ARKA JAIN University
Jharkhand

Syllabus & Lecture Plan of
B.Sc. Biotechnology
Semester I, II, III, IV, V &VI
w.e.f. – Batch (2021-22)

BIOCHEMISTRY AND METABOLISM

Code: BTG21001

4 Credits | Semester I

Total Lectures Required –60 **Total Tutorials Required – 12**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO1: Have foundational understanding of the chemical constituents of cells, the basic units of living organisms.

CO2: Explain various types of weak interactions between the biomolecules.

CO3: Able to understand the simple precursors that give rise to large biomolecules such as proteins, carbohydrates, lipids, nucleic acids.

CO4: Understand about biocatalyst and their role

CO5: Understand metabolism of the biomolecules to produces energy and other precursor molecules.

CO6: Able toevaluate, interpret and correlate the biochemical information.

MODULE 1	**TOPICS**	**10 Hours**
1	Water as solvent for molecules in cell	
2	Conformations of molecules; Tautomerism and resonance; Forces between molecules and chemical groups	
3	Acids and Bases – Titration curves; pH, its measurement and significance in biological systems	
4	Buffers; Buffering against pH changes in biological systems	
5	Structure, Function and properties of Monosaccharaides, and disaccharides	
6	Homo & Hetero Polysaccharides, Glycoprotein's and their biological functions	
MODULE 2	**TOPICS**	**10 Hours**
1	Structure and properties of amino acids	
2	Proteins and their classification, Forces stabilizing protein structure and shape	
3	Different level of structural organization of proteins	

4	Protein Purification. Denaturation and renaturation of proteins	
5	Fibrous and globular proteins	
MODULE 3	**TOPICS**	**10 Hours**
1	Enzymes – Nomenclature and classification of Enzymes Enzyme Kinetics and Enzyme inhibition	
2	Enzyme specificity – types & theories, Biocatalysts from extreme thermophiles and hyperthermophilicarchaea and bacteria.	
3	Vitamin and Minerals	
MODULE 4	**TOPICS**	**15 Hours**
1	Lipids: Structure and functions –Classification, nomenclature and properties of fatty acids, essential fatty acids.	
2	Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, Cholesterol.	
3	Structure and functions – Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, purines &pyrimidines.	
4	Biologically important nucleotides, Double Helical model of DNA structure and forces responsible for A, B & Z – DNA, denaturation and renaturation of DNA	
MODULE 5	**TOPICS**	**15 Hours**
1	Carbohydrates Metabolism – Reactions, energetics and regulation	
2	Glycolysis – Fate of pyruvate under aerobic and anaerobic conditions	
3	Pentose phosphate pathway and its significances	
4	Gluconeogenesis, Glycogenolysis and glycogen synthesis	
5	TCA cycle, Electron Transport Chain, Oxidative phosphorylation	
6	ß-oxidation of fatty acids	

Text Books:

1) Biochemistry by U. Satyanarayana, U. Chakrapani (5^{th} Ed. Elsevier)
2) Fundamentals of Biochemistry – A.C. Deb (7th Ed. New Central Book Agency)
3) A Textbook of Medical Biochemistry – M.N Chatterjea; Rana Shinde
   (8^{nd} Ed. JaypeeBrothersMedicalPublisher(P) Ltd)

Reference Books:

1. Lehninger Principle of Biochemistry – David L. Nelson and Michael M. Cox
(W.H Freeman and Co).

CELL BIOLOGY

Code: BTG21002

4 Credits | Semester I

Total Lectures Required –60 **Total Tutorials Required – 12**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO1: Understand structure and function of a prokaryotic and eukaryotic cells (both plant and animal cells)

CO2: Explain structure and function of different cell organelles such as mitochondria, nucleus, Golgi apparatus etc.

CO3: Understand Signal transduction and various cell signaling pathways

CO4: Attain knowledge about Cancer, causes of Cancer, agents of cancer and molecular basis of cancer.

CO5: Explain expression and regulation of cell receptor and their function.

MODULE 1	**TOPICS**	**8 Hours**
1	Introduction and classification of organisms by cell structure	
2	Plasma membrane, structure, function, fluid mosaic model, membranes, lipids and proteins, transport across the membrane – passive and active.	
MODULE 2	**TOPICS**	**12 Hours**
1	Endoplasmic reticulum – Structure, function including role in protein segregation. Membrane Vacuolar system	
2	Cytoskeleton and cell motility – Structure and function of microtubules, Microfilaments, Intermediate filaments.	
3	Golgi complex – Structure, biogenesis and functions including role in protein secretion.	
MODULE 3	**TOPICS**	**15 Hours**
1	Lysosomes – Vacuoles and micro bodies: Structure and functions, phagocytosis, endocytosis, autophagy; Ribosomes - Structures and function including role in protein synthesis.	
2	Mitochondria – Structure and function, Genomes, biogenesis.	
3	Chloroplasts – Structure and function, genomes, biogenesis	
4	Nucleus – Structure and function, chromosomes and their structure.	
MODULE 4	**TOPICS**	**15 Hours**
1	Extracellular Matrix – Composition, molecules that mediate cell adhesion, membrane receptors for extra cellular matrix, macromolecules, regulation of receptor expression and function.	
2	Signal transduction; cell signalling; cAMP, Role of G-proteins coupled receptors, Tyrosine kinases, etc.	
MODULE 5	**TOPICS**	**10 Hours**

1	Cancer: Carcinogenesis, agents promoting carcinogenesis, characteristics and molecular basis of cancer. Cell death; apoptosis events and related proteins, necrosis and senescence	

Text Books:

1. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th Ed. ASMPress& Sunderland, Washington, D.C.; Sinauer Associates, MA.

Reference Books:

2. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Ed. John Wiley &Sons.Inc.

CORE PRACTICAL-1

Code: BTG21003

4 Credits | Semester I

Total Lectures Required –60 **Total Tutorials Required – 12**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO1: Understand calorimetric work principle and titration principle

CO2: Perform estimation of biomolecules

CO3: Understand the process of cell division (Mitosis and Meiosis) principle and its various stages

CO4: Perform Plasmolysis and de-plasmolysis experiment

CO5: Identify structure of the prokaryotic cell and eukaryotic cell

CO6: Acquire knowledge about Microtome: Fixation, block making, section cutting, double staining of animaltissues.

SYLLABUS:

1. Principles of Colorimetry: (i) Verification of Beer's law, estimation of protein.
   (ii) To study relation between absorbance and % transmission.
2. Preparation of buffers.
3. Qualitative tests for Carbohydrates, lipids and proteins.
4. Separation of Amino acids by paper chromatography.
5. To study activity of any enzyme under optimum conditions.
6. To study the effect of pH, temperature on the activity of salivary amylase enzyme.
7. Determination of - pH optima, temperature optima, Km value, Vmax value, Effect of inhibitor (Inorganic phosphate) on the enzyme activity.
8. Estimation of blood glucose by glucose oxidase method.
9. Demonstration of dialysis.
10. Study of plasmolysis and de-plasmolysis.
11. Study of structure of any Prokaryotic and Eukaryotic cell.
12. Cell division in onion root tip/ insect gonads.
13. Microtomy: Fixation, block making, section cutting, double staining of animal tissues.

ENVIRONMENT STUDY

Code: MGT21010

2 Credits | Semester I

Total Lectures Required –30 **Total Tutorials Required –06**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO1: Describe the ecosystems and their components

CO2: Understand the concept of sustainability and sustainable development

CO3: Explain International Agreement on Environmental Management

CO4: Attain knowledge about Human Population Growth and its effects on the environment

CO5: Understand the concepts of Biodiversity, Biosphere reserves, National Parks and sanctuaries

CO6: Gain Knowledge of renewable and non-renewable energy resources

MODULE 1	**Ecosystems and How They Work**	**5 Hours**
	TOPICS	
1	Why EVS, Objective & Learning Outcome	
2	Structure and function of an ecosystem, Types of Eco-Systems, Producers, Consumers and Decomposers	
3	Food chains, food webs and ecological pyramids, Energy flow in the ecosystem	
4	Introduction, Types, Characteristic features, Structure and Function of Forest ecosystem, Desert Ecosystem, Aquatic ecosystems	
5	Major issues of Biodiversity, Biosphere reserves, National Parks and sanctuaries	

MODULE 2	**Concept of sustainability and international efforts for environmental protection**	**5 Hours**
	TOPICS	
1	Concept of Sustainable Development	
2	Emergence of Environmental Issues	
3	International Agreement on Environmental Management	

MODULE 3	Human Population Growth and its effects on the environment	5 Hours
TOPICS		
1	Problem of Population growth	
2	Poverty and Environment, Population Explosion	
3	Family Welfare Program	

MODULE 4	Renewable and Non-Renewable Resources	7 Hours
TOPICS		
1	Defining resources, classification of resources	
2	Soil and land degradation, economic development and resources use, natural resources accounting	
3	Energy needs, renewable and non-renewable energy resources, solar energy and its availability, wind power and its potential, hydropower as a clean source of energy. Coal, oil, natural gas etc., bio fuel	

MODULE 5	Energy Requirements	8 Hours
TOPICS		
1	Legal framework; Constitutional provisions, The Indian Penal Code, Role of Judiciary in Environmental protection, Wild life {protection} Act, 1972,Water [prevention and control of pollution] Act,1974, Environment [protection] Act,1986,Air [prevention and control of pollution]Act,1981, Forest Conservation Act.	

Text Book:

1. Ambasht, R.S. and P.K. Ambasht; Environment and Pollution-An Ecological Approach, third edition, CBS Publishers, New Delhi, 1999.

Reference Books:

1. Agarwal, A, Narain; S. State of India's Environment, Published by Centre for Science and Environment, New Delhi, 1999.
2. Divan, Shyam and RosenCeranz; Armin. Environmental Law and Policy in India, Cases,materials and statutes, second edition, Oxford University Press, 2001.
3. Gupta N.C.; Social Auditing of Environmental Law in India, edited book, New Century Publications, Delhi-2003.
4. Uberoi, N.K.; Environmental Management, Excel Books, New Delhi, 2000

ENTREPRENEURSHIP& SMALLBUSINESS

Code: MGT21070

2 Credits | Semester I

Total Lectures Required –30 **Total Tutorials Required –06**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO1: Understand entrepreneurship and entrepreneur and their characteristics

CO2: Attain knowledge about various types of business organization and size of business organization

CO3: Explain role of different Entrepreneurship development programs

CO4: Understand the differences between business ideas and opportunities

CO5: Attain knowledge about project identification and appraisal.

CO6: Acquire knowledge about small scale industries

MODULE 1	**Introduction**	**8 Hours**
	TOPICS	
1	Why ETP, Objective & Learning Outcome	
2	Definition and concept of Entrepreneurship; Classification and type of Entrepreneurship; Nature and importance of Entrepreneurship& small Business. Problems of entrepreneurship and Concept of Intrapreneurship	
3	Introduction to Entrepreneurship: Entrepreneurs; entrepreneurial personality and intentions - characteristics, traits and behavioral.	
4	Entrepreneurial Opportunities: Opportunities. discovery/ creation, Pattern identification and recognition for venture creation: prototype and exemplar model, reverse engineering	
MODULE 2	**Choice of Business Organization**	**6 Hours**
	TOPICS	
1	Size of Business unit, Optimum firm	
2	Role of EDI's, NIESBUD, NSIC,SIDO, SIDC, DIC'S in promoting entrepreneurial decision making	
	Selection of a product, line, design and development processes economics on material and energy requirement, stock the product and release the same for making etc.	
MODULE 3	**ENTREPRENEURSHIP OPPORTUNITY IN AGRI BIOTECHNOLOGY**	**6 Hours**

TOPICS		
1	Business opportunity, Essential requirement, marketing, strategies. Schemes, polyhouse culture. Herbal bulk drug production, Nutraceuticals, value added herbal products. Bioethanol production using Agri-waste, Algal source. Integration of system biology for agricultural applications. Biosensor development in Agri management.	
MODULE 4	**ENTREPRENEURSHIP OPPORTUNITY IN INDUSTRIAL BIOTECHNOLOGY**	**5 Hours**
TOPICS		
1	1. Business opportunity, Essential requirement, marketing strategies, schemes, challenges 2. Pollution monitoring and Bioremediation for Industrial pollutants, Pesticides, Herbicides etc. Integrated compost production- microbe enriched compost. Biopesticide/insecticide production 3. Fermented products-probiotic and prebiotics. Stem cell production, stem cell bank, contract research. Production of monoclonal/polyclonal antibodies, Single cell protein and secondary metabolite production. Contact research in microbial genomics	
MODULE 5	**Bioethics & Biosafety in industry**	**5 Hours**
TOPICS		
1	Necessity of Bioethics, different paradigms of Bioethics – National & International. Ethical issues against the molecular technologies. Introduction to biosafety and health hazards concerning biotechnology. Introduction to the concept of containment level and Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP).	

Text Book

1. S. S. Khanka., Entrepreneurial Development. S. Chand Publication

References

1. Gupta, Saniay, Fundamentals of Entrepreneurship, SBPD Publications
2. Hisirich, Peterrs., Entrepreneurship, TMH Publication
3. David H Holt., Entrepreneurship& New venture creation. Prentice hall of IndiaLtd.
4. Vasant Desai., Dynamics of Entrepreneurial Development – Himalaya Publishing House
5. Gupta, C.B. and N.P. Srinivasan, Entrepreneurial Development, S.CHAND Publication

ENGLISH

Code: ENG21025

2 Credits | Semester I

Total Lectures Required –30 **Total Tutorials Required –06**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO1: Use the formal way of presentation & comprehension of simple words and phrases used in day to day context.

CO2: Relish the different aspects of literature.

CO3: Use basic knowledge about English Grammar, used in Presentation and conversation.

MODULE 1		**5 Hours**
TOPICS		
1	Vocabulary Synonyms, Antonyms, Prefix and Suffix, Homonyms, Analogies and Portmanteau words	
2	Active, Passive, Direct and Indirect speech, Prepositions, Conjunctions and Euphemisms	
MODULE 2	**GRAMMAR**	**5 Hours**
TOPICS		
1	Letter Writing, Email, Essay, Articles, Memos, one word substitutes, note making and Comprehension Formal speech, Phonetics, semantics and pronunciation **5**	
MODULE 3	**Communication**	**10 Hours**
TOPICS		
1	Communication process. • Elements of communication • Barriers of communication and how to overcome them. • Nuances for communicating with patients and their attenders in hospitals	
MODULE 4		**6 Hours**
TOPICS		
1	Importance of speaking efficiently • Voice culture. • Preparation of speech. Secrets of good delivery • Audience psychology, handling • Presentation skills. • Individual feedback for each student • Conference/Interview technique Importance of listening • Self-assessment • Action plan execution. • Barriers in listening. • Good and persuasive listening What is efficient and fast reading • Awareness of existing reading habits • Tested techniques for improving speed • Improving concentration and comprehension through systematic study	
MODULE 5		**4 Hours**
TOPICS		
1	Basics of non-verbal communication • Rapport building skills	

Text Books:

1. The Wringed Word "By David Green, Macmillan India, New Delhi."
2. High school English grammar & composition "by Wren & Martin
3. (S.Chand&Co.ltd, New Delhi)"

Reference Books:

1. A comprehensive Grammar of Current English' by Dr. C .J. Joseph , E.G Myall , andABiswas (Inter University Press (P) Ltd, Delhi).

MAMMALIAN PHYSIOLOGY

Code: BTG22004
4 Credits | Semester II

Total Lectures Required –60 **Total Tutorials Required – 12**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO1: Understand the physiology of respiration

CO2: Attain knowledge about physiology and mechanism of digestion & absorption

CO3: Understand the Circulation of body fluid (Blood and Lymph), Role of Hearth and blood vessels in blood circulation

CO4: Acquire knowledge aboutmechanism of blood Coagulation

CO5: Understand physiology of muscle and role of muscle contraction in movement and locomotion.

CO6: Understand the concept of excretion and Osmoregulation

CO7: Able to understand the physiologyNervous and Endocrine coordination in Human Body.

MODULE 1	**TOPICS**	**10 Hours**
1	Digestion – Mechanism of digestion & absorption of carbohydrates, Proteins, Lipids and nucleic acids.	
2	Composition of bile, Saliva, Pancreatic, gastric and intestinal juice	
3	Respiration – Exchange of gases, Transport of O2 and CO2, Oxygen dissociation curve, Chloride shift.	
MODULE 2	**TOPICS**	**10 Hours**
1	Circulation – Composition of blood, Plasma proteins & their role, blood cells, Haemopoisis, Mechanism of coagulation of blood. Blood groups: Rh factor, ABO and MN	
2	Structure of mammalian heart. Mechanism of working of heart – Cardiac output, cardiac cycle, Origin & conduction of heart beat.	
MODULE 3	**TOPICS**	**15 Hours**
1	Muscle physiology and osmoregulation – Structure of cardiac, smooth & skeletal muscle. Threshold stimulus, All or None rule, single muscle twitch, muscle tone, isotonic and isometric contraction, Physical, chemical & electrical events of mechanism of muscle contraction.	
2	Excretion – modes of excretion, Ornithine cycle, Structure of Nephron, Mechanism of urine formation.	

3	Skeleton System	
MODULE 4	**TOPICS**	**12 Hours**
1	Nervous coordination – Mechanism of generation & propagation of nerve impulse, structure of synapse, synaptic conduction, saltatory conduction.	
2	Neurotransmitters	
MODULE 5	**TOPICS**	**13 Hours**
1	Endocrine coordination – Different endocrine glands: Hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid and adrenals, hypo & hyper-secretions. Mechanism of action of hormones (insulin and steroids)	
2	Hypothalamus (neuroendocrine gland) - principal nuclei involved in neuroendocrine control of anterior pituitary and endocrine system; Placental hormones	

Text Books:

1) Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition. John wiley&sons,Inc.

Reference Books:

1) Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company.

PLANT PHYSIOLOGY

Code: BTG22005
4 Credits | Semester II

Total Lectures Required –60 **Total Tutorials Required – 12**

COURSE OUTCOMES
Course Outcomes: At the end of the course, students will be able to:

CO1: Understand the different types of cells, tissue differentiation and organization in plants

CO2:Understand significance of phenomenon like diffusion, osmosis, plasmolysis, imbibition, Guttation, transpiration

CO3:Acquire knowledge about nitrogen cycle,fixation assimilation of Nitrogen in plants, nitrogen

CO4: Understand the mechanism of uptake of nutrients, mechanism of food transport

CO5: Attain knowledge about Plant hormonesand their role in the growth of plants

CO6: Understand primary structure of shoot; root, secondary growth, leaf anatomy

CO7: To acquaint with carbon metabolism: photosynthesis and photorespiration

On completion of the course, students are expected:

MODULE 1	**TOPICS**	**10 Hours**
1	Anatomy – The shoot and root apical meristem and its histological organization.	
2	Simple & complex permanent tissues, primary structure of shoot & root, secondary growth, growth rings.	
3	Leaf anatomy (dorsi-ventral and isobilateral leaf).	
MODULE 2	**TOPICS**	**10 Hours**
1	Plant water relations – Plant water relations: Importance of water to plant life, diffusion, osmosis, plasmolysis, imbibition, guttation, transpiration, stomata & their mechanism of opening & closing.	
MODULE 3	**TOPICS**	**15 Hours**
1	Nutrients – Micro & macro nutrients: criteria for identification of essentiality of nutrients, roles and deficiency systems of nutrients,	
2	Mechanism of uptake of nutrients, mechanism of food transport.	
MODULE 4	**TOPICS**	**15 Hours**
1	Carbon and nitrogen metabolism: Photosynthesis- Photosynthesis pigments, concept of two photo systems, photphosphorylation, calvin cycle, CAM plants, photorespiration, compensation point	

2	Nitrogen metabolism – inorganic & molecular nitrogen fixation, nitrate reduction and ammonium assimilation in plants.	
MODULE 5	**TOPICS**	**10 Hours**
1	Growth and development – Definitions, phases of growth, growth curve, growth hormones (auxins, gibberlins, cytokinins, abscisic acid, ethylene)	
2	Physiological role and mode of action, seed dormancy and seed germination, concept of photoperiodism and vernalization.	

Text Books:

1. Dickinson, W.C. 2000 Integrative Plant Anatomy. Harcourt Academic Press, USA.
2. Fahn, A. 1974 Plant Anatomy. Pergmon Press, USA and UK.
3. Hopkins, W.G. and Huner, P.A. 2008 Introduction to Plant Physiology. John Wiley and Sons.
4. Mauseth, J.D. 1988 Plant Anatomy. The Benjammin/Cummings Publisher, USA.
5. Salisbury, F.B. and Ross, C.W. 1991 Plant Physiology, Wadsworth Publishing Co. Ltd.
6. Taiz, L. and Zeiger, E. 2006 Plant Physiology, 4thedition, Sinauer Associates Inc . MA, USA

CORE PRACTICAL-2

Code: BTG22006

4 Credits | Semester II

Total Lectures Required –60 **Total Tutorials Required – 12**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO1: Able to separate photosynthetic pigments by paper chromatography
CO2: Learn the process of opening & closing of stomata
CO3: Understand the mechanism of guttation in leaves by experiment
CO4: Experimentally demonstrate aerobic respiration in plant
CO5: Perform isolation of root nodules from a leguminous plants
CO6: Prepare stained mounts of anatomy of monocot and dicot's root, Stem & leaf.
CO7: Demonstrate the process of plasmolysis using the leaf peel.

SYLLABUS:

PLANT PHYSIOLOGY

1. Preparation of stained mounts of anatomy of monocot and dicot's root, Stem & leaf.
2. Demonstration of plasmolysis by Tradescantia leaf peel.
3. Demonstration of opening & closing of stomata
4. Demonstration of guttation on leaf tips of grass and garden nasturtium.
5. Separation of photosynthetic pigments by paper chromatography.
6. Demonstration of aerobic respiration.
7. Preparation of root nodules from a leguminous plant.

Mammalian Physiology

1. Finding the coagulation time of blood
2. Determination of blood groups
3. Counting of mammalian RBCs
4. Determination of TLC and DLC
5. Demonstration of action of an enzyme
6. Determination of Hemoglobin

BIOTECHNOLOGY AND HUMAN WELFARE

Code: BTG22007

4 Credits | Semester II

Total Lectures Required –60 **Total Tutorials Required – 12**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO1: Understand the role of Biotechnology in different sectors

CO2: Understand the application of biotechnology processesin Human Welfare

CO-3: Understand the concept of interactionbetween plants and microorganisms

CO-4: Acquire knowledge about biodegradable materials to protect environment pollution

CO-5: Attain the knowledge about DNA finger printing, gene therapy and Monoclonal antibodies

MODULE 1	**TOPICS**	**10 Hours**
	1. Brief introduction to Biotechnology. 2. Brief introduction to Protein Engineering. 3. Enzyme Biotechnology- Methods of enzyme immobilization and applications. 4. Biosensors- Working and applications of biosensors. 5. Industrial Production of penicillins, citric acid, Vitamin B12, Glutamic acid. 6. Basic principles of genetic engineering. 10	
MODULE 2	**TOPICS**	**10 Hours**
	Agriculture - N2 fixation: transfer of pest resistance genes to plants; interaction between plants and microbes; qualitative improvement of livestock. 10	
MODULE 3	**TOPICS**	**10 Hours**
	Environments – chlorinated and non-chlorinated organic pollutant degradation; degradation of hydrocarbons and agricultural wastes, stress management, development of biodegradable polymers such as PHB.	
MODULE 4	**TOPICS**	**15 Hours**
	Forensic science – solving violent crimes such as murder and rape; solving claims of paternity and theft etc. using various methods of DNA finger printing. Health –Monoclonal antibodies, human genome project. Application of r DNA technology and genetic engineering in the production of: i) Interferon ii) Vaccines- hepatitis- B iii) Hormones-	

	Insulin.	
MODULE 5	**TOPICS**	**15 Hours**
	Intellectual property rights (IPR) , Patent	

Text Book:

1. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.
2. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international Publishers

BIOTECHNOLOGY AND HUMAN WELFARE PRACTICAL

Code: BTG22008

2 Credits | Semester II

Total Lectures Required –30 **Total Tutorials Required –06**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO1: Understand fermentation processesto make different commercial products

CO2: Observe the plant parts (leaves and stems) infected with microbes

CO3: Perform qquantitative estimation of residual chlorine in water samples

CO4: Isolate and analyze the DNA from different biological samples

CO5: Understand the Use of PCR for biological samples

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

1. Perform of ethanolic fermentation using Baker's yeast
2. Study of a plant part infected with a microbe
3. To perform quantitative estimation of residual chlorine in water samples
4. Isolation and analysis of DNA from minimal available biological samples
5. Case studies on Bioethics (any two)

MATH AND COMPUTER

Code: SCI22004

2 Credits | Semester II

Total Lectures Required –30 **Total Tutorials Required – 06**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO 1: Encourage students about logical thinking and reasoning.

CO 2: Understand the mathematical concept of other subjects of Biotechnology.

CO 3: Acquire and effective way of building mental discipline and problem solving ability.

CO 4: Attain knowledge about collecting, arranging, evaluating, analyzing and interpreting the data.

MODULE 1	**TOPICS**	**7 Hours**
1	Set theory – Definition and the element method of proof, properties of subsets, Disproof, Algebraic Proof	
2	Linear and geometric functions	
3	Limits of functions, derivations of functions	
MODULE 2	**TOPICS**	**7 Hours**
1	Counting and Probability – Introduction, Possibility Trees and the Multiplication Rule	
2	Counting Elements of Disjoint Sets – The Addition Rule, The Pigeonhole PrincipleCounting Subsets of a Set: Combinations, r-Combinations with Repetition Allowed, Probability Axioms and Expected Value	
MODULE 3	**TOPICS**	**6 Hours**
1	Methods sampling, confidence level	
2	Measurement of central tendencies	
3	Measurement of deviations. Mean, median and Mode	
MODULE 4	**TOPICS**	**5 Hours**
1	Computer – general introduction of computer, input device, output device	
2	Microsoft office	
MODULE 5	**TOPICS**	**5 Hours**
1	Data presentation Graph preparation Use of internet for the search of research article	

Text Book

1. Discrete Mathematics, Schaum's Outlines Series, Seymour Lipschutz, Marc Lipson, Tata McGraw Hill.
2. Discrete Mathematics and its Applications, Kenneth H. Rosen, Tata McGraw Hill

HINDI

Code: HIN21001

2 Credits | Semester II

Total Lectures Required –30 **Total Tutorials Required –06**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO 1: To make students understand about the literature of different authors.

CO 2: To make students aware about various concepts about Hindi grammar.

CO 3: To make students acquire knowledge about heritage and culture of Hindi language.

CO 4: Attain knowledge about presentation and articulation in Hindi.

इकाई1		**5 Lectures**
	TOPICS	
1	बुराजोदेखनमैंचला, बुरानमिलियाकोय।	5
2	जोदिलखोजाआपना, मुझसेबुरानकोय॥	
3	पोथीपढ़िपढ़िजगमुआ, पंडितभयानकोय।	
4	ढाईआखरप्रेमका, पढ़ेसोपंडितहोय॥	
5	साधुऐसाचाहिए, जैसासूपसुभाय।	
6	सार-सारकोगहिरहै, थोथादेईउड़ाय॥	
7	धीरे-धीरेरेमना, धीरेसबकुछहोय।	
8	मालीसींचेसौघड़ा, ऋतुआएफलहोय॥	
9	मालाफेरतजुगभया, फिरानमनकाफेर। करकामनकाडारदे, मनकामनकाफेर॥	
10	जिनखोजातिनपाइया, गहरेपानीपैठ। मैंबपुराबूडनडरा, रहाकिनारेबैठ॥	
11	बोलीएकअनमोलहै, जोकोईबोलैजानि। हियेतराजूतौलिके, तबमुखबाहरआनि॥	
12	“ऐसीबनीबोलिये, मनकाआपाखोय। औरनकोशीतलकरै, आपौशीतलहोय॥	
13	मायामुईनमनमुआ, मरीमरीगयासरीर। आसात्रिसनानमुई, योंकहीगएकबीर॥	
14	निंदकनियरेराखिए, आँगनकुटीछवाय, बिनपानी, साबुनबिना, निर्मलकरेसुभाय।	
15	दुर्लभमानुषजन्महै, देहनबारम्बार, तरुवरज्योंपत्ताझड़े, बहुरिनलागेडार।	
16	कबीराखड़ाबाज़ारमें, मांगेसबकीखैर। नाकाहूसेदोस्ती,नकाहूसेबैर॥	
17	रातगंवाईसोयके, दिवसगंवायाखाय। हीराजन्मअमोलसा, कोड़ीबदलेजाय॥	

	बड़ाहुआतोक्याहुआजैसेपेड़खजूर। पंछीकोछायानहींफललागेअतिदूर॥	
	मनहींमनोरथछांड़ीदे, तेराकियानहोई। पानीमेंघिवनिकसे, तोरूखाखाएनकोई॥	

इकाई२	आधुनिककविता	4 Lectures
	TOPICS	
1	सुभद्राकुमारीचौहानझांसीकीरानी -	4

इकाई३	कहानिया	9 Lectures
	TOPICS	
1	प्रेमचंद्रकीकहानिया	9
2	कप्तानसाहब	
3	जिहाद	
4	मंत्र	

इकाई -4	व्याकरण	5 Lectures
	TOPICS	
1	व्याकरण - लिंग, वचन,समास, विपरीतशब्द, अंगेजीशब्दकाहिंदीअनुवाद, हिंदीशब्दकाअंगेजीअनुवाद,	5

इकाई 5	TOPICS	2 Lectures
1	पत्रलेखन - औपचारिक,अनौपचारिक,निबंध	2

Text Book:

1) पॉचफूल– **प्रेमचंद**
2) आधुनिकहिंदीव्याकरणऔररचना–**वासुदेवनंदनप्रसाद**

Genetics

Code: BTG23009

4 Credits | Semester III

Total Lectures Required –60 **Total Tutorials Required – 12**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO-1: Comprehend and apply knowledge of genetics as it relates to a variety of topics including inheritance patterns, population and quantitative genetics, and mutation.

CO-2: Discuss about Mendelian genetics, multiple allele and Various Epistasis

CO3: Understand in detail about chromosomal and gene mutation

C04: Understand about various genetic disorders and their causes

CO5: Attain knowledge about Karyotyping and its application in the field of Genetics

MODULE 1	**Introduction and genetic material**	**15 Hours**
	TOPICS	
1	Introduction: Historical developments in the field of genetics. Organisms suitable for genetic experimentation and their genetic significance.	
2	Cell Cycle: Mitosis and Meiosis: Control points in cell-cycle progression in yeast. Role of meiosis in life cycles of organisms.	
3	Chromosome and genomic organization: Eukaryotic nuclear genome nucleotide sequence composition –unique & repetitive DNA, satellite DNA. Centromere and telomere DNA sequences, middle repetitive sequences- VNTRs & dinucleotide repeats, repetitive transposed sequences-SINEs & LINEs, middle repetitive multiple copy genes, noncoding DNA.	
MODULE 2	**Genetic organization of prokaryotic and viral genome**	**10 Hours**
	TOPICS	
	Genetic organization of prokaryotic and viral genome. Structure and characteristics of bacterial and eukaryotic chromosome, chromosome morphology, concept of euchromatin and heterochromatin.	
	Packaging of DNA molecule into chromosomes, chromosome banding pattern, karyotype, giant chromosomes, one gene one polypeptide hypothesis, concept of cistron, exons, introns, genetic code, gene function.	
MODULE 3	**Mendelian genetics:**	**10 Hours**
	TOPICS	
	Mendel's experimental design, monohybrid, di-hybrid and tri hybrid crosses, Law of segregation & Principle of independent assortment. Verification of segregates by test and back crosses, Chromosomal theory of inheritance, Allelic interactions: Concept of dominance, recessiveness, incomplete dominance, co-dominance, semi-dominance, pleiotropy, multiple allele, pseudo-allele, essential and lethal genes, penetrance and expressivity.	
	Non allelic interactions: Interaction producing new phenotype complementary genes, epistasis (dominant & recessive), duplicate genes and inhibitory genes.	
MODULE 4	**Chromosome and gene mutations:**	**15 Hours**
	TOPICS	
	Definition and types of mutations, causes of mutations, Ames test for	

	mutagenic agents, screening procedures for isolation of mutants and uses of mutants, variations in chromosomes structure - deletion, duplication, inversion and translocation (reciprocal and Robertsonian), position effects of gene expression, chromosomal aberrations in human beings, abnormalities– Aneuploidy and Euploidy.	
	Sex determination and sex linkage: Mechanisms of sex determination, Environmental factors and sex determination, sex differentiation, Barr bodies, dosage compensation, genetic balance theory, Fragile-X-syndrome and chromosome, sex influenced dominance, sex limited gene expression, sex linked inheritance.	
MODULE 5	**Genetic linkage, crossing over and chromosome mapping:**	**10 Hours**
TOPICS		
	Linkage and Recombination of genes in a chromosome crossing over, Cytological basis of crossing over, Molecular mechanism of crossing over, Crossing over at four strand stage, Multiple crossing overs, Genetic mapping.	
	Extra chromosomal inheritance: Rules of extra nuclear inheritance, maternal effects, maternal inheritance, cytoplasmic inheritance, organelle heredity, genomic imprinting.	
	Evolution and population genetics: In breeding and out breeding, Hardy Weinberg law (prediction, derivation), allelic and genotype frequencies, changes in allelic frequencies, systems of mating, evolutionary genetics, natural selection.	

SUGGESTED READING

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.

General Microbiology

Code: BTG23010

4 Credits | Semester III

Total Lectures Required –60 **Total Tutorials Required – 12**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO1: Understand the diversified branches of microbiology

CO2: Describe the theoretical and practical aspects of microbial growth and physiology

CO3: Define the morphology and physiological characteristics of different groups of microorganisms

CO4: Understand the process of virus cultivation, phages and bacterial/yeast genetics

CO5: Acquire detained knowledge about genome of various types of microorganism

MODULE 1	**Fundamentals, History and Evolution of Microbiology**	**10 Hours**
	TOPICS	
1	Fundamentals, History and Evolution of Microbiology. Microbial Diversity: Distribution and characterization Prokaryotic and Eukaryotic cells,	
2	Classification of microorganisms: Microbial taxonomy, criteria used including molecular approaches, Microbial phylogeny and current classification of bacteria.	
3	Morphology and cell structure of major groups of microorganisms eg. Bacteria, Algae, Fungi, Protozoa and Unique features of viruses.	
MODULE 2	**Cultivation and Maintenance of microorganisms:**	**10 Hours**
	TOPICS	
1	Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms, methods of isolation, Purification and preservation.	
MODULE 3	**Microbial growth:**	**15 Hours**
	TOPICS	
1	Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria.	
2	Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways	
3	Bacterial Reproduction: Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria.	
MODULE 4	**Control of Microorganisms**	**10 Hours**
	TOPICS	
1	Control of Microorganisms: By physical, chemical and chemotherapeutic Agents	
MODULE 5	**Water Microbiology:**	**15 Hours**
	TOPICS	
1	Bacterial pollutants of water, coliforms and non coliforms. Sewage composition and its disposal.	
2	Food Microbiology: Important microorganism in food Microbiology: Moulds,	

	Yeasts, bacteria.
3	Major food born infections and intoxications, Preservation of various types of foods. Fermented Foods.

SUGGESTED READING

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

CORE PRACTICALS-3

Code: BTG23011
4 Credits | Semester III

Total Lectures Required –60 **Total Tutorials Required – 12**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO1: Solve Problems related Mendelian Genetics in monohybrid and dihybrid cross

CO2: Explain Karyotyping with the help of photographs

CO3: Analyze autosomal and sex linked disease using Pedigree charts.

CO4: Perform polyploidy induction in onion root tips by colchicines treatment.

CO5: Carry out Sterilization process (autoclave) techniques followed in microbiology laboratory

CO6: Isolate and Identify bacteria from different sources using different media for cultivation of bacteria/fungi.

CO7: Stain isolated bacteria using different methods (Gram staining, Spore staining).

SYLLABUS:

1. Permanent and temporary mount of mitosis.
2. Permanent and temporary mount of meiosis.
3. Mendelian deviations in dihybrid crosses
4. Demonstration of - Barr Body-Rhoeo translocation.
5. Karyotyping with the help of photographs
6. Pedigree charts of some common characters like blood group, color blindness and PTC tasting.
7. Study of polyploidy in onion root tip by colchicines treatment.
8. Isolation of bacteria & their biochemical characterization.
9. Staining methods: simple staining, Gram staining, spore staining, negative staining, hanging drop.
10. Preparation of media & sterilization methods, Methods of Isolation of bacteria from different sources.
11. Determination of bacterial cell size by micrometry.
12. Enumeration of microorganism - total & viable count.

CHEMISTRY-1

Code: SCI23001

4 Credits | Semester III

Total Lectures Required –60 **Total Tutorials Required – 12**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO1: Learn the concept of Stereochemistry, conformation and geometrical isomerism
CO2: Discuss relative and absolute configuration
CO3: Describe hydrogenation and hydro halogenation reactions
CO4: Demonstrate reactions of aldehydes and ketones with ammonia and its derivative
CO5: Understand aldol, cross aldol and cannizzaro reactions
CO6: Understand the reaction mechanism of halogenations of alkanes, allylic compounds and alkyl benzenes, elimination reaction

MODULE 1	**Introduction to organic chemistry**	**11 Hours**
	TOPICS	
1	Conformation: Restricted rotation about single bonds, Various conformations of ethane, butane and cyclohexane. Relative stability of different conformations in terms of energy difference is to be discussed for all these compounds.	
2	Geometrical Isomerism: Requirements for a molecule to show geometrical isomerism, Cis-Trans and E/ Z notation along with CIP rules for geometrical isomers.Optical Isomerism: Optical activity, specific and molar rotation, chirality, enantiomerism, diastereoisomerism, racemic mixtures and their resolution by salt formation method	
3	Relative and absolute configuration: D / L nomenclature system for configuration of carbohydrates (difference between d/l and D/L notations). Threo and Erythro designation. R and S configuration (up to two chiral centres).	
MODULE 2	**Hydrocarbanes**	**12 Hours**
	TOPICS	
1	Hydrogenation, addition of halogens, Hydrohalogenation(Markovnikov's and anti-Markovnikov's addition), hydration, hydroxylation (cis and trans), oxymercurationdemercuration, hydroboration-oxidation, ozonolysis. Reactivity of alkenes vs alkynes.	
2	Aldehydes and ketones: (formaldehyde, acetaldehyde, benzaldehyde, acetone) Addition of sodium bisulphite, hydrogen cyanide and alcohols. Addition-elimination reactions with ammonia and its derivatives	
MODULE 3	**Name reactions**	**12 Hours**
	TOPICS	
1	Aldol, cross Aldol, Claisen, Knoevengel, Cannizzaro, cross Cannizzaro reaction	
2	Free radical substitution reactions: Halogenation of alkanes, allylic compounds and alkylbenzenes.	
3	Electrophilic Substitution Reactions (aromatic compounds): General mechanism of electrophilic substitution reactions (nitration, halogenation, sulphonation, Friedel Crafts alkylation and acylation), directive influence of substituents	
MODULE 4	**Types of reaction**	**15 Hours**
	TOPICS	
1	Nucleophilic substitution reactions: Alkyl, allyl and benzyl halides – substitution of halogen by some common nucleophiles.	
2	Mechanism of SN1 and SN2 reactions (stereochemistry, nature of substrate,	

	nucleophile and leaving group) Benzene diazonium chloride: Replacement of diazo group Alcohols, amines and phenols: Substitution of active hydrogen, replacement of hydroxyl group in alcohols (using PCl5, SOCl2 and HI)	
3	Elimination Reactions: Alkyl halides (dehydrohalogenation, Saytzeff's rule), vicinal dihalides(dehalogenation), alcohols (dehydration), Quaternary ammonium salts (Hofmann's elimination). Mechanism of E1 and E2 reactions (nature of substrate and base), elimination vs substitution. Oxidation Aromatic side chain: Nitro compounds: Acidic, alkaline and neutral reducing agents, lithium aluminium hydride and electrolytic reduction.	
MODULE 5	**Types of reaction**	**10 Hours**
TOPICS		
1	Physical and chemical properties of compounds: Chemical catalysis; Acid-base concepts; Concepts of pH and buffer; Conjugative effects and resonance; Inductive effects; Electromeric effects; Photochemistry; and Electrochemistry	

SUGGESTED READING

1. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical OrganicChemistry, 5th Ed., Pearson (2012).
2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Longman, London & New York.
3. Ahluwalia, V.K.; Dhingra, S. &Gulati, A. College Practical Chemistry, Universities Press.
4. I. L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.
5. R. T. Morrison & R. N. Boyd: Organic Chemistry, Pearson Education.
6. ArunBahl and B. S. Bahl : Advanced Organic Chemistry, S. Chand
7. Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
8. Eliel, E. L. &Wilen, S. H. Stereochemistry of Organic Compounds; Wiley: London, 1994.
9. T. W. Graham Solomon's Organic Chemistry, John Wiley and Sons.
10. P.S. Kalsi, Stereochemistry, Conformation and Mechanism, John Wiley and Sons.
11. D. Nasipuri, Stereochemistry of Organic Compounds, New Age International Publishers.

CHEMISTRY-1 PRACTICAL

Code: SCI23002
2 Credits | Semester III

Total Lectures Required –60 **Total Tutorials Required – 12**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO1: Classify organic compounds in terms of their functional groups and reactivity
CO2: Identify the organic compounds by specific chemical reaction

Syllabus

1. Systematic qualitative analysis of unknown organic compounds like

A. Preliminary test: Color, odour, aliphatic/aromatic compounds, saturation and unsaturation, etc.

B. Detection of elements like Nitrogen, Sulphur and Halogen by Lassaigne's test

C. Solubility test

D. Functional group test like Phenols, Amides/ Urea, Carbohydrates, Amines, Carboxylic acids, Aldehydes and Ketones, Alcohols, Esters, Aromatic and Halogenated Hydrocarbons, Nitro compounds and Anilides.

E. Melting point/Boiling point of organic compounds

F. Minimum 5 unknown organic compounds to be analysed systematically.

2. Preparation of suitable solid derivatives from organic compounds

3. Construction of molecular models

BACTERIOLOGY AND VIROLOGY

Code: BTG23012

4 Credits | Semester III

Total Lectures Required –60 **Total Tutorials Required – 12**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO1. Explain knowledge about the basic concepts of Bacteriology

CO2. Demonstrate different bacteriology techniques for diagnosis

CO3. Gain knowledge about various bacterial gene transfer

CO4. Explain about the basic concepts of virology

CO5. Describe virological techniques for diagnosis

CO6. Explain viral groups and viral treatment

MODULE 1	**Morphology and ultra-structure of bacteria**	**10 Hours**
	TOPICS	
1	Morphology and ultra-structure of bacteria, morphological types, cell walls of archaebacteria, gramnegative, gram positive, eubacteria, L-forms,cell wall synthesis, antigenic properties, capsule, types,composition and function, Structure and function(s) of flagella, cilia, pilli, gas vesicles, chromosomes, carboxysomes, magnetosomes and phycobolisomes, nucleoid, cell division, spores.	
2	Classification of microorganisms, introduction, Haeckel's three kingdom concept, Whittaker's five kingdom concept, three domain concept of Carl Woese, Basis of microbial classification, Classification and salient features of bacteria according to the Bergey's manual of determinative bacteriology.	
3	Reserve food materials, polyhydroxybutyrate, polyphosphate granules, oil droplets, cyanophycin granules and sulphur inclusions. Modes of nutrition and transport mechanisms in prokaryotes.	
MODULE 2	**Cultivation of bacteria**	**12 Hours**
	TOPICS	
1	Cultivation of bacteria, cell division, aerobic, anaerobic, shaker, still, nutritional types, culture mediaused, growth curve, generation time, asynchronous, synchronous culture, measurement of growth.	
2	Control of bacteria, physical and chemical agents, preservation methods	
3	Endospore, structure, properties, germination, sporulation and morphogenesis, Dormancy.	
MODULE 3	**Viruses**	**8 Hours**
	TOPICS	
1	Introduction – Viruses as distinct living organisms. The origin of virology, classification and nomenclature of viruses, isolation, purification and titration of viruses.	
2	Particles – Structure of viruses- capsid symmetry and architecture, envelop viruses, complex viruses, virus receptors, interaction with the host cell,	

	attachment and penetration.	
3	The Baltimore classification. Bacteriophages and its classification, Multiplication and Reproduction. Lysogency-with special reference to lambda and PI phages.	
MODULE 4	**Cultivation of viruses**	**15 Hours**
TOPICS		
1	Brief information about cultivation of viruses; Pathogenesis- Mechanism of cellular injury, virusesandimmuno deficiency, HIV and AIDS, cellular viruses and cancer;	
2	Prevention and Therapy of viruses infections; Novel infectious agents: Emergent viruses, Satellites, viroids and prions; Transmission of viruses and epidemiology of viruses infections, prevention and control measures of viral infections	
MODULE 5	**Diseases causing viruses**	**15 Hours**
TOPICS		
1	Brief information about important groups of viruses causing diseases in man including in followinggroups: Picornaviruses, papovaviruses, herpes viruses, poxviruses, reoviruses, paramyxoviruses,paramyxoviruses, rhabdoviruses, leukemiaviruses, Hepatitis virus, orthomyxoviruses, Dengue,Yellow fever and Japanese encephalitis virus.	

SUGGESTED READING

1. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. 12th edition. Pearson/Benjamin Cummings.
2. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
3. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

BACTERIOLOGY & VIROLOGY PRACTICAL

Code: BTG23013

2 Credits | Semester III

Total Lectures Required –30 **Total Tutorials Required –06**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO1: Use Sterilization techniques, wet heat, dry heat, filter types, laminar flow chamber types

CO2: Isolate of high titer of Bacteriophage.

CO3: Numeration of Bacteriophage in a sample by Plaque forming unit.

CO4: Serological test for viral studies

CO5: Isolate Bacteriophage from sewage

CO6: Adjust microscope, understand Microscopy, and learn Microscope and its operations, components, Microscope types, Light sources, microscopic measurements and calibration

CO7: Perform culture techniques, adjustment of pH, buffers, pure culture techniques, preparation of slants, Sub-culturing

SYLLABUS

1. Microscopy, Microscope and its operations, components, Microscope adjustments, Light sources, microscopic measurements, calibration: Types of microscope available, theory. Observation of various types of microbes under phase contrast, dark field and fluorescence.
2. Preparation of glassware, washing, sterilization techniques, wet heat, dry heat, filter types, laminar flow chamber types, CDC, safety levels.
3. Preparation of culture media, nutritional needs of microbes, dehydrated, selective, differential, autotrophic, heterotrophic. Culture techniques, adjustment of pH, buffers, pure culture techniques, preparation of slants, Sub-culturing.
4. Isolation and identification of bacteria
5. Microbial growth measurements, cell count, turbidity measurements, percentage transmission, Optical density, serial dilution, standard plate count.
6. Morphological, nutritional and cultural characteristics of bacteria and identification of microbes: types of dyes, preparation, staining techniques, Gram, capsule, negative, flagella, spore and nuclear.
7. Isolation of Bacteriophage from sewage.
8. Isolation of high titer of Bacteriophage.
9. Enumeration of Bacteriophage in a sample by Plaque forming unit.
10. Serological test for viral studies (Hepatitis antigens AND H.I.V.).

Molecular Diagnostics

Code: BTG23014

4 Credits | Semester III

Total Lectures Required –60 **Total Tutorials Required – 12**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO1: Understand Immunoassays, different enzyme available for immunoassays and immunohistochemically techniques

CO2: Acquire knowledge about Application of enzyme immunoassays

CO3: Understand the uses of monoclonal bodies in Immunoassays

CO4: Explain application of PCR in clinical microbiology

CO5: Understand different lab test in chemotherapy

CO6: Comprehend the Rapid diagnostic approaches and standardization of antigen and specific antibodies

CO7: Understand Radioimmunoassay, and epitope designing

CO8: Attain practical knowledge about HPLC, Flow cytometry and cell sorting

MODULE 1	**Enzyme Immunoassays**	**12 Hours**
TOPICS		
1	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.	
2	Use of polyclonal or monoclonal antibodies in enzymes immuno assays. Applications of enzyme immunoassays in diagnostic microbiology	
MODULE 2	**Molecular methods in clinical microbiology**	**12 Hours**
TOPICS		
1	Applications of PCR, RFLP, Nuclear hybridization methods, Single nucleotide polymorphism and plasmid finger printing in clinical microbiology	
2	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.	
MODULE 3	**Microbial diagnosis**	**12 Hours**
TOPICS		
1	Biosensors in clinical diagnosis, Use of nucleic acid probes and antibodies in clinical diagnosis and tissue typing. Nanotechnology in diagnosis.	
MODULE 4	**Immunodiagnostic**	**12 Hours**
TOPICS		
1	Antiidiotypes and molecular mimicry and receptors. Epitope design and	

	applications. Immunodiagnostic tests. Immuno florescence. Radioimmunoassay.	
MODULE 5	**Molecular diagnosis**	**12 Hours**
TOPICS		
1	GLC, HPLC, Electron microscopy, flowcytometry and cell sorting.	
2	Transgenic animals.	

SUGGESTED READING

1. Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker
2. Bioinstrumentation, Webster
3. Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes, J.F. Van Impe,Kluwer Academic
4. Ananthanarayan R and Paniker CKJ. (2005). Textbook of Microbiology. 7th edition (edited by Paniker CKJ). University Press Publication.
5. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. McGraw Hill Publication.
6. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mims' Medical Microbiology. 4th edition. Elsevier.
7. Joklik WK, Willett HP and Amos DB (1995). Zinsser Microbiology. 19th edition. Appleton-Centuary-Crofts publication.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.
9. Microscopic Techniques in Biotechnology, Michael Hoppert

BIOETHICS AND BIOSAFETY

Code: BTG23037

4 Credits | Semester III

Total Lectures Required –60 **Total Tutorials Required – 12**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO1: Interpret basics of Biosafety and bioethics and its impact on all the biological sciences and the quality of human life

CO2: Recognize importance of Biosafety practices and guidelines in research

CO3: Comprehend benefits of GM technology and related issues

CO4: Recognize importance of protection of new knowledge and innovations and its role in business

MODULE 1		**12 Hours**
	TOPICS	
1	Bioethics: Introduction to ethics and bioethics and its framework – Ethical, legal and socioeconomic aspects of gene therapy, germ line, somatic, embryonic and adult stem cell research - Ethical implications of GM crops, GMOs, human genome project and cloning, designer babies, biopiracy and biowarfare – Eugenics –Animal right activities and Ethical limits– Green peace - Human Rights and Responsibilities.	
MODULE 2		**12 Hours**
1	Biosafety: Definition – Causes: classification, identification of hazards – Issues. Handling – Types of accidents, first aid and precautionary measures – Clean room procedures: Classification specification – Basic methods for safe handling, transport, and storage of biological and chemical materials – Equipment related hazards.	
MODULE 3		**12 Hours**
1	Levels of Biosafety: Biological safety cabinets: Horizontal and Vertical Laminar Air Flow Cabinet, Fume hood – Primary and secondary containments – Biosafety levels of specific Microorganisms (food and water borne pathogens), Infectious Agents (Chemicals and carcinogens) – Material Safety Data Sheet. Guidelines: Biosafety Guidelines and regulations (National and International including Cartegana Protocol) of Government of India – GMOs and LMOs – Roles of Institutional Biosafety Committee.	
MODULE 4		**12 Hours**
1	Intellectual Property Rights: Significance of IPR - Types of IP: Patents, Trademarks, Copyright, Industrial Designs, Trade Mark, Trade secret and Geographical Indications – Treaties on IPR, GATT, WTO, WIPO and TRIPS - Farmers rights.	
MODULE 5		**12 Hours**
1	Patents and Patenting System: Patent law: Principles – Need for patent law in biotechnology – Types of patents –Role of a Country Patent office – Patent applications: Forms and guidelines– Types of patent application – Patent specification: provisional and complete specification – Patent databases: India, USPTO, and EPO – Patent infringement: Case studies on Turmeric and Neem	

Suggested Readings

1. Sateesh, M.K., Bioethics and Biosafety, IK International Publishers (2008)

2. Singh I. and Kaur, B., Patent law and Entrepreneurship, Kalyani Publishers (2006).

3. Srinivasan, K. and Awasthi, H.K., Law of Patents, Jain Book Agency (1997)

4. Jonathan, Y.R., Anthology of Biosafety (Vols. 1-4), American Biological Safety Association (2005).
5. Encyclopedia of Ethical, Legal and Policy issues in Biotechnology, John Wiley & Sons Inc. (2005**).**

Molecular Biology

Code: BTG24015

4 Credits | Semester IV

Total Lectures Required –60 **Total Tutorials Required – 12**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO1: Understand the concept of DNA replication, transcription and translation

CO2:Attain knowledge about DNA damage and various DNA repair mechanisms

CO3: Understand the mechanism of recombination in DNA

CO4: Able to elaborate the modern tools and techniques of molecular biology and isolation and identification of genes

CO5: Able to understand the biology and application of antisense technologies and biology of cancer

MODULE 1	**TOPICS**	**10 Hours**
1	Experiments on genetic material (Griffith, Hershey and Chase; Avery and McCarty experiments); Watson and Crick model; Chargaff's rule, Topology of DNA.	
2	Replication of DNA in prokaryotes and eukaryotes: Semi-conservative nature of DNA replication, Bi-directional replication, DNA polymerases, The replication complex: Pre-primming proteins, primosome, replisome, Rolling circle replication.	
3	Unique aspects of eukaryotic chromosome replication, Fidelity of replication.	
MODULE 2	**TOPICS**	**10 Hours**
1	DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Photoreactivation, base excision repair, nucleotideexcision repair, mismatch repair, translesion synthesis, recombinational repair, nonhomologousend joining.	
2	Homologous recombination: models and mechanism.	
MODULE 3	**TOPICS**	**10 Hours**
1	RNA structure and types of RNA, Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains	
MODULE 4	**TOPICS**	**15 Hours**
1	Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation	
2	Post transcriptional Modification: 5' cap formation, polyadenylation, splicing, rRNA and tRNA splicing.	

MODULE 5	TOPICS	15 Hours
1	Regulation of gene expression in prokaryotes: Operon concept (inducible and repressible system), Genetic code and its characteristics.	
2	Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, amino acyl tRNAsynthetases, Mechanism of initiation, elongation and termination of polypeptides, Fidelity of translation, Inhibitors of translation.]	
3	Post translational modifications of proteins.	

SUGGESTED READING

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
4. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008) Molecular Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub.

IMMUNOLOGY

Code: BTG24016

4 Credits | Semester IV

Total Lectures Required –60 **Total Tutorials Required – 12**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO1. Understand the basic concept of innate and acquired immunity.

CO2. Acquire knowledge about immunoglobulin structures and diversity of antibodies, morphology and functions of various immune cells such as dendritic cells, macrophages, Neutrophils and their association with MHC molecules will be studied.

CO3. Acquire understanding of immunology and immune responses in response to various infectious and noninfectious diseases.

CO4. Gain knowledge about various kinds of vaccines and their action

MODULE 1	**TOPICS**	**10 Hours**
1	An overview, components of mammalian immune system.	
2	Antigen: Types and properties of antigens, Heptan Cells and Tissues of the Immune system: Different lineages. Organs of immune system.	
3	Molecular structure of Immuno-globulins or Antibodies.	
4	Major Histocompatibility Complex: class I & class II MHC antigens, antigen processing	
MODULE 2	**TOPICS**	**10 Hours**
1	Humoral& Cellular immune responses, Tlymphocytes& immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells).	
2	T-cell receptors, Antibody affinity maturation class switching	
3	T-lymphocyte differentiation maturation and activation	
MODULE 3	**TOPICS**	**10 Hours**
1	Regulation of immunoglobulin gene expression – clonal selection theory, allotypes&idiotypes,allelic exclusion, immunologic memory, heavy chain gene transcription,	
2	Antibody diversity: genetic basis of antibody diversity, hypotheses (germ line & somatic mutation),	
MODULE 4	**TOPICS**	**15 Hours**
1	Hypersensitivity reactions, Immune stimulation and Immune suppressions.	
2	Immunity to infection – immunity to different organisms, pathogen defense strategies, avoidance of recognition. Autoimmune diseases, Immunodeficiency-AIDS.	
MODULE 5	**TOPICS**	**15 Hours**

1	Vaccines & Vaccination – adjuvants, cytokines, passive & active immunization.
2	Immunological assays; Agglutination tests, Complement fixation tests, In vivo tests, Neutralization tests, Radioimmunoassays, Enzyme immunoassays, ELISPOT assayImmunoblotting, Immunohistochemistry and immunohistopathology and Immunofluorescenece techniques.

SUGGESTED READING

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'sImmunobiology. 7th edition Garland Science Publishers, New York.
5. PeakmanM, 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.

CORE PRACTICAL-4

Code: BTG24017

4 Credits | Semester IV

Total Lectures Required –60 **Total Tutorials Required – 12**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO1: Isolate chromosomal and plasmid DNA from E. coli

CO2: Perform Qualitative and quantitative analysis of DNA using spectrophotometer

CO3: Carry out Restriction digestion of DNA

CO4: Prepare competent cell and transformation of competent cells.

CO5: Explain steps to carry out PCR process

CO6: Observe and identify the immune cells under microscope

CO7: Understand the process of Double immuno-diffusion test using specific antibody and antigen

SYLLABUS

1. Preparation of solutions for Molecular Biology experiments.
2. Isolation of chromosomal DNA from bacterial cells.
3. Isolation of Plasmid DNA by alkaline lysis method
4. Agarose gel electrophoresis of genomic DNA & plasmid DNA
5. Preparation of restriction enzyme digests of DNA samples
6. Demonstration of AMES test or reverse mutation for carcinogenicity
7. Differential leucocytes count
8. Total leucocytes count
9. Total RBC count
10. Haemagglutination assay
11. Haemagglutination inhibition assay
12. Separation of serum from blood
13. Double immuno-diffusion test using specific antibody and antigen.
14. ELISA

CHEMISTRY-2

Code: SCI24003

4 Credits | Semester IV

Total Lectures Required –60 **Total Tutorials Required – 12**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO1: Understand concept of resonance in various inorganic compounds

CO2: Understand Intermolecular forces and their effect

CO3: Acquire knowledge about Transition elements

CO4: Clearly understand Lanthanides and actinides

CO5: To be able to explain structural and stereoisomerism in complexes

CO6: Understand Co-ordination compounds in biological systems

MODULE 1	**TOPICS**	**10 Hours**
1	The covalent bond and the structure of molecules: Valence bond approach, Concept of resonance in various organic and inorganic compounds.	
2	Hybridization and structure, equivalent and nonequivalent hybrid orbitals, Bent's rule and its applications, VSEPR model for predicting shapes of molecules and ions containing lone pairs, sigma and pi bonds.	
MODULE 2	**TOPICS**	**10 Hours**
1	Molecular Orbital Approach: LCAO method, symmetry and overlap for s-s ,s-p and p-p combinations, MO treatment of homonuclear diatomic molecules of 2nd period (B2, C2 ,N2, O2 , F2) and heteronuclear di-atomic molecules (CO, NO) and their ions.	
2	Intermolecular forces: Van der Waals forces, Hydrogen bonding and its applications, effects of these forces on melting point, boiling point and solubility.	
MODULE 3	**TOPICS**	**10 Hours**
1	Chemical catalysis; Acid-base concepts; Concepts of pH and buffer; Conjugative effects and resonance; Inductive effects; Electromeric effects; Photochemistry; and Electrochemistry	
MODULE 4	**TOPICS**	**15 Hours**
1	Valence Bond Theory (VBT): Inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 4 and 6).	
2	Structural and stereoisomerism in complexes with coordination numbers 4 and 6. Drawbacks of VBT. IUPAC system of nomenclature.	
MODULE 5	**TOPICS**	**15 Hours**
1	Coordination compounds in biological systems: Fe, Cu, Co, Mn, Ni, Zn and heavy metal ions. Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral	

	symmetry. Factors affecting the magnitude of D.
2	Spectrochemical series. Comparison of CFSE for *Oh* and *Td* complexes, Tetragonal distortion of octahedral geometry. Jahn-Teller distortion, Square planar coordination.

SUGGESTED READING

1. James E. Huheey, *"Inorganic Chemistry: Principles of structure and reactivity"*, Prentice Hall, IV Edition.
2. D. S. Shriver and P.A. Atkins, *"Inorganic Chemistry"*, Oxford University Press, IV Edition.
3. Alan G. Sharpe, "*Inorganic Chemistry"*, University of Cambridge, III Edition.

CHEMISTRY-2 PRACTICAL

Code: BTG24038

2 Credits | Semester IV

Total Lectures Required –30 **Total Tutorials Required –06**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO1: Prepare different solution and the analysis of salt

CO2: Estimate different cations, anions and separation of salts

CO3: Separation of Acid and Basic radicals from a salt mixture

Syllabus

1. Salt analysis
2. Preparation of solutions of different Molarity/Normality
3. Estimation of cations
4. Estimation of anions
5. Principles involved in chromatographic separations. Paper chromatographic separation of following metal ions: i. Ni (II) and Co (II) ii. Fe (III) and Al (III)

MICROBIAL METABOLISM

Code: BTG24018

4 Credits | Semester IV

Total Lectures Required –60 **Total Tutorials Required – 12**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO1: Apply the knowledge to understand the microbial physiology and to identify the microorganisms.

CO2: Comprehend the concept of various pathways in the microbial metabolism

CO3: Understand the regulation of biochemical pathway in microorganisms

CO4: Attain knowledge aboutpossible process modifications for improved control over microorganisms for microbial product synthesis

MODULE 1	**TOPICS**	**10 Hours**
1	Introduction, scope of microbial physiology studies, organization of prokaryotic and eukaryotic cells,organelles of the microbial cells and their functions. Brief account of archaebacteria.	
2	Microbial nutrition, classification of microorganisms on the basis of their nutrition requirements. Uptake of nutrients	
MODULE 2	**TOPICS**	**10 Hours**
1	Detailed study of Carbohydrates catabolism with special emphasis of bacteria and yeasts.	
2	Glycolysis, Phosphogluconate Pathway, Heterolactic Fermentation, Enter-Doudord Pathway, Neuberg'sSchemes of Glucose fermentation, Mixed Acid Fermentation, Butyric Acid and solvents producing fermentations.	
3	Krebs Cycle, Glyoxylate cycle, Electron Transport, Chemiosomotic theory. Methyl Glyoxal metabolism.	
MODULE 3	**TOPICS**	**10 Hours**
1	Metabolism of Nitrogen Compounds, anaerobic amino acids catabolism, paired degradation of amino acids (Stickland reaction).	
MODULE 4	**TOPICS**	**15 Hours**
1	Microbial Growth: Trophophase and Idophase, Primary and secondary metabolites, growth kinetics.	
2	Types of growth: Batch, Fed-Batch, and Continuous and their industrial applications. Transport of compounds in microbes.	
MODULE 5	**TOPICS**	**15 Hours**
1	Sugar and Polysaccharide Synthesis, Cell Wall and Teichoic acid,	

	Lipopolysaacharides biosynthesis.
2	Anaplerotic sequences, bacterial photosynthesis, synthesis of lipids, essential amino acid synthesis.
3	Regulation of bacterial metabolism: enzyme induction, catabolite repression, feed-back inhibition and repression, properties of allosteric enzymes.

SUGGESTED READING:

1. Principles of Biochemistry- Lehninger, A.L. Nelson, D.L. and Cox, M.M.
2. Biochemistry of Industrial Micro-organisms – Eds., C. Rainbow, A. H. Rose and A.C.Press, New York.
3. Chemical Microbiology – A. H. Rose
4. Bacterial Metabolism - G. Gottschalk, Springer Verlag.
5. Principles of Fermentation Technology - Whittaker
6. Biochemistry- Stryer, L
7. The Microbial World-Stanier, R.Y. et al. Prentice Hall (India) Pvt. Ltd.
8. Microbial Physiology-Moat, A.G. & Foster, J.W. John Wiley & Sons.

MICROBIAL METABOLISM PRACTICAL

Code: BTG24019

2 Credits | Semester IV

Total Lectures Required –30 **Total Tutorials Required –06**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO1: Prepare liquid and solid media for growth of microorganisms.

CO2: Isolate and perform and maintain organisms by plating, streaking and serial dilution methods.

CO3: Isolate pure; microbial cultures from soil and water Study of Growth: Growth curve

CO4: Carry out direct microscopes counting of bacteria.

CO5: Study Motility by hanging drop techniques.

CO6: Do Microscopic examination of bacterial, yeast and molds

CO7: Measure of bacterial population by turbidometry

SYLLABUS:

1. Preparation of liquid and solid media for growth of microorganisms.
2. Isolation and maintenance of organisms by plating, streaking and serial dilution methods.
3. Isolation of pure; cultures from soil and water
4. Growth: Growth curve
5. Measurement of bacterial population by turbidometry and serial dilution methods.
6. Direct microscopes counting of bacteria.
7. Motility by hanging drop techniques.
8. Microscopic examination of bacterial, yeast and molds and study of organisms by Gram stain, Acid fast stain and staining for spores.
9. Assay of antibiotics and demonstration of antibiotic resistance.
10. Protein estimation by Lowry's / Bradford's method.
11. Estimation of carbohydrates in given solution by Anthrone Method.

INDUSTRIAL FERMENTATIONS

Code: BTG24020

4 Credits | Semester IV

Total Lectures Required –60 **Total Tutorials Required – 12**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO1: To impact knowledge about biological and biochemical technology, with a focus on biological products, the design and operation of industrial practices.

CO2: Students will able to evaluate factors that contribute in enhancement of cell and product formation during fermentation process.

CO3: Students will be able to analyses kinetics of cell and product formation in batch, continuous and fed-batch cultures and differentiate the rheological changes during fermentation process

MODULE 1	**TOPICS**	**10 Hours**
1	Production of industrial chemicals, biochemicals and chemotherapeutic products. Propionic acid,butyric acid, 2-3 butanediol, gluconic acid, itaconic acid.	
2	Biofuels: Biogas, Ethanol, butanol, hydrogen, biodiesel, microbial electricity, starch conversion processes; Microbial polysaccharides	
3	Microbial insecticides; microbial flavours and fragrances, newer antibiotics, anti cancer agents, amino acids.	
MODULE 2	**TOPICS**	**10 Hours**
1	Microbial products of pharmacological interest, steriod fermentations and transformations. Overproduction of microbial metabolite, Secondary metabolism – its significance and products.	
2	Metabolic engineering of secondary metabolism for highest productivity.	
MODULE 3	**TOPICS**	**10 Hours**
1	Enzyme and cell immobilization techniques in industrial processing, enzymes in organicsynthesis, proteolytic enzymes, hydrolytic enzymes, glucose isomerase, enzymes in foodtechnology/organic synthesis.	
MODULE 4	**TOPICS**	**15 Hours**
1	Purification & characterization of proteins, Upstream and downstream processing, solids and liquid handling.	
2	Distribution of microbial cells, centrifugation, filtration of fermentation broth, ultra centrifugation, liquid extraction, ion-exchange recovery of biological products.	
3	Experimental model for design of fermentation systems, Anaerobic fermentations	
MODULE 5	**TOPICS**	**15 Hours**
1	Rate equations for enzyme kinetics, simple and complex reactions. Inhibition kinetics; effect ofpH and temperature on rate of enzyme reactions.	
2	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.
3	Metabolic engineering of antibiotic biosynthetic pathways.

SUGGESTED READING

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,

BIOSTATISTICS

Code: BTG24039

4 Credits | Semester IV

Total Lectures Required –60 **Total Tutorials Required – 12**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO1: Describe the roles biostatistics serves in the discipline of public health.

CO2: Apply basic statistical concepts commonly used in public health and health Sciences

CO3: Demonstrate basic analytical techniques to generate results

CO4: Interpret results of commonly used statistical analyses in written summaries

MODULE 1	**TOPICS**	**10 Hours**
1	Bio-Statistics: Concepts of statistics-types of data, methods of collection of data. Sampling design – essentials of sampling – sampling methods – statistical laws and errors. Experimental designs. Data representation: Tabulation, Diagrammatic and graphical representation of data.	
MODULE 2	**TOPICS**	**10 Hours**
1	Measures of central tendency – mean, median and mode. Measures of dispersion: Mean deviations, standard deviation. Correlation analysis (Karl Pearson's and Spearman's Rank). Regression analysis – simple linear.	
MODULE 3	**TOPICS**	**10 Hours**
1	Tests of significance -'t'-test, Chi-square and goodness of fit, 'F' test - Analysis of variance (ANOVA): One-way.& Two-way.	
MODULE 4	**TOPICS**	**15 Hours**
1	Probability classical & axiomatic definition of probability, Theorems on total and compound probability), Elementary ideas of Binomial, Poisson and Normal distributions	
MODULE 5	**TOPICS**	**15 Hours**
1	Correlation and Regression. Emphasis on examples from Biological Sciences	

Suggested Readings

1. Le CT (2003) Introductory biostatistics. 1st edition, John Wiley, USA
2. Glaser AN (2001) High YieldTM Biostatistics. Lippincott Williams and Wilkins, USA
3. Edmondson A and Druce D (1996) Advanced Biology Statistics, Oxford University Press.
4. Danial W (2004) Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc

BIOPROCESS TECHNOLOGY

Code: BTG25021

4 Credits | Semester V

Total Hours: 60 **Tutorial Hours: 12**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO1: Understand various types of bioprocess carried out in industry andvarious types of bioreactor

CO2: Understand the application and functioning of bioreactors system, computer aided Bioreactors

CO3: Understand upstream, downstream process for different bioprocess, and their control

CO4:Acquire the basic understanding of various parameters for mass transfer

MODULE 1	**TOPICS**	**10 Hours**
1	Introduction to bioprocess technology. Range of bioprocess technology and its chronological development.	
2	Basic principle components of fermentation technology.	
MODULE 2	**TOPICS**	**10 Hours**
1	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.	
2	Principles of upstream processing – Media preparation, Inocula development and sterilization.	
MODULE 3	**TOPICS**	**10 Hours**
1	Introduction to oxygen requirement in bioprocess; mass transfer coefficient; factors affecting KLa.	
2	Bioprocess measurement and control system with special reference to computer aided process control.	
MODULE 4	**TOPICS**	**15 Hours**
1	Introduction to downstream processing, product recovery and purification. Effluent treatment.	
2	Microbial production of ethanol, amylase, lactic acid and Single Cell Proteins.	
MODULE 5	**TOPICS**	**15 Hours**
1	Types of microbial culture and its growth kinetics– Batch, Fedbatch and Continuous culture.	

SUGGESTED READING

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.

RECOMBINANT DNA TECHNOLOGY

Code: BTG25022

4 Credits | Semester V

Total Hours: 60 **Tutorial Hours: 12**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO1. Understand the tools and techniques of genetic engineering-DNA manipulation enzymes, genome and transcriptome analysis and manipulation tools, gene expression regulation, production and characterization of recombinant proteins.

CO2. Acquire knowledge about applications of genetic engineering in biological research.

CO3. Perform basic genetic engineering experiments at the end of course.

CO4. Acquire knowledge of advances in biotechnology- healthcare, agriculture and environment cleanup via recombinant DNA technology.

MODULE 1	**TOPICS**	**10 Hours**
1	Molecular tools and applications- restriction enzymes, ligases, polymerases, alkaline phosphatase.	
2	Gene Recombination and Gene transfer: Transformation, Episomes, Plasmids and other cloning vectors (Bacteriophage-derived vectors, artificial chromosomes), Microinjection, Electroporation, Ultra-sonication.	
3	Principle and applications of Polymerase chain reaction (PCR), primer-design, and RT- (Reverse transcription) PCR.	
MODULE 2	**TOPICS**	**10 Hours**
1	Restriction and modification system, restriction mapping. Southern and Northern hybridization.	
2	Preparation and comparison of Genomic and cDNA library, screening of recombinants, reverse transcription,. Genome mapping, DNA fingerprinting.	
MODULE 3	**TOPICS**	**10 Hours**
1	Applications of Genetic Engineering Genetic engineering in animals: Production and applications of transgenic mice, role of ES cells in gene targeting in mice.	
2	Therapeutic products produced by genetic engineering-blood proteins, human hormones, immune modulators and vaccines (one example each).	
MODULE 4	**TOPICS**	**15 Hours**
1	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).	
MODULE 5	**TOPICS**	**15 Hours**

1	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,
2	Gene targeting in plants, Use of plant viruses as episomal expression vectors.

SUGGESTED READING

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.

CORE PRACTICAL-5

Code: BTG25023

4 Credits | Semester V

Total Hours: 60 **Tutorial Hours: 12**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO1: Understand the parts and operation of the fermenter and their use for the production of commercial products

CO2: Understand the concept of various downstream processes

CO3: Isolation of chromosomal and plasmid DNA from E. *Coli*

CO4: Carry out restriction digestion of DNA

CO5: Make competent cell and Transformation of competent cells.

CO6: Able to perform amplification of DNA by a thermocycler

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.
6. Isolation of industrially important microorganism from natural resource.
6. 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

BIOINFORMATICS

Code: BTG25024

4 Credits | Semester V

Total Hours: 60 **Tutorial Hours: 12**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO1. Understand and describe and use the biological databases, perform structured query and analyze and discuss the results in biologically significant way.

CO2. Attain knowledge about the use of BLAST, FASTA and use NCBI site for, *in silico* molecular biology

CO3. Understand principle, algorithm and different methods of sequence alignments as well as execute alignments to address research problems

CO4. Perform wide variety of bioinformatics tools and software and apply these to conduct basic bioinformatics research and thus develop platform for molecular biology experiments

MODULE 1	**TOPICS**	**10 Hours**
1	History of Bioinformatics. The notion of Homology.	
2	Databases, types, pairwise and multiple alignments. Structure-function relationship. Sequence assembling using computers. Computer applications in molecular biology, Protein domains and human genome analysis program (BLAST, FASTA, GCC etc.) Search and retrieval of biological information and databases sequence, databank. (PDB and gene bank), accessing information (Network expasy, EMB Net, ICGEB Net).	
MODULE 2	**TOPICS**	**10 Hours**
1	Protein Information Sources, PDB, SWISSPROT, TREMBL.	
2	Understanding the structure of each source and using it on the web.	
3	Introduction of Data Generating Techniques and Bioinformatics problem posed by them- Restriction Digestion, Chromatograms, Blots, PCR, Microarrays, Mass Spectrometry.	
MODULE 3	**TOPICS**	**10 Hours**
1	Sequence and Phylogeny analysis, Detecting Open Reading Frames, Outline of sequence Assembly, Mutation/Substitution Matrices, Pairwise Alignments.	
2	Introduction to BLAST, using it on the web, Interpreting results, Multiple Sequence Alignment, Phylogenetic Analysis.	
MODULE 4	**TOPICS**	**15 Hours**
1	Searching Databases: SRS, Entrez, Sequence Similarity Searches-BLAST, FASTA, Data Submission. FASTA.	
MODULE 5	**TOPICS**	**15 Hours**
1	Genome Annotation: Pattern and repeat finding, Gene identification tools.	

SUGGESTED READING

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.

BIOINFORMATIC PRACTICAL

Code: BTG25025

2 Credits | Semester V

Total Hours: 30 **Tutorial Hours: 06**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO1: SNP databases at NCBI and other sites

CO2: Learn the application of OMIM database

CO3: Detect Open Reading Frames using ORF finder

CO4: Able to work on Proteomics 2D PAGE database

CO5: Analyze the Protein localization by using different software

Syllabus

1. Sequence information resource
2. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene, Protein
3. information resource (PIR)
4. Understanding and using: PDB, Swissprot, TREMBL
5. Using various BLAST and interpretation of results.
6. Retrieval of information from nucleotide databases.
7. Sequence alignment using BLAST.
8. Multiple sequence alignment using Clustal

ANIMAL BIOTECHNOLOGY

Code: BTG25026

4 Credits | Semester V

Total Hours: 60 **Tutorial Hours: 12**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO1: Understand the concept of gene transfer technologies for animals and animal cell lines.

CO2: Attain knowledge about application of biotechnology in animal diseases control

CO3: Understand basic principles and techniques in genetic manipulation and genetic engineering.

CO4: Acquire knowledge aboutgenetic modification in the field of Medicineand health care : Gene therapy

CO5:Understand the techniques and problems both technical and ethical in animal and human cloning.

MODULE 1	**TOPICS**	**10 Hours**
1	Gene transfer methods in Animals–Microinjection, Embryonic Stem cell, gene transfer, Retrovirus & Gene transfer.	
MODULE 2	**TOPICS**	**10 Hours**
1	Introduction to transgenesis. Transgenic Animals – Mice, Cow, Pig, Sheep, Goat, Bird, Insect.	
2	Animal Cell culture primary and established cell line cultures, functions of different constituents of culture media, serum and protein free media and their applications ,scaling up of animal cell culture, cell synchronization, cell cloning and micro manipulation. Organ and histotypic culture.	
MODULE 3	**TOPICS**	**10 Hours**
1	Animal diseases need help of Biotechnology – Foot-and mouth disease, Coccidiosis, Trypanosomiasis, Theileriosis.	
MODULE 4	**TOPICS**	**15 Hours**
1	Animal propagation – Artificial insemination, Animal Clones. Conservation Biology – Embryo transfer techniques.	
2	Introduction to Stem Cell Technology and its applications.	
MODULE 5	**TOPICS**	**15 Hours**
1	Genetic modification in Medicine - gene therapy, types of gene therapy, vectors in gene therapy, molecular engineering.	
2	Human genetic engineering, problems & ethics.	

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 DNAgenes and genomes- A short course. III Edition. Freeman and Co., N.Y., USA.

ANIMAL BIOTECHNOLOGY PRACTICAL

Code: BTG25027

2 Credits | Semester V

Total Hours: 30 **Tutorial Hours: 06**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO1: Use Sterilization techniques for glass ware and media

CO2: Prepare media for animal biotechnology

CO3: Use Lab sterilization processes

CO4: Isolate DNA from animal tissue

CO5: Prepare Minimal Essential Growth medium

CO6: Isolate lymphocytes for culturing

CO7: Prepare Balance solution

SYLLABUS

1. Sterilization techniques: Theory and Practical: Glass sterilization, Laboratory sterilization ware sterilization, Media
2. Sources of contamination and decontamination measures.
3. Preparation of Hanks Balanced salt solution
4. Preparation of Minimal Essential Growth medium
5. Isolation of lymphocytes for culturing
6. DNA isolation from animal tissue
7. Quantification of isolated DNA.
8. Resolving DNA on Agarose Gel.

BIO ANALYTICAL TOOLS

Code: BTG26028

4 Credits | Semester VI

Total Hours: 60 **Tutorial Hours: 12**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO1: Understand the basic principle of different Bioanalytical techniques

CO2: Understand the technique of DNA separation

CO3: Understand techniques of protein separation

CO4: To analyzed the biological analytes

MODULE 1	**TOPICS**	**10 Hours**
1	Basics of Instrumental analysis: Selection of analytical methods, Accuracy, Precision, Detection Limit, Sensitivity and Analytical Range – Types of errors: Random and Systematic – Calibration methods: Standard curve and internal standard addition.	
2	Simple microscopy, phase contrast microscopy, florescence Electron microscopy (TEM and SEM)	
MODULE 2	**TOPICS**	**10 Hours**
1	Spectroscopy: Absorption and emission spectroscopy pH meter.	
MODULE 3	**TOPICS**	**10 Hours**
1	NMR, MS–Ionization (MALDI, ESI), Analyzer (TOF and Quadrupole) and Detector.	
2	Centrifugation, cell fractionation techniques, isolation of sub-cellular organelles and particles.	
MODULE 4	**TOPICS**	**15 Hours**
1	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.	
MODULE 5	**TOPICS**	**15 Hours**
1	Introduction to electrophoresis. Starch-gel, polyacrylamide gel (native and SDS-PAGE), agarose-gel electrophoresis, pulse field gel electrophoresis, immuno- electrophoresis, isoelectric focusing, Western blotting. Introduction to	
2	Biosensors and Nanotechnology and their applications**.**	

SUGGESTED READING

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 The World of the Cell.7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

BIOANALYTICAL TOOL PRACTICALS

Code: BTG26029

2 Credits | Semester VI

Total Hours: 30 **Tutorial Hours: 06**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO1: Find relation between absorbance and % transmission using spectrophotometer

CO2: Separate different types of amino acids by paper chromatography (ascending method)

CO3: Separate the proteins by SDS-polyacrylamide gel electrophoresis.

CO4: Identify the lipids in a given sample by TLC

CO5: Verify the validity of Beer‟s law and determine the molar extinction coefficient of NADH

CO6: Separate the plant pigments by adsorption column chromatography

SYLLABUS:

1. Native gel electrophoresis of proteins
2. SDS-polyacrylamide slab gel electrophoresis of proteins under reducing conditions.
3. Preparation of the sub-cellular fractions of rat liver cells.
4. Preparation of protoplasts from leaves.
5. Separation of amino acids by paper chromatography.
6. To identify lipids in a given sample by TLC.
7. To verify the validity of Beer’s law and determine the molar extinction coefficient of NADH.

GENOMICS AND PROTEOMICS

Code: BTG26030

4 Credits | Semester VI

Total Hours: 60 **Tutorial Hours: 12**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO1: Explain scope of genomics and proteomics

CO2: Gain insight into Protein sequencing methods

CO3: Analyse Genome sequences, human genome project

CO4: Use Genomic databases and genome analysis

CO5: carry out analysis of proteomes

CO6: Explain mass spectrometry based methods for protein identification

MODULE 1	**TOPICS**	**10 Hours**
1	Introduction to Genomics, DNA sequencing methods – manual & automated: Maxam& Gilbert and Sangers method.	
2	Pyrosequencing, Genome Sequencing: Shotgun & Hierarchical (clone contig) methods.	
MODULE 2	**TOPICS**	**10 Hours**
1	Managing and Distributing Genome Data: Web based servers and softwares for genome analysis: ENSEMBL, VISTA, UCSC	
2	Genome Browser, NCBI genome. Selected Model Organisms' Genomes and Databases.	
MODULE 3	**TOPICS**	**10 Hours**
1	Introduction to protein structure, Chemical properties of proteins. Physical interactions that determine the property of proteins.	
2	Short-range interactions, electrostatic forces, van der waal interactions, hydrogen bonds, Hydrophobic interactions.	
3	Determination of sizes (Sedimentation analysis, gel filteration, SDS-PAGE); Native PAGE, Determination of covalent structures – Edman degradation.	
MODULE 4	**TOPICS**	**15 Hours**
1	Introduction to Proteomics, Analysis of proteomes. 2D-PAGE. Sample preparation, solubilization, reduction, resolution.	
2	Reproducibility of 2D-PAGE. Mass spectrometry based methods for protein identification. *De Novo* sequencing using mass spectrometric data.	
MODULE 5	**TOPICS**	**15 Hours**
1	Computer tools for sequencing projects: Genome sequence assembly software.	

SUGGESTED READING

1. Genes IX by Benjamin Lewin, Johns and Bartlett Publisher, 2006.
2. Modern Biotechnology, 2nd Edition, S.B. Primrose, Blackwell Publishing, 1987.
3. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition,
4. B.R. Glick, J.J. Pasternak and C.L. Patten, 2010.
5. Molecular Cloning: A Laboratory Manual (3rd Edition) Sambrook and Russell Vol. I to III, 1989.
6. Principles of Gene Manipulation 6th Edition, S.B.Primrose, R.M.Twyman and R.W. Old. Blackwell Science, 2001.
7. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and SonsInc.
8. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.
9. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
10. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
11. Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition. John Wiley & Sons.

GENOMICS AND PROTEOMICS PRACTICALS

Code: BTG26031

2 Credits | Semester VI

Total Hours: 30 **Tutorial Hours: 06**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO1: Use SNP databases at NCBI and other sites

CO2: Use OMIM database

CO3: Detect Open Reading Frames using ORF finder

CO4: Use Proteomics 2D PAGE database

CO5: Analyse Protein localization by using different software

SYLLABUS:

1. Use of SNP databases at NCBI and other sites
2. Use of OMIM database
3. Detection of Open Reading Frames using ORF Finder
4. Proteomics 2D PAGE database
5. Softwares for Protein localization.
6. Hydropathy plots
7. Native PAGE
8. SDS-PAGE

ENVIRONMENTAL BIOTECHNOLOGY

Code: BTG26032

4 Credits | Semester VI

Total Hours: 60 **Tutorial Hours: 12**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO1: Evaluate the potential of biodegradation of organic pollutants, taking microbial and physical/chemical environments, as well as the chemical structure of the compound itself, into consideration

CO2: Explain the phenomenon of phytoremediation for the decontamination of soil and water, wetlands as treatment processes, biofilms/biofilters for vapor-phase wastes, and composting

CO3: Evaluate environmental quality, monitoring, and remediation of contaminated environments

CO4: Understand the use of biosensors in environmental analysis, environmental engineering.

MODULE 1	**TOPICS**	**10 Hours**
1	Introduction to environment; pollution and its control; pollution indicators; waste management: domestic, industrial, solid and hazardous wastes.	
2	Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents. Degradation of lignin and cellulose using microbes.	
MODULE 2	**TOPICS**	**10 Hours**
1	Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents.	
2	Degradation of lignin and cellulose using microbes.	
MODULE 3	**TOPICS**	**10 Hours**
1	Phyto-remediation. Degradation of pesticides and other toxic chemicals by micro-organisms.	
2	Degradation aromatic and chlorinates hydrocarbons and petroleum products.	
MODULE 4	**TOPICS**	**15 Hours**
1	Treatment of municipal waste and Industrial effluents. Bio-fertilizers.	
2	Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil. Algal andfungalbiofertilizers (VAM)	
MODULE 5	**TOPICS**	**15 Hours**
1	Bioleaching, Enrichment of ores by microorganisms (Gold, Copper and Uranium).	
2	Environmental significance of genetically modified microbes, plants and animals.	

SUGGESTED READING

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

ENVIRONMENTAL BIOTECHNOLOGY PRACTICALS

Code: BTG26033
2 Credits | Semester VI

Total Hours: 60 **Tutorial Hours: 12**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO1: Calculate Total Dissolved Solids (TDS) of water sample.

CO2: Examine Bacterial count of Water by MPN Method

CO3: Calculate BOD of water sample

CO4: Calculate COD of water sample

SYLLABUS:

1. Calculation of Total Dissolved Solids (TDS) of water sample.
2. Calculation of BOD of water sample.
3. Calculation of COD of water sample.
4. Bacterial Examination of Water by MPN Method.

PLANT BIOTECHNOLOGY

Code: BTG26034

4 Credits | Semester VI

Total Hours: 60 **Tutorial Hours: 12**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO1. Understand the principle and technical advances behind the in vitro culture of plant cells and rDNA techniques

CO2 Able to understand the applications of plant transformation for improving the productivity and performance of plants under biotic and abiotic stresses

CO3. Understand the use of antisense technologies for improvement of crop plants

CO4: To grow soil less plant (Plant tissue culture)

MODULE 1	**TOPICS**	**10 Hours**
1	Introduction, Cryo and organogenic differentiation, Types of culture: Seed , Embryo, Callus, Organs, Cell and Protoplast culture.	
2	Micropopagation Axillary bud proliferation, Meristem and shoot tip culture, cud culture, organogenesis, embryogenesis, advantages and disadvantages of micropropagation.	
MODULE 2	**TOPICS**	**10 Hours**
1	In vitro haploid production Androgenic methods: Anther culture, Microspore culture andogenesis. Sgnificance and use of haploids.	
2	Ploidy level and chromosome doubling, diplodization, Gynogenic haploids, factors effecting gynogenesis, chromosome elimination techniques for production of haploids in cereals.	
MODULE 3	**TOPICS**	**10 Hours**
1	In vitro haploid production Androgenic methods: Anther culture, Microspore culture andogenesis. Sgnificance and use of haploids.	
2	Ploidy level and chromosome doubling, diplodization, Gynogenic haploids, factors effecting gynogenesis, chromosome elimination techniques for production of haploids in cereals.	
MODULE 4	**TOPICS**	**15 Hours**
1	Somaclonal variation Nomenclautre, methods, applications basis and disadvantages. Synthetic or artificial seeds, cytoplasmic male sterility	
MODULE 5	**TOPICS**	**15 Hours**
1	Plant Growth Promoting bacteria. Nitrogen fixation, Nitrogenase, Hydrogenase, Nodulation. Growth promotion by free-living bacteria. Biocontrol of pathogens	
2	Transgenic plants for virus resistance, herbicide tolerance, delay of fruit ripening, resistance to insect, fungi and bacteria. Production of antibodies, viral antigens and peptide hormones in plants.	

SUGGESTED READING

1. Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice.
2. Brown, T. A. Gene cloning and DNA analysis: An Introduction. Blackwell Publication.
3. Gardner, E.J. Simmonns, M.J. Snustad, D.P. 2008 8th edition Principles of Genetics. Wiley India.
4. Raven, P.H., Johnson, GB.,Losos, J.B. and Singer, S.R. 2005 Biology. Tata MC Graw Hill.
5. Reinert, J. and Bajaj, Y.P.S. 1997 Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture. Narosa Publishing House.
6. Russell, P.J. 2009 Genetics – A Molecular Approach. 3rdedition. Benjamin Co.
7. Sambrook&Russel. Molecular Cloning: A laboratory manual. (3rd edition)
8. Slater, A., Scott, N.W. & Fowler, M.R. 2008 Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press.

PLANT BIOTECHNOLOGY PRACTICALS

Code: BTG26035

2 Credits | Semester VI

Total Hours: 30 **Tutorial Hours: 06**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO-1: Prepare simple growth nutrient (Knop's medium), full strength, half strength, solid and liquid.

CO-2 Prepare complex nutrient medium

CO-3 Select, Prune, sterilize and prepare an explant for culture.

CO-4 Understand Significance of growth hormones in culture medium.

CO -5 Perform various steps of Micro propagation using explant.

SYLLABUS:

1. Preparation of simple growth nutrient (Knop's medium), full strength, half strength, solid and liquid.
2. Preparation of complex nutrient medium (Murashige&Skoog's medium)
3. To selection, Prune, sterilize and prepare an explant for culture.
4. Significance of growth hormones in culture medium.
5. To demonstrate various steps of Micropropagation.

PROJECT

Code: BTG26036
4 Credits | Semester VI

Total Hours: 60 **Tutorial Hours: 12**

COURSE OUTCOMES

Course Outcomes: At the end of the course, students will be able to:

CO-1: Students will able to work in team
CO-2: Students can able to perform research
CO-3: Student can able to make research hypothesis
CO-4: Students can be able to think novel ideas based on previous work
CO-5: Student can able to collect data's and arrangement
CO-6: To be well versed of data analysis using statistical software
CO-7: To get skills of data presentation
CO-8: To induce go for further studies
CO-9: To be well versed with lab chemicals
CO-10: To know about research need

Dissertation is introduced in last semester to make students understand the basic methods of research and to familiarize them with the research data analysis. Students will be provided presentation skills