter B. Galvin, Gerg Gange
- Operating System – by P. Bala Krishna Prasad
- Digital Design - by M. Morris R. Mano (Author), Michael D. Ciletti (Author)
- Digital Logic and Computer Design – by M. Morris Mano.

BSUBTG-2(1,2,3,….n): MOOCS **Credit: 6**

MOOC Basket 1
MOOC Basket 2
MOOC Basket 3
MOOC Basket 4

SEMESTER-III

BSUBTC- 301 Genetics — Credit 4

UNIT I

Prokaryotic Genomes - Physical organization of bacterial genomes (Structure of the bacterialnucleoid, Replication and partitioning of the bacterial genome and Genome of Archaea).Mechanism of genetic exchange: Plasmid and bacterial sex, Types of plasmids (F Plasmid : a Conjugate plasmid', Mobilization of Non-conjugative plasmid, R plasmid, Col plasmid Copy number and incompatibility), Episomes.

Transcriptional regulation in prokaryotes (inducible and repressible system, positive regulation and negative regulation); Operon concept – lac, trp, Ara operons. Transduction (Generalized transduction, Specialized Transduction)- gene mapping.

UNIT II

Genome organisation and Fine structure of the Gene: Genes and Gene numbers, C value paradox, Denaturation and Renaturation of DNA- Tm values and Cot curves, Repetitive and non-repetitive DNA, Inverted and Tandem repeats, Satellite DNA, Gene clusters-Histone, rRNA

Eukaryotic Chromosome- Macro-molecular organization. Primary and Secondary constriction, Sat-bodies, telomeres. Heterochromatin and Euchromatin and its significance. Ultrastructureof chromosome- Nucleosome model and Nucleosome Structure.

UNIT III

Unique genetic features of plants - Ability to photosynthesize, Totipotency of plant cells, Hermaphroditism and ability to reproduce both sexually and asexually, Doublefertilization, Alternation of generations, Mitosis in haploid state.

Genes controlling flower development in Plants – genes responsible for steps offlower development, genes for floral organ identity, MADS-Box genes, molecular expression of floral organ genes andfloral commitment genes.

Genome Organization and Function - Analysis of Genomes by Re-association Experiments,Organization of Single-copy Sequences, Chloroplast Genome Organization, Mitochondrial Genome Organization, RNA editing.

Cis-acting elements and Trans-acting factors – Regulatory sequences that control gene expression, Enhancer and Silencer elements, role of 3' sequences, role of introns, conserved sequences in Eukaryotic promoters, Cis-acting elements, Trans-acting factors, Transposon tagging of Plant genes – McClintock and the Ac-Ds transposable elements of Corn,

UNIT IV

Chromosomal variation in Number & Structure– Euploidy, Non-disjunction & Aneuploidy, Aneuploid segregation in plants and animal, Polyploidy in Plants & Animals, Induced Polyploidy, applications of Polyploidy, Chromosomal Mosaics, Polytene chromosome in Diptera, structural chromosomal variation, Chromosomal aberrations & evolution.

Human Cyto-Genetics– Human karyotype, Banding techniques, classification, use of Human Cyto-genetics in Medical science, , viable monosomies&trisomies, chromosomal deletions & duplications, genetics of chromosomal inversions & translocations, human traits.

BSUBTC-391: (Lab) [Lab on Genetics] — Credit 2

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Permanent and temporary mount of mitosis.
2. Permanent and temporary mount of meiosis.
3. Problems based on Reassociation Kinetics

4. Karyotyping with the help of photographs.

Learning Resources

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Edition John Wiley & Sons.
2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.
4. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis, W. H. Freeman & Co.4. Theory and problems in Genetics by Stansfield.

BSUBTC-302 Chemistry I — Credit 4

Atomic Structure, radioactivity and Nuclear Structure of Atoms:
Bohr,s atomic model & limitation. Idea of de Broglie matter weaves. Hisenberg'suncertaintyprinciple. Schrodinger's wave equation. Significance of wave function. Quantum numbers. Multielectron system- Pauli's exclusion principal, Hunds rules of maximum multiplicity. Stability of half filled and full field orbitals, Afbau principal & its limitation. Electronic configuration of atoms.
Radioactive disintegration series, group displacement law, law of radioactive decay, half-life and average life of radio elements, radioactive equilibrium, measurement of radioactivity. Stability of atomic nucleus, n/p ratio. Radioisotopes and their application: Determination of age of earth, radio carbon dating, Medicinal and agriculture use of isotopes, hazards of radio activity.

Chemical Bonding and Structure:

(a) Ionic Bonding:
General characteristics of ionic compounds: ionization energy, electron affinity etc. Sizes of Ions, radius ratio rule and its limitation. Lattice energy, Born-Haber cycle.
(b) Covalent Bonding:

General characteristics of covalent compounds, valence bond approach, directional character of covalent bond, hybridization involving s-, p- and d- orbitals. Valence State Electron Pair Repulsion (VSEPR) concept, shapes of simple molecules and ions. Fajan's Rules, M.O. Theory. Hydrogen bonding and its effect on physical and chemical properties. Others types of molecular interaction.

Acids-Bases and Solvents:
Modern concepts of acids and bases: Arrhenius theory, theory of solvent system, Bronsted and Lowry's concept, Lewis concept with typical examples, applications and limitations. Strengths of acids and bases (elementary idea). Ionization of weak acids and bases in aqueous solution, ionization constants, ionic product of water, pH scale

Nomenclature and Bonding in organic compounds :
Classification, trivial names and IUPAC system of nomenclature of organic compounds. Nature of covalent bond and its orbital representation. Hybridization, bond energy, polarity of bond & dipole moment of molecules, inductive effect, hydrogen bond, conjugation, resonance.
Haemolytic&heterolytic fission of bonds electrophiles & nucleophiles, carbocation, carbanions and radicals- there stability, geometry & generation.

Alkanes, Alkenes, Alkynes:
Isomerism, synthesis , chemical reactivity of alkanes, Mechanism of free radical halogenation of

alkanes, sulphonation of alkanes. Chemical reactivity, hydrogenation, heat of hydrogenation and stability of alkanes, electrophilic addition reaction & mechanism, halogenation, hydrohalogenation, hydration, hydroboration, Markownikoffs rule, peroxide effect, 1-3 dipolar addition (only formation no details mechanism is required). Alkyne synthesis hydration, substitution reactions, polymerization.

Mechanism of SN1 & SN2 reactionSNi reaction, E1&E2 reaction (elementary treatment) of aliphatic hydrocarbon. Saytzeff& Hofmann elimination.

Aromatics Hydrocarbons and Aromatic substitution reactions :
Isomerism of aromatic compounds, their nomenclature, structure of benzene ring. General mechanism of aromatic electrophilic substitution (elementary treatment)

Methods of synthesis, nitration, Sulphonation, halogenation.
Friedel-crafts alkylation and acylation, reaction, nuclear and side chain halogination. Mechanism of Nucleophilic and electrophilic aromatic substitution.

Stereochemistry:
Dissymmetric Molecules: Different types of Isomerism,Structural Isomers, Geometrical, Stereoisomerism, Configurational Isomers, Conformational Isomers, Concept of asymmetric carbon atom, Enantiomers, Diastereiosmers, Stereogenic atom / center, Chirotopic / Achirotopic Centre, Protereoisomerism, Concept of Topicity of Ligands and Faces (Homotopic, Enantiotopic, Diastereotopic atoms and groups; Prochiral, Homotopic, Enantiotopic, Diastereotopic Faces), Projection Structures of Streoisomers (Fischer, Sawhorse, Newman, Flying-Wedge projection and Interconversion of these projections formulas) of simple molecules containing one or two asymmetric carbon atom, Optical isomerism, Optical activity, Element of symmetry and chirality,Meso compounds, Chiral centers and the number of stereoisomers, Racemic modifications,Racemic mixture or (+/-)-Conglomerate, Racemic Compounds or racenate, Stereochemical nomenclature of Stereoisomers containing chiral centers(R/S and E/Z or cis-trans or sec cis- sec trans of C=C system);D,L system of designation; Pro-R, Pro-S, Re, Si, Erythro, threo, Pref and Praf designation of enantiotopic groups and atoms; Chirality of Organic molecules without chiral center and concept of chiral axis.

Alcohols, Ethers and phenols:
Methods of synthesis, physical properties, distinction of primary, secondary and tertiary alcohols. Chemical reactivity. Ethers, methods of synthesis, Chemical reactivity. physical properties acidic character of phenols, chemical reaction –Reimer-Tiemann reaction, Fries rearrangement, Kolbe's reaction, phenol formaldehyde resins (Lederer-Manasse reaction) Cresols, nitro and amino phenols.(Synthesis only).

Aldehydes and ketones:
Methods of synthesis of aldehydes and ketones, chemical reactivity of carbonyl group, cannizzaro reaction and aldol condensation, relative reactivities of aldehyde and ketones. Perking reaction, benzoine condensation, Claisen condensation.

Carboxylic acid and their derivatives:
Methodes of synthesis, acidity of aliphatic and aromatic acid, effects of substitutents on acidity (simple cases). Chemicalreactivity. Mechanism of esterification. Methods of synthesis and reaction of acid halides, amides, esters and anhydrides.

BSUBTC-392: (Lab)[Lab on Chemistry] **Credit 2**

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Qualitative organic analysis:

Detection of elements (N,S,Cl,Br,I), unsaturation & all the functional groups (alcoholic & phenolic

hydroxyl/ aldehydic & ketonic carbonyl / carboxylic acid & aromatic amino, anilide and nitro) present in a supplied mono- or bi- functional organic compounds.

2. Gravimetric Analysis :

Techniques of Precipitations, filtration, washing, drying, igniting and weighing precipitates.Gravimatric estimation of any ion. Determination of hardness water.

3. Qualitative Inorganic Analysis:

Estimation of glucose & phenol. sulphaides, sulphites, sulphates, nitrites, nitrates, nitrites, & phosphates, (Acid insoluble compounds & phosphate separation omitted).

Learning Resources:-

1. Inorganic Chemistry by R. L. Dutta
2. Organic Chemistry by I. L. Finer (Vol. I)
3. Advanced practical chemistry, 3rd edition by Subhas C Das
4. An advanced course in practical chemistry by Ghoshal, Mahapatra and Nad.

BSUBTC- 303: Molecular Biology Credit4

UNIT I

DNA structure and replication.

DNA as genetic material, structure of DNA, Types of DNA, Replication of DNA in prokaryotes and Eukaryotes, Semiconservative nature of DNA replication, Bi-directional replication, DNA polymerases, The replication complex: Pre-primming proteins, primosome, replisome, Rolling circle replication, Unique aspects of eukaryotic chromosome replication, Fidelity of replication.

UNIT II

DNA damage, repair, nonhomologous and homologous recombination.

DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Photo-reactivation, base excision repair, nucleotide excision repair, mismatch repair, translesion synthesis, recombinational repair, nonhomologous end joining. Homologous recombination:models and mechanism.

UNIT III

Transcription and RNA processing.

RNA structure and types of RNA, Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters,enhancers, mechanism of transcription initiation, promoter clearance and elongation RNA splicing and processing: processing of pre-mRNA: 5' cap formation, polyadenylation, splicing, rRNA and tRNA splicing.

UNIT IV

Regulation of gene expression and translation.

Regulation of gene expression in prokaryotes: Operon concept (inducible and system), Genetic code and its characteristics, Prokaryotic and eukaryotic eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoacyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides, Fidelity of translation, Inhibitors of translation., Posttranslational modifications of proteins.

UNIT V

How to clone a gene.

What is clone, overview of the procedure, Gene library, hybridization Cutting and Joining DNA-Restriction Endonucleases, Ligation, Alkaline phosphate, Modification of Restriction fragment ends, Other ways of joining DNA molecules. Plasmid vectors, Vectors based on the lambda bacteriophage,cosmids, M13 vectors, Expression vectors, Vectors for cloning and expression in

Eukaryotic cells, Super vectors- YACs and BACs

BSUBTC- 393(Lab) [lab On Molecular Biology] **Credit2**

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Preparation of buffers and solutions for molecular biology experiments
2. DNA isolation from Cabbage leaves/ goat liver/Human blood and Microbes
3. Plasmid DNA isolation
4. Agarose gel Electrophoresis of genomic DNA and plasmid DNA
5. Preparation of restriction digestion of DNA samples
6. Gel Documentation and photography Learning Resources

Reference:

1. Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication
2. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7th edition,Pearson Benjamin Cummings Publishing, San Francisco
3. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia
4. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc.
5. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
6. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
7. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India.

BSUBTS- 301:Enzymology **Credit2**

UNIT - I

Isolation, and purification of enzymes, Enzyme classification (rationale, overview and specific examples) Enzyme substrate complex: concept of E-S complex, binding sites, active site, specificity, Kinetics of enzyme activity, Michaelis-Menten equation and its derivation, Different plots for the determination of Km and Vmax and their physiological significance, factors affecting initial rate, E, S, temp. &pH.

UNIT - II

Mechanism of enzyme action: General mechanistic principle, factors associated with catalytic efficiency: proximity, orientation, distortion of strain, acid-base, nucleophilic and covalent catalysis. Techniques for studying mechanisms of action, chemical modification of active site groups, specific examples-: chymotrypsin, Iysozyme, GPDH, aldolase, RNase, Carboxypeptidase and alcohol dehydrogenase. Enzyme regulation: Product inhibition, feed backcontrol, covalent modification.

UNIT – III

Allosteric enzymes with special reference to aspartate transcarbomylase and phosphofructokinase. Qualitative description of concerted and sequential models. Negative cooperativity and half site reactivity. Enzyme - Enzyme interaction, Protein ligand binding, measurements analysis of binding isotherm, cooperativity, Hill and scatchard plots, kinetics of allosteric enzymes

UNIT - IV

Enzyme Technology: Methods for large scale production of enzymes. Immobilized enzyme and their comparison with soluble enzymes, Methods for immobilization of enzymes. Immobilized enzyme

reactors. Application of Immobilized and soluble enzyme in health and industry. Application to fundamental studies of biochemistry.

Learning Resources

1. Biochemistry, LubertStryer, 6th Edition, WH Freeman, 2006.
2. Harper's illustrated Biochemistry by Robert K. Murray, David A Bender, Kathleen M.Botham, Peter J. Kennelly, Victor W. Rodwell, P. Anthony Weil. 28th Edition, McGrawHill, 2009.
3. Biochemistry, Donald Voet and Judith Voet, 2nd Edition, Publisher: John Wiley and Sons, 1995.
4. Biochemistry by Mary K.Campbell& Shawn O.Farrell, 5th Edition, Cenage Learning,2005.
5. Fundamentals of Enzymology Nicholas Price and Lewis Stevens Oxford University Press 1999
6. Fundamentals of Enzyme Kinetics Athel Cornish-Bowden Portland Press 2004
7. Practical Enzymology Hans Bisswanger Wiley–VCH 2004
8. The Organic Chemistry of Enzyme-catalyzed Reactions Richard B. Silverman Academic Press 2002.

BSUBTS-302 Industrial Biotechnology Credit2

UNIT I

Production of industrial chemicals, biochemicals and chemotherapeutic products. Propionic acid, butyric acid, 2-3 butanediol, gluconic acid, itaconic acid, Biofuels: Biogas, Ethanol, butanol, hydrogen, biodiesel, microbial electricity, starch conversion processes; Microbial polysaccharides; Microbial insecticides; microbial flavours and fragrances, newer antibiotics, anti cancer agents, amino acids.

UNIT II

Microbial products of pharmacological interest, steriod fermentations and transformations. Over production of microbial metabolite, Secondary metabolism – its significance and products. Metabolic engineering of secondary metabolism for highest productivity. Enzyme and cell immobilization techniques in industrial processing, enzymes in organic synthesis, proteolytic enzymes, hydrolytic enzymes, glucose isomerase, enzymes in food technology/organic synthesis.

UNIT III

Purification & characterization of proteins, Upstream and downstream processing, solids and liquid handling. Distribution of microbial cells, centrifugation, filtration of fermentation broth, ultra centrifugation, liquid extraction, ion-exchange recovery of biological products. Experimental model for design of fermentation systems, Anaerobic fermentations.

UNIT IV

Rate equations for enzyme kinetics, simple and complex reactions. Inhibition kinetics; effect of pH and temperature on rate of enzyme reactions. Mathematical derivation of growth kinetics, mathematical derivations of batch and continuous culture operations; single stage CSTR; mass transfer in aerobic fermentation; resistances encountered; overall mass transfer co-efficient (Ka) determination, factors depending on scale up principle and different methods of scaling up. Metabolic engineering of antibiotic biosynthetic pathways.

Learning Resource

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
4. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.
5. Salisbury, Whitaker and Hall. Principles of fermentation Technology,

BSUBTS-303 Plant and Animal Chromosome Preparation and Karyotyping Credit-2

1. Basic Principle of Cytogenetics Procedure- Specimen procurement , culture procedure,harvesting, slide making (plant and animal)
2. Chromosome Preparation from Different Plant Parts- basic procedures
3. Peripheral Blood and Bone Marrow Culture- sample collection , setting up of culture, media preparation and culture procedure, significance of different types of culture
4. Chromosome Staining (Plant and Animal)- Acetoorcein and feulgen staining for plants – principle and methods, conventional giemsa staining, differential staining techniques
5. Photomicrograph and Image Processing –basic concepts
6. Chromosome Analysis and Karyotype - Karyotyping of normal male and female individuals and interpretentions, plant chromosomes grouping
7. Chromosome Identification- individual band position and characteristics

Learning resources-

Barch MJ et al. The AGT cytogenetics Laboratory Manual; 3rd ed,1007, Lippincott-Raven; New York

PurandareHema&Chakravarty Amit: Human cytogenetics Techniques& clinical applications,2000, Bhalani Publishing House, Mumbai

Culture of Animal cells-a manual of basic Techniques:R IAN Freshney (Wiley Publication)

Arun Kumar Sharma and Archana Sharma :2014 Chromosome Techniques Theory and Practice, Butterworth-Heinemann, Oxford,

BSUBTG-3(1,2,3,….n): MOOCS Credit 6

MOOC Basket 1
MOOC Basket 2
MOOC Basket 3
MOOC Basket 4

SEMESTER-IV

BSUBTC-401: Immunology **Credit 4**

UNIT I
Introduction
Concept of Innate and Adaptive immunity; Contributions of following scientists to the development of field of immunology - Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Peter Medawar, MacFarlane Burnet, Neils K Jerne, Rodney Porter and Susumu Tonegawa

UNIT II
Immune Cells and Organs
Structure, Functions and Properties of: Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT

UNIT III
Antigens
Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T & B cell epitopes); T-dependent and T-independent antigens; Adjuvants

UNIT IV
Antibodies
Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic); Monoclonal and Chimeric antibodies

UNIT V
Major Histocompatibility Complex
Organization of MHC locus (Mice & Human); Structure and Functions of MHC I & II molecules; Antigen processing and presentation (Cytosolic and Endocytic pathways)

UNIT VI
Complement System
Components of the Complement system; Activation pathways (Classical, Alternative and Lectin pathways); Biological consequences of complement Activation

UNIT VII
Generation of Immune Response
Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response (Self MHC restriction, T cell activation, Co- stimulatory signals); Killing Mechanisms by CTL and NK cells, Introduction to tolerance

UNIT VIII
Immunological Disorders and Tumor Immunity
Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies - Animal models (Nude and SCID mice), SCID, DiGeorge syndrome, Chediak- Higashi syndrome, Leukocyte adhesion deficiency, CGD; Types of tumors, tumor Antigens and cancer.

UNIT IX
Immunological Techniques

Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT, Western blotting, Immunofluoresence, Flow cytometry, Immunoelectron microscopy.

UNIT X

Vaccines & Vaccination

adjuvants, cytokines, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, vaccines to other infectious agents, tumor vaccines, principles of vaccination, passive & active immunization, immunization programs & role of WHO in immunization programs.

BSUBTC- 491(Lab)[Immunology] **Credit 2**

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Identification of human blood groups.
2. Perform Total Leukocyte Count of the given blood sample.
3. Perform Differential Leukocyte Count of the given blood sample.
4. Separate serum from the blood sample (demonstration).
5. Perform immunodiffusion by Ouchterlony method.
6. Immunoelectrophoresis
7. Antigen- antibody reaction (Coomb's test)
8. ELISA.
9. antibody and antigen(Ouchterlony method)

Learning Resources

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6 th edition Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley-Blackwell Scientific Publication, Oxford.
3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
4. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.
5. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
6. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

BSUBTC-402: Chemistry II **Credit 4**

Chemical analysis :

i) Comparative study of the following groups of elements:

(a) B, Al (b) C, Si, Ge, Sn, Pb (c) N, P, As, Sb, Bi, (d) O, S, Se, Te (e) F,Cl, Br,I

In respect of electronic configuration, elemental states, oxidation states, hydrides, halides, oxides, and oxyacides.

Double & complex salt:

Werner's theory of co-ordination compounds. Chelates. Polydentate ligands including naturally occurring ones. Electronic interpretation of compounds formation. Stepwise and overall stability constants. (elementary idea only) Geometrical & optical isomerism. Nomenclature of coordination compounds.

Interhalogen compounds:

Basic properties of iodine, pseudo halogens.

Organometallic Compounds:
Organomagnesium Compounds, Organozinc Compounds, Organolead Compounds, Organocadmium Compounds.
Bio-inorganic chemistry
Role of metal complexes in biological system : Role of Iron and Magnesium

Ideal and real Gases:
Distribution of molecular velocities, root-mean-square velocity, kinetic molecular theory of ideal gases, deduction of kinetic gas equation. P=⅓mnc2, deduction of gases laws. Deviations of real gas from ideal behavior, vanderwaal's equation. Andrews experiment, critical phenomena in light of vanderwaal's equation of state, law of corresponding state.

Thermodynamics and Homogeneous chemical equilibrium:
Cyclic process, Reversible & irreversible process , internal energy, enthalpy, work Done, an isothermal & adiabatic process, heat capacities, Cp-Cv =R for an ideal gas. Thermochemistry, Carnot cycle, Elementary treatment of entropy, free entry, work function & criterion of equilibrium. Gibbs Helmohltz equation, ClasiousClapeyron equation and its application. Law of mass action and equilibrium constant Kp,Kc,Kx and their relationship. Le-chatelier's principal- effect of temperature, pressure and addition of products and inert gases. vant'shoff equation (derivation not required) and its application.

Solubility and Ionic Equilibrium:
Solubility product, common ion effect and factors of solubility. Strong and weak electrolytes degree of dissociation. Ostwald's dilution law. Hydrolysis, buffer, calculation of pH, salt effect, elementary idea of activity & activity co-efficient of electrolytes, ionic strength, buffer reaction of blood.

EMF :
Electrochemical cells, half-cell, electrode potential, standard electrode potential, Nernst equation, redox potential, reference electrode,standered cell, measurement of emf, determination of pH, potentiometric titration, storage battery, corrosion.

Dilute solution:
Rault's law, ideal solution, non- ideal solution, and qualitative treatment of colligative properties relative lowering of vapour pressure, elevation of boiling point, and osmotic pressure-their application in finding molecular weight. Van't Hoff 'i' factor, plasmolysis, haemolysis, isotonic solution, normal saline, role of osmosis in living organism.

Reference books:
1. Inorganic Chemistry by R. L. Dutta
2. Organic Chemistry by I. L. Finer (vol. I)
3. Physical chemistry by P. C. Rakshit

BSUBTC-492: (Lab)[lab On Chemistry] **Credit-2**

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Quantitative inorganic analysis
2. Preparation and standardization Mohr's solution by KMnO4 solution.
3. Preparation of standard K2Cr2O7 solution and standardization
4. Mohr's Salt solution.
5. Sodium thiosulphate solution.
6. Estimation of Fe(II) +Fe (III) mixture using standard solution ofK2Cr2O7
7. Determination of Cu (II) using standard sodium thiosulphatesolution.

BSUBTC-403 Bio-Analytical Tools — Credit 4

UNIT I
Simple microscopy, phase contrast microscopy, fluorescence and electron microscopy (TEM and SEM), pH meter

UNIT II
Absorption Spectroscopy – Simple theory of the absorption of light by molecules, Beer-Lambert law, Instrumentation for measuring the absorbance of visible light, Factors affecting the absorption properties of a Chromophore. Principle of absorption fluorimetry,

UNIT III
Centrifugation – Basic Principle of Centrifugation, Instrumentation of Ultracentrifuge (Preparative, Analytical), Factors affecting Sedimentation, Standard Sedimentation Coefficient, Rate-Zonal centrifugation, sedimentation equilibrium Centrifugation. Cell fractionation techniques, isolation of sub- cellular organelles and particles.

UNIT IV
Introduction to the principle of chromatography. Paper chromatography, thin layer chromatography, column chromatography: silica and gel filtration, affinity and ion exchange chromatography, gas chromatography, HPLC. Introduction to electrophoresis. Starch-gel, polyacrylamide gel (native and SDS-PAGE), agarose-gel electrophoresis, pulse field gel electrophoresis, immuno- electrophoresis, isoelectric focusing, Western blotting.

UNIT V
Mass spectrometry(MALDI, ESI) and Introduction to Biosensors and Nanotechnology and their applications. Radioactive labeling & counting, Autoradiography.

UNIT VI
X-Ray Crystallography – X-ray diffraction, Bragg equation, Reciprocal lattice, Miller indices & Unit cell, Concept of different crystal structure, determination of crystal structure [concept of rotating crystal method, powder method].

UNIT VII
NMR Spectroscopy – Basic principle of NMR spectroscopy, Experimental technique & instrumentation, Chemical shift, hyperfine splitting, Relaxation process

BSUBTC-492 (Lab)[Bio-Analytical Tools] — Credit 2

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Microscopy-light microscopy: principles, , parts and function, operation
2. Principles and operations of incubators, centrifuge
3. Principles and operations of pH meter and colorimeter
4. Determination pH of unknown solution
5. Native gel electrophoresis of proteins
1. Separation of sample mixture by column chromatography
2. Principles and operations of spectrophotometer
3. To identify lipids in a given sample by TLC.
4. Separation of amino acids by paper chromatography
5. Preparation of the sub-cellular fractions of liver cells.

Learning Resources:
1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley& Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM, Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009
5. The World of the Cell.7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

BSUBTS-401 : Molecular Diagnostics — Credit-2

UNIT I
Enzyme Immunoassays: Comparison of enzymes available for enzyme immunoassays, conjugation of enzymes. Solid phases used in enzyme immunoassays. Homogeneous and heterogeneous enzyme immunoassays. Enzyme immunoassays after immuno blotting. Enzyme immunohistochemical techniques. Use of polyclonal or monoclonal antibodies in enzymes immuno assays. Applications of enzyme immunoassays in diagnostic microbiology

UNIT II
Molecular methods in clinical microbiology: Applications of PCR, RFLP, Nuclear hybridization methods, Single nucleotide polymorphism and plasmid finger printing in clinical microbiology Laboratory tests in chemotherapy: Susceptibility tests: Micro-dilution and macro-dilution broth procedures. Susceptibility tests: Diffusion test procedures. Susceptibility tests: Tests for bactericidal activity. Automated procedures for antimicrobial susceptibility tests (.Lab – Demonstration of RAPD, Kirby-Bauyer method (disc-diffusion method) to study antibiotic sensitivity of a bacterial culture)

UNIT III
Automation in microbial diagnosis, rapid diagnostic approach including technical purification and standardization of antigen and specific antibodies. Concepts and methods in idiotypes. Antiidiotypes and molecular mimicry and receptors. Epitope design and applications. Immunodiagnostic tests. Immuno florescence. Radioimmunoassay.

UNIT IV
GLC, HPLC, Electron microscopy, flowcytometry and cell sorting.

Reference:
Culture of Animal cells-a manual of basic Techniques:R IAN Freshney (Wiley Publication)
Arun Kumar Sharma and Archana Sharma :2014 Chromosome Techniques Theory and Practice, Butterworth-Heinemann, Oxford,

BSUBTS- 402 : Plant-Microbe Interaction — Credit-2

UNITI: General account about the microbes used as biofertilizer – Rhizobium – isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis.

UNIT II: Azospirillum: isolation and mass multiplication – carrier based inoculant, associative effect of different microorganisms. Azotobacter: classification, characteristics – crop response to Azotobacter inoculum, maintenance and mass multiplication.

UNITIII: Cyanobacteria (blue green algae), Azolla and Anabaena azollae association, nitrogen fixation, factors affecting growth, blue green algae and Azolla in rice cultivation.

UNITIV: Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants.

UNIT V: Organic farming – Green manuring and organic fertilizers, Recycling of biodegradable municipal, agricultural and Industrial wastes – biocompost making methods, types and method of vermicomposting – field Application.

Learning Resources

1. Dubey, R.C., 2005 A Text book of Biotechnology S.Chand& Co, New Delhi.
2. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.
3. John Jothi Prakash, E. 2004. Outlines of Plant Biotechnology. Emkay Publication, New Delhi.
4. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.
5. SubhaRao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New Delhi.
6. Vayas,S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic Farming AktaPrakashan, Nadiad

BSUBTS-403 Research Methodology — Credit-2

UNITI: Foundations of Research
Meaning, Objectives, Motivation: Research Methods vs Methodology, Types of Research: Analytical vs Descriptive, Quantitative vs Qualitative, Basic vs Applied

UNIT II: Research Design
Need for research design: Features of good design, Important concepts related to good design- Observation and Facts, Prediction and Explanation, Development of Models. Developing a research plan: Problem identification, Experimentation, Determining experimental and sample designs

UNIT III: Data Collection, Analysis and Report Writing
Observation and Collection of Data-Methods of data collection- Sampling Methods, Data Processing and Analysis Strategies, Technical Reports and Thesis writing, Preparation of Tables andBibliography. Data Presentation using digital technology.

UNITIV: Ethical Issues
Concepts of Copy Right, Royalty, Patent law, Plagiarism, Citation, Acknowledgement

BSUBTS-404 Basics of Forensic Science — Credit-2

UNIT I
Introduction and principles of forensic science, forensic science laboratory and its organization and service, tools and techniques in forensic science, branches of forensic science, causes of crime, role of modus operandi in criminal investigation. Classification of injuries and their medico-legal aspects, method of assessing various types of deaths.

UNIT II
Classification of fire arms and explosives, introduction to internal, external and terminal ballistics. Chemical evidence for explosives. General and individual characteristics of handwriting, examination and comparison of handwritings and analysis of ink (various samples).

UNIT III

Role of the toxicologist, significance of toxicological findings, Fundamental principles offingerprinting, classification of fingerprints, development of finger print as science for personal identification.

UNIT IV

Principle of DNA fingerprinting, application of DNA profiling in forensic medicine, Investigation Tools, e-Discovery, Evidence Preservation, Search and Seizure of Computers, Introduction to Cyber security.(Lab- Demo on PCR amplification on target DNA and DNA profiling).

BSUBTG-4(1,2,3,….n): MOOCS **Credit 6**

MOOC Basket 1
MOOC Basket 2
MOOC Basket 3
MOOC Basket 4

SEMESTER-V

BSUBTC-501:Bioprocess Technology **Credit 4**

UNIT I
Introduction to bioprocess technology. Range of bioprocess technology and its chronological development. Basic principle components of fermentation technology. Types of microbial culture and its growth kinetics– Batch, Fedbatch and Continuous culture.

UNIT II
Design of bioprocess vessels- Significance of Impeller, Baffles, Sparger; Types of culture/production vessels- Airlift; Cyclone Column; Packed Tower and their application in production processes. Principles of upstream processing – Media preparation, Inocula development and sterilization.

UNIT III
Introduction to oxygen requirement in bioprocess; mass transfer coefficient; factors affectingKLa. Bioprocess measurement and control system with special reference to computer aided process control.

UNIT IV
Introduction to downstream processing, product recovery and purification. Effluent treatment. Microbial production of ethanol, amylase, lactic acid and Single Cell Proteins.

BSUBTC- 591Bioprocess technology (Lab) **Credit 2**

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Bacterial growth curve.
2. Calculation of thermal death point (TDP) of a microbial sample.
3. Production and analysis of ethanol.
4. Production and analysis of amylase.
5. Production and analysis of lactic acid.

Suggested Reading

1. Shuler, M. L., & Kargi, F. (2002). Bioprocess Engineering: Basic Concepts. Upper Saddle River, NJ: Prentice Hall
Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
4. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

BSUBTC-502 Recombinant DNA Technology **Credit 4**

UNIT I
Molecular tools and applications- restriction enzymes, ligases, polymerases, alkalinephosphatase. Gene Recombination and Gene transfer: Transformation, Episomes, Plasmids and other cloning vectors (Bacteriophage-derived vectors, artificial chromosomes), Microinjection,Electroporation,

Ultrasonication, Principle and applications of Polymerase chain reaction (PCR),primer-design, and RT- (Reverse transcription) PCR.

UNIT II

Restriction and modification system, restriction mapping. Southern and Northern hybridization.Preparation and comparison of Genomic and cDNA library, screening of recombinants, reverse transcription,. Genome mapping, DNA fingerprinting, Applications of Genetic Engineering,Genetic engineering in animals: Production and applications of transgenic mice, role of ES cells in gene targeting in mice, Therapeutic products produced by genetic engineering-blood proteins, human hormones, immune modulators and vaccines (one example each).

UNIT III

Random and site-directed mutagenesis: Primer extension and PCR based methods of site directed mutagenesis, Random mutagenesis, Gene shuffling, production of chimeric proteins, Protein engineering concepts and examples (any two).

UNIT IV

Genetic engineering in plants: Use of Agrobacterium tumefaciens and A. rhizogenes, Ti plasmids, Strategies for gene transfer to plant cells, Direct DNA transfer to plants, Gene targeting in plants, Use of plant viruses as episomal expression vectors.

BSUBTC-592: Recombinant DNA Technology (Lab) Credit 2

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Isolation of chromosomal DNA from plant cells
2. Isolation of chromosomal DNA from E.coli
3. Qualitative and quantitative analysis of DNA using spectrophotometer
4. Plasmid DNA isolation
5. Restriction digestion of DNA
6. Making competent cells
7. Transformation of competent cells.
8. Demonstration of PCR

Learning resources:

1. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pazdernik NJ. (2009). Biotechnology-Applying the Genetic Revolution. Elsevier Academic Press, USA.
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington
4. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
5. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.

BSUBTD- 501A Animal Biotechnology Credit: 6

1. Gene transfer methods in Animals – Microinjection, Embryonic Stem cell gene transfer, Retrovirus & Gene transfer.
2. Transgenic Animals – Mice, Cow, Pig, Sheep, Goat, Bird, Insect.

3. Animal diseases need help of Biotechnology – Foot-and-mouth disease, Coccidiosis, Trypanosomiasis, Theileriosis.
4. Animal propagation – Artificial insemination, Animal Clones.
5. Cryopreservation technology Basic techniques,–Animal cell culture and cryopreservation, Embryo conservation techniques Role of cryopreservation in assisted reproductive technology.

SUGGESTED READING

1. Brown, T.A. (1998). Molecular biology Labfax II: Gene analysis. II Edition. Academic Press, California,USA.
2. Butler, M. (2004). Animal cell culture and technology: The basics. II Edition. Bios scientific publishers.
3. Glick, B.R. and Pasternak, J.J. (2009). Molecular biotechnology- Principles and applications of recombinant DNA. IV Edition. ASM press, Washington, USA.
4. Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). An introduction to genetic analysis. IX Edition. Freeman & Co., N.Y., USA.
5. Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). Recombinant DNA genes and genomes- A short course. III Edition. Freeman and Co., N.Y., USA.

BSUBTD- 502 A: Model Organism and Human Genome Project Credit: 6

UNIT I
Genome – about genomes of model organisms (E. coli, Yeast, Arabidopsis thaliana, C. elegans, Drosophila melanogaster, laboratory mouse, Zebra fish, Human), types of genomes, genomes & genetic variation, comparison of different genomes, genome evolution.
Genomics – about the genomics, history, comparative genomics, comparative genomic hybridization, functional genomics.

UNIT II
Genome projects – an overview of genome projects of human and other model organisms of Human Genome Project.
Human Genome Project (HGP) – an overview of the project, goals of the project, major scientific strategies & approaches used in HGP, expected scientific & medical benefits of this project, about the organizations behind this project.

UNIT III
How Human genome was mapped – physical mapping, genetic mapping, gene ontology, geneannotation.

UNIT IV
Technologies used in HGP – RFLP, microsatellite markers, STS, EST, DNA sequencing, DNA microarray.

BSUBTD- 503A Medical Biotechnology Credit: 6

UNIT I: Gene therapy – background, types of gene therapy (ex vivo & in vivo), choosing targets for gene therapy, vectors in gene therapy, retroviruses, adenoviruses, adeno-associated viruses, types of gene delivery, Weismann barrier (soma-to-germ line barrier), epigenetic inheritance, problems & ethics.
Gene Delivery methods – Viral delivery (through Retroviral vectors, through Adenoviral vectors), Non- viral delivery, Antibody engineering.
Gene therapy Models – Liver diseases, Lung diseases, Hematopoietic diseases, Circulated gene products, Cancer & Auto-immune diseases.

UNIT II: Vaccines – Vaccine vectors, nucleic acid vaccines, immuno-enhancing technology. Synthetic therapy – synthetic DNAs, therapeutic Ribozymes, synthetic drugs.

UNIT III: Tissue Engineering – Skin, Liver, Pancreas.
Xenotransplantation – terminology, technology behind it, organ donors, social &ethical issues.
Cell Adhesion-based therapy – integrins, inflammation, cancer & metastasis.

UNIT IV: Drug delivery – conventional & new approaches to drug delivery.

BSUBTD- 501B : Plant Biotechnology — Credit: 6

UNIT I
Plant Tissue Culture applications – Introduction, organogenic differentiation, Types of culture: Seed , Embryo, Callus, Organs, Cell. Micropopagation of Axillary bud proliferation, Meristem and shoot tip culture, organogenesis, embryogenesis, advantages and disadvantages of micropropagation.

UNIT II
In vitro haploid production Androgenic methods: Anther culture, Microspore culture Andogenesis, Double haploid production Significance and use of double haploids, Gynogenic haploids, factors effecting gynogenesis.

UNIT III
Protoplast Isolation and fusion Methods of protoplast isolation, Protoplast development, Somatic hybridization, identification and selection of hybrid cells, Cybrids, Potential of somatic hybridization limitations. Somaclonal variation.

UNIT IV
Applications of Plant Genetic Engineering – crop improvement, herbicide resistance,insect resistance, virus resistance, plants as bioreactors.
Genetic modification in Agriculture – transgenic plants, genetically modified foods,application, future applications, ecological impact of transgenic plants.

BSUBTD-502B : Plant Secondary Metabolites and Bio-transformation — Credit-6

1. Introduction to primary & secondary metabolites: structure
2. Types of secondaryb metabolites -Glycosides, isoprenoids, cardenolides, alkaloids, and phenylpropanoids
3. various Biotechnological Method for the Production of Secondary
4. biosynthesis of important secondary products-Alkaloids, Flavonoids
5. Important groups of secondary metabolites-Sources and uses
6. Importance of secondary metabolites
7. Production of secondary metabolites by bioconversion genetic transformation for production of secondary metabolite
8. Basic concepts of Biotransformation. –Introduction, Applications and limitations.

SEMESTER-VI

BSUBTC-601: Genomics, Proteomics and Bioinformatics **Credit 4**

UNIT I: Introduction to Genomics:
Information flow in biology, DNA sequencing methods– manual & automated: Maxam & Gilbert and Sangers method. Pyrosequencing, Genome Sequencing: Shotgun & Hierarchical (clone contig) methods, Computer tools for sequencing projects: Genome sequence assembly software.

UNIT II: Managing and Distributing Genome Data:
Web based servers and softwares for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome, GenBank, EMBL. Concept of INSDC, Selected Model Organisms' Genomes and Databases.

UNIT III: Single Nucleotide Polymorphisms:
Genome variation; Single nucleotide polymorphism idea of Missense,Synonymous, FrameshiftSNPs, SNP profiling, Disease and SNPs. Basic idea of DNA microarray and SNP array.

UNIT IV: Structure and properties of proteins
Introduction to protein structure, Chemical properties of proteins, Physical interactions that determine the property of proteins. Determination of sizes (Sedimentation analysis, gel filtration, Native PAGE, SDS- PAGE); Determination of covalent structures of proteins.

UNIT V: Introduction to Proteomics
Fundamental goals of proteomics, Analysis of proteomes. 2D-PAGE (Samplepreparation,solubilization, reduction, resolution. Reproducibility of 2D-PAGE). Mass spectrometry based methods for protein identification. De novo sequencing using mass spectrometric data.

UNIT VI: Protein databases and networks:
protein sequence and structural data, protein information resources and secondary data bases, protein data bank. Introduction to preliminary analysis of the transcriptome, Proteomics-Expression analysis & Characterization of proteins, Protein microarray, Metabolomics & global biochemical networks.

UNIT VII: Introduction to Bioinformatics
History of Bioinformatics. Importance of Bioinformatics in the field of biology and healthcare, Goal and Scope of bioinformatics. Central Dogma and bioinformatics.

UNIT VIII: Data Generation and Data Retrieval
Sequence submission tools (BankIt, Sequin); Sequence filenformat (flat file, FASTA, Genbank, Genpept, EMBL, Swiss-Prot); D ata retrieval systems (NCBI Entrez).

UNIT IX: Sequence Alignment and Pattern recognition
Sequence similarity searching; Methods of Alignment (Dot matrix,Dynamic Programming, BLAST and FASTA algorithm); Local and global alignment, pairwise and multiple sequence alignments (without algorithm); Concept of identity and homology of sequences. Scoring Matrices (PAM, BLOSUM).

Reference Books:
1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition.Wiley-Blackwell.
3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics.

II Edition. Benjamin Cummings.
4. David W Mount Bioinformatics: Sequence and Genome analysis Cold Spring Harbor Laboratory Press.
5. Fundamentals of Biochemistry by Voet, Voet and Pratt.

BSUBTC-691: (Lab)[Lab on Genomics, Proteomics and Bioinformatics] Credit 2

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Internet basics in hand (Introduction to computer hardware and software, Concept of intranet and internet. LAN, MAN and WAN, IP address, MAC address. Internet Browsers and search engine.)
2. Introduction to NCBI

Database Handling of NCBI; PubMed, Nucleotide, Protein, Gene, SNP, EST, OMIM.Tools of NCBI;Genome Browser, performing various kinds of blast.

3. Multiple Sequence alignment tool; Clustal W2
4. USING PIR,
5. Handling Structural data; PDB
6. Visualization of structures; using Rasmol.

BSUBTC-602 : IPR, Biosafety and Ethical Issues Credit 4

Introduction to Intellectual property Rights- Concept of IPR, different forms of IPR
Classification of patents, Special patents, Patenting biological products, Patentale and non patentable inventions in India, grant of patents, Grant process and requirements,
Introduction and Overview of Biosafety, Categories and Cartagena protocol .Good laboratory biosafety practices
Genetic technologies – an overview of Genetic screening for any predisposition symptoms, Cancer screening, Cloning, Gene therapy, DNA fingerprinting,(Paternity and Forensics) in vitro fertilization, surrogate motherhood, PGD, transgenic organisms, xenotransplantation, GMOs.
Ethical issues – ethical issues against the molecular technologies.
Bioethics – Necessity of Bioethics, Scope of bioethics, different paradigms of Bioethics – National & International.

BSUBTC-692 [Bio-safety and ethical issues] (Lab) Credit 2

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Proxy filing of Indian Product/ Process patent
2. Seminar presentation on Bio-safety
3. Seminar presentation on Bio-ethics
4. Assignments

BSUBTD-601A Genetic Modification In agriculture, food & medicine Credit 6

1. Genetic Modification – terminology, methods of genetic modification, Basics of genetic modification of bacteria, plant & animal, controversies over genetic modification, policy around the world (USA, European Union, EU regulation, Japan, China & other developing countries).
2. Genetic Modification in Agriculture – types of transgenic plants, genetically modified foods, application, future applications, ecological impact of transgenic plants.
3. Genetically Modified Foods – organic foods, types of organic foods, identifying organic foods, organic food & preservatives.

4. Genetic Modification in Food Industry – background, history, controversies over Risks Examples of modification and future application.
5. Genetic Modification in Medicine – gene therapy, types of gene therapy, vectors in gene therapy, nanotechnology in gene therapy, molecular engineering, human genetic engineering, problems & ethics.

BSUBTD-602A Environmental Biotechnology Credit 6

UNIT I
Conventional fuels and their environmental impact – Firewood, Plant, Animal, Water, Coal and Gas. Modern fuels and their environmental impact – Methanogenic bacteria, Biogas, Microbial hydrogen Production, Conversion of sugar to alcohol Gasohol

UNIT II
Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents. Degradation of lignin and cellulose using microbes. Phyto-remediation. Degradation of pesticides and other toxic chemicals by micro-organisms- degradation aromatic and chlorinates hydrocarbons and petroleum products.

UNIT III
Treatment of municipal waste and Industrial effluents. Bio-fertilizers, Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil. Algal and fungal biofertilizers (VAM)

UNIT IV
Bioleaching, Enrichment of ores by microorganisms (Gold, Copper and Uranium). Environmental significance of genetically modified microbes, plants and animals.

Learning Resources:-
1. Environmental Science, S.C. Santra
2. Environmental Biotechnology, Pradipta Kumar Mohapatra
3. Environmental Biotechnology – Concepts and Applications, Hans-Joachim Jordening and Jesef Winter
4. Waste Water Engineering, Metcalf and Eddy, Tata McGraw hill
5. Agricultural Biotechnology, S.S. Purohit
6. Environmental Microbiology : Methods and Protocols, Alicia L. Ragout De Spencer, John F.T. Spencer
7. Introduction to Environmental Biotechnology, Milton Wainwright
8. Principles of Environmental Engineering, Gilbert Masters
9. Wastewater Engineering – Metcalf & Eddy

BSUBTD- 681B : Dissertation on Biotechnology Credit6

A project work should be done individually under the guidance of one faculty member on any topic related to the subject & can be recorded as dissertation & also be presented by the candidate in front of externals in a seminar.