SCHEME FOR CHOICE BASED CREDIT SYSTEM FOR B.Sc. HONOURS BIOTECHNOLOGY

SEMESTER	CORE COURSE (12)		Credits	Ability Enhancement Compulsory Course (AECC), (2)	Credits	Skill Enhancement Course (SEC), (2)	Credits	Discipline Specific Elective: (DSE), (4)	Credits	Generic Elective: (GE), (4)	Credits
I	**BIOTECH1C01TH** **BIOTECH1C01PR**	Biochemistry & Metabolism Biochemistry & Metabolism	4 2	**ENGL103**/Hindi/MIL Communication	4					**BIOTECH1GE01TH** : Bacteriology and Virology **BIOTECH1GE01PR** : Bacteriology and Virology	4 2
	BIOTECH1C02TH **BIOTECH1C02PR**	Cell Biology Cell Biology	4 2								
II	**BIOTECH2C03TH** **BIOTECH2C03PR**	Mammalian Physiology Mammalian Physiology	4 2	**ENVS2AECC02** Environment Science	4					**BIOTECH2GE02TH**: IPR Ent. Bioethics and Biosafety **BIOTECH2GE02PR**: IPR Ent Bioethics and Biosafety	4 2
	BIOTECH2C04TH **BIOTECH2C04PR**	Plant Physiology Plant Physiology	4 2								
III	**BIOTECH3C05TH** **BIOTECH3C05PR**	Genetics Genetics	4 2			***Any 1 SEC Subject in semester 3***	4			**BIOTECH3GE03TH**: Biotechnology and Human Welfare` **BIOTECH3GE03PR**: Biotechnology and Human Welfare	4 2
	BIOTECH3C06TH **BIOTECH3C06PR** **BIOTECH3C07TH** **BIOTECH3C07PR**	General Microbiology General Microbiology Chemistry-1 Chemistry-1	4 2								
IV	**BIOTECH4C08TH** **BIOTECH4C08PR**	Molecular Biology Molecular Biology	4 2			***Any 1 SEC Subject in semester 4***	4			***Any 1 GE Subject in semester 4 with Theory & Practical (Theory=4 & Practical=2)***	6
	BIOTECH4C09TH **BIOTECH4C09PR** **BIOTECH4C10TH** **BIOTECH4C10PR**	Immunology Immunology Chemistry-2 Chemistry-2	4 2								
V	**BIOTECH5C11TH** **BIOTECH5C11PR**	Bioprocess Technology Bioprocess Technology	4 2					***Any 2 DSE Subjects in semester 5 with Theory & Practical (Theory=4+4& Practical=2+2)***	12		
	BIOTECH5C12TH **BIOTECH5C12PR**	Recombinant DNA Technology Recombinant DNA Technology	4 2								
VI	**BIOTECH6C13TH** **BIOTECH6C13PR**	Bio Analytical Tools Bio Analytical Tools	4 2					***Any 2 DSE Subjects in semester 6 with Theory & Practical (Theory=4+4 & Practical=2+2)***	12		
	BIOTECH6C14TH **BIOTECH6C14PR**	Genomics and Proteomics Genomics and Proteomics	4 2								
		Core Course Total Credits:	**84**	**AECC Total Credits:**	**8**	**SE Total Credits:**	**8**	**Discipline Specific Total Credits:**	**24**	**Generic Elective Total Credits:**	**24**

Total Credits: 84+8+8+24+24 = 148

TH: Theory; **PR:** Practical; **C:** Core Courses; **GE:** Generic Elective; **AECC:** Ability Enhancement Compulsory Course; **SEC:** Skill Enhancement Courses; **DSE:** Discipline Specific Elective

Structure of B.Sc. (Hons) Biotechnology under CBCS

Core Course

BIOTECH1C01: Biochemistry & Metabolism
BIOTECH1C02: Cell Biology
BIOTECH2C03: Mammalian Physiology
BIOTECH2C04: Plant Physiology
BIOTECH3C05: Genetics
BIOTECH3C06: General Microbiology
BIOTECH3C07: Chemistry-1
BIOTECH4C08: Molecular Biology
BIOTECH4C09: Immunology
BIOTECH4C10: Chemistry-2
BIOTECH5C11: Bioprocess Technology
BIOTECH5C12: Recombinant DNA Technology
BIOTECH6C13: Bio Analytical Tools
BIOTECH6C14: Genomics and proteomics

Discipline Specific Elective

(***Any 2 DSE Subjects in semester 5& any 2 DSE Subjects in semester 6 from the list***)

Semester-V

BIOTECH5DSE01: Bioinformatics
BIOTECH5DSE02: Animal Biotechnology
BIOTECH5DSE03: Medical Microbiology
BIOTECH5DSE04: Plant Biotechnology
BIOTECH5DSE05: Animal Diversity I
BIOTECH5DSE06: Plant Diversity I
BIOTECH5DSE07: Animal Diversity II
BIOTECH5DSE08: Plant Diversity II

Semester-VI

BIOTECH6DSE09: Environmental Biotechnology
BIOTECH6DSE10: Microbial Physiology
BIOTECH6DSE11: Biostatistics
BIOTECH6DSE12: Ecology and Environment Management
BIOTECH6DSE13: Biochemical Engineering
BIOTECH6DSE14: Food Biotechnology
BIOTECH6DSE15: Chemistry-3
BIOTECH6DSE16: Chemistry-4

Generic Elective

(***Any 1 per semester in semesters 1-4)***

BIOTECH1GE01: Bacteriology and Virology
BIOTECH2GE02: IPR Entrepreneurship, Bioethics and Biosafety
BIOTECH3GE03: Biotechnology and Human Welfare
BIOTECH4GE04: Developmental Biology
BIOTECH4GE05: Microbial Metabolism

Ability Enhancement Compulsory Course

ENGL103: English Communication
ENVS2AECC02: Environment Science

Skill Enhancement Elective Course

(***Any 1 SEC Subject in semester 3 & any 1 SEC Subject in semester 4 from the list***)

Semester-III

BIOTECH3SEC01: Molecular Diagnostics
BIOTECH3SEC02: Enzymology

Semester-IV

BIOTECH4SEC03: Industrial Fermentations
BIOTECH4SEC04: Basics of Forensic Science

CHOICE BASED CREDIT SYSTEM

B.Sc. (Hons.) Biotechnology

SEMESTER I		SEMESTER II	
BIOTECH1C01	Biochemistry & Metabolism	**BIOTECH2C03**	Mammalian Physiology
BIOTECH1C02	Cell Biology	**BIOTECH2C04**	Plant Physiology
ENGL103	English/ Hindi/MIL Communication	**ENVS2AECC02**	Environment Science
BIOTECH1GE01	Bacteriology and Virology	**BIOTECH2GE02**	IPR Entrepreneurship Bioethics and Biosafety

SEMESTER III		SEMESTER IV	
BIOTECH3C05	Genetics	**BIOTECH4C08**	Molecular Biology
BIOTECH3C06	General Microbiology	**BIOTECH4C09**	Immunology
BIOTECH3C07	Chemistry-1	**BIOTECH4C10**	Chemistry-2
BIOTECH3SEC01-SEC02	***Any 1 SEC Subject listed***	**BIOTECH4SEC03-SEC04**	***Any 1 SEC Subject listed***
BIOTECH3GE03	Biotechnology and Human Welfare	**BIOTECH4GE04-GE05**	***Any 1 GE Subject listed***

SEMESTER V		SEMESTER VI	
BIOTECH5C11	Bioprocess Technology	**BIOTECH6C13**	Bio Analytical Tools
BIOTECH5C12	Recombinant DNA	**BIOTECH6C14**	Genomics and Proteomics
BIOTECH5DSE01-DSE08	***Any 2 DSE Subjects listed***	**BIOTECH6DSE09-DSE16**	***Any 2 DSE Subjects listed***

C: Core Courses

GE: Generic Elective

AECC: Ability Enhancement Compulsory Course

SEC: Skill Enhancement Courses

DSE: Discipline Specific Elective

HIMACHAL PRADESH UNIVERSITY
SUMMER-HILL, SHIMLA-171005

B.Sc. (Honours) Biotechnology

GENERAL INSTRUCTIONS/ GUIDELINES FOR EXECUTION OF CURRICULUM

I. The B.Sc. (Honours) Biotechnology will be of three years duration semester-based Choice Based Credit System [CBCS] course.

II. There will be broadly three types of courses for B.Sc. (Honours) Biotechnology degree program.

1. The **Core Courses** (14 courses for Honours; and 4 discipline specific papers) will be of 6- credits each including 2 credits assigned to the practical component. Thus a candidate will have to pass 14 courses for earning 14 X 6 = 84 credits during six semesters. Each of the 6-credits courses will carry 100 marks. These 100 marks will be split into marks assigned for Theory [TH]: 50 marks; Practical [PR]: 30 marks and Internal Assessment [IA]: 20. The Internal Assessment [20 marks] will include one Multi Choice Questions (MCQ)-based examination of 15 marks [15 or 30 questions of 1.0 or 0.5 mark each as the case may be]; and Classroom Attendance Incentive marks (5 marks). The Lab-based practical will be of 2-hours [One credit]. A total of 14 X 6 = 84 credits could be accumulated under these courses during the Honours degree program.

2. The **Elective Courses** will be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope or which enables an exposure to some other discipline/ subject/ domain or nurtures the candidate's proficiency / skill. The Elective Courses will include;

Discipline Specific Elective [**DSE**] Courses: A total of 4 courses offered under the main discipline/ subject of study is referred to as Discipline Specific Elective. These courses are discipline related and/ or interdisciplinary in nature. A total of 4 X 6 = 24 credits could be accumulated under DSE courses during the Honours degree program.

Generic Elective [GE] Courses: A total of 4 courses of 6-credits each including 2 credits assigned for the practical component of each of these courses *i.e.* one course per 1st to 4th semester will be studied by the candidates. An elective course chosen from an unrelated discipline/ subject, with an intention to seek exposure beyond discipline(s) of choice is called Generic Elective Course. The purpose of this category of papers is to offer the students the option to explore disciplines of interest beyond the choices they make in Core and Discipline Specific Elective papers. Further, a course offered in a discipline/ subject may be treated as an elective by other discipline/ subject and vice versa and such electives may also be referred to as Generic Elective Course. A total of 4 X 6 = 24 credits could be accumulated under GE courses during the Honours degree program.

3. **Ability Enhancement Compulsory Courses [AECC]:** Ability Enhancement Courses are of two types; Ability Enhancement Compulsory Courses [AECC] and Skill Enhancement Courses [SEC]. A total of 4 X 4 = 16 credits could be accumulated under these courses

during the Honours degree program i.e. 4 X 2 = 8 credits for AECC, and 4 X 2 = 8 credits for SEC courses.

The AECC courses are the mandatory courses based upon the content that leads to knowledge enhancement; i. Environment Science and ii. English/ Hindi/ MIL Communication. All these are mandatory courses for obtaining a B.Sc. (Honours) degree in the concerned subject. These courses are mandatory for all disciplines. SEC courses are value-based and/ or skill-based and are aimed at providing hands-on-training, competencies, skills *etc*. A minimum of two such courses for obtaining an Honours degree are selected amongst the courses designed to provide value-based and/ or skill-based knowledge and may contain both theory and lab/ hands-on training. The main purpose of these courses is to provide students life-skills in hands-on mode so as to increase their employability.

III. Practical [PR] component has been included in every core and discipline/ generic specific elective paper. The list of practicals to be conducted by the candidates has been provided alongside each of such courses. The marks (30 marks) for the practical examination will be split as follows;

Write up of Practical I:	5 marks
Write up of Practical II:	5 marks
Performance of any one of above practicals:	7 marks
Practical record/ notebook:	5 marks
Viva voce:	8 marks

IV. **Classroom Attendance Incentive**: Those candidates who have greater than 75% attendance (for those participating in Co-curricular activities, 25% will be added to per cent attendance) will be awarded CAI marks as follows:

≥ 75% but < 80%	1 marks
≥ 80% but <85%	2 marks
≥ 85 but <90%	3 marks
≥ 90% but < 95%	4 marks
≥ 95% to 100%	5 marks

V. The candidate has to secure minimum pass marks individually in Theory paper, Practical as well as Internal Assessment to earn full credits in the concerned course. A candidate thus failing in any of these components shall be consider failed in that course.

VI. The admission to B.Sc. (Honours) Biotechnology programme of Himachal Pradesh University will be as per guidelines of Himachal Pradesh University, Shimla from time to time.

i. The candidate should have passed 10+2 (class XII) Examination or its equivalent from a recognized Board/ University with any of the three subjects out of Physics, Chemistry and Biology or any other science subject with 50% or equivalent grade (for SC/ ST candidates marks of eligibility will be 45% or equivalent grade).

ii. In case of candidates who are studying in University/Board/College/Schools in any of the foreign countries the eligibility/Qualifying marks will be the same as recognized/equivalent to 10+2 by the University or the association of the Indian

University with 50% marks of equivalent grade (for SC/ ST candidates, eligibility will be 45% marks or equivalent grade).

iii. The candidate who has appeared in the qualifying examination but whose result has so far not been declared can also apply but his/her eligibility for the entrance test will be purely provisional subject to the condition that he/she has to produced a passing certificate scoring at least the minimum percentage of marks as prescribed for the qualifying examination on the day and the specified time of counseling.

The candidate shall not be more than 22 years of age as on 01st July of the year of admission. Date of birth as recorded in the Secondary Education Board/ University Certificate Only will be considered as authentic.

CORE COURSES

Course: BIOTECH1C01TH
BIOCHEMISTRY AND METABOLISM
(Theory)

Semester end examination: 50 marks
Practical examination: 30 marks
Internal Assessment: 20 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I **(10 Periods)**

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

Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero Polysaccharides, Mucopolysaccharides, Bacterial cell wall polysaccharides, Glycoprotein's and their biological functions

UNIT II **(10 Periods)**

Lipids: Structure and functions –Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, Cholesterol.

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

UNIT III **(20 Periods)**

Enzymes: Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenzyme, prosthetic groups, metalloenzymes, monomeric &oligomeric enzymes, activation energy and transition state, enzyme activity, specific activity, common features of active sites, enzyme specificity: types & theories, Biocatalysts from extreme thermophilic and hyperthermophilicarchaea and bacteria. Role of: NAD^+, $NADP^{+,}$ FMN/FAD, coenzymes A, Thiamine pyrophosphate, Pyridoxalphosphate,lipoic-acid, Biotin vitamin B12, Tetrahydrofolate and metallic ions

UNIT IV **(20 Periods)**

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

Course: BIOTECH1C01PR
BIOCHEMISTRY AND METABOLISM
(Practical)

PRACTICALS

1. To study activity of any enzyme under optimum conditions.
2. To study the effect of pH, temperature on the activity of salivary amylase enzyme.
3. Determination of - pH optima, temperature optima, Km value, Vmax value, Effect of inhibitor (Inorganic phosphate) on the enzyme activity.
4. Estimation of blood glucose by glucose oxidase method.
5. Principles of Colorimetry**: (i)** Verification of Beer's law, estimation of protein. (**ii**) To study relation between absorbance and % transmission.
6. Preparation of buffers.
7. Separation of Amino acids by paper chromatography.
8. Qualitative tests for Carbohydrates, lipids and proteins

SUGGESTED READING

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.
2. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants.American Society of Plant Biologists.
3. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA.
4. Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology. John Wiley and Sons.
5. Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co. Ltd.

Course: BIOTECH1C02TH
CELL BIOLOGY
(Theory)

Semester end examination: 50 marks
Practical examination: 30 marks
Internal Assessment: 20 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10)short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I **(10 Periods)**

Cell: Introduction and classification of organisms by cell structure, cytosol, compartmentalization of eukaryotic cells, cell fractionation.

Cell Membrane and Permeability: Chemical components of biological membranes, organization and Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport.

UNIT II **(15 Periods)**

Membrane Vacuolar system, cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments.

Endoplasmic reticulum: Structure, function including role in protein segregation.

Golgi complex: Structure, biogenesis and functions including role in protein secretion.

UNIT III **(20 Periods)**

Lysosomes: Vacuoles and micro bodies: Structure and functions.

Ribosomes: Structures and function including role in protein synthesis.

Mitochondria: Structure and function, Genomes, biogenesis.

Chloroplasts: Structure and function, genomes, biogenesis

Nucleus: Structure and function, chromosomes and their structure.

UNIT IV **(15 Periods)**

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

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

Course: BIOTECH1C02PR
CELL BIOLOGY
(Practical)

PRACTICALS

1. Study the effect of temperature and organic solvents on semi permeable membrane.
2. Demonstration of dialysis.
3. Study of plasmolysis and de-plasmolysis.
4. Cell fractionation and determination of enzyme activity in organelles using sprouted seed or any other suitable source.
5. Study of structure of any Prokaryotic and Eukaryotic cell.
6. Microtomy: Fixation, block making, section cutting, double staining of animal tissues like liver, oesophagus, stomach, pancreas, intestine, kidney, ovary, testes.
7. Cell division in onion root tip/ insect gonads.
8. Preparation of Nuclear, Mitochondrial & cytoplasmic fractions.

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. ASMPress& 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.

Course: BIOTECH2C03TH
MAMMALIAN PHYSIOLOGY
(Theory)

Semester end examination: 50 marks
Practical examination: 30 marks
Internal Assessment: 20 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I **(15 Periods)**

Digestion: Mechanism of digestion & absorption of carbohydrates, Proteins, Lipids and nucleic acids. Composition of bile, Saliva, Pancreatic, gastric and intestinal juice

Respiration: Exchange of gases, Transport of O2 and CO2, Oxygen dissociation curve, Chloride shift.

UNIT II **(15 Periods)**

Digestion and Respiration: Composition of blood, Plasma proteins & their role, blood cells, Haemopoisis, Mechanism of coagulation of blood.

Mechanism of working of heart: Cardiac output, cardiac cycle, Origin & conduction of heart beat.

UNIT III **(15 Periods)**

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.

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

UNIT IV **(15 Periods)**

Nervous and endocrine coordination: Mechanism of generation & propagation of nerve impulse, structure of synapse, synaptic conduction, saltatory conduction, Neurotransmitters.

Mechanism of action of hormones (insulin and steroids)

Different endocrine glands: Hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid and adrenals, hypo & hyper-secretions.

Course: BIOTECH2C03PR
MAMMALIAN PHYSIOLOGY
(Practical)

PRACTICALS

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 Haemoglobin

SUGGESTED READING

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company.
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition. John wiley&sons,Inc.

Course: BIOTECH2C04TH
PLANT PHYSIOLOGY
(Theory)

Semester end examination: 50 marks
Practical examination: 30 marks
Internal Assessment: 20 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I **(10 Periods)**

Anatomy: The shoot and root apical meristem and its histological organization, simple & complex permanent tissues, primary structure of shoot & root, secondary growth, growth rings, leaf anatomy (dorsi-ventral and isobilateral leaf).

UNIT II **(12 Periods)**

Plant water relations and micro & macro nutrients: Plant water relations: Importance of water to plant life, diffusion, osmosis, plasmolysis, imbibition, guttation, transpiration, stomata & their mechanism of opening & closing.

Micro & macro nutrients: criteria for identification of essentiality of nutrients, roles and deficiency systems of nutrients, mechanism of uptake of nutrients, mechanism of food transport.

UNIT III **(20 Periods)**

Carbon and nitrogen metabolism: Photosynthesis- Photosynthesis pigments, concept of two photo systems, photphosphorylation, calvin cycle, CAM plants, photorespiration, compensation point

Nitrogen metabolism- inorganic & molecular nitrogen fixation, nitrate reduction and ammonium assimilation in plants.

UNIT IV **(18 Periods)**

Growth and development: Definitions, phases of growth, growth curve, growth hormones (auxins, gibberlins, cytokinins, abscisic acid, ethylene)

Physiological role and mode of action, seed dormancy and seed germination, concept of photo-periodism and vernalization.

Course: BIOTECH2C04PR
PLANT PHYSIOLOGY
(Practical)

PRACTICALS

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.

SUGGESTED READING

1. Dickinson, W.C. 2000 Integrative Plant Anatomy. Harcourt Academic Press, USA.
2. Esau, K. 1977 Anatomy of Seed Plants. Wiley Publishers.
3. Fahn, A. 1974 Plant Anatomy. Pergmon Press, USA and UK.
4. Hopkins, W.G. and Huner, P.A. 2008 Introduction to Plant Physiology. John Wiley and Sons.
5. Mauseth, J.D. 1988 Plant Anatomy. The Benjammin/Cummings Publisher, USA.
6. Nelson, D.L., Cox, M.M. 2004 Lehninger Principles of Biochemistry, 4th edition, W.H. Freeman and Company, New York, USA.
7. Salisbury, F.B. and Ross, C.W. 1991 Plant Physiology, Wadsworth Publishing Co. Ltd.
8. Taiz, L. and Zeiger, E. 2006 Plant Physiology, 4edition, Sinauer Associates Inc .MA, USA

Course: BIOTECH3C05TH
GENETICS
(Theory)

Semester end examination: 50 marks
Practical examination: 30 marks
Internal Assessment: 20 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I **(12 Periods)**

Introduction: Historical developments in the field of genetics. Organisms suitable for genetic experimentation and their genetic significance.

Cell Cycle: Mitosis and Meiosis: Control points in cell-cycle progression in yeast. Role of meiosis in life cycles of organisms.

Mendelian genetics : 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.

UNIT II **(18 Periods)**

Non allelic interactions: Interaction producing new phenotype complementary genes, epistasis (dominant & recessive), duplicate genes and inhibitory genes.

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.

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.

UNIT III **(15 Periods)**

Chromosome and gene mutations: 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, abonormalities– 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.

UNIT IV **(15 Periods)**

Genetic linkage, crossing over and chromosome mapping: 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.

Course: BIOTECH3C05PR
GENETICS
(Practical)

PRACTICALS

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 colchicine treatment.

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.

Course: BIOTECH3C06TH
GENERAL MICROBIOLOGY
(Theory)

Semester end examination: 50 marks
Practical examination: 30 marks
Internal Assessment: 20 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I **(10 Periods)**

Fundamentals, History and Evolution of Microbiology.
Classification of microorganisms: Microbial taxonomy, criteria used including molecular approaches, Microbial phylogeny and current classification of bacteria.
Microbial Diversity: Distribution and characterization Prokaryotic and Eukaryotic cells, Morphology and cell structure of major groups of microorganisms eg. Bacteria, Algae, Fungi, Protozoa and Unique features of viruses.

UNIT II **(10 Periods)**

Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms, methods of isolation, Purification and preservation.

UNIT III **(20 Periods)**

Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria.
Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways
Bacterial Reproduction: Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria.

UNIT IV **(20 Periods)**

Control of Microorganisms: By physical, chemical and chemotherapeutic Agents
Water Microbiology: Bacterial pollutants of water, coliforms and non coliforms. Sewage composition and its disposal.
Food Microbiology: Important microorganism in food Microbiology: Moulds, Yeasts, bacteria. Major food born infections and intoxications, Preservation of various types of foods. Fermented Foods.

Course: BIOTECH3C06PR
GENERAL MICROBIOLOGY
(Practical)

PRACTICAL

1. Isolation of bacteria & their biochemical characterization.
2. Staining methods: simple staining, Gram staining, spore staining, negative staining, hanging drop.
3. Preparation of media & sterilization methods, Methods of Isolation of bacteria from different sources.
4. Determination of bacterial cell size by micrometry.
5. Enumeration of microorganism - total & viable count.

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.

Course: BIOTECH3C07TH
CHEMISTRY-1
(Theory)

Semester end examination: 50 marks
Practical examination: 30 marks
Internal Assessment: 20 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I **(18 Periods)**

Stereochemistry: Writing of Fischer projection, Newmann and Sawhorse projection and Wedge formulae. Interconversion of one type of structural representation into another type.

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.

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.

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 (upto two chiral centres).

UNIT II **(10 periods)**

Alkenes and Alkynes: Hydrogenation, addition of halogens, Hydrohalogenation (Markovnikov's and anti-Markovnikov's addition), hydration, hydroxylation (cis and trans), oxymercuration-demercuration, hydroboration-oxidation, ozonolysis. Reactivity of alkenes vs alkynes.

Aldehydes and ketones: (formaldehyde, acetaldehyde, benzaldehyde, acetone)

Addition of sodium bisulphite, hydrogen cyanide and alcohols.

Addition- elimination reactions with ammonia and its derivatives

Name reactions: Aldol, cross Aldol, Claisen, Knoevengel, Cannizzaro, cross Cannizzaro

UNIT III **(15 Periods)**

Free radical substitution reactions: Halogenation of alkanes, allylic compounds and alkylbenzenes.

Nucleophilic substitution reactions: Alkyl, allyl and benzyl halides – substitution of halogen by some common nucleophiles. 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)

Carboxylic acid derivatives: Hydrolysis

Ethers: Cleavage by HI

Electrophilic Substitution Reactions (aromatic compounds): General mechanism of electrophilic substitution reactions (nitration, halogenation, sulphonation, Friedel Crafts alkylation and acylation), directive influence of substituents.

UNIT IV **(17 Periods)**

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: Oxidation with potassium permanganate, potassium dichromate
Alcohols: Oxidation with potassium permanganate, potassium dichromate, catalytic dehydrogenation and Oppenauer oxidation. Oxidation of 1,2–diols with periodic acid and lead tetraacetate.
Aldehydes: Oxidation with potassium permanganate, chromic acid and Tollen's reagent
Ketones: Oxidation with potassium permanganate, sodium hypoiodite (iodoform reaction) and Baeyer–Villiger oxidation
Reductions Aldeydes and Ketones: Catalytic hydrogenation, reduction with sodium borohydride, lithium aluminium hydride, Clemmensen, Wolff-Kishner
Carboxylic acids and their derivatives: Lithium aluminium hydride, sodium-ethanol and Rosenmund reduction.
Nitro compounds: Acidic, alkaline and neutral reducing agents, lithium aluminium hydride and electrolytic reduction.

Course: BIOTECH3C07PR
CHEMISTRY-1
(Practicals)

1. Purification of organic compounds by crystallization using the following solvents: (a) Water (b) Alcohol
2. Determination of the melting points of organic compounds (by Kjeldahl method and electrically heated melting point apparatus).
3. Determination of optical activity by using polarimeter

Organic preparations: Carry out the following preparations using 0.5 - 1 g of starting compound. Recrystallize the product and determine the melting point of the recrystallized sample.

4. To prepare acetanilide by the acetylation of aniline.
5. To prepare p-bromoacetanilide.
6. Benzolyation of aniline or β-naphthol by Schotten-Baumann reaction
7. Hydrolysis of benzamide or ethyl bezoate.
8. Semicarbazone derivative of one the following compounds: acetone, ethyl methylketone, diethylketone, cyclohexanone, benzaldehyde.
9. Nitration of nitrobenzene.
10. Oxidation of benzaldehyde by using alkaline potassium permanganate.

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. Arun Bahl 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.
10. T. W. Graham Solomon's *Organic Chemistry,* John Wiley and Sons.
11. P.S. Kalsi, *Stereochemistry, Conformation and Mechanism,* John Wiley and Sons.
12. D. Nasipuri, *Stereochemistry of Organic Compounds,* New Age International Publishers.

Course: BIOTECH4C08TH
MOLECULAR BIOLOGY
(Theory)

Semester end examination: 50 marks
Practical examination: 30 marks
Internal Assessment: 20 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I **(15 Periods)**

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

UNIT II **(10 Periods)**

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

UNIT III **(17 Periods)**

Transcription and RNA processing: RNA structure and types of RNA, Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains

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

UNIT IV **(18 Periods)**

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

Course: BIOTECH4C08PR
MOLECULAR BIOLOGY
(Practical)

PRACTICALS

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

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.

Course: BIOTECH4C09TH
IMMUNOLOGY
(Theory)

Semester end examination: 50 marks
Practical examination: 30 marks
Internal Assessment: 20 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I **(20 Periods)**

Immune Response - An overview, components of mammalian immune system, molecular structure of Immuno-globulins or Antibodies, Humoral & Cellular immune responses, T-lymphocytes & immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells), T-cell receptors, genome rearrangements during B-lymphocyte differentiation, Antibody affinity maturation class switching, assembly of T-cell receptor genes by somatic recombination.

UNIT II **(15 Periods)**

Regulation of immunoglobulin gene expression – clonal selection theory, allotypes&idiotypes, allelic exclusion, immunologic memory, heavy chain gene transcription, genetic basis of antibody diversity, hypotheses (germ line & somatic mutation), antibody diversity.

UNIT III **(13 Periods)**

Major Histocompatibility complexes – class I & class II MHC antigens, antigen processing. Immunity to infection – immunity to different organisms, pathogen defense strategies, avoidance of recognition. Autoimmune diseases, Immunodeficiency-AIDS.

UNIT IV **(12 Periods)**

Vaccines & Vaccination – adjuvants, cytokines, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, vaccines to other infectious agents, passive & active immunization. Introduction to immunodiagnostics – RIA, ELISA.

Course: BIOTECH4C09PR
IMMUNOLOGY
(Practical)

PRACTICALS

1. Differential leucocytes count
2. Total leucocytes count
3. Total RBC count
4. Haemagglutination assay
5. Haemagglutination inhibition assay
6. Separation of serum from blood
7. Double immunodiffusion test using specific antibody and antigen.
8. ELISA.

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. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
6. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

Course: BIOTECH4C10TH
CHEMISTRY-2
(Theory)

Semester end examination: 50 marks
Practical examination: 30 marks
Internal Assessment: 20 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I **(10 Periods)**

Carbohydrates: Classification of carbohydrates, reducing and non-reducing sugars, General properties of Glucose and Fructose, their open chain structure. Epimers, mutarotation and anomers. Determination of configuration of glucose (Fischer proof). Cyclic structure of glucose. Haworth projections. Cyclic structure of fructose. Linkage between monosachharides, structure of disachharides (sucrose, maltose, lactose) and polysachharides (starch and cellulose) excluding their structure elucidation.

UNIT II **(12 Periods)**

Amino Acids, Peptides and Proteins: Classification of Amino Acids, Zwitterion structure and Isoelectric point.

Overview of Primary, Secondary, Tertiary and Quaternary structure of proteins. Determination of primary structure of peptides, determination of N-terminal amino acid (by DNFB and Edman method) and C–terminal amino acid (by thiohydantoin and with carboxypeptidase enzyme). Synthesis of simple peptides (upto dipeptides) by N-protection (t-butyloxycarbonyl and phthaloyl) & C-activating groups and Merrifield solid phase synthesis.

UNIT III **(20 Periods)**

Enzymes and correlation with drug action: Mechanism of enzyme action, factors affecting enzyme action, Coenzymes and cofactors and their role in biological reactions, Specificity of enzyme action (including stereospecificity), Enzyme inhibitors and their importance, phenomenon of inhibition (competitive and noncompetitive inhibition including allosteric inhibition). Drug action - receptor theory. Structure - activity relationships of drug molecules, binding role of –OH group, -NH2 group, double bond and aromatic ring.

Concepts of Energy in Biosystems: Calorific value of food. Standard caloric content of carbohydrates, proteins and fats. Oxidation of foodstuff (organic molecules) as a source of energy for cells: Introduction to metabolism (catabolism, anabolism), ATP: the universal currency of cellular energy, ATP hydrolysis and free energy change.

Conversion of food into energy: Outline of catabolic pathways of Carbohydrates - Glycolysis, Fermentation, Krebs Cycle. Overview of catabolic pathways of fats and proteins.

Interrelationships in the metabolic pathways of proteins, fats and carbohydrates.

UNIT IV **(18 Periods)**

Components of Nucleic acids: Adenine, guanine, thymine and cytosine (structure only), other components of nucleic acids, Nucleosides and nucleotides (nomenclature), Structure of polynucleotides; Structure of DNA (Watson-Crick model) and RNA (types of RNA), Genetic code, Biological roles of DNA and RNA: Replication, Transcription and Translation.

Introduction to lipids, classification.

Oils and fats: Common fatty acids present in oils and fats, Omega fatty acids, Trans fats,

Hydrogenation, Saponification value, Iodine number. Biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol).

SUGGESTED READING

1. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. *Organic Chemistry* (*Volume 2)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Bioch*emistry *7th Ed.,* W. H. Freeman.
5. Berg, J. M., Tymoczko, J. L. & Stryer, L. *Biochemistry 7th Ed.,* W. H. Freeman.

Course: BIOTECH4C10PR
CHEMISTRY-2
(Practical)

Practicals

1. Separation of amino acids by paper chromatography
2. To determine the concentration of glycine solution by formylation method.
3. Study of titration curve of glycine
4. Action of salivary amylase on starch
5. Effect of temperature on the action of salivary amylase on starch.
6. To determine the saponification value of an oil/fat.
7. To determine the iodine value of an oil/fat
8. Differentiate between a reducing/nonreducing sugar.
9. Extraction of DNA from onion/ cauliflower
10. To synthesize aspirin by acetylation of salicylic acid and compare it with the ingredient of an aspirin tablet by TLC.

SUGGESTED READING

1. Furniss, B.S.; Hannaford, A.J.; Rogers, V.; Smith, P.W.G.; Tatchell, A.R. *Vogel's Textbook of Practical Organic Chemistry*, ELBS.
2. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry,* Universities Press.

Course: BIOTECH5C11TH
BIOPROCESS TECHNOLOGY
(Theory)

Semester end examination: 50 marks
Practical examination: 30 marks
Internal Assessment: 20 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I **(10 Periods)**

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

UNIT II **(20 Periods)**

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

UNIT III **(15 Periods)**

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

UNIT IV **(15 Periods)**

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

Course: BIOTECH5C11PR
BIOPROCESS TECHNOLOGY
(Practical)

PRACTICALS

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.

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.

Course: BIOTECH5C12TH
RECOMBINANT DNA TECHNOLOGY
(Theory)

Semester end examination: 50 marks
Practical examination: 30 marks
Internal Assessment: 20 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I **(15 Periods)**

Molecular tools and applications- restriction enzymes, ligases, polymerases, alkaline phosphatase. Gene Recombination and Gene transfer: Transformation, Episomes, Plasmids and other cloning vectors (Bacteriophage-derived vectors, artificial chromosomes), Microinjection, Electroporation, Ultrasonication, Principle and applications of Polymerase chain reaction (PCR), primer-design, and RT- (Reverse transcription) PCR.

UNIT II **(20 Periods)**

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

UNIT III **(10 Periods)**

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

UNIT IV **(15 Periods)**

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

Course: BIOTECH5C12PR
RECOMBINANT DNA TECHNOLOGY
(Practical)

PRACTICALS

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

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.

Course: BIOTECH6C13TH
BIO-ANALYTICAL TOOLS
(Theory)

Semester end examination: 50 marks
Practical examination: 30 marks
Internal Assessment: 20 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I **(10 Periods)**

Simple microscopy, phase contrast microscopy, florescence and electron microscopy (TEM and SEM), pH meter, absorption and emission spectroscopy

UNIT II **(15 Periods)**

Principle and law of absorption fluorimetry, colorimetry, spectrophotometry (visible, UV, infra-red), centrifugation, cell fractionation techniques, isolation of sub-cellular organelles and particles.

UNIT III **(15 Periods)**

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.

UNIT IV **(20 Periods)**

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 Biosensors and Nanotechnology and their applications**.**

Course: BIOTECH6C13PR
BIO-ANALYTICAL TOOLS
(Practical)

PRACTICALS

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.

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.

Course: BIOTECH6C14TH
GENOMICS AND PROTEOMICS
(Theory)

Semester end examination: 50 marks
Practical examination: 30 marks
Internal Assessment: 20 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I **(15 Periods)**

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

UNIT II **(10 Periods)**

Managing and Distributing Genome Data: Web based servers and softwares for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome. Selected Model Organisms' Genomes and Databases.

UNIT III **(20 Periods)**

Introduction to protein structure, Chemical properties of proteins. Physical interactions that determine the property of proteins. Short-range interactions, electrostatic forces, van der waal interactions, hydrogen bonds, Hydrophobic interactions. Determination of sizes (Sedimentation analysis, gel filteration, SDS-PAGE); Native PAGE, Determination of covalent structures – Edman degradation.

UNIT IV **(15 Periods)**

Introduction to Proteomics, Analysis of proteomes. 2D-PAGE. Sample preparation, solubilization, reduction, resolution.

Reproducibility of 2D-PAGE. Mass spectrometry based methods for protein identification. *De Novo* sequencing using mass spectrometric data.

Course: BIOTECH6C14PR
GENOMICS AND PROTEOMICS
(Practical)

PRACTICALS

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

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,
6. 1989.
7. Principles of Gene Manipulation 6th Edition, S.B.Primrose, R.M.Twyman and R.W. Old.
8. Blackwell Science, 2001.
9. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and SonsInc.
10. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition.
11. Benjamin Cummings.
12. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
13. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of
14. recombinant DNA. ASM Press, Washington.
15. Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition. John Wiley & Sons.

DISCIPLINE SPECIFIC ELECTIVE

Course: BIOTECH5DSE01TH
BIOINFORMATICS
(Theory)

Semester end examination: 50 marks
Practical examination: 30 marks
Internal Assessment: 20 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I **(10 Periods)**

History of Bioinformatics. The notion of Homology. Sequence Information Sources, EMBL, GENBANK, Entrez, Unigene, Understanding the structure of each source and using it on the web.

UNIT II **(20 Periods)**

Protein Information Sources, PDB, SWISSPROT, TREMBL, Understanding the structure of each source and using it on the web. Introduction of Data Generating Techniques and Bioinformatics problem posed by them- Restriction Digestion, Chromatograms, Blots, PCR, Microarrays, Mass Spectrometry.

UNIT III **(20 Periods)**

Sequence and Phylogeny analysis, Detecting Open Reading Frames, Outline of sequence Assembly, Mutation/Substitution Matrices, Pairwise Alignments, Introduction to BLAST, using it on the web, Interpreting results, Multiple Sequence Alignment, Phylogenetic Analysis.

UNIT IV **(10 Periods)**

Searching Databases: SRS, Entrez, Sequence Similarity Searches-BLAST, FASTA, Data Submission.FASTA.
Genome Annotation: Pattern and repeat finding, Gene identification tools.

Course: BIOTECH5DSE01PR
BIOINFORMATICS
(Practical)

PRACTICALS

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

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.

Course: BIOTECH5DSE02TH
ANIMAL BIOTECHNOLOGY
(Theory)

Semester end examination: 50 marks
Practical examination: 30 marks
Internal Assessment: 20 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I **(10 Periods)**

Gene transfer methods in Animals – Microinjection, Embryonic Stem cell, gene transfer, Retrovirus & Gene transfer.

UNIT II **(10 Periods)**

Introduction to transgenesis. Transgenic Animals – Mice, Cow, Pig, Sheep, Goat, Bird, Insect. Animal diseases need help of Biotechnology – Foot-and mouth disease, Coccidiosis, Trypanosomiasis, Theileriosis.

UNIT III **(20 Periods)**

Animal propagation – Artificial insemination, Animal Clones. Conservation Biology – Embryo transfer techniques. Introduction to Stem Cell Technology and its applications.

UNIT IV **(20 Periods)**

Genetic modification in Medicine - gene therapy, types of gene therapy, vectors in gene therapy, molecular engineering, human genetic engineering, problems & ethics.

Course: BIOTECH5DSE02PR
ANIMAL BIOTECHNOLOGY
(Practical)

PRACTICALS

1 . Sterilization techniques: Theory and Practical: Glass ware sterilization, Media sterilization, Laboratory sterilization
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.

SUGGESTED READING

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

Course: BIOTECH5DSE03TH
MEDICAL MICROBIOLOGY
(Theory)

Semester end examination: 50 marks
Practical examination: 30 marks
Internal Assessment: 20 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I **(18 Periods)**

Introduction: Normal microflora of human body, nosocomial infections, carriers, septic shock, septicemia, pathogenicity, virulence factors, toxins, biosafety levels.

Morphology, pathogenesis, symptoms, laboratory diagnosis, preventive measures and chemotherapy of gram positive bacteria: *S.aureus, S.pyogenes, B.anthracis, C.perferinges, C.tetani, C.botulinum, C.diphtheriaeM.tuberculosis, M. leprae.*

UNIT II **(15 Periods)**

Morphology, pathogeneis, symptoms, laboratory diagnosis, preventive measures and chemotherapy caused by gram negative bacteria: *E.coli, N. gonorrhoea, N. meningitidis, P. aeruginosa, S. typhi, S. dysenteriae, Y. pestis, B. abortus, H. influenzae, V. cholerae, M. pneumoniae, T. pallidum M. pneumoniae, Rickettsiaceae, Chlamydiae.*

UNIT III **(12 Periods)**

Diseases caused by viruses- Picornavirus, Orthomyxoviruses, Paramyxoviruses, Rhabdoviruses, Reoviruses, Pox virus, Herpes virus, Papova virus, Retro viruses (including HIV/AIDS) and Hepatitis viruses.

UNIT IV **(15 Periods)**

Fungal and Protozoan infections. Dermatophytoses (*Trichophyton, Microsporun and Epidermophyton*) Subcutaneous infection (*Sporothrix, Cryptococcus*), systemic infection (*Histoplasma, Coccidoides)* and opportunistic fungal infections (*Candidiasis, Aspergillosis*), Gastrointestinal infections (Amoebiasis, Giardiasis), Blood-borne infections (Leishmaniasis, Malaria)

Course: BIOTECH5DSE03PR
MEDICAL MICROBIOLOGY
(Practical)

PRACTICALS

1. Identification of pathogenic bacteria (any two) based on cultural, morphological and biochemical characteristics.
2. Growth curve of a bacterium.
3. To perform antibacterial testing by Kirby-Bauer method.
4. To prepare temporary mounts of *Aspergillus* and *Candida* by appropriate staining.
5. Staining methods: Gram's staining permanent slides showing Acid fast staining, Capsule staining and spore staining.

SUGGESTED READINGS

1. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. McGraw Hill Publication.
2. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mims' Medical Microbiology. 4th edition. Elsevier. .
3. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

Course: BIOTECH5DSE04TH
PLANT BIOTECHNOLOGY
(Theory)

Semester end examination: 50 marks
Practical examination: 30 marks
Internal Assessment: 20 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I **(15 Periods)**

Introduction, Cryo and organogenic differentiation, Types of culture: Seed , Embryo, Callus, Organs, Cell and Protoplast culture. Micropopagation Axillary bud proliferation, Meristem and shoot tip culture, cud culture, organogenesis, embryogenesis, advantages and disadvantages of micropropagation.

UNIT- II **(20 Periods)**

In vitro haploid production Androgenic methods: Anther culture, Microspore culture andogenesisSgnificance and use of haploids, Ploidy level and chromosome doubling, diplodization, Gynogenic haploids, factors effecting gynogenesis, chromosome elimination techniques for production of haploids in cereals.

UNIT – III **(15 Periods)**

Protoplast Isolation and fusion Methods of protoplast isolation, Protoplast development, Somatic hybridization, identifiation and selection of hybrid cells, Cybrids, Potential of somatic hybridization limitations.
Somaclonal variation
Nomenclautre, methods, applications basis and disadvantages.

UNIT – IV **(10 Periods)**

Plant Growth Promoting bacteria.
Nitrogen fixation, Nitrogenase, Hydrogenase, Nodulation,
Biocontrol of pathogens, Growth promotion by free-living bacteria.

Course: BIOTECH5DSE04PR
PLANT BIOTECHNOLOGY
(Practical)

PRACTICALS

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.

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.

Course: BIOTECH5DSE05TH
ANIMAL DIVERSITY I
(Theory)

Semester end examination: 50 marks
Practical examination: 30 marks
Internal Assessment: 20 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I **(15 Periods)**

a) Outline of classification of Non- Chordates up to subclasses. Coelomata, Acoelomata, Symmetries, Deutrostomes, Protostomes.
b) Protozoa: Locomotion, Reproduction, evolution of Sex, General features of *Paramoecium*and *Plasmodium*. Pathogenic protozoans
c) Porifera: General characters, outline of Classification; skeleton, Canal System

UNIT II **(15 Periods)**

a) Coelenterata: General Characters, Outline of classifications Polymorphism, Various types of stinging cells; Metagenesis, coral reefs and their formation.
b) Platyhelminthes- General Characters; Outline of classification; Pathogenic flatworms: Parasitic adaptations.
c) Aschelminthes: General features, Outline of classification, Pathogenic roundworms and their vectors in relation to man: Parasite adaptation.

UNIT III **(15 Periods)**

a) Annelida: - General features, Outline of classification, Coelom: Metameric segmentation, General features of Earthworm, Vermicomposting.
b) Arthropoda: General Features, Outline of Classification; Larval forms of crustacean, Respiration in Arthropoda; Metamorphosis in insects; Social insects; Insect vectors of diseases; Apiculture, Sericulture.

UNIT IV **(15 Periods)**

a) Mollusca : general features, Outline of classification, Shell Diversity; Torsion in gastropoda,
b) Echinodermata: General features, Outline of Classification Larval forms
c) Hemichordata: Phylogeny: Affinities of *Balanoglossus*

Course: BIOTECH5DSE05PR
ANIMAL DIVERSITY I
(Practical)

PRACTICALS

1. Identification and Classification of Any these of the following –
   Porifera*: Scypha, ,Leucosolenia, Euspongia, Hylonema, EuplectellaCnidaria: Medrepora, Millepora, Physalia, Porpita, Valella, Aurelia, Metridium*
   Platyhelminthes: *Taenia, Fasciola*, Aschelminthes*: Ascaris, Ancylostoma, Enterobius*Annelida: *Pheretima, Hirudinaria, Chaetopterus, Nereis, Aphrodite* Arthropoda: *Julus, Scolopendra, Peripatus, Carcinus, Limulus, Lepisma, Dragonfly, Musca, Acheta*Mollusca: *Pila, Unio, Mytilus, Loligo, Sepia, Octopus, Solen*
   Echinodermata: *Asterias, Ophiothrix, Echinus, Holothuria, Astrophyton*
   Hemichordata: *Balanoglossus*

2. Identification of slides with two points of identification.
   Amoeba, Paramoecium, Ceratium, Plasmodium, Opalina, L.S. Sponge, Spicules of sponges, L.S. *Hydra, Obelia, Bougainvillia*, Larvae of *Fasciola,* Seta of Earthworm, Radula
3. Ecological Note – On any of the specimens in Exercise No 1 Models of dissection of Earthworm, Cockroach
   Earthworm: Digestive, Nervous System,
   Cockroach: Digestive Reproductive, Nervous System

SUGGESTED READING

1. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. & J.I., Spicer (2002) The Invertebrates: A New Synthesis. III Edition. Blackwell Science.
2. Barrington, E.J.W. (1979) Invertebrate Structure and Functions. II Edition. E.L.B.S. and Nelson.
3. Boradale, L.A. and Potts, E.A. (1961) Invertebrates: A Manual for the use of Students. Asia Publishing Home.
4. Bushbaum, R. (1964) Animals without Backbones. University of Chicago Press.
5. Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition. The McGraw-HillCompanies.

Course: BIOTECH5DSE06TH
PLANT DIVERSITY I
(Theory)

Semester end examination: 50 marks
Practical examination: 30 marks
Internal Assessment: 20 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I

Algae: **(20 Periods)**

General character, classification and economic importance. Life histories of algae belonging to various classes:
Chlorophyceae – *Volvox, Oedogonium*
Xanthophyceae –*Vaucheria*
Phaeophyceae– *Ectocarpus*
Rhodophyceae-*Polysiphonia*

UNIT II

Fungi: **(20 Periods)**

General characters, classification & economic importance.
Life histories of Fungi:
Mastigomycontina- *Phytophthora*
Zygomycotina-*Mucor*
Ascomycotina- *Saccharomyces*
Basidomycotina-*Agaricus*
Deutromycotina-*Colletotrichum*

UNIT III

Lichens : **(10 Periods)**

Classification, general structure, reproduction and economic importance. Plant diseases:
4 of 36
Casual organism, symptoms and control of following plant diseases.
Rust & Smut of Wheat.
White rust of Crucifers.
Late blight of Potato.
Red rot of Sugarcane.
Citrus Canker.

UNIT IV

Bryophytes: **(10 Periods)**

General characters, classification & economic importance.
Life histories of following:
Marchantia.
Funaria

Course: BIOTECH5DSE06PR
PLANT DIVERSITY I
(Practical)

PRACTICALS.

1. Comparative study of thallus and reproductive organs of various algae mentioned in theory
2. Comparative study of vegetative and reproductive parts of various fungi mentioned in theory.
3. Study and section cutting and lectophenol mount of plant disease materials studied in theory.
4. Study of various types of lichens.
5. Study of external features & anatomy of vegetative and reproductive parts of Marchantia and Funaria
6. Collection of algae, fungi, plant diseases materials and bryophytes available locally.

SUGGESTED READING

1. Agrios, G.N. 1997 Plant Pathology, 4th edition, Academic Press, U.K.
2. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. 1996 Introductory Mycology, 4 edition, John Wiley and Sons (Asia) Singapore.
3. Bold, H.C. & Wayne, M.J. 1996 (2 Ed.) Introduction to Algae.
4. Kumar, H.D. 1999. Introductory Phycology. Aff. East-West Press Pvt Ltd., Delhi.
5. Lee, R.E. 2008. Phycology, Fourth Edition, Cambridge University Press, USA.
6. Sambamurty 2008 A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany. IK International Publishers.
7. Shaw, A.J. and Goffinet, B. 2000 Bryophyte Biology. Cambridge University Press.
8. Van den Hoek, C.; Mann, D.J. &Jahns, H.M. 1995. Algae: An introduction to Phycology. Cambridge Univ. Press.
9. Vander-Poorteri 2009 Introduction to Bryophytes. COP. rd
10. Webster, J. and Weber, R. 2007 Introduction to Fungi. 3 edition, Cambridge University Press, Cambridge.
11. Wickens, G.E. 2004 Economic Botany: Principles and Practices, Springer. Kuwer Publishers, Dordrecht, The Netherlands

Course: BIOTECH5DSE07TH
ANIMAL DIVERSITY II
(Theory)

Semester end examination: 50 marks
Practical examination: 30 marks
Internal Assessment: 20 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I **(15 Periods)**

Proto-chordates: Outline of classification, General features and important characters of *Herdmania, Branchiostoma*
Origin of Chordates
Pisces: Migration in Pisces, Outline of classification
Amphibia: Classification, Origin, Parental care, Paedogenesis

UNIT II **(15 Periods)**

Reptelia: Classification, Origin
Aves: Classification, Origin, flight- adaptations, migration
Mammalia: Classification, Origin, dentition

UNIT III **(15 Periods)**

Comparative anatomy of various systems of vertebrates: Integumentary, digestive respiratory systems.

UNIT IV **(15 Periods)**

Comparative Anatomy of vertebrates: Heart, Aortic arches, Kidney & urinogenital system, Brain, Eye, Ear.
Autonomic Nervous system in Mammals

Course: BIOTECH5DSE07PR
ANIMAL DIVERSITY II
(Practical)

PRACTICALS

1. Identification & Classification upto order of the following: Proto-chordata: *Salpa, Doliolum, Herdmania, Branchiostoma*
   Cyclostomata*: Myxine, Petromyzon*
   Chondrichthyes: *Scoliodon, Zygnea, Pristis, Trygon, Raja, Chimaera*
   Ostiechthyes: *Labeo, Mystus, Catla, Hippocampus, Anabas, Echeneis, Lophius, Polypeterus*
   Amphibia: *Rana, Hyla, Amblystoma, Necturus, Proteus*.
   Reptiles: *Hemidactylus, Calotes, Draco, Phrynosoma, NajaVipera, Bungarus*
   Aves*: Columba, Alcedo, Passer*
   Mammalia: *Ornithorhynchus, Macropus, Didelphes, Dasypus*
2. An Ecological Note on any one of the specimens in Experiment 1
3. Identification of the following slides
   Mammalian Histology: Liver, Lung, Intestine, Kidney, Ovary, Testes
   Slides of *Salpa, Doliolum,* Spicules of *Herdmania*, Tadpole of Frog
4. Preparation of a permanent mount of *Salpa*, Placoid scales, spicules of *Herdmania,* Pharynax of *Amphioxus*, Tadpole Larva of frog
5. Identification of endoskeletons of frog and rabbit.

SUGGESTED READING

1. Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.
2. Kardong, K.V. (2005) Vertebrates Comparative Anatomy, Function and evolution. IV Edition. McGraw-Hill Higher Education.
3. Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition. The McGraw-HillCompanies.
4. Weichert, C.K. (1970). Anatomy of Chordate. McGraw Hill.
5. Young, J.Z. (2004). The life of vertebrates. III Edition. Oxford university press.

Course: BIOTECH5DSE08TH
PLANT DIVERSITY II
(Theory)

Semester end examination: 50 marks
Practical examination: 30 marks
Internal Assessment: 20 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I **(10 Periods)**

Pteridophytes: General characters of pteridophytes, affinities with bryophytes & gymnosperms, classification, economic importance, study of life histories of fossil Pteridophytes – *Rhynia.*

UNIT II **(20 Periods)**

Pteridophytes: Type studies: Life histories of *Selaginella*- (Heterospory and seed habit), *Equisetum, Pteris, Lycopodium.*

UNIT III **(20 Periods)**

Gymnosperms: General characters, classification, geological time scale, theories of fossil formation, types of fossils, fossil gymnosperms- *Williamsonia&Glossopteris,* telome and stele concept.

UNIT IV **(10 Periods)**

Gymnosperms: Type studies Life histories of *Cycas&Pinus*, economic importance of gymnosperms.

Course: BIOTECH5DSE08PR

PLANT DIVERSITY II

(Practical)

PRACTICALS

1. Examination of morphology and anatomy of vegetative and reproductive parts of *Selaginella, Equisetum &Pteris*.
2. Examination of morphology and anatomy of vegetative & reproductive parts of - *Cycas&Pinus*
3. Plant collection (pteridophytes & gymnosperms)

SUGGESTED READING

1. Bhatnager, S.P. and Moitra, A. 1996 Gymnosperms. New Age International (P) Ltd. Publishers, New Delhi.
2. Parihar, N.S. 1996. The Biology and Morphology of Pteridophytes. Central Book Depot, Allahabad.
3. Sambamurty 2008 A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany. IK International Publishers.
4. Wickens, G.E. 2004 Economic Botany: Principles and Practices, Springer. Kuwer Publishers, Dordrecht, The Netherlands

Course: BIOTECH6DSE09TH
ENVIRONMENTAL BIOTECHNOLOGY
(Theory)

Semester end examination: 50 marks
Practical examination: 30 marks
Internal Assessment: 20 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I **(18 Periods)**

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

UNIT II **(20 Periods)**

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

UNIT III **(12 Periods)**

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

UNIT IV **(10 Periods)**

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

Course: BIOTECH6DSE09PR
ENVIRONMENTAL BIOTECHNOLOGY
(Practical)

PRACTICALS

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.

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

Course: BIOTECH6DSE10TH
MICROBIAL PHYSIOLOGY
(Theory)

Semester end examination: 50 marks
Practical examination: 30 marks
Internal Assessment: 20 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I **(12 Periods)**

Nutritional classification of microorganisms based on carbon, energy and electron sources, Metabolite Transport, Diffusion: Passive and facilitated, Primary active and secondary active transport, Group translocation (phosphotransferase system), symport, antiport and uniport, electrogenic and electro neutral transport, transport of Iron.

UNIT II **(13 Periods)**

Microbial Growth. Definition of growth, balanced and unbalanced growth, growth curve, the mathematics of growth-generation time, specific growth rate, batch and continuous culture, synchronous growth, diauxie growth curve. Measurement of microbial growth. Measurement of cell numbers, cell mass and metabolic activity

UNIT III **(15 Periods)**

Effect of the environment on microbial growth

Temperature- temperature ranges for microbial growth, classification based on temperature ranges and adaptations, pH-classification based on pH ranges and adaptations, solutes and water activity, oxygen concentration, radiation and pressure. Chemolithotrophic metabolism, Physiological groups of aerobic and anaerobic chemolithotrophs. Hydrogenoxidizing bacteria and methanogens.

UNIT IV **(20 Periods)**

Phototrophic metabolism. Historical account of photosynthesis, diversity of phototrophic bacteria, anoxygenic and oxygenic photosynthesis, photosynthetic pigments: action and absorption spectrum, type, structure and location, physiology of bacterial photosynthesis: light reactions, cyclic and non-cyclic photophosphorylation. Carbon dioxide fixation, Calvin cycle and reductive TCA cycle.

Course: BIOTECH6DSE10PR
MICROBIAL PHYSIOLOGY
(Practical)

PRACTICALS

1. To study and plot the growth curve of *E coli* using turbidometric method and to calculate specific growth rate and generation time.
2. To study and plot the growth curve of *Aspergillus niger*by radial growth measurements.
3. To study the effect of pH on the growth of *E. coli*
4. To study the effect of temperature of *Aspergillus niger*by dry weight method.
5. Demonstration of the thermal death time and decimal reduction time of *E. coli.*

SUGGESTED READING

1. Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag
2. Madigan MT, Martinko JM and Parker J. (2003). Brock Biology of Microorganisms.10th edition. Pearson/ Benjamin Cummings.
3. Moat AG and Foster JW. (2002). Microbial Physiology. 4th edition. John Wiley & Sons.
4. Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific Publishers India.
5. Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition, McMillan Press.
6. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

Course: BIOTECH6DSE11TH
BIOSTATISTICS
(Theory)

Semester end examination: 80 marks
Internal Assessment: 20 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I **(12 Periods)**

Types of Data, Collection of data; Primary & Secondary data, Classification and Graphical representation of Statistical data. Measures of central tendency and Dispersion. Measures of Skewness and Kurtosis.

UNIT II **(18 Periods)**

Probability classical & axiomatic definition of probability, Theorems on total and compound probability), Elementary ideas of Binomial, Poisson and Normal distributions.

UNIT III **(18 Periods)**

Methods of sampling, confidence level, critical region, testing of hypothesis and standard error, large sample test and small sample test. Problems on test of significance, t-test, chi-square test for goodness of fit and analysis of variance (ANOVA)

UNIT IV **(12 Periods)**

Correlation and Regression. Emphasis on examples from Biological Sciences.

Course: BIOTECH6DSE12TH
ECOLOGY AND ENVIRONMENT MANAGEMENT
(Theory)

Semester end examination: 50 marks
Practical examination: 30 marks
Internal Assessment: 20 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT-I **(12 Periods)**

Our Environment: Geological consideration of Atmosphere, Hydrosphere, Lithosphere Scope of Ecology. Development & Evolution of Ecosystem. Principles & Concepts of Ecosystem. Structure of ecosystem. Strata of an ecosystem. Types of ecosystem including habitats. Cybernetics & Homeostasis. Biological control of chemical environment.

UNIT II **(20 Periods)**

Energy transfer in an Ecosystem. Food chain, food web, Energy budget, Production & decomposition in a system. Ecological efficiencies, Trophic structure & energy pyramids, Ecological energetic, principles pertaining to limiting factors, Bio-geochemical cycles (N,C,P cycles).

UNIT-III **(18 Periods)**

Pollution & environmental Health related to Soil, Water, Air, Food, Pesticides, Metals, Solvents, Radiations ,Carcinogen, Poisons. Detection of Environmental pollutant. Indicators & detection systems. Bio-transformation, Plastic, Aromatics, Hazardous wastes Environmental cleanup : Case studies

UNIT-IV **(10 Periods)**

Environmental biotechnologies, Biotechnologies in protection and preservation of environment. Bioremediation, Waste disposal.

Course: BIOTECH6DSE12PR
ECOLOGY AND ENVIRONMENT MANAGEMENT
(Practical)

PRACTICALS

1. Study of all the biotic and abiotic components of any simple ecosystem- natural pond or terrestrial ecosystem or human modified ecosystem.
2. Determination of population density in a terrestrial community or hypothetical community by quad rate method and calculation of the Simpson's and Shannon- Weiner diversity index for the same community.
3. Principle of GPS (Global Positioning System).
4. Study of the life table and fecundity table, plotting of the three types of survivorship curves from the hypothetical data.
5. Study of the types of soil, their texture by sieve method and rapid tests for –pH, chlorides, nitrates, carbonates and organic carbon
6. Study any five endangered/ threatened species- one from each class.

SUGGESTED READING

1. Chapman, J.L., Reiss, M.J. 1999. Ecology: Principles and applications (2nd edition) Cambridge University Press.
2. Divan Rosencraz, Environmental laws and policies in India, Oxford Publication.
3. Ghosh, S.K., Singh, R. 2003. Social forestry and forest management. Global Vision Publishing House
4. Joseph, B., Environmental studies, Tata Mc Graw Hill.
5. Michael Allabay, Basics of environmental science, Routledge Press.
6. Miller, G.T. 2002. Sustaining the earth, an integrated approach. (5thedition) Books/Cole, Thompson Learning, Inc.
7. Mohapatra Textbook of environmental biotechnology IK publication.
8. Rana SVS, Environmentalpollution – health and toxicology, Narosa Publication
9. Sinha, S. 2010. Handbook on Wildlife Law Enforsement in India. TRAFFIC, India.
10. Thakur, I S, Environmental Biotechnology, I K Publication.

Course: BIOTECH6DSE13TH
BIOCHEMICAL ENGINEERING
(Theory)

Semester end examination: 50 marks
Practical examination: 30 marks
Internal Assessment: 20 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I **(15 Periods)**

Microbial Growth Kinetics: Thermodynamic principles, Stationary cell growth, Growth yield, Specific growth rate, Product yield, Saturation constant, Biomass energetics, Yield equations based on Y_G, Y_{O2}, Y_{ATP}, Maintenance energy, Growth kinetics of batch, fed-batch, plug flow and continuous culture, High cell density cultures; Types of fermentation depending upon the product formation, Product synthesis kinetics, Growth and non-growth associated product synthesis.

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UNIT II **(15 Periods)**

Bioreactors and Scale up: Basic concepts of bioreactors, parameters of biochemical process, packed bed, fed-batch, bubble column, fluidized bed, trickle bed, CSTR, plug flow reactors, Innovative bioreactors, Reactor Dynamics and reactors with non-ideal characteristics; Translation of laboratory, pilot and plant scale data, Criteria for translation between two scale of operation, Scale-up practices; Manual and automatic control system, on-line and off-line analytical instruments.

UNIT III **(20 Periods)**

Kinetics and Engineering of Sterilization: Kinetics of media sterilization, design of batch sterilization process,D-time, Z-value and F-value, calculation of Del-factor and holding time, Richards rapid method for design of sterilization cycles, Design of continuous sterilization, Air sterilization-design of air filters, Effect of air velocity and bed depth on filtration.

UNIT IV **(10 Periods)**

Mass Transfer and Downstream Processing: Fluids and its properties, Non-Newtonian fluids, introduction to transport phenomena, Gas–liquid mass transfer, mass transfer resistances, and determination of oxygen transfer coefficient; Recovery and purification of products from fermentation broth, Main Unit Operations in downstream processing, Membrane separation (microfiltration and ultrafiltration), Disruption of microbial cells.

List of Books

1. Biochemical Engineering: **Aiba and Hemphery**
2. Biochemical Engineering Fundamentals: **J. E. Bailey and D. F.Ollis**

3. Principles of Microbes and Cell Cultivation: **S. John Pirt**
4. Bioprocess Engineering Principles: **Pauline M. Doran**
5. Principles of fermentation technology: **P.F. Stanbury and A. Whitekar**

Course: BIOTECH6DSE13PR
BIOCHEMICAL ENGINEERING
(Practical)

Practicals

1. Microbial Growth kinetics-Determination of specific growth rate (μ_{max}), saturation constant (K_S) and growth yield ($Y_{X/S}$) for *Saccharomyces cerevisiae* in batch culture.
2. Determination of K_La by sulphite oxidation method.
3. Determination of thermal death rate constant and decimal reduction time for *E. coli*.
4. Disruption of microbial cells (Baker's yeast) for the release of the intracellular protein.
5. Bio-transformation of sucrose into high fructose syrup by immobilized cell of *Saccharomyces cerevisiae*

Course: BIOTECH6DSE14TH
FOOD BIOTECHNOLOGY
(Theory)

Semester end examination: 50 marks
Practical examination: 30 marks
Internal Assessment: 20 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I **(15 Periods)**

Historical Background, Composition of Food, Improvement of food resources through Biotechnology (e.g. Golden Rice, Potato etc.), Traditional fermented foods (meat, fish, bread, sauerkraut, soy bean, coffee, cocoa, tea)

UNIT II **(20 Periods)**

Food Fermentations: Fermented milk, Cheese, Butter, Yoghurt
Alcoholic beverages (Beer, Wine, Whisky), Sauerkraut, Pickles, Soy products,
Tea, coffee etc.

UNIT III **(20 Periods)**

Value addition products like High Fructose Syrup, Invert Sugars etc.
SCPs (e.g. Spirulina, Yeast etc.) as food supplements, Edible fungus: Mushrooms
Potential of Probiotics
Flavour enhancers: Nucleosides, nucleotides and related compounds
Organic acids (Citric acid, Acetic acid) and their uses in foods/food products
Importance of Vitamins and their supplementation in foods and feedstock.
Food preservation and storage
Food Processing

UNIT IV **(10 Periods)**

Growth of microorganisms in food: Intrinsic and extrinsic factors
Food Spoilage (microbial and non-microbial)
Control mechanisms of food spoilage: Physical and Chemical
Food and water borne diseases: Gastroenteritis, Diarrhea, Shigellosis, Salmonellosis, Typhoid, Cholera, Polio, Hepatitis, Dental Infections, etc.
Food borne intoxications: Staphylococcal, Bacillus, Clostridium etc.
Detection of food-borne pathogens.

SUGGESTED READING

1. Food Sciences and Food biotechnology- **G.F.G. Lopez, G. Canaas, E.V.Nathan**
2. Genetically Modified Foods- **M.Ruse, D. Castle (Eds.)**
3. Biotechnology of Food Crops in Developing Countries- **T.Hohn and K.M. Leisinger (Eds.)**
4. Biotechnology and Food Process Engineering- **H.G. Schwartzberg, M.A. Rao (Eds.)**

5. Food Biotechnology- **(Eds.) R.Angold, G.A.Beech, J.Taggart.**
6. Food Biotechnology—Microorganisms-**(Ed.) Y.H. Hui et al.**

Course: BIOTECH6DSE14PR
FOOD BIOTECHNOLOGY
(Practical)

1. Estimation of Total Plate Count in any food sample.
2. Detection of *Salmonella, E. coli* in food material.
3. MBRT test of milk samples.
4. Malt preparation for beer making.
5. Cheese making (Non-ripened cheese).
6. Sauerkraut production
7. Acetic acid/Vinegar Production and estimation of the product.
8. Toxin detection in the food materials.
9. Effect of internal factors on microbial growth in food *i.e.* pH, Temperature, Water Activity.

Course: BIOTECH6DSE15TH

CHEMISTRY-3

(Theory)

Semester end examination: 50 marks
Practical examination: 30 marks
Internal Assessment: 20 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I **(10 Periods)**

The covalent bond and the structure of molecules: Valence bond approach, Concept of resonance in various organic and inorganic compounds, Hybridization and structure, equivalent and non-equivalent hybrid orbitals, Bent's rule and its applications, VSEPR model for predicting shapes of molecules and ions containing lone pairs, sigma and pi bonds.

UNIT II **(15 Periods)**

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.

Intermolecular forces: Van der Waals forces, Hydrogen bonding and its applications, effects of these forces on melting point, boiling point and solubility.

UNIT III **(12 Periods)**

Transition Elements (3*d* series): General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes and stability of various oxidation states (Latimer diagrams) for Mn, Fe and Cu.

Lanthanoids and actinoids: Electronic configurations, oxidation states, colour, magnetic properties, lanthanide contraction, separation of lanthanides (ion exchange method only).

UNIT IV **(20 Periods)**

Valence Bond Theory (VBT): Inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 4 and 6). Structural and stereoisomerism in complexes with coordination numbers 4 and 6.

Drawbacks of VBT. IUPAC system of nomenclature.

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. 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.

4. J. D. Lee, *"A New Concise Inorganic Chemistry"*, ELBS IV Edition
5. Grey L. Miessler and Donald A. Tarr, *"Inorganic Chemistry"*, Prentice Hall, III Edition.
6. B. Douglas, D. H. McDaniel and J. J. Alexander, *"Concepts and Models of Inorganic Chemistry", John Wiley and Sons, III Edition.*
7. Rodgers, G.E. *Inorganic & Solid State Chemistry,* Cengage Learning India Ltd., 2008.

Course: BIOTECH6DSE15PR
CHEMISTRY-3
(Practical)

Titrimetric Analysis:
Preparations of standard solutions (concept of primary and secondary standards), Different units of concentration (molarity, molality, normality and formality)
(A) Titrations involving Acids-Bases:
Principles of acid-base titrations, Principle behind selection of an appropriate indicator.
1. Standardization of NaOH solution (standard solution of oxalic acid to be prepared)
2. Determination of concentration of carbonate and hydroxide present in a mixture.
3. Determination of concentration of carbonate and bicarbonate present in a mixture.
4. Determination of concentration of free alkali present in soaps/detergents /shampoos.
(B) Titrations involving redox reactions:
Concept of electrode potential, principle behind selection of an appropriate indicator.
5. Standardization of KMnO4 solution (standard solution of Mohr's salt to be prepared).
6. Determination of concentration of Fe(II) in Mohr's salt and/or K2Cr2O7 using diphenylamine/ N-phenylanthranilic acid as internal indicator (standard solution of K2Cr2O7 and /or Mohr's salt to be prepared).
7. Determination of iron content in ores / alloys using appropriate redox titration.
(C) Complexometric Titrations
Principles of complexometric titrations
8. Determination of concentration of Mg (II) & Zn (II) by titrimetric method using EDTA.
9. Determination of concentration of Ca/Mg in drugs or in food samples.
10. Determination of concentration of total hardness of a given sample of water by complexometric titration.
(At least 2 experiments from each set.)

SUGGESTED READING

1. Vogel, A.I. *A Textbook of Quantitative Inorganic Analysis*, ELBS.
2. Harris, D.C. & Freeman, W.H. & Co. *Quantitative Chemical Analysis 7th Ed.,* New York.

Course: BIOTECH6DSE16TH
CHEMISTRY-4
(Theory)

Semester end examination: 50 marks
Practical examination: 30 marks
Internal Assessment: 20 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I **(18 Periods)**

Thermodynamics: Review of the Laws of Thermodynamics.

Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formation, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data.

Variation of enthalpy of a reaction with temperature – Kirchhoff's equation.

Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

Chemical Equilibrium: Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG^o, Le Chatelier's principle. Relationships between *Kp, Kc* and *Kx* for reactions involving ideal gases.

UNIT II **(12 Periods)**

Ionic Equilibria: Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

UNIT III **(16 Periods)**

Introduction to spectroscopy: Electromagnetic radiation, fundamental definitions,electromagnetic spectrum, introduction to concepts of absorption and emission spectroscopy, Beer-Lambert law.

IR Spectroscopy: Fundamental and non-fundamental molecular vibrations, IR spectrum, fingerprint and group frequency regions and their significance, Hooke's law and vibrational frequency. Factors affecting vibrational frequency. Characterization of functional groups: alkanes, alkenes, alkynes (only alicyclic systems), aldehydes, ketones, carboxylic acids and their derivatives, hydroxy compounds and amines. Study of hydrogen bonding.

Electronic Spectroscopy: Electronic transitions, singlet and triplet states, dissociation and predissociation.

UV spectroscopy: Types of electronic transitions, UV spectrum, λ_{max}, ε_{max}, chromophores, auxochromes, bathochromic shift, hypsochromic shift (definitions and elementary examples) and solvent effect. Characteristic UV transitions in common functional groups. General applications of UV spectroscopy including distinction between cis-trans isomers.Woodward rules for calculating λ_{max} in the following systems:

Conjugated dienes: alicyclic, homoannular, heteroannular.

α,β-Unsaturated aldehydes and ketones.

Extended conjugated systems: dienes, aldehydes and ketones.

PMR spectroscopy: Basic principles of NMR spectroscopy, PMR scale, chemical shifts (concept of shielding and deshielding), factors influencing chemical shifts, simple spin-spin couplings, coupling constant, chemical shift equivalence, anisotropic effects in alkenes, alkynes, aldehydes and

aromatics. Interpretation of PMR spectra of simple compounds.
Application of UV, IR and PMR in solving structures of simple molecules.

UNIT IV **(14 Periods)**

Chemical Kinetics and Photochemistry: The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction. Derivation of integrated rate equations for zero and first order reactions. Half–life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation. Enzyme kinetics.
Laws of photochemistry. Fluorescence and phosphorescence. Quantum efficiency and reasons for high and low quantum yields. Primary and secondary processes in photochemical reactions. Photochemical and thermal reactions.

SUGGESTED READING

1. Atkins, P. W. & Paula, J. de *Atkin's Physical Chemistry 9*th Ed., Oxford University Press (2011).
2. Ball, D. W. *Physical Chemistry* Thomson Press, India (2007).
3. Castellan, G. W. *Physical Chemistry* 4th Ed. Narosa (2004).
4. Mortimer, R. G. *Physical Chemistry* 3rd Ed. Elsevier: NOIDA, UP (2009).
5. Chang, R. *Physical Chemistry for the Biosciences.* University Science Books (2005).

Course: BIOTECH6DSE16PR
CHEMISTRY-4
(Practical)

Practical

(I) Thermochemistry

1. Determination of heat capacity of a calorimeter for different volumes.
2. Determination of the enthalpy of neutralization of hydrochloric acid with Sodium hydroxide.
3. Determination of integral enthalpy of solution of salts (endothermic and exothermic).

(III) pH-metric and potentiometric measurements

4. Preparation of sodium acetate-acetic acid buffer solutions and measurement of their pH.
5. Potentiometric titrations of (i) strong acid *vs* strong base (ii) weak acid *vs* strong base
6. Determination of dissociation constant of a weak acid.

(IV) Study the kinetics of the following reactions:

7. Initial rate method: Iodide-persulphate reaction
8. Integrated rate method:
    a. Acid hydrolysis of methyl acetate with hydrochloric acid.
    b. Saponification of ethyl acetate

(V) Colourimetry

9. Verification of Lambert-Beer's Law for potassium dichromate/ potassium Permanganate solution.
10. Determination of pK (indicator) for phenolphthalein.
11. Study the kinetics of interaction of crystal violet with sodium hydroxide colourimetrically.

SUGGESTED READING

1. Khosla, B.D.; Garg, V.C.; Gulati, A. & Chand, R. *Senior Practical Physical Chemistry*, New Delhi.

GENERIC

ELECTIVE

Course: BIOTECH1GE01TH
BACTERIOLOGY AND VIROLOGY
(Theory)

Semester end examination: 50 marks
Practical examination: 30 marks
Internal Assessment: 20 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I **(15 Periods)**

Morphology and ultra structure of bacteria, morphological types, cell walls of archaebacteria, gram negative, 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, Reserve food materials, polyhydroxybutyrate, polyphosphate granules, oil droplets, cyanophycin granules and sulphur inclusions. Modes of nutrition and transport mechanisms in prokaryotes, 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.

UNIT II **(15 Periods)**

Cultivation of bacteria, cell division, aerobic, anaerobic, shaker, still, nutritional types, culture media used, growth curve, generation time, asynchronous, synchronous culture, measurement of growth, control of bacteria, physical and chemical agents, preservation methods, Endospore, structure, properties, germination, sporulation and morphogenesis, Dormancy.

UNIT III **(15 Periods)**

Introduction – Viruses as distinct living organisms. The origin of virology, classification and nomenclature of viruses , isolation, purification and titration of viruses.

Particles – Structure of viruses- capsid symmetry and architecture , envelop viruses, complex viruses, virus receptors, interaction with the host cell ,attachment and penetration.The Baltimore classification.

Bacteriophages and its classification, Multiplication and Reproduction.

Lysogency-with special reference to lambda and PI phages.

UNIT IV **(15 Periods)**

Brief information about cultivation of viruses; Pathogenesis- Mechanism of cellular injury, viruses and immuno deficiency, HIV and AIDS, cellular viruses and cancer; 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

Brief information about important groups of viruses causing diseases in man including in following groups: Picornaviruses, papovaviruses, herpes viruses, poxviruses, reoviruses, paramyxoviruses, paramyxoviruses, rhabdoviruses, leukemiaviruses, Hepatitis virus, orthomyxoviruses, Dengue, Yellow fever and Japanese encephalitis virus.

Course: BIOTECH1GE01PR
BACTERIOLOGY AND VIROLOGY
(Practical)

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.).

Course: BIOTECH2GE02TH
IPR ENTREPRENEURSHIP, BIOETHICS AND BIOSAFETY
(Theory)

Semester end examination: 50 marks
Practical examination: 30 marks
Internal Assessment: 20 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT-I **(15 Periods)**

Introduction to Indian Patent Law. World Trade Organization and its related intellectual property provisions. Intellectual/Industrial property and its legal protection in research, design and development. Patenting in Biotechnology, economic, ethical and depository considerations.

UNIT II **(20 Periods)**

Entrepreneurship: 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. The basic regulations of excise: Demand for a given product, feasibility of its production under given constraints of raw material, energy input, financial situations export potential etc.

UNIT III **(10 Periods)**

Bioethics – Necessity of Bioethics, different paradigms of Bioethics – National & International. Ethical issues against the molecular technologies.

UNIT IV **(15 Periods)**

Biosafety– 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).

Course: BIOTECH2GE02PR
I.P.R. ENTREPRENEURSHIP BIOETHICS AND BIOSAFETY
(Practical)

PRACTICALS

1. Proxy filing of Indian Product patent
2. Proxy filing of Indian Process patent
3. Planning of establishing a hypothetical biotechnology industry in India
4. A case study on clinical trials of drugs in India with emphasis on ethical issues.
5. Case study on women health ethics.
6. Case study on medical errors and negligence.
7. Case study on handling and disposal of radioactive waste

SUGGESTED READING

1. Entrepreneurship: New Venture Creation : David H. Holt
2. Patterns of Entrepreneurship : Jack M. Kaplan
3. Entrepreneurship and Small Business Management: C.B. Gupta, S.S. Khanka, Sultan Chand & Sons.
4. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.
5. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers

Course: BIOTECH3GE03TH
BIOTECHNOLOGY AND HUMAN WELFARE
(Theory)

Semester end examination: 50 marks
Practical examination: 30 marks
Internal Assessment: 20 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I **(20 Periods)**

Industry and Agriculture: protein engineering; enzyme and polysaccharide synthesis, activity and secretion, alcohol and antibiotic formation.

N2 fixation: transfer of pest resistance genes to plants; interaction between plants and microbes; qualitative improvement of livestock.

UNIT II **(15 Periods)**

Environments: chlorinated and non-chlorinated organ pollutant degradation; degradation of hydrocarbons and agricultural wastes, stress management, development of biodegradable polymers such as PHB..

UNIT III **(12 Periods)**

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

UNIT IV **(13 Periods)**

Health: development of non-toxic therapeutic agents, recombinant live vaccines, gene therapy, diagnostics, monoclonal antibodies and human genome project.

Course: BIOTECH3GE03PR

BIOTECHNOLOGY AND HUMAN WELFARE

(Practical)

PRACTICALS

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

1. Perform of ethanolicfermentaion 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)

SUGGESTED READING

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

Course: BIOTECH4GE04TH
DEVELOPMENTAL BIOLOGY
(Theory)

Semester end examination: 50 marks
Practical examination: 30 marks
Internal Assessment: 20 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I **(10 Periods)**

Gametogenesis and Fertilization: Definition, scope & historical perspective of development Biology, Gametogenesis – Spermatogenesis, Oogenesis Fertilization - Definition, mechanism, types of fertilization. Different types of eggs on the basis of yolk.

UNIT II **(20 Periods)**

Early embryonic development: Cleavage: Definition, types, patterns & mechanism Blastulation: Process, types & mechanism Gastrulation: Morphogenetic movements– epiboly, emboly, extension, invagination, convergence, de-lamination. Formation & differentiation of primary germ layers, Fate Maps in early embryos.

UNIT III **(20 Periods)**

Embryonic Differentiation: Differentiation: Cell commitment and determination- the epigenetic landscape: a model of determination and differentiation, control of differentiation at the level of genome, transcription and post-translation level Concept of embryonic induction: Primary, secondary & tertiary embryonic induction, Neural induction and induction of vertebrate lens.

UNIT IV **(10 Periods)**

Organogenesis: Neurulation, notogenesis, development of vertebrate eye. Fate of different primary germlayers Development of behaviour: constancy & plasticity, Extra embryonic membranes, placenta in Mammals**.**

Course: BIOTECH4GE04PR
DEVELOPMENTAL BIOLOGY
(Practical)

PRACTICALS

1. Identification of developmental stages of chick and frog embryo using permanent mounts
2. Preparation of a temporary stained mount of chick embryo
3. Study of developmental stages of *Anopheles*.
4. Study of the developmental stages of *Drosophila* from stock culture/ photographs..
5. Study of different types of placenta.

SUGGESTED READING

1. Gilbert, S. F. (2006). Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
2. Balinsky, B.I. (2008). An introduction to Embryology, International Thomson Computer Press.
3. Kalthoff, (2000). Analysis of Biological Development, II Edition, McGraw-Hill Professional.

Course: BIOTECH4GE05TH
MICROBIAL METABOLISM
(Theory)

Semester end examination: 50 marks
Practical examination: 30 marks
Internal Assessment: 20 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I **(10 Periods)**

Introduction, scope of microbial physiology studies, organization of prokaryotic and eukaryotic cells, organelles of the microbial cells and their functions. Brief account of archaebacteria.
Microbial nutrition, classification of microorganisms on the basis of their nutrition requirements. Uptake of nutrients

UNIT II **(20 Periods)**

Detailed study of Carbohydrates catabolism with special emphasis of bacteria and yeasts. Glycolysis, Phosphogluconate Pathway, Heterolactic Fermentation, Enter-Doudord Pathway, Neuberg's Schemes of Glucose fermentation, Mixed Acid Fermentation, Butyric Acid and solvents producing fermentations. Methyl Glyoxal metabolism. Krebs Cycle, Glyoxylate cycle, Electron Transport, Chemiosomotic theory.

Metabolism of Nitrogen Compounds, anaerobic amino acids catabolism, paired degradation of amino acids (Stickland reaction).

UNIT III **(20 Periods)**

Microbial Growth: Trophophase and Idophase, Primary and secondary metabolites, growth kinetics. Types of growth: Batch, Fed-Batch, and Continuous and their industrial applications. Transport of compounds in microbes.

UNIT IV **(10 Periods)**

Sugar and Polysaccharide Synthesis, Cell Wall and Teichoic acid, Lipopolysaacharides biosynthesis. Anaplerotic sequences, bacterial photosynthesis, synthesis of lipids, essential amino acid synthesis.

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.**

Course: BIOTECH4GE05PR
MICROBIAL METABOLISM
(Practical)

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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.

ABILITY ENHANCEMENT COMPULSORY COURSE

Course: ENGL103

ENGLISH COMMUNICATION (Theory)

Course: ENVS2AECC02
ENVIRONMENT SCIENCE
(Theory)

Semester end examination: 80 marks
Internal Assessment: 20 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing eight (8) short-answer type questions of 2 marks each that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I **(20 Periods)**

Introduction to environmental studies & ecosystems: Multidisciplinary nature of environmental studies: Scope and importance; What is an ecosystem? The structure and function of ecosystem, Energy flow in an ecosystem, food chains, food webs and ecological succession, forest ecosystem, grassland ecosystem, desert ecosystem, aquatic ecosystems; Levels of biological diversity such as genetic, species and ecosystem diversity; biogeography zones of India, biodiversity patterns and global biodiversity hot spots, India as a mega-biodiversity nation, endangered and endemic species of India, threats to biodiversity, habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions, conservation of biodiversity, *in-situ* and *ex-situ* conservation of biodiversity, concept of sustainability and sustainable development.

UNIT II **(15 Periods)**

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

UNIT III **(15 Periods)**

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

UNIT IV **(10 Periods)**

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

SUGGESTED READING

1. Carson, R. 2002. *Silent Spring*. Houghton Mifflin Harcourt.
2. Gadgil, M., & Guha, R. 1993. *This Fissured Land: An Ecological History of India*. Univ. of California Press.
3. Gleeson, B. and Low, N. (eds.) 1999. *Global Ethics and Environment*, London, Routledge.
4. Gleick, P. H. 1993. *Water in Crisis*. Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press.
5. Groom, Martha J., Gary K. Meffe, and Carl Ronald Carroll. *Principles of Conservation Biology*. Sunderland: Sinauer Associates, 2006.
6. Grumbine, R. Edward, and Pandit, M.K. 2013. Threats from India's Himalaya dams. *Science,* 339: 36-37.
7. McCully, P. 1996. *Rivers no more: the environmental effects of dams* (pp. 29-64). Zed Books.
8. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press.
9. Rao, M.N. & Datta, A.K. 1987. *Waste Water Treatment*. Oxford and IBH Publishing Co. Pvt. Ltd.
10. Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012. *Environment*. 8th edition. John Wiley & Sons.
11. Rosencranz, A., Divan, S., & Noble, M. L. 2001. *Environmental law and policy in India. Tripathi 1992*.
12. Sengupta, R. 2003. *Ecology and economics*: An approach to sustainable development. OUP.
13. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. *Ecology, Environmental Science and Conservation*. S. Chand Publishing, New Delhi.
14. Sodhi, N.S., Ehrlich, P.R., Stiassny, M.L.J. & Raven, P.H. (eds). 2013. *Conservation Biology*: *Voices from the Tropics*. John Wiley & Sons.
15. Wilson, E. O. 2006. *The Creation: An appeal to save life on earth*. New York: Norton.
16. World Commission on Environment and Development. 1987. *Our Common Future*. Oxford University Press.

SKILL ENHANCEMENT ELECTIVE COURSE

Course: BIOTECH3SEC01TH
MOLECULAR DIAGNOSTICS
(Theory)

Semester end examination: 50 marks
Practical examination: 30 marks
Internal Assessment: 20 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I **(15 Periods)**

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

Applications of enzyme immunoassays in diagnostic microbiology

UNIT II **(15 Periods)**

Molecular methods in clinical microbiology: Applications of PCR, RFLP, Nuclear hybridization methods, Single nucleotide polymorphism and plasmid finger printing in clinical microbiology

Laboratory tests in chemotherapy:

Susceptibility tests: Micro-dilution and macro-dilution broth procedures. Susceptibility tests:Diffusion test procedures. Susceptibility tests: Tests for bactericidal activity. Automated procedures for antimicrobial susceptibility tests.

UNIT III **(18 Periods)**

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

UNIT IV **(12 Periods)**

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

Transgenic animals.

Course: BIOTECH3SEC01PR
MOLECULAR DIAGNOSTICS
(Practical)

PRACTICALS

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

1. Perform/demonstrate RFLP and its analysis
2. Kirby-Bauyer method (disc-diffusion method) to study antibiotic sensitivity of a bacterial culture
3. A kit-basd detection of a microbial infection (Widal test)
4. Study of Electron micrographs (any four).
5. Perform any one immuno diagnostic test (Typhoid, Malaria, Dengue)

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

Course: BIOTECH3SEC02TH
ENZYMOLOGY
(Theory)

Semester end examination: 50 marks
Practical examination: 30 marks
Internal Assessment: 20 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I **(20 Periods)**

Isolation, crystallization and purification of enzymes, test of homogeneity of enzyme preparation, methods of enzyme analysis.
Enzyme classification (rationale, overview and specific examples) Zymogens and their activation (Proteases and Prothrombin).
Enzyme substrate complex: concept of E-S complex, binding sites, active site, specificity, Kinetics of enzyme activity, Michaelis-Menten equation and its derivation,
Different plots for the determination of Km and Vmax and their physiological significance, factors affecting initial rate, E, S, temp. &pH. Collision and transition state theories, Significance of activation energy and free energy.

UNIT II **(15 Periods)**

Two substrate reactions (Random, ordered and ping-pong mechanism) Enzyme inhibition types of inhibition, determination of Ki, suicide inhibitor.
Mechanism of enzyme action: General mechanistic principle, factors associated with catalytic efficiency: proximity, orientation, distortion of strain, acid-base, nucleophilic and covalent catalysis. chemical modification of active site groups, specific examples-: chymotrypsin, Iysozyme, GPDH, aldolase, RNase, Carboxypeptidase and alcohol dehydrogenase.
Enzyme regulation: Product inhibition, feed backcontrol, covalent modification.

UNIT – III **(13 Periods)**

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

UNIT IV **(12 Periods)**

Enzyme Technology: Methods for large scale production of enzymes.
Immobilized enzyme and their comparison with soluble enzymes, Methods for immobilization of enzymes. Immobilized enzyme reactors. Application of Immobilized and soluble enzyme in health and industry. Application to fundamental studies of biochemistry.

Course: BIOTECH3SEC02PR
ENZYMOLOGY
(Practical)

PRACTICALS

1. Purification of an enzyme from any natural resource
2. Quantitative estimation of proteins by Bradford/Lowry's method.
3. Perform assay for the purified enzyme.
4. Calculation of kinetic parameters such as Km, Vmax, Kcat

SUGGESTED READING

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

Course: BIOTECH4SEC03TH
INDUSTRIAL FERMENTATIONS
(Theory)

Semester end examination: 40 marks
Practical examination: 30 marks
Internal Assessment: 30 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I **(12 Periods)**

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

UNIT II **(15 Periods)**

Microbial products of pharmacological interest, steriod fermentations and transformations. Over production of microbial metabolite, Secondary metabolism – its significance and products. Metabolic engineering of secondary metabolism for highest productivity.

Enzyme and cell immobilization techniques in industrial processing, enzymes in organic synthesis, proteolytic enzymes, hydrolytic enzymes, glucose isomerase, enzymes in food technology/organic synthesis.

UNIT III **(13 Periods)**

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

UNIT IV **(20 Periods)**

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

Course: BIOTECH4SEC03PR
INDUSTRIAL FERMENTATIONS
(Practical)

PRACTICALS

1. Comparative analysis of design of a batch and continuous fermenter.
2. Calculation of Mathematical derivation of growth kinetics.
3. Solvent extraction & analysis of a metabolite from a bacterial culture.
4. Perform an enzyme assay demonstrating its hydrolytic activity (protease/peptidase/glucosidase etc.)

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,

Course: BIOTECH4SEC04TH
BASICS OF FORENSIC SCIENCE
(Theory)

Semester end examination: 50 marks
Practical examination: 30 marks
Internal Assessment: 20 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

Unit I **(15 Periods)**

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

Unit II **(15 Periods)**

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

Unit III **(15 Periods)**

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

Unit IV **(15 Periods)**

Principle of DNA fingerprinting, application of DNA profiling in forensic medicine, Investigation Tools, eDiscovery, Evidence Preservation, Search and Seizure of Computers, Introduction to Cyber security.

Course: BIOTECH4SEC04PR
BASICS OF FORENSIC SCIENCE
(Practical)

PRACTICALS

1. Documentation of crime scene by photography, sketching and field notes.
2. a. Simulation of a crime scene for training.

   b. To lift footprints from crime scene.
3. Case studies to depict different types of injuries and death.
4. Separation of nitro compounds (explosives)/ ink samples by thin layer chromatography.
5. Investigate method for developing fingerprints by Iodine crystals.
6. PCR amplification on target DNA and DNA profiling,
7. E-Mail Investigation, E-Mail Tracking, IP Tracking, E-Mail Recovery, Recovering deleted evidences, Password Cracking

SUGGESTED READING

1. Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
2. B.B. Nanda and R.K. Tiwari, Forensic Science in India: A Vision for the Twenty First Century, Select Publishers, New Delhi (2001).
3. M.K. Bhasin and S. Nath, Role of Forensic Science in the New Millennium, University of Delhi, Delhi (2002).
4. S.H. James and J.J. Nordby, Forensic Science: An Introduction to Scientific and Investigative Techniques, 2nd Edition, CRC Press, Boca Raton (2005).
5. W.G. Eckert and R.K. Wright in Introduction to Forensic Sciences, 2nd Edition, W.G. Eckert (ED.), CRC Press, Boca Raton (1997).
6. R. Saferstein, Criminalistics, 8th Edition, Prentice Hall, New Jersey (2004).
7. W.J. Tilstone, M.L. Hastrup and C. Hald, Fisher's Techniques of Crime Scene Investigation, CRC Press, Boca Raton (2013)