COURSES OF STUDY
M.Sc Biotechnology (Autonomous)

DEPARTMENT OF BIOTECHNOLOGY & BIOINFORMATICS
SAMBALPUR UNIVERSITY, JYOTI VIHAR
BURLA- 768019, ODISHA

PEOs

PEO1: Understand the nature and basic concepts of _____ relating to the M.Sc. in Biotechnology

PEO2: Analyze the relationships among different concepts

PEO3: Perform procedures as laid down in the areas of study

PEO4: Apply the Basic Concepts learned to execute them

POs

PO-1: **Critical Thinking:** Take informed actions after identifying the assumptions that frame our thinking and actions

PO-2: **Effective Communication:** Will be able to speak, read, write and listen clearly in person and through electronic media in English and in one Indian Language

PO-3: **Social Interation (Interpersonal Relation):** Elicit views of others, mediate disagreements and prepared to work in team

PO-4: **Entrepreneurship Capability:** Demonstrate qualities to be prepared to become an enterpreneur

PO-5: **Ethics:** Recognize different value systems including your own, understand the moral dimensions and accept responsibility for them

PO-6: **Environment and Sustainability:** Understand the issues of environmental contexts and sustainable development

PO-7: **Life-Long Learning:** Acquire the ability to engage in independent and life-long learning in the context of socio-technological changes

COs

CO-1: Remember and understand the basic concepts/Principles of _____

CO-2: Analyze the Various Concepts to understand them through case studies

CO-3: Apply the knowledge in understanding practical problems

CO-4: Execute/Create the Project or field assignment as per the knowledge gained in the course

COURSE AT A GLANCE
Biotechnology

First Semester

Course Number	Course Title	Credit Hour	Mark Distribution (ET+MT+HA)	Maximum Mark
BT-C-411	(A) Physical Sciences (B) Foundation Biology	2	80+10+10	100
BT-C-412	Chemistry of Biomolecules	4	80+10+10	100
BT-C-413	Genetics and Biostatistics	4	80+10+10	100
BT-C-414	Microbiology	4	80+10+10	100
BT-C-415	Molecular Biology-I	4	80+10+10	100
BT-C-416	Practical-I	2	50	50
ESDMS-419	Environmental Sc. & Disaster Manage (Coordinated by Dept. of Env. Sc.)	2	60+20+20	100
	Total	**22**		**650**

Second Semester

Course Number	Course Title	Credit Hour	Mark Distribution (ET+MT+HA)	Maximum Mark
BT-C-421	Molecular Biology-II	4	80+10+10	100
BT-C-422	Bioenergetics and Metabolism	4	80+10+10	100
BT-C-423	Instrumentation and Techniques	4	80+10+10	100
BT-C-424	Industrial Microbiology	4	80+10+10	100
BT-C-425	Practical -II	4	50	50
BT-C-426 (IDC)	Biotechnology and its Applications (Inter Disciplinary Course)	3	60+20+20	100
	Participation in NCC or NSS or other non-credit course			
	Total	**23**		**550**

Third Semester

Course Number	Course Title	Credit Hour	Mark Distribution (ET+MT+HA)	Maximum Mark
BT-C-511	Recombinant DNA Technology, IPRs and Biosafety	4	80+10+10	100
BT-C-512	Immunology	4	80+10+10	100
BT-C-513	Plant and Animal Biotechnology	4	80+10+10	100
BT-C-514	Cell Culture Techniques and Developmental Biology	4	80+10+10	100
BT-C-515	Practical- III	2	50	50
BT-C-516	Seminar	2	50	50
EDPS-439	Entrepreneurship Development Programme	2	60+20+20	100
	Total	**22**		**600**

Fourth Semester

Course Number	Course Title	Credit Hour	Mark Distribution (ET+MT+HA)	Maximum Mark
BT-C-521	Genomics, Proteomics and Metabolomics	4	80+10+10	100
BT-C-522	Bioprocess Engineering	4	80+10+10	100
BT-C-523	Concepts of Bioinformatics	4	80+10+10	100
BT-E-524 Elective Paper (Any one)	(A) Agricultural Biotechnology	4	80+10+10	100
	(B) Clinical pathology and Diagnostics			
	(C) Environmental Biotechnology			
	(D) Pharmaceutical Biotechnology			
BT-525	Project work and Viva voce	4	100	100
	MOOCs Course	3	75+25	100
	Total	**23**		**600**
	Grand Total	**90**		**2400**

ET: End Term Examination, MT: Mid Term Examination, HA: Home Assignment

MOOC Courses	Semester	Title of the course	Credit Hours
MOOC Course-I	3rd Sem	Principle of Downstream Techniques in Bioprocess	3
MOOC Course-II		Experimental Biotechnology	3
MOOC Course-III		Organic Farming for Sustainable Agriculture	3
MOOC Course-IV		Genome Editing & Engineering	3
MOOC Course-V		Drug Delivery Principles and Engineering	3
MOOC Course-VI		Medical Image Analysis	3

FIRST SEMESTER

BT-C-411 (A)	PHYSICAL SCIENCES	2 CH	100 MARKS

CO-1: Remember and understand the basic concepts/Principles of **Physical Sciences**
CO-2: Analyze the Various Concepts to understand them through case studies
CO-3: Apply the knowledge in understanding practical problems
CO-4: Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit-I

Basic Mathematics: Logarithms, exponential series, factorials, graphs, coordinate geometry – straight line and non-linear relationships. Differentiation– Rates and limits, Differential coefficients, differentiation of a function, Maxima and Minima. Integration – basic concepts of integration, integration by substitution, integration by parts. matrix algebra – linear transformation between vector spaces, representation of linear transformation by matrices, algebra of matrices, eigen values and eigen vectors of linear transformation.

Unit-II

Basic Physics and Computer Fundamentals: Surface tension, viscosity, photoelectric effect, basic characteristics of electricity and magnetism, charge, current, voltage, resistance, capacitor, electric field and impedence diodes, photoresistors, Semiconductors, transistors, integrated circuits and chips.

Unit-III

Basic chemistry: atomic structure – waves and wave functions, quantum numbers, atomic orbitals, electronic configuration of atoms and periodic properties of elements, ionic radii's, ionization potential, electronic configuration of molecules. Bond lengths, bond angles, bond order and bond energies, types of chemical bond (weak and strong), intermolecular forces, structure of simple ionic and covalent bonds, carboxylic acids, aldehydes and ketones, amines (overview). Buffers and pH.

Unit-IV

Basics of computer: types, basic organization of computers, computer memory and storage, Storage devices, ROM and RAM, Basics of computer languages, Concept of hardware and software, Generation of computers, Classification of computers (workstation, server, grid computing, parallel computing, cloud computing), Operating systems.

Suggested readings:

1. Basic Mathematics, Serge A. Lang, Springer publisher (1988).ISBN-13: 978-0387967875.
2. Higher Engineering Mathematics, B.S. Grewal and J.S.Grewal, Khanna Publishers, New Delhi (2007).ISBN-13: 978-8900120905.
3. Calculus and analytical geometry, G. B Thomas, R. L. Finney, 9th Ed., Pearson Education Asia (Adisson Wesley), New Delhi (2000). ISBN-13: 978-0201531749.
4. Trigonometry, Algebra and Calculus, T.Veerarajan, Tata McGraw Hill Publishing Co. Ltd, New Delhi (2003). ISBN: 978-0070535077.
5. Fundamentals of Physics, D. Halliday, R. Resnick, J. Walker. John Wiley and Sons (2010).ISBN-13: 978-9971513306.
6. Chemistry: An Introduction to General, Organic, and Biological Chemistry,Karen C. Timberlake. Pearson(2015). ISBN-13: 978-1292061320.
7. Fundamental Principles of Inorganic Chemistry,D Banerjea. Sultan Chand and Sons(2001). ISBN-13: 978-8170148159
8. Fundamentals of Computers,ReemaThareja. Oxford University Press (2015). ISBN-13: 978-0199452729.

BT-C-411(B)	FOUNDATION BIOLOGY	2 CH	100 MARKS

CO-1: Remember and understand the basic concepts/Principles of **Foundation Biology**
CO-2: Analyze the Various Concepts to understand them through case studies
CO-3: Apply the knowledge in understanding practical problems
CO-4: Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit I

Chemistry of living organisms: biomolecules, origin of life, cell- unit of living organisms and multicellular organisms, structure of animal, plant and bacterial cell, sub-cellular organelles (cytoskeleton, mitochondria, golgi complex, endoplasmic reticulum, chloroplast, ribosome, lysosome, nucleus).

Unit II

Classification and nomenclature of plant and animal; Microbial classification; Phylogeny, Organic evolution, Evidences in support of evolution (Morphological, Embryological, Taxonomic, Genetic, Biochemical and Molecular); Origin of species and speciation; Environmental and anthropogenic impact on living organisms.

Unit III

Plant and animal tissue system and function; Physiology of locomotion, respiration, digestion, circulation, excretion in animals; hormonal regulations in animals; Photosynthesis; Respiration; Transportation in plants.

Unit IV

Physiology of reproduction in plants and animals; Genetics- science of heredity: chromosome number and structure, cell division- meiosis and mitosis, mendelian principle of heredity; Monohybrid and Dihybrid cross (examples).

Suggested readings:

1. Life: The Science of Biology: Volume III: Plants and Animals. David Sadava, David M. Hillis, H. Craig Heller, May Berenbaum. 10th Ed., W. H. Freeman(2003).ISBN-13: 978-1464141249.
2. Biology, Peter H. Raven, George B Johnson, Kenneth A. Mason, 10thEd., Tata McGraw Hill (2013). ISBN-13: 978-9351341802.
3. Life Sciences Fundamentals and Practice (Part I&II), Pranav Kumar, Usha Mina. Pathfinder Academy Pvt. Ltd (2017). ISBN-13: 978-8190642705.
4. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, P.S. Verma,V.K. Agarwal V.K, S. Chand and Company Limited (2016). ISBN-13: 978-8121924429.
5. Cell Biology for Biotechnologists, Shaleesha A Stanley. Narosa Publishing House (2008). ISBN-13: 978-8173198083.
6. Concepts of Genetics, William S Klug, Michael R Cummings, Charlotte A Spencer, 10thEd., Pearson Education Limited (2016). ISBN-13: 978-9332577466.
7. Principles of genetics, Eldon John Gardner, Michael J Simmons, D Peter Snustad, 8th Ed., Wiley India Pvt.Ltd (2014). ISBN-13: 978-8126510436.

BT-C-412	CHEMISTRY OF BIOMOLECULES	4 CH	100 MARKS

CO-1: Remember and understand the basic concepts/Principles of **Chemistry of Biomolecules**
CO-2: Analyze the Various Concepts to understand them through case studies
CO-3: Apply the knowledge in understanding practical problems
CO-4: Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit I

DNA structures: Nucleotides and nucleosides, DNA double helix, DNA structure (Z-DNA, B-DNA, A-DNA), triple helix DNA, tetraplex DNA, DNA binding proteins, Protein – DNA interactions, RNA secondary and tertiary structures. Isolation, purification and quantification of DNA and RNA.

Unit II

Biomolecules: Carbohydrates (Monosaccharides, Disaccharides, and Polysaccharides); Biological importance of Carbohydrates: Cell wall structure and its diversity. Purification of carbohydrates. Structure and functions of lipids (fatty acids, storage lipids, structural lipids); Lipids as signals, cofactors and pigments; Isolation of lipids.

Unit III

Protein structure: Chemical building blocks, Peptide bond, Torsion angles, Ramachandran map, Protein structures (Primary, Secondary Super-secondary, Tertiary, Quaternary), Protein folding, Protein motifs and domains; Purification of proteins, Crystallization of proteins, Protein structure determination, X-ray crystallography, NMR (1D and 2D NMR).

Unit IV

Engineering & design of protein structure, Homologous protein, Protein sequencing, Protein flexibility and stability, Engineering of protein structure and applications (case studies). Membrane proteins and its function, Metalloproteins, Carbohydrate binding proteins, Glycosylation and its importance. Metalloenzymes: Structure and Function.

Suggested reading:

1. DNA Structure and Function,Richard R Sinden. Academic Press (2012). ISBN-13: 978-0126457506.
2. Lehninger Principles of Biochemistry,David L. Nelson, Michael M. Cox, Freeman, W. H. & Company (2008). ISBN-13: 978-0716743392.
3. Fundamentals of Biochemistry: life at the molecular level,Donald Voet, Judith G. Voet, Charlotte W. Pratt, New York: Wiley (2016). ISBN-13: 978-1118129180.
4. Outlines of Biochemistry,Eric E Conn, Paul K Stumpf, George Bruening,Wiley India Pvt.Ltd (2011). ISBN-13: 978-8126509300.
5. Biochemistry, Jeremy M. Berg, John L. Tymoczko, Gregory J. Gatto, LubertStryer,8th Ed., Freeman and company (2015). ISBN-13: 978-1464126109.
6. Harper's Illustrated Biochemistry,Victor W Rodwell, David A Bender, Kathleen M Botham, Victor W Rodwell, David A Bender, Kathleen M Botham, 29th Ed., Mcgraw-Hill Book Company (2015). ISBN-13: 9781259252860.

BT-C-413	GENETICS AND BIOSTATISTICS	4 CH	100 MARKS

CO-1: Remember and understand the basic concepts/Principles of **Genetics and Biostatistics**
CO-2: Analyze the Various Concepts to understand them through case studies
CO-3: Apply the knowledge in understanding practical problems
CO-4: Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit-I

Mendelian principle: dominance, segregation and independent assortment; extensions of Mendelian principle: co-dominance, Incomplete dominance, gene interactions, supplementary genes, complementary genes, duplicate genes, epistasis, plieotropy, sex determination in plants and animals, dosage compensation, sex linkage, sex limited and sex influenced characters; extra chromosomal inheritance; maternal inheritance, polygenic inheritance in human beings.

Unit-II

Concept of gene: allele, multiple alleles, complementation tests; linkage and crossing over; linkage and mapping in eukaryotes: two-point cross, three-point cross, haploid mapping (tetrad analysis), human chromosomal maps: X linkage, autosomal linkage, Lod score for linkage testing, Pedigree analysis, penetrance and expressivity, family tree, dominance inheritance, recessive inheritance, sex-linked inheritance; Population genetics: gene pool, gene frequency, Hardy Weinberg genetic equilibrium; Gene flow and Genetic drift.

Unit III

Concepts from probability: probability rules, probability distributions, Binomial distribution, Poisson distribution, Systematic organization of data**:** populations, samples, types of data, frequency tables and histograms; Measure of central tendency (arithmetic mean, median, mode, geometrical mean); Measure of dispersion (range, mean deviation, variance, standard deviation, coefficient of variation); Normal distribution: importance and properties; Areas under standard normal curve; Skewness and Kurtosis.

Unit IV

Tests of hypothesis**:** Student's t-test, Paired t-test, Hypothesis testing; categorical data and Chi-square tests: 2 x 2 contingency table, Correlation and linear regression: Scatter diagram, Pearson's correlation coefficient, Regression analysis, Analysis of variance: one-way analysis of variance, Two way analysis of variance.

Suggested readings:

1. Genetics, Monroe W Strickberger. 3rdEdition. Prentice Hall India Learning Private Limited (2015). ISBN-13: 978-9332555105.
2. Genetics, B.D. Singh, Kalyani Publishers / LyallBk Depot (2016). ISBN-13: 978-8127248673.
3. Principles of Population Genetics, Andrew G. Clark, Daniel L. Hartl, 4th Ed., Sunderland: Sinauer Associates (2007). ISBN-13: 978-0878933082.
4. Principles of Genetics, Robert H. Tamarin, 7th Edition, Tata McGraw-Hill Edition. ISBN-0-07-048667-0.
5. Introductory Biostatistics for the Health Sciences, Michael R. Chernick, Robert H. Friis, Wiley-Interscience Publications (2003). ISBN-13: 9780471411376.
6. Statistics: Concepts and Applications, Nabendu Pal, Sahadeb Sarkar, Prentice-Hall Of India Pvt Ltd (2009). ISBN-13: 9788120334458.
7. Probability and statistics for engineers and scientists, Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying E. Ye, 9th Ed., Pearson (2011). ISBN-13: 9781292161365.

BT-C-414	MICROBIOLOGY	4 CH	100 MARKS

CO-1: Remember and understand the basic concepts/Principles of **Microbiology**
CO-2: Analyze the Various Concepts to understand them through case studies
CO-3: Apply the knowledge in understanding practical problems
CO-4: Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit-I

Microbial world (bacteria, archea, eukaryote). Classification of Archea and Eubacteria as per Bergey's manual; Microbial phylogeny. Structural organization of prokaryotic cell (bacterial wall, capsule, flagella, pilli, pronucleus, ribosomes, plasmid).

Unit-II

Bacterial nutrition and nutritional category, bacterial culture: Types of Media; synchronous and asynchronous culture, continuous culture and chemostat. Bacterial growth, Mathematical expression of growth, generation time, specific growth rate; Diauxic growth.

Unit-III

Bacterial metabolism: Glucose dissimilation pathways, Bacterial respiration with organic and inorganic reluctant, Chemolithotrophy. Principle of bacterial conjugation, transduction and transformation. Bacterial pathogenecity and anti-microbial compounds.

Unit-IV

Virus**:** general properties, structure, purification, cultivation; Principle of viral taxonomy. Bacteriophage: structure, classification; One-step growth experiment. Production of DNA phage, RNA phage, lytic cycle, temperate phage and lysogeny. Animal virus and its reproduction, Viral infection (persistent, latent and slow virus infection). Plant virus and their transmission. Anti-viral agents; M-13, Lambda, HIV, Influenza virus, Viriods and Prions.

Suggested reading:

1. Microbiology,Jr Michael J Pelczar, Ecs Chan, Noel R Krieg,Tata Mcgraw Hill Publishing Co Ltd (2016). ISBN-13: 978-0074623206.
2. Brock Biology of Microorganisms, Michael T Madigan, John M Martinko, Kelly S Bender, Pearson Education Limited (2014). ISBN-13: 978-9332586864.
3. Microbiology: An Introduction,Gerard J Tortora, Berdell R Funke, Christine L Case,8thEdition, Pearson/Benjamin Cummings(2015). ISBN-13: 978-9332575417.
4. Microbiology: Principles and Applications,J. Black, Prentice Hall(2004). ISBN-13: 978-0131907454.
5. Microbiology,Donald A. Klein, John P. Harley, Lansing M. Prescott, 6th Ed., McGraw Hill(2005).ISBN-13: 978-0072951752.
6. Microbiology: A Human Perspective, Eugene Nester, Denise Anderson, Jr., C. Evans Roberts, Martha Nester, 6th Ed., McGraw-Hill Science/Engineering/Math (2008). ISBN-13: 978-0077250416.

BT-C-415	MOLECULAR BIOLOGY- I	4 CH	100 MARKS

CO-1: Remember and understand the basic concepts/Principles of **Molecular Biology**
CO-2: Analyze the Various Concepts to understand them through case studies
CO-3: Apply the knowledge in understanding practical problems
CO-4: Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit-I

Genetic organization of prokaryotes and eukaryotes including nuclear genome and organelle genome; DNA as the genetic material (experimental evidences); Central dogma; Genome complexity; C-value paradox, Cot value, Repetitive DNA, Satellite DNA; Gene structure in prokaryotes and eukaryotes; split genes, overlapping genes, pseudogenes, clusters and repeats.

Unit-II

Condensation of chromosome, Lampbrush chromosome, Polytene chromosome, Supercoiling of DNA, nucleosomes, DNA methylation, Genetic imprinting, Epigenetic inheritance, Transposable elements, Types of transposable elements, Mechanism of transposition, Retroposons and its types, Mechanism of retrotransposition, Rearrangement of DNA.

Unit-III

DNA replication: Models of DNA replication, Enzymes involved in DNA replication, Process of DNA replication (initiation, elongation, termination), DNA replication at telomere; Replication of extranuclear genome (Mitochondrial and Chloroplast), DNA recombination (Site specific and Homologous); DNA repair mechanisms (base-excision, mis-match, SOS, Recombination).

Unit-IV

Mutation: types, causes and detection; Mutant types – lethal, conditional, biochemical, loss of function, gain of function; germinal verses somatic mutants, insertional mutagenesis; structural and numerical alterations in chromosomes (deletion, duplication, inversion, translocation, ploidy and their genetic implications).

Suggested reading:

1. Molecular Biology of the Cell, Bruce Alberts, Alexander Johnson, Julian Lewis, 6th Ed., Taylor & Francis Group / Spon Press (2015). ISBN-13: 9780815344643.
2. Genes IX, Benjamin Lewin, Jones and Bartlett Publishers (2010). ISBN-13: 978-9380108537.
3. Molecular cell biology, Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, HiddePloegh, Angelika Amon, Kelsey Martin, 8th Ed., WH Freeman(2016). ISBN-13: 978-1464183393.
4. Molecular Biology of the Gene, James D Watson, Tania A Baker, Stephen P Bell,Pearson Education Limited (2017). ISBN-13: 978-9332585478.
5. Cell and Molecular Biology, Gerald Karp, 5th Edition, John Wiley (2013). ISBN-13: 978-1118301791.
6. Cell Biology, Thomas D. Pollard, William C. Earnshaw, Jennifer Lippincott-Schwartz, 3rd Ed., Elsevier - Health Sciences Division (2017). ISBN-13: 978-0323417402.

BT-C-416	Practical-I	2 CH	50 marks
ESDMS-419	Environmental Science and Disaster Management	2 CH	100 marks

SECOND SEMESTER

BT-C-421	MOLECULAR BIOLOGY-II	4 CH	100 marks

CO-1: Remember and understand the basic concepts/Principles of **Molecular Biology**
CO-2: Analyze the Various Concepts to understand them through case studies
CO-3: Apply the knowledge in understanding practical problems
CO-4: Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit-I

Transcription: components of transcription machinery in prokaryotes and eukaryotes, trancriptional factors, transcription process (initiation, elongation and termination); Post-transcriptional processing, regulation of transcription (protein-DNA interaction: zinc finger motif, homeodomain, helix-loop-helix, leucine zipper), m-RNA stability, m-RNA editing; nuclear splicing, catalytic RNA, mechanism of gene silencing.

Unit-II

Translation:genetic code- principle of translation, translation machinery in prokaryotes and eukaryotes (t-RNA, aminoacyl synthetase, ribosome), translation process (initiation, elongation and termination). Regulation of gene expression: constitutive and induced gene expression; Operon concept (lac, ara, trp and his); Regulation of gene expression in prokaryotes and eukaryotes.

Unit-III

Structure and function of cytoskeleton and its role in motility; Biomembrane composition dynamics and function; Membrane carbohydrates and their role in cellular recognition, Endocytosis, budding and fusion reaction. Transport across the membrane: carriers and channels, Mechanism of transport through Glut, Na^+-K^+ pump, Na^+ -Glucose co-transporter, Acetylcholine receptor, K^+ Channel, Aquaporin. Protein trafficking: mechanism of sorting and regulation of intracellular transport.

Unit IV

Biosignaling: Ion channel, Receptor enzymes, and G protein mediated signaling; Ras/MAPK pathway, JAK-STAT pathway, BMP pathway, Hedghog pathway; NF-κB pathway, Notch/Delta pathway, IP_3-DAG pathway, Quorum Sensing, Cell cycle and its regulation; Genetics of cancer (Proto-oncogenes, Tumor suppressor genes); Virus-induced cancer, metastasis Therapeutic interventions of uncontrolled cell growth.

Suggested readings:

1. Molecular Biology of the Cell, Bruce Alberts, Alexander Johnson, Julian Lewis, 6th Ed., Taylor & Francis Group / Spon Press (2015). ISBN-13: 9780815344643.
2. Genes IX, Benjamin Lewin, Jones and Bartlett Publishers (2010). ISBN-13: 978-9380108537.
3. Molecular cell biology, Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon, Kelsey Martin, 8th Ed., WH Freeman (2016). ISBN-13: 978-1464183393.
4. Cell and Molecular Biology, Gerald Karp, 5th Edition, John Wiley (2013). ISBN-13: 978-1118301791.
5. Cell Biology, Thomas D. Pollard, William C. Earnshaw, Jennifer Lippincott-Schwartz, 3rd Ed., Elsevier - Health Sciences Division (2017). ISBN-13: 978-0323417402.
6. Molecular Biology of the Gene, James D Watson, Tania A Baker, Stephen P Bell,Pearson Education Limited (2017). ISBN-13: 978-9332585478.
7. Genetics, Monroe W Strickberger. 3rd Edition. Prentice Hall India Learning Private Limited (2015). ISBN-13: 978-9332555105.

BT-C-422	BIOENERGETICS AND METABOLISM	4 CH	100 marks

CO-1: Remember and understand the basic concepts/Principles of **Bioenergetics and Metabolism**
CO-2: Analyze the Various Concepts to understand them through case studies
CO-3: Apply the knowledge in understanding practical problems
CO-4: Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit I
Enzymes: basic concepts and kinetics, classification of enzymes, Coenzymes and cofactors, effect of temperature and pH on enzyme activity, Michaelis-menten kinetics, inhibitors and activators, enzyme inhibition (Competititive, Non-competitive, Uncompetitive), K_{cat} and turnover number, Allosteric enzymes and its regulation, Multi-enzyme complexes, Regulatory enzymes, feedback and feed forward systems, Bi-substrate reaction kinetics, Enzyme substituted model (Ping pong model).

Unit II
Metabolism and regulation of carbohydrate (Glycolysis, Gluconeogenesis, Pentose phosphate pathway and its physiological significance); Co-ordinated regulation of glycogen synthesis and breakdown; Citric acid cycle, Regulation of citric acid cycle, glyoxylate cycle; Electron transport in mitochondria.

Unit III
Amino acid oxidation and production of urea (metabolic fates of amino groups, fatty acid catabolism (digestion, metabolism and transport of fats), Oxidation of fatty acids, ketone bodies, Lipid biosynthesis, Urea cycle, Amino acid degradation), biosynthesis of amino acids, Biosynthesis of nucleotides (Purines and Pyrimidines). Metabolic disorders, In-born error due to metabolism, Hormonal regulation of metabolism.

Unit IV
Photosynthesis: Light harvesting complexes; mechanisms of electron transport in chloroplast; photoprotective mechanisms; CO_2 fixation-C_3, C_4 and CAM pathways. Alternate oxidase; photorespiratory pathway; Biosynthesis, storage, breakdown and transport of plant hormones; Physiological effects and mechanisms of action of plant hormones; Endocrine glands: An overview, Mechanism of hormone action (Peptide and Second messenger concept). Nitrogen fixation; Nitrate and ammonium assimilation.

Suggested readings:

1. Lehninger Principles of Biochemistry, David L. Nelson, Michael M. Cox, Freeman, W. H. & Company (2008). ISBN-13: 978-0716743392.
2. Biochemistry, Jeremy M. Berg, John L. Tymoczko, Gregory J. Gatto, Lubert Stryer, 8th Ed., Freeman and company (2015). ISBN-13: 978-1464126109.
3. Fundamentals of Biochemistry: life at the molecular level, Donald Voet, Judith G. Voet, Charlotte W. Pratt, New York: Wiley (2016). ISBN-13: 978-1118129180.
4. Basic Concepts In Biochemistry: A Student's Survival Guide, Hiram F. Gilbert, 2nd Ed., McGraw-Hill Publisher (1999). ISBN-13: 9780071356572.
5. Harper's Illustrated Biochemistry, Victor W Rodwell, David A Bender, Kathleen M Botham, Victor W Rodwell, David A Bender, Kathleen M Botham, 29th Ed., Mcgraw-Hill Book Company (2015). ISBN-13: 9781259252860.

BT-C-423	INSTRUMENTATION & TECHNIQUES	4 CH	100 marks

CO-1: Remember and understand the basic concepts/Principles of **Instrumentation and Techniques**
CO-2: Analyze the Various Concepts to understand them through case studies
CO-3: Apply the knowledge in understanding practical problems
CO-4: Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit-I

Laws of absorption of light: Beer-Lambert's Law, factors affecting the absorption properties of chromophores; Principle, instrumentation and application of Spectrophotometer and fluorimeter. Principle, instrumentation and application of Chromatography (Paper, Thin layer, Affinity, Ion-exchange, Size exclusion chromatography, GLC and HPLC)

Unit-II

Principle, instrumentation and application of Infrared spectroscopy, atomic absorption spectroscopy, Mass spectroscopy (LC-MS, GC-MS, MALDI-TOF, Fluorescent spectroscopy, FTIR; Circular dichroism spectroscopy, Surface plasmon resonance; Flow cytometry.

Unit-III

Centrifugation – Principles and types (Density gradient, differential centrifugation and ultracentrifugation); Radioactivity; Principle and application of G.M. counter and Liquid Scintillation Counter, Microscopy (Compound, Phase contrast, Fluorescence, Confocal); Electron microscopy (TEM, SEM), Different fixation and staining techniques (Freeze-etch and Freeze-fracture methods for EM).

Unit-IV

Principle, instrumentation and application of pH meter, Flame photometer, Electrophoresis (Agarose, PAGE, SDS-PAGE, IEF). Principle and application of Blotting (Southern, Northern) techniques. PCR and its Variants.

Suggested readings:

1. Biochemical Techniques Theory and Practice, John F Robyt, Cbs Publishers & Distributors (2015). ISBN-13: 978-8123926605.
2. An Introduction to Practical Biochemistry, David T Plummer, Tata Mcgraw Hill Publishing Co Ltd (2015). ISBN-13: 978-0070994874.
3. Analytical Chemistry, Gary D. Christian, John Wiley & Sons Inc (2013). ISBN-13: 978-0470887578.
4. Principle and Techniques of Biochemistry and Molecular Biology, Keith Wilson, John Walker, 7th Ed., Cambridge University Press (2010). ISBN-13: 978-0521731676.

BT-C-424	INDUSTRIAL MICROBIOLOGY	4 CH	100 marks

CO-1: Remember and understand the basic concepts/Principles of **Industrial Microbiology**
CO-2: Analyze the Various Concepts to understand them through case studies
CO-3: Apply the knowledge in understanding practical problems
CO-4: Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit-I
Introduction to industrial biotechnology: history and scope; Commercial strain development (induced mutation, over producing decontrolled mutants, genetically engineered strain); Industrial production of enzymes (Amylases, proteases, Pectinases, Lipases); Chemicals Butanol, Ethanol, Amino acids (L-glutamic acid, L-lysine), Organic acids (Citric acid, Lactic acid), Vinegar production (Acetification using trickling generator).

Unit-II
Industrial biotechnology in pharmaceutical and alcoholic beverages industry: Industrial scale production of Antibiotic (Penicillin, Streptomycin, Cephalosporin), Alkaloids (Ergot alkaloids), Therapeutic proteins and peptides (DNase, Erythropoietin, Somatotrophin, Insulin, Interferon). Vitamins (B_{12}, Riboflavin: B_2, L-Ascorbic acid: C), Fermentation technology: Alcoholic beverages (beer, wine and cider) production (malting, mashing, brewing, wort preparation), Post-fermentation treatments and maturation.

Unit-III
Industrial biotechnology in food and allied sectors; Dairy fermentation (butter and cheese): Strategies of cheese production and ripening, Factor affecting cheese production; Application of enzymes in food processing; Microbial biomass production: Commercial production of SCP (Bel process, Symba, Pekilo, Pruteen and Quorn process), Advantages and limitations of SCP, Microbial leaching of metals, Biofertilizers.

Unit-IV
Principle of food preservation, method of food preservation (Thermal processing, cold preservation, Pascalisation, Irradiation, Chemical and atural food preservatives). Operational units in food industry, Preservation by fermentation. Food safety and standards (adulteration, contamination, food laws, HACCP for food safety. ISO 9000 series and other standards).

Suggested readings:

1. Bioprocess Engineering Principles, Pauline M. Doran, 2nd Ed., Academic Press (2012), ISBN-13: 9780122208515.
2. Bioprocess Engineering-Basic Concepts, Michael L Shuler, Fikret Kargi, Pearson Education Limited (2015). ISBN-13: 9789332549371.
3. Fermentation Microbiology and Biotechnology, C F A Bryce, E M T El Mansi, 2nd Ed., anebooks - T & F / Routledge (2006), ISBN-13: 9780849353345.
4. Biotechnology- A text book of Industrial Biotechnology, Wulf Crueger, Anneliese Crueger, Kr Aneja, Medtec (2017). ISBN-13: 9789385998638.

BT-C-425	PRACTICAL -II	4 CH	50 marks

BT-C-426 (IDC)	BIOTECHNOLOGY AND ITS APPLICATIONS	3 CH	100 marks

CO-1: Remember and understand the basic concepts/Principles of **Biotechnology and Its Applications**
CO-2: Analyze the Various Concepts to understand them through case studies
CO-3: Apply the knowledge in understanding practical problems
CO-4: Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit-I

Fundamentals of Biotechnology: Structure of DNA and RNA; DNA as the genetic material (experimental evidences); Central dogma of molecular biology. Genome organization of prokaryotes and eukaryotes; Nucleosome concept.

Unit-II

Concept of gene cloning: DNA isolation techniques; Restriction endonucleases, DNA polymerase, Ligase; Cloning vectors: plasmid, bacteriophage, cosmid, BAC, YAC; Expression vectors: bacteria and yeast based expression vector; Introduction of recombinant DNA into host cells, Screening of recombinants. C-DNA library and Genomic library.

Unit-III

Biotechnological applications in agriculture**:** Pest resistant plants, Bt Cotton; Biotechnological applications in medicine; Gene Therapy**;** PCR and its variants; DNA finger printing; Therapeutic proteins and peptides (Insulin).

Unit-IV

Transgenic animal production: Induction of superovulation, Embryo collection and evaluation, Embryo splitting, Embryo sexing, Embryo transfer, Advantages of embryo transfer in farm animals, *In vitro* fertilization, Embryo cloning. Applications of transgenic animals. Ethical Issues: Public concerns on GMOs & LMOs, Roles of Institutional Biosafety Committee, RCGM, GEAC; Ethics in clinical trials, Genetic testing.

Suggested readings:

1. Elements of Biotechnology, P K Gupta, Rastogi Publication (2015). ISBN-13: 9788171339372.
2. Recombinant DNA: A Short Course, Amy A. Caudy, James D. Watson, Jan A. Witkowski, Richard M. Myers, WH Freeman (2006), ISBN-13: 9780716728665.

	PARTICIPATION IN NCC OR NSS OR OTHER (NON-CREDIT COURSE)		

*Interdisciplinary Value Aided Course with total intake of 60 students from other departments

THIRD SEMESTER

BT-C-511	RECOMBINANT DNA TECHNOLOGY, IPRs AND BIOSAFETY	4 CH	100 marks

CO-1: Remember and understand the basic concepts/Principles of **Recombinant DNA Technology, IPRs and Biosafety**
CO-2: Analyze the Various Concepts to understand them through case studies
CO-3: Apply the knowledge in understanding practical problems
CO-4: Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit-I
Restriction endonuclease, ligases; DNA & RNA markers, linker, adapter and MCS, PCR and its variants; Cloning vectors- plasmid, bacteriophage, cosmid, BAC, YAC; Expression vectors: bacteria and yeast based expression vector; Gene library- genomic and c-DNA, contig library, Screening of libraries.

Unit-II
Concept of gene cloning; cloning of interacting gene: two hybrid and three hybrid assay; cloning of differentially expressed gene, gene regulation analysis-DNA transfection, Primer extension, SI mapping, RNase protection assay, reporter assay and phage display; DNA microarrays and chips- principle and process; DNA finger printing and DNA foot printing; DNA sequencing; site directed mutagenesis; expression of heterologous gene; *In vitro* transcription and translation; gene knock out strategies; RNA interference: antisense RNA, siRNA, mi RNA; Ribozyme Technology.

Unit-III
Intellectual property rights and its types-patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs; process patent vs product patent; Basic requirement of a patentable invention; Indian Patent Act 1970 and recent amendments; Procedure for filing a patent, international patenting-requirement, patent infringement- meaning, scope, litigation, remedies; case studies and examples-Rice, Neem *etc*.

Unit-IV
Introduction to biosafety regulations; primary containment for biohazards and biosafety levels; biosafety guidelines - government of india. Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC. Bioethics, Public concerns on human genome research and transgenics: genetic testing and screening, Ethics in clinical trials and GCP, ELSI & human genome project; Ethics in human cloning (case study).

Suggested readings:

1. Biotechnology and Intellectual Property Rights, Kshitij Kumar Singh, Springer (2016), ISBN-13: 9788132229759.
2. Intellectual Property and Biotechnology: Biological Inventions, Rimmer Matthew, Edward Elgar,U.K. - Edward Elgar (2009). ISBN-13: 9781845429478.
3. Bioethics and Biosafety, M. K. Sateesh, Ik International Pvt Ltd (2014), ISBN-13: 9788190675703.
4. Biosafety and Bioethics, Rajmohan Josi, Isha Books (2006). ISBN-13: 9788182053779.
5. Principle of gene manipulation and Genomics, S.B Primrose, R.M Twyman, 6th Ed., Blackwell Science Ltd (2014). ISBN-13: 9788126548392
6. Biotechnology: Expanding Horizons, BD Singh, Kalyani Publishers / Lyall Bk Depot (2016). ISBN-13: 9789327222982.
7. Elements of Biotechnology, P K Gupta, Rastogi Publication (2015). ISBN-13: 9788171339372.

BT-C-512	IMMUNOLOGY	4 CH	100 marks

CO-1: Remember and understand the basic concepts/Principles of **Immunology**
CO-2: Analyze the Various Concepts to understand them through case studies
CO-3: Apply the knowledge in understanding practical problems
CO-4: Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit-I

Basics of immunity: cell and organs of immune system in human and evolution of immune system. Immunogen, antigen and haptens. Factors affecting immunogenicity. Immunoglobulins – classification, structure and properties; Primary and Secondary immune response; Genetic basis of antibody diversity; Other B cell receptors.

Unit-II

Complement system: Mechanism of activation and its regulations. Major histocompatibility complex proteins; antigen processing and presentation; T-cell receptors. Cytokines and cytokine receptors: structure, function and therapeutic applications. Immunology of allergy, AIDS, Organ transplantation; Autoimmune diseases. Immunology of cancer cells.

Unit-III

Tools and techniques in immunology: experimental animal models, cell culture. Application of immunological concepts in drug development, vaccines and diagnostics: development of antibodies, antibodies as drugs, Designing vaccines for active and passive immunization; Hybridoma technology and application of Mabs. Catalytic antibodies, Generation of Immunoglobulin library.

Unit-IV

Immunotechnology: antigen-antibody interaction (Scatchard equation); Immunodiffusion (SRID and DRID); Immunoelectrophoresis: types and uses; ELISA; RIA; ELISPOT assay; Western blotting; Immunofluorescence; Immunoelectron microscopy; Surface plasmon resonance; CMI techniques- lymphoproliferation assay, mixed lymphocyte reaction.

Suggested readings:

1. Immunology, Janis Kuby, 3rd Edition, WH Freeman (2007). ISBN-13: 9789812435163.
2. Janeway's Immunobiology, Kenneth Murphy, 8th Edition, Garland Science 2016. ISBN-13: 9780815345305
3. Cellular and Molecular Immunology, Abul K. Abbas, Andrew H. H. Lichtman, Shiv Pillai, 7th Ed., Elsevier (2001). ISBN-13: 9788131248928.
4. Kuby Immunology. Judith A Owen, Jenni Punt, Sharon A Stranford, 7th Ed., W.H. Freeman and Co., New York (2013). ISBN-13: 9781429219198
5. Essential Immunology, Ivan M Roitt, Peter J Delves, 12th Ed., Blackwell Scientific Publications (2011). ISBN-13: 9781405196833.
6. Principle of gene manipulation and Genomics, S.B Primrose, R.M Twyman, 6th Ed., Blackwell Science Ltd (2014). ISBN-13: 9788126548392

BT-C-513	PLANT AND ANIMAL BIOTECHNOLOGY	4 CH	100 marks

CO-1: Remember and understand the basic concepts/Principles of **Plant and Animal Biotechnology**

CO-2: Analyze the Various Concepts to understand them through case studies

CO-3: Apply the knowledge in understanding practical problems

CO-4: Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit-I

Tools of plant genetic engineering: *agrobacterium* biology, basis of tumor and hairy root formation, mechanisms of T-DNA transfer, role of virulence genes, plant gene vector based on Ti plasmid, direct transformation (gene gun, electroporation, microinjection, calcium phosphate, PEG, DEAE, liposomes *etc.*); selection of clones, marker and reporter genes involved in screening, application of genetic transformation: promoter tagging, activation tagging; terminator seed technology; transgene stability and gene silencing; Case studies.

Unit-II

DNA profiling techniques and genetic diversity analysis, RAPD, ISSR, SSR, AFLP. Stress and Adaptation: Responses of plants to biotic (Pathogen and insects) and abiotic (wather temperature and salt) stresses; Mechanisms of resistance to biotic stress and tolerance to abiotic stress. Plant growth regulators and their physiological effects: Auxin, Gibberellin, Cytokinin, ABA, Ethylene.

Unit-III

Micromanipulation of animal cells, Induction of superovulation, Embryo collection and evaluation, Embryo splitting, Embryo sexing, Embryo transfer, Advantages of embryo transfer in farm animals, *In vitro* fertilization, Embryo cloning, Nuclear transplantation, Production of transgenic animals and gene farming, Identification and transfer of gene influencing production and disease resistance.

Unit-IV

Embryonic stem cells and adult stem cell; differences between stem cells and differentiated cells; isolation and culture of stem cells; use of embryonic stem cells and adult stem cells for health care; Tissue engineering; three-dimensional culture: multi-cellular tumour spheroids. Assessment of immune responses in humans, Adoptive transfer of lymphocytes and hematopoietic stem cell transfers, Animal models: Transgenic mice and gene knockout by targeted disruption, *In vivo* cell tracking techniques, Cell imaging techniques *in vitro* and *in vivo*.

Suggested readings:

1. Plant Biotechnology Genetic Manipulation Of Plants,Adrian Slater, Nigel W. Scott and Mark R. Fowler, Oxford University Press (2017). ISBN-13: 9780199560875.
2. Biotechnology: Expanding Horizons, BD Singh, Kalyani Publishers / Lyall Bk Depot (2016). ISBN-13: 9789327222982.
3. Introduction to Plant biotechnology, H.S Chawala, Oxford & Ibh Publishing Co. Pvt Ltd (2016). ISBN-13: 9788120417328.
4. Cellular and Molecular Immunology, Abul K. Abbas, Andrew H. H. Lichtman, Shiv Pillai, 7th Ed., Elsevier (2001). ISBN-13: 9788131248928.
5. Kuby Immunology. Judith A Owen, Jenni Punt, Sharon A Stranford, 7th Ed., W.H. Freeman and Co., New York (2013). ISBN-13: 9781429219198
6. Animal Biotechnology Models in Discovery and Translation. 2nd Edition - June 9, 2020 Editors: Ashish Verma, Anchal Singh eBook ISBN: 9780128117255 Hardcover ISBN: 9780128117101

BT-C-514	CELL CULTURE TECHNIQUE AND DEVELOPMENTAL BIOLOGY	4 CH	100 marks

CO-1: Remember and understand the basic concepts/Principles of **Cell Culture Technique and Developmental Biology**
CO-2: Analyze the Various Concepts to understand them through case studies
CO-3: Apply the knowledge in understanding practical problems
CO-4: Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit-I

Plant tissue culture concepts and methods: Concept of totipotency and plasticity, Tissue culture media and its composition, Initiation and establishment of culture: explant preparation, callus culture, single cell culture, suspension culture, microspore culture, embryo rescue; Micropropagation: Organogenesis, Somatic embryogenesis, Artificial seed; Protoplast technology: Isolation and culture of protoplast, Somatic hybridization, screening and Selection of somatic hybrid.

Unit-II

Animal cell culture: Equipments and safety parameters, Aseptic techniques, Cell culture reagents, Media (defined and undefined media, complete-incomplete media), Culture condition, Maintenance of cell culture: culturing, sub-culturing, primary and continuous culture; *In vitro* transformation of animal cells; Anchorage-dependent, Monolayer and Suspension culture; Cryopreservation and Cell revival; Cell line banking; Contamination check and prevention; Biological characterization of cultured cell; Transfection, transient and stable cell line generation measuring parameter of growth; Cytotoxicity assay and cell viability measurement.

Unit-III

Cellular basis of differentiation and development: Gametogenesis; Fertilization, Cleavage – types and mechanism, Gastrulation, anterior/posterior, Dorsal/ventral polarity development of drosophilla, Signaling cascades involved in the control of developmental program, Cell specification *w.r.t.* amphibian, chick, Phenomenon of the organizer *w.r.t.* Amphibians: Progressive determination, Regional specificity of induction. Tetrapod limb development; axes formation, Coordination of the three axes, Regeneration: Epimorphic, Morphallactic and Compensatory.

Unit-IV

Plant meristem organization and differentiation in *Arabidopsis*, Spatial and temporal regulations of gene expression during development and differentiation, Organization of shoot and root apical meristem; Shoot and root development; Leaf development and phyllotaxy; Transition to flowering, Floral meristems and floral development in *Arabidopsis* and *Antirrhinum;* Regulation of flower development; Programmed cell death, Aging and senescence. Pollen production, Pollen-stigma interactions, Seed development, Seed germination and mobilization of food reserves.

Suggested readings:

1. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications,RIan Freshney,Oxford University Press (2000). ISBN-13: 9780199632138.
2. Introduction to Plant biotechnology, H.S Chawala, Oxford & Ibh Publishing Co. Pvt Ltd (2016). ISBN-13: 9788120417328.
3. Plant tissue culture: Theory and Practice, S.S.Bhojwani, M.K Razadan, Reed Elsevier India Pvt.Ltd (2016). ISBN-13: 9788181473257.
4. Developmental Biology,Scott F Gilbert,8th Edition,Sinauer Associates Inc Publisher(2010). ISBN-13: 9780878933846.
5. Principles of Development, Louis Wolpert, 2nd Edition, Oxford University Press (2007). ISBN-13: 9780198748670.

BT-C-515	**PRACTICAL-III**	**2 CH**	**50 marks**
BT-C-516	**Seminar**	**2 CH**	**50 marks**
EDPS-439	**ENTREPRENEURSHIP DEVELOPMENT PROGRAMME**	**2 CH**	**100 marks**

FOURTH SEMESTER

BT-C-521	GENOMICS PROTEOMICS AND METABOLOMICS	4 CH	100 marks

CO-1: Remember and understand the basic concepts/Principles of **Genomics Proteomics and Metabolomics**
CO-2: Analyze the Various Concepts to understand them through case studies
CO-3: Apply the knowledge in understanding practical problems
CO-4: Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit-I

Concept of genome organization and minimal cell genome; genome sequencing strategies, principles and methodology; genome sequencing projects- microbes, plants and animals; accessing and retrieving genome project information from web; recognition of coding and non-coding sequences and gene annotation.
Reverse genetics- strategies and applications, structural genomics, functional genomics and comparative genomics; High throughput screening in genome for drug discovery; Identification of gene targets and drug development.

Unit-II

Introduction to proteome, Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); 2-D electrophoresis of proteins; LC/MS-MS and MALDI-TOF; for identification of proteins and modified proteins; peptide mass fingerprinting; SAGE and differential display proteomics, Protein-protein interactions, Yeast two hybrid and three hybrid system; Proteomics and drug delivery.

Unit-III

Introduction to metabolomics: Metabolome, Metabonomics, Metabolite profiling, Metabolome fingerprinting, Role of biomarker in metabolomics, Tools of metabolome studies: NMR, MS, GC, LC, IR and its application, Metabolome projects of plant and human, Prospect of metabolomics.

Unit-IV

Overview of next generation sequencing technology (Roche/454 FLX, Illumina Genome Analyzer, SOLiD™ sequencing, Ion Torrent™, Nanopore), data processing, DNA and Protein microarray: Fabrication of microarray, Printing of DNA, Sample preparation and hybridization, image segmentation and data acquisition, data normalization, data analysis and clustering, Screening of proteins: Protein array, Antibody array, Case studies.

Suggested readings:

1. Principle of gene manipulation and Genomics, S.B Primrose, R.M Twyman, 6th Ed., Blackwell Science Ltd (2014). ISBN-13: 9788126548392
2. Discovering Genomics, proteomics & bioinformatics, Malcolm Campbell, Laurie J Heyer, Pearson Education Limited (2013). ISBN-13: 9788131715598.
3. From Genes to Genomes: Concepts and Applications of DNA Technology, Jeremy W. Dale, Malcolm von Schantz, Wiley, John & Sons (2007) ISBN-13: 9780470017340.
4. Molecular Biotechnology: Principles and Applications of Recombinant DNA, Bernard R Glick, Jack J Pasternak, Panima Book Distributors (2002). ISBN-13: 9788186535080.
5. Genetic Engineering,Smita Rastogi, Neelam Pathak, Oxford University Press (2009). ISBN-13: 9780195696578.

BT-C-522	BIOPROCESS ENGINEERING & TECHNOLOGY	4 CH	100 marks

CO-1: Understand the basic concepts/Principles of Bioprocess Engineering & Technology
CO-2: Analyze the Various Concepts to understand them through case studies
CO-3: Apply the knowledge in understanding practical problems
CO-4: Execute/Create the Project or field assignment as per the knowledge gained in course

Unit-I

Concepts of Bioprocess Engineering; Design and operation of the conventional bioreactor; Upstream processes: media formulation, sterilization and aseptic culture condition, agitation; Aeration in bioreactor; Concepts of heat transfer and mass transfer; Gaseous exchange: Aeration capacity and oxygen demand, Measurement and control of parameters; Bioreactor design: mechanically agitated, pneumatic and hydrodynamic fermenter; Mode of operation (Batch, Fed-batch and Continuous); Variations in fermenter design, Submerged fermentation; Solid substrate fermentation (SSF): its advantages and limitations; Factors affecting biotransformation; Fermentation economics.

Unit II

Bioreactor designs: its advantages and limitations (Tubular flow reactor, Packed bed reactor, Plug flow reactor, CSTR, Fluidized bed reactor and Trickle bed bioreactors); Mass transfer balance; Rate of change in substrate concentration in CSTR; Factors affecting rate of product formation; Bioreactor design and analysis: ideal and non-ideality flow reactors; Residence time distribution in bioreactor (Batch and CSTR); Determination of residence time (E-curve, F-curve, C-curve), Conversion rate in Batch and CSTR; Scale up and Scale down process.

Unit-III

Bacterial growth model: Logistics growth model, Structured/Unstructured models of growth and product formation (Compartment model), Cybernetic model (Metabolic model); Growth kinetics (Malthus model, Parl and Read model, Konark model); Diauxic growth and kinetics; Determination of specific growth rate, yield, productivity, microbial metabolic quotient; Substrate inhibition kinetics to determine the optimal substrate concentration; Modeling mass and heat transfer in bioreactor.

Unit-IV

Strategies of downstream processing: Bioseparation (filtration, ultrafiltration, centrifugation and sedimentation, flocculation), Cell disruption, Liquid-liquid extraction, Purification (Electrophoretic, Chromatographic techniques), Reverse osmosis, Drying, Crystallization, Packaging and storage.

Mass culture of cell in bioreactor: Integrated suspension culture, Immobilized cell cultivation system; Methods of enzyme immobilization and its application in bioreactor; Strategies of maximizing the productivity of amino acid and SCP.

Suggested readings:

1. Bioprocess Engineering Principles, Pauline M. Doran, 2nd Ed., Academic Press (2012), ISBN-13: 9780122208515.
2. Bioprocess Engineering-Basic Concepts, Michael L Shuler, Fikret Kargi, Pearson Education Limited (2015). Isbn-13: 9789332549371.
3. Fermentation Microbiology and Biotechnology, El Mansi Emt, Cfa Bryce, Al Demain, Taylor & Francis Group / Spon Press (2012).ISBN-13: 9781439855799.
4. Biotechnology- A text book of Industrial Biotechnology, Wulf Crueger, Anneliese Crueger, Kr Aneja, Medtec (2017). ISBN-13: 9789385998638.

BT-C-523	CONCEPTS OF BIOINFORMATICS	4 CH	100 marks

CO-1: Remember and understand the basic concepts/Principles of **Concepts of Bioinformatics**
CO-2: Analyze the Various Concepts to understand them through case studies
CO-3: Apply the knowledge in understanding practical problems
CO-4: Execute/Create the Project or field assignment as per the knowledge gained in course

Unit-I
Bioinformatics: origin and applications; Major Bioinformatics resources: NCBI, EBI, ExPASy, RCSB; Nucleic acid sequence databases: GenBank, EMBL, DDBJ; Protein sequence databases: UniProt-KB: SWISS-PROT, TrEMBL, UniParc; Data contents and formats; Structural database: PDB, NDB,, MMDB, CATH, SCOP, FSSP, DALI, protein structural alignment databases, protein-protein interaction database, ligand databases (PubChem, ChEMBL and ZINC databases); sequence patterns: InterPro, Prosite, Pfam, ProDom.

Unit-II
Sequence alignments algorithms: Scoring matrices and scoring functions (PAM, BLOSUM); Dynamic programming; Pairwise alignment algorithms (local and Global); Multiple sequence alignment; Database search (BLAST, FASTA); Phylogenetic analysis: concepts and terminology; Phylogenetic analysis algorithms: Distance-based methods (Fitch–Margoliash method, UPGMA, NJ), Character-based methods (Maximum parsimony, Maximum likelihood), Bootstrapping.

Unit-III
Protein structure prediction: Secondary structure prediction (Chou-Fasman, GOR and Neural Networks) and Reliability (Q3 value and SOV score); Tertiary structure prediction methods (homology, Fold recognition, *Ab initio* method); Validation of protein structure (Ramachandran plot analysis, ERRAT score, VERIFY3D); RNA secondary structure prediction algorithm; Nussinov folding algorithm, Energy minimization or Zuker folding algorithm.

Unit-IV
Introduction to chemical informatics; Representation of 2D and 3D structures; atom lookup and connection tables; SMILES; SD files; Fragment codes and fingerprints; 2D chemical database applications; QSAR modeling and drug designing; Pharmacophore and drug designing; Computational models for ADME/Tox; Application of predictive models to pharmacology and toxicity testing; Structure based designing of drug molecules; Concept of molecular docking.

Suggested readings:

1. Bioinformatics (Databases, Tools and Algorithms), OrpitaBosu, Simminder Kaur Thukral, Oxford University Press (2007). ISBN-13: 9780195676839.
2. Bioinformatics: Principles and Application, Zhumur Ghosh and Bibekanand Mallick, Oxford Publication (2015). ISBN-13: 9780195692303.
3. Bioinformatics: Sequence and Genome Analysis, David Mount, CBS Publishers & Distributors. ISBN-13: 9788123912417.
4. Bioinformatics – A practical guide to the Analysis of Genes and Proteins, Andreas D Baxevanis, Bf Francis Ouellette, Wiley India Pvt. Ltd (2014). ISBN-13: 9788126521920.
5. An Introduction to Chemoinformatics, A.R. Leach, V.J. Gillet, Kluwer Academic Publishers (2009). ISBN-13: 9788184892550.
6. Drug Design: Structure- and Ligand-based Approaches, KMMerz, D Ringe, CHReynolds, Cambridge University Press (2014). ISBN-13: 9780521887236.

BT-E-524 (A)	AGRICULTURAL BIOTECHNOLOGY	4 CH	100 marks

CO-1: Remember and understand the basic concepts/Principles of **Agricultural Biotechnology**
CO-2: Analyze the Various Concepts to understand them through case studies
CO-3: Apply the knowledge in understanding practical problems
CO-4: Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit -I

Introduction to agricultural biotechnology: Conventional method of crop improvements vs. Biotechnological interventions, Manipulation of resistance: Fungal and bacterial disease, Viral disease, Strategies for engineering insect resistance (BT genes, protease inhibitors, α-amylase inhibitors), Strategies for engineering herbicide resistance, Strategies for engineering stress resistance (Drought stress, Salt stress, Temperature stress).

Unit-II

Plant disease resistance: Introduction, Plant pathogen interaction, Major type of plant pathogens, Natural disease resistance pathways, Biotechnological approaches to disease resistance (case studies),

Unit-III

Improvement of crop yield and quality: Long shelf life of fruits and flowers, Use of ACC synthase, Poly-galactorunase, ACC oxidase; Modification of fruit and flower color, Seed storage protein quality, Vitamin E fortification, Fe and mineral fortification, Case studies of phytase production and golden rice.

Unit-IV

Genetic manipulation of crop yield by photosynthesis, Nitrogen fixation, Advances in agricultural biotechnology: Molecular farming: plants as factories for pharmaceuticals and biomaterials, Smart breeding: Marker-assisted selection: Non-invasive biotechnology alternative to genetic engineering of plant varieties, Biofertilizers and biopesticides.

Suggested readings:

1. Plant Biotechnology Genetic Manipulation Of Plants, Adrian Slater, Nigel W. Scott and Mark R. Fowler, Oxford University Press (2017). ISBN-13: 9780199560875.
2. Biotechnology: Expanding Horizons, BD Singh, Kalyani Publishers / Lyall Bk Depot (2016). ISBN-13: 9789327222982.
3. Introduction to Plant biotechnology, H.S Chawala, Oxford & Ibh Publishing Co. Pvt Ltd (2016). ISBN-13: 9788120417328.
4. Elements of Biotechnology, P K Gupta, Rastogi Publication (2015). ISBN-13: 9788171339372.
5. Modern Food Microbiology, James M. Jay, CBS Publishers & Distributors (2005). ISBN-13: 9788123904757.
6. Food Microbiology: Fundamentals and frontiers, M.P. Doyle, L.R. Beuchat, Thoma J. Montville, ASM press (2007). ISBN-13: 9781555814076.
7. Genetic transformation of plants, J.F. Jackson, H.F. Linskens, CBSPD (2009). ISBN-13: 9788184891065.

BT-E-524 (B)	CLINICAL PATHOLOGY & DIAGNOSTICS	4 CH	100 marks

CO-1: Remember and understand the basic concepts/Principles of **Clinical Pathology & Diagnostics**
CO-2: Analyze the Various Concepts to understand them through case studies
CO-3: Apply the knowledge in understanding practical problems
CO-4: Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit- I

General pathology: Introduction to systemic pathology haematology, Cytopathology, Chemical pathology, Immunopathology, and general neoplasia. Histopathology: Collection of specimen, Labelling, Documentation, Fixation. Grossing techniques and tissue processing.

Unit- II

Cutting and staining of sections, Use of special stains and immunocytochemistry, Frozen sections, Interpretation and reporting Haematology: Haemoglobin estimation , Blood counts, staining and Reporting of smears, LE cells , ESR , Packed cell volume and absolute values, Staining methods for blood cells, Blood bank serology , ABO grouping , Rh typing , Special blood groups, Blood banking

Unit-III

Clinical and chemical pathology: Examination of urine, Body fluids and stool, Collection of blood , Anti-coagulants, Protein precipitants, Estimation of blood sugar, urea, creatinine, proteins, bilirubin, cholesterol, uric acid, electrolytes, calcium and enzymes, Use of autoanalyzer techniques. Microbiology and serology: collection, handling, documentation and section of material, Use of microbiological stains, Use of culture media and identification of bacteria.

Unit-IV

Antibiotic sensitivity tests, Sterilization and disinfection . Identification of fungi in specimen and culture. Diagnostic procedures in important viral infections. Serological techniques, widal, weil felix, VDRL, HIV, HBV, CRP, RF, ASO and pregnancy tests. ELISA and CLIA, Medical imaging techniques: CT scan, X-ray, Ultrra-sound.

Suggested readings:

1. District Laboratory Practice In Tropical Countries, Monica Cheesbrough, Cambridge University Press (2006), ISBN-13: 9780521684590.
2. Basic Medical Microbiology, Patrick R. Murray, Elsevier (2017). ISBN-13: 9780323476768.
3. Medical Microbiology, David Greenwood, Richard Slack, John Peutherer, Churchill Livingstone (2012). ISBN-13: 9780702040900.

BT-E-524 (C)	ENVIRONMENTAL BIOTECHNOLOGY	4 CH	100 marks

CO-1: Remember and understand the basic concepts/Principles of **Environmental Biotechnology**
CO-2: Analyze the Various Concepts to understand them through case studies
CO-3: Apply the knowledge in understanding practical problems
CO-4: Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit-I

Water pollution: Causes and prevention, Eutrophication, Water pollution abatement: Aerobic treatment (Activated sludge process, Biological filters, Rotating biological contractors), Anaerobic treatment (Contact digester, Packed bed or Packed volume reactor, Anaerobic baffled digester, Upflow anaerobic sludge blanket reactors), Membrane bioreactor; Microbial bioflim and waste water treatment, Microbial mediated removal of nitrogen and phosphorous; Primary, secondary, tertiary treatment of waste water; Oxidation pond, Phytoremidiation.

Unit-II

Air pollution: causes and prevention, Acid rain, Green house gases and global warming, Air pollution abatement (bioscrubber and biofilter), Fluidized bed reactors, Inverse fluidized bed bioflim reactor, expanded bed reactor).
Solid waste management: Composting of crop residue, Principles and Advantages of composting, Factors influencing composting, Techniques of compost enrichment, Vermicomposting and Crop productivity, Plant succession, Biomagnification, Bioaugmentation.

Unit-III

Biodegradation: Methods for biodegradation of xenobiotic, pesticides and pollutants; Kinetics of biodegradation: Zero order kinetics, First order kinetics, Factors affecting biodegradation. Biosorption: Role of bacteria, fungi and algal communities in biosorption. Biomineralization and Bioleaching (case study). Bioremediation: Types of bioremediation, Microbial mediated bioremediation of agrochemicals and heavy metals, Bioreactors used for bioremediation, Application of bioremediation.

Unit-IV

Biofertilizers: Types of biofertilizer, Methods of biofertilizer production, Nitrogen fixation: Role of nitrogen fixing bacteria in biofertilizer: Mechanism and growth promotion, Large scale production of biofertilizer, Biotransfermation of food waste to biofertilizer (Composting and anaerobic digestion): Case study, Application of biofertilizers.

Suggested readings:

1. Environmental Biotechnology, A.K. Chatterjee, Prentice-Hall Of India Pvt Ltd (2011). ISBN-13: 9788120342989.
2. Environmental Biotechnology, Mh Fulekar, Oxford & Ibh Publishing Co Pvt Ltd (2006). ISBN-13: 9788120416918.
3. Environmental Biology by Varma and Agarwal (2012)
4. Environment Problems and Solution, DK Asthana, Meera Asthana,S Chand & Company Pvt Ltd (2010). ISBN-13: 9788121916547.
5. Environmental Biotechnology, Monika Jain, Narosa Publishing House (2014). ISBN-13: 9788184872705.

BT-C-524 (D)	PHARMACEUTICAL BIOTECHNOLOGY	4 CH	100 marks

CO-1: Remember and understand the basic concepts/Principles of **Pharmaceutical Biotechnology**
CO-2: Analyze the Various Concepts to understand them through case studies
CO-3: Apply the knowledge in understanding practical problems
CO-4: Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit-I
Introduction to pharmaceutical industry and development of drugs; Economics and regulatory aspects; quality management; GMP. Bioavailability and factor affecting bioavailability; Drug kinetics and biopharmaceutics; Mechanism of drug absorption, distribution, biotransformation and excretion; Factors affecting ADME process; Bioequivalence; Pharmacokinetics.

Unit-II
Principles of drug manufacture; liquid dosage forms (solutions, suspensions and emulsions); topical applications (ointments, creams, suppositories); solid dosage forms (powders, granules, capsules, tablets, coated tablets); aerosols; preservation; Packing techniques.

Unit III
Advanced drug delivery systems; Sustained release of drug dosage form and controlled release; transdermals, liposomes; drug targeting; Biopharmaceuticals understanding principles of pharmacology; Pharmacodynamics: Classes of therapeutics recombinant therapeutics, Monoclonal antibodies, Vaccines, Gene therapy, Antibiotics and Hormones.

Unit-IV
Immunogenicity of biopharmaceuticals: immunogenicity; Factors contributing to immunogenicity (Product related factors, host- related factors), Consequence of immunogenicity to biopharmaceuticals; Measurement of immunogenicity. Case studies: Insulin, Somatotropin, Interleukin-2, Interferon, Factor VIIa, Factor IX, Factor VIII, Monoclonal antibodies etc.

Suggested readings:

1. Pharmaceutical Biotechnology, Manoj Kumar, Anmol Publications Pvt Ltd (2010). ISBN-13: 9788126142231.
2. Pharmaceutical Biotechnology: Fundamentals and Applications, Daan J. A. Crommelin, Robert D. Sindelar, Bernd Meibohm, Springer (2016). ISBN-13: 9781493943395.
3. Handbook of Pharmaceutical Biotechnology, Shayne Cox Gad, Wiley, John & Sons (2007). ISBN-13: 9780471213864.
4. Biopharmaceuticals: Biochemistry and Biotechnology, Gary Walsh, 2nd Ed., John Wiley & Sons Inc (Sea) Pte Ltd (2011). ISBN-13: 9788126530014.
5. Pharmaceutical Biotechnlogy: Concepts and Applications, Gary Walsh, cbspd (2007). ISBN-13: 9780470012451.
6. Handbook of Pharmaceutical Biotechnology, Jay P Rho, Stan G Louie, Viva Books Private Ltd (2004).ISBN-13: 9788176497855.

BT-C-525	Project work and Viva Voce	4 CH	100 marks
	MOOCS COURSE	3 CH	100 marks

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DEPT. OF BIOTECHNOLOGY & BIOINFORMATICS
SAMBALPUR UNIVERSITY

M.Sc. Biotechnology, Semester-I
End Term Examination, December 2024

Full Marks – 80 **BT-C-411(A): Physical Sciences** **Time – 3 hours**

Q.1 Answer all the questions (Compulsory). (20 x 1 = 20) From Unit-I to IV

A.
B.
C.
D.
E.
F.
G.
H.
I.
J.
K.
L.
M.
N.
O.
P.
Q.
R.
S.
T.

Q.2 Answer the following questions. (15) From Unit-I

(a)
(b)

OR

Answer the following questions. (15)

(a)
(b)

Q.3 Answer the following questions. (15) From Unit-II

(a)
(b)

OR

Answer the following questions. (15)

(a)
(b)

Q.4 Answer the following questions. (15) From Unit-III

(a)
(b)

OR

Answer the following questions. (15)

(a)
(b)

Q.5 Answer the following questions. (15) From Unit-IV

(a)
(b)

OR

Answer the following questions. (15)

(a)
(b)

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Sem.II-2025:BT-C- 426

DEPT. OF BIOTECHNOLOGY & BIOINFORMATICS
SAMBALPUR UNIVERSITY

M.Sc. Biotechnology, Semester-II
End Term Examination, April 2025

Full Marks – 60 **IDCBT-C-426: Biotechnology and its applications** **Time – 3 hours**

Q.1 Answer all the questions (Compulsory). (12 x 1 = 12)

A.
B.
C.
D.
E.
F.
G.
H.
I.
J.
K.
L.

Q.2 Answer the following questions. (12)

(a)
(b)

OR

Answer the following questions. (12)

(a)
(b)

Q.3 Answer the following questions. (12)

(a)
(b)

OR

Answer the following questions. (12)

(a)
(b)

Q.4 Answer the following questions. (12)

(a)
(b)

OR

Answer the following questions. (12)

(a)
(b)

Q.5 Answer the following questions. (12)

(a)
(b)

OR

Answer the following questions. (12)

(a)
(b)

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DEPT. OF BIOTECHNOLOGY & BIOINFORMATICS
SAMBALPUR UNIVERSITY

M.Sc. Biotechnology, Semester-II
End Term Examination, April 2025

Full Marks – 50 **BT-425: Practical-II** **Time – 4 hours**

Q.1 Perform any one of the following experiments chosen by lot. (20)

(a)
(b)
(c)
(d)
(e)
(f)
(g)
(h)
(i)
(j)
(k) Any other experiment as suggested by the examiners.

Q.2 Perform any one of the following experiments chosen by lot. (15)

(a)
(b)
(c) Any other experiment suggested by the examiners.

Q.3 Practical Record (07)

Q.4 Viva Voce (08)

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