COURSE OUTLINE

B.Sc. WITH MAJOR IN BIOTECHNOLOGY CBCS-2015

HIMACHAL PRADESH UNIVERSITY

SHIMLA

Effective from session 2015-16

HIMACHAL PRADESH UNIVERSITY
SUMMER-HILL, SHIMLA-171005

B.Sc. WITH MAJOR IN BIOTECHNOLOGY

GENERAL INSTRUCTIONS/GUIDELINES FOR EXECUTION OF CURRICULUM

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

2. There will be broadly four types of courses for B.Sc. Biotechnology Programme.
The one credit of practical/laboratory shall be of 2 hours duration and one credit of lecture/tutorial will be of one hour duration per week.
A. The Compulsory courses will be of 3 credits each and a candidate has to choose a minimum of 3 Compulsory courses being offered by the concerned college/ institute. Thus a minimum of 9 [3 X 3 credits] will be opted by a candidate. Each of 3-credit courses will carry 75 marks.
B. The core courses will comprise Hard core [Compulsory subject courses where no choice will be available] and Soft core courses [Choice for opting a course will be available] of 4-credits each, and a candidate will opt a total of 14 courses of 4-credits each [4 X 14 = 56 credits]. Each credit will carry 30 marks and each course of 4-credits will carry 100 marks. There will be 70 marks for theory and 30 marks for practical in each of the major/core courses. In theory 40 marks will be for semester end examination and 30 marks will be for continuous internal assessment. The component of internal assessment and marks will be as following:
Internal assessment test I =10 marks (20 MCQs of ½ marks each)
Internal assessment test II =10 marks (20 MCQs of ½ marks each)
Assignment and presentation = 5 marks
Attendance = 5 marks
The criteria for attendance to be followed shall be: i) upto 75% lectures including condonation of lectures as per ordinances: zero mark, ii) without condonation of lectures upto 75% : 1 mark; iii) 76-80% lectures : 2 marks, iv) 81-85% lectures : 3 marks; v) 86-90% lectures : 4 marks; vi) 91% and above lectures : 5 marks.
C. Elective courses will comprise related to Minor subjects. Each Elective course will be of 4-credits each and a candidate opts for 5 courses of a Minor subject [say Chemistry, Botany, Zoology etc.] or at least 5 courses of two different minor subjects. A minimum of 10 Elective courses [4 X 12 = 48 credits] will be chosen by a candidate to get specialization in one or two minor subjects.
D. General Interest and/ or Hobby courses will comprise such courses as the name suggests and each candidate will opt for at least one course of 1 credit.

3. (a) The admission to B.Sc. Biotechnology Programme of Himachal Pradesh University will be as per guidelines of Himachal Pradesh University, Shimla from time to time.
(b) 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).
(c) 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).
(d) 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.

(e) 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.

4. Admission will be based on the merit of the entrance test to be conducted by HP University or any other mode as to be decided by the University from time to time.

5. The tuition fee and other monthly/annual charges will be as per University rules.

OUTLINE OF COURSES FOR B. Sc. WITH MAJOR IN BIOTECHNOLOGY

Semester	Courses to be opted	Course name	Credits	
			Course	Cumulative
I [ODD]	Compulsory Course-I	Select from the listed compulsory courses	3	Compulsory: 03 Core: 08 Elective: 08 GI & H: 01 **Total: 20**
	Major Core Course-I B.SC.BT101	**Biomolecules**	**4**	
	Major Core Course-II B.SC.BT102	**Introductory Cell Biology**	**4**	
	Minor Elective Course-I (a)	To be selected from the list of minor elective courses	4	
	Minor Elective Course-I (b)	To be selected from the list of minor elective courses	4	
	GI & H Course-I	To be selected from the list of GI & H courses	1	
II [EVEN]	**Major Core Course-III B.SC.BT201**	**Fundamental Microbiology**	**4**	Compulsory: 03 Core: 08 Elective: 08 GI & H: 01 **Total: 20**
	Major Core Course-IV B.SC.BT202	**Genetics & Molecular Biology**	**4**	
	Compulsory Course-II [Skill based]	To be selected from the list of compulsory courses	3	
	Minor Elective Course-II (a)	To be selected from the list of minor elective courses	4	
	Minor Elective Course-II (b)	To be selected from the list of minor elective courses	4	
	GI & H Course-II	To be selected from the list of GI & H courses	1	
III [ODD]	**Major Core Course-V B.SC.BT301**	**Fundamentals of Immunology**	**4**	Compulsory: 03 Core: 08 Elective: 08 GI & H: 01 **Total: 20**
	Major Core Course-VI B.SC.BT302	**Basics of Recombinant DNA Technology**	**4**	
	Compulsory Course-III	To be selected from the list of compulsory courses	3	
	Minor Elective Course-III (a)	To be selected from the list of minor elective courses	4	
	Minor Elective Course-III (b)	To be selected from the list of minor elective courses	4	
	GI & H Course-III	To be selected from the list of GI & H courses	1	
IV [EVEN]	**Major Core Course-VII B.SC.BT401**	**Instrumental Methods of Analysis**	**4**	Compulsory: 03 Core: 08 Elective: 08 GI & H: 01 **Total: 20**
	Major Core Course-VIII B.SC.BT402	**Introduction to Bioinformatics**	**4**	
	Compulsory Course-IV [Skill based]	To be selected from the list of compulsory courses	3	
	Minor Elective Course-IV (a)	To be selected from the list of minor elective courses	4	
	Minor Elective Course-IV (b)	To be selected from the list of minor elective courses	4	
	GI & H Course-IV	To be selected from the list of GI & H courses	1	
V [ODD]	**Major Core Course-IX B.SC.BT501**	**Animal Cell Culture**	**4**	Core: 12 Elective: 08 **Total: 20**
	Major Core Course-X B.SC.BT502	**Plant Cell Culture**	**4**	
	Major Core Course-XI B.SC.BT503	**Enzyme Technology**	**4**	
	Minor Elective Course-V (a)	To be selected from the list of minor elective courses	4	
	Minor Elective Course-V (b)	To be selected from the list of minor elective courses	4	
VI [EVEN]	**Major Core Course-XII B.SC.BT601**	**Environmental Biotechnology**	**4**	Core: 12 Elective: 08

	Major Core Course-XIII B.SC.BT602	**Bioprocess Technology**	**4**	**Total: 20**
	Major Core Course-XIV B.SC.BT603	**Intellectual Property Rights and Entrepreneurship**	**4**	
	Minor Elective Course-VI (a)	To be selected from the list of minor elective courses	4	
	Minor Elective Course-VI (b)	To be selected from the list of minor elective courses	4	

Selection of various courses

A. Compulsory courses [Minimum 3 courses; 3 X 3 = 9 credits]

(a) Languages

i. Compulsory English
ii. Compulsory Hindi

(b) Social Sciences/Commerce/Management

iii. Compulsory Social Science/ Commerce/management course
iv. Compulsory Geography of Himachal Pradesh
v. Compulsory Indian Constitution
vi. Compulsory Himachal Past, Present and Future

(c) Science

vii. Compulsory Basic Science (not for students majoring in science subjects)
viii. Climate Change and its impact on mountain sustainability
ix. Compulsory Environmental Science (Audit Pass Course)

(d) Skill based courses

x. Functional English
xi. Office Computing
xii. Functional Hindi
xiii. Application Packages for finance
xiv. Secretarial practice
xv. Short hand and word processing
xvi. Web applications

B. Major Core courses (BIOTECHNOLOGY)

CORE COURSES [Minimum 14 courses; 14 X 4 = 56 credits]

L: Lecture T: Tutorial P: Practical C: Total Credits

Code	Hard core courses	L-T-P-C
B.SC.BT101	Biomolecules	3-0-1-4
B.SC.BT102	Introductory Cell Biology	3-0-1-4
B.SC.BT201	Fundamentals of Microbiology	3-0-1-4
B.SC.BT202	Genetics and Molecular Biology	3-0-1-4
B.SC.BT301	Fundamentals of Immunology	3-0-1-4
B.SC.BT302	Basics of Recombinant DNA Technology	3-0-1-4
B.SC.BT401	Instrumental Methods of Analysis	3-0-1-4
B.SC.BT402	Introduction to Bioinformatics	3-0-1-4
B.SC.BT501	Animal Cell Culture	3-0-1-4
B.SC.BT502	Plant Cell Culture	3-0-1-4
B.SC.BT503	Enzyme Technology	3-0-1-4
B.SC.BT601	Environmental Biotechnology	3-0-1-4
B.SC.BT602	Bioprocess Technology	3-0-1-4
B.SC.BT603	Intellectual Property Rights and Entrepreneurship	3-1-0-4

Minor (Elective) Biotechnology Courses

Code	Courses	L-T-P-C
B.SC.BT-101	Biomolecules	3-0-1-4
B.SC.BT-202	Genetics and Molecular Biology	3-0-1-4
B.SC.BT-203	Food Biotechnology	3-0-1-4
B.SC.BT-301	Fundamentals of Immunology	3-0-1-4
B.SC.BT-302	Basics of Recombinant DNA Technology	3-0-1-4
B.SC.BT-401	Instrumental Methods of Analysis	3-0-1-4
B.SC.BT-403	Fermentation Technology	3-0-1-4
B.SC.BT-501	Animal Cell Culture	3-0-1-4
B.SC.BT-502	Plant Cell Culture	3-0-1-4
B.SC.BT-602	Bioprocess Technology	3-0-1-4

C. Minor Elective Courses

Details of the syllabus will be as prescribed by the University.
Chemistry shall be compulsory minor elective for B.Sc. students majoring in Biotechnology and second minor elective will be one of following subjects:.

1. Economics
2. Public Administration
3. Computer
4. Physics
5. Mathematics
6. Sociology
7. Geography

D. General Interest (GI) and / or Hobby (H)

Details of the syllabus will be as prescribed by the University.

1. Commercial arts
2. German language
3. Russian language
4. Spoken English
5. Photography
6. General computer applications
7. Fine arts
8. Playing musical instrument(s)

COURSE: B.SC.BT101
BIOMOLECULES

L	T	P	C
3	0	1	4

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

Instructions for setting end semester examination question paper:

The examiner will set nine questions in all. Q.No. 1 will be compulsory, objective type and covering entire syllabus. There will be 2 questions from each unit and each question will have 3-4 parts. Students will attempt one question from each unit including compulsory question and each question will carry 8 marks.

Unit I

Water and its property: Physico chemical properties of water, dissociation and association constants. pH and buffers, pI, pka, Hasselberg Handerson equation and its implication.

Carbohydrates: Structure of important mono, di, oligo and polysaccharides, glycoproteins and peptidoglycan, glycolipids and lipopolysaccharides. Reaction of monosaccharides.

Unit II

Proteins: Structure of amino acids, non-protein and rare amino acids and their chemical reactions. Structural organisation of proteins (primary, secondary, quaternary domain structure), protein classification and function. Forces stabilizing primary, secondary and tertiary structure. Laboratory synthesis of protein, lectin antibodies

Unit III

Lipids: Classification of lipids and fatty acids, general functions of major lipid subclasses, acyglycerols, phosphoglycerols, phosphoglycerides, sphingolipids, glycosphingolipids and terpens, sterols, steroids. Prostagladins, Prostaryclins, Leukotrienes etc.

Unit IV

Nucleic acids: Structure of nucleosides, nucleotides and nucleic acids, biologically important nucleotides and their functions. Applications of biochip and microarray.

Vitamins and hormones: Types of vitamins and their chemistry vitamins as cofactors, steroids and peptide hormones

Suggested books:

1. Biochemistry- **Rawn, J.D.**
2. Principles of Biochemistry- **Lehninger, A.L. Nelson, D.L. and Cox, M.M**
3. Biochemistry- **Stryer, L.**
4. Principles of Biochemistry: Student Study Art Notebook- **Zubay, G.L, Parson, W.W. and Vance, D.E.**
5. Carbohydrate Biotechnology Protocols- **Bucke C.**
1. Principles of Biochemistry- **Horton *et al.***
7. An Introduction of practical biochemistry- **Plummer D.T.**
8. Practical Biochemistry- **Bansal, D.D., Khardori, R & Gupta, M.M.**

List of Practical:

1. Preparation of physiological buffers
2. Verification of Beer lamberts law for P-nitrophenol or cobaltchloride
3. Determination pKa value of p-nitrophenol
4. The colorimetric estimation of inorganic phosphates
5. Estimation of carbohydrates in given solution by Anthron method.
6. Estimation of sugars in biological samples
7. Protein estimation by lowry's method.
8. Protein estimation by Bradford methods.
9. Analysis of urine for urea, glucose, uric acid and chloride.
10. The determination of acid value of a fat
11. Saponifaction value of a fat
12. Separation of lipids by thin layer chromatography.

COURSE: B.SC.BT102
INTRODUCTORY CELL BIOLOGY

L	T	P	C
3	0	1	4

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

Instructions for setting end semester examination question paper:

The examiner will set nine questions in all. Q.No. 1 will be compulsory, objective type and covering entire syllabus. There will be 2 questions from each unit and each question will have 3-4 parts. Students will attempt one question from each unit including compulsory question and each question will carry 8 marks.

Unit-I

Cell as a basic unit of living systems. The cell theory. Precellular evolution: artificial creation of cells. **Broad classification of cell types:** PPLO's, bacteria, eukaryotic, microbes, plant and animal cells. A detailed classification of cell types within an organism. Cell, tissue organ and organisms as different levels of organizations of otherwise genetically similar cells.

Unit-II

Ecological amplitude of cells in high altitude, sediments, arctic, hotspring, arid, brackish, extremophytes and freshwater environments.

Biochemical composition of cells (proteins, lipids, carbohydrates, nucleic acids and the metabolic pool)

Biological Membranes: Supramolecular architecture of membranes; solute transport across membranes, model membranes and lipsomes.

Unit-III

Structure and function of cell organelles, ultra structure of cell membrane, cytosol, Golgi bodies, endoplasmic reticulum (rough and smooth), ribosomes, cytoskeletal structures (actin, microtubules etc.) Mitochondria, chloroplasts, lysosomes, peroxysomes, nucleus (nuclear membrane, nucleoplasm, nucleolus chromatin).

Unit-IV

Cell division and cell cycle: mitosis, meiosis, stages of cell cycle, binary fission amitosis.

Cell-cell interaction

Cell locomotion (amoeboid, flagellar and ciliar)

Cell senescence and death: Apoptosis and necrosis

Cell differentiation in plants and animals: totipotent, multipotent, pleuripotent cell.

Suggested books:

1. Cell and Molecular Biology- **De-Robertis, F.D.P. and De-Robertis Jr. E.M.F.**
2. Molecular Cell Biology- **Lodish, H., Baltimore, D., Berk, A., Zipursky, S.L.Matsudaira, P. and Darnell**
3. The Cell: A Molecular Approach- **Geoffrey, M**
4. Cell Biology: A Laboratory Handbook- **Celis, J.E.**

List of Practical:

1. Microscopy:
    a. Principles of compound, phase contrast, electron microscopy
    b. Use and care of Light compound microscope.
2. Study of cells:
    a. Prokaryotic cells: *Lactobacillus*, *E.Coli*, Blue green algae
    b. Eukaryotic cells. Testicular material (for studies of spermatogenesis)
3. Microtomy: Introduction of the instrument, its use, care, section cutting and stretching.
4. Preparation of permanent slides: Principles and procedures; section cutting of tissues and staining of tissues with Haematoxylin/eosin method.
5. Study of permanent slides of various tissues (gut region, liver, lung, spleen, kidney, pancreas testis, ovary, tongue, skin etc.)
6. Cytochemical techniques to study carbohydrates, nucleic acids and proteins.
7. Preparation and study of meiosis slides from meristem tissue by squash method.

COURSE: B.SC.BT201

FUNDAMENTAL MICROBIOLOGY

L	T	P	C
3	0	1	4

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

Instructions for setting end semester examination question paper:

The examiner will set nine questions in all. Q.No. 1 will be compulsory, objective type and covering entire syllabus. There will be 2 questions from each unit and each question will have 3-4 parts. Students will attempt one question from each unit including compulsory question and each question will carry 8 marks.

Unit I

History of Microbiology: A.Leeuwenhoek, L.Pasteur, R.Koch, J.Lister, J.Tyndall, etc.
Biogenesis vs Abiogenesis, Koch's Postulates, Discovery of antibiotics.
Principle of Microscopy: Bright field, Dark field, Phase contrast, Fluorescent, Electron Microscopy.

Unit II

Microbial classification: Bacteria, Fungi and Algae.
Morphology of bacteria, Viruses and fungi with major emphasis on bacterial structure specially cell wall. Gram positive and Gram negative bacteria. Microbial spores, Sporulation/germination process.

Unit III

Microbial growth, nutritional biodiversity, phases of growth, generation time, growth rates, monoauxic, diauxic and synchronous growth, chemostat.
Microbes in extreme environment like high temperature and high/ low pH values. Physical and chemical agents to kill microbes, sterilization and pasteurization processes

Unit IV

Normal micro flora in humans/animals. Types of microbial pathogens and disease caused by them. Microbial interactions like symbiosis and antibiosis etc. Host defense mechanism against pathogens.
Nitrogen fixing microbes in agriculture.
Microbial metabolism, unique pathways, photosynthesis, fermentation and its products, production of heterologous proteins in microbes.

Recommended books:

1. Microbiology- **Davis, B.D Dulbecco, R., Eiser, H.N. and Ginsberg, H.S.**
2. Microbiology: an introduction- **Tortora, G.J., Funke, B.R. and Case, C.L.**
3. General Microbiology- **Stanier, R.Y.**
4. Microbiology- **Pelczar, M.T.**
5. General microbiology- **Schlegel, H.G.**
6. Industrial Microbiology- **Prescot and Dunn**
7. Microbiology: fundamentals and Applications- **Purohit, S.S.**
8. Microbes and Man- **Postgate, J.**
9. Microbiology: Laboratory manual- **Cappuccino, J.G and Sherman, N.**

List of Practical:

1. Aseptic techniques
2. Cleaning of glass wares, Preparation of media, Cotton plugging and sterilization
3. Personal hygiene-microbes from hands, Tooth-scums and other body parts.
4. Isolation of microorganisms from air, water and soil samples
5. Dilution and pour plating techniques.
6. Enumeration of microorganisms total vs viable counts.
7. Identification of isolated bacteria
8. Gram staining, other staining methods, metabolic characterisation (e.g ImVIC) Tests
9. Growth curve of microorganisms.
10. Antibiotics sensitivity of microbes. Use of antibiotic discs.

11. Testing of water quality
12. Test for antibodies against given Bacteria
13. One step growth of bacteriophage.
14. Culture from body fluids (stool, urine, blood).
15. Alcoholic and mixed acid fermentation.

COURSE: B.SC.BT202
GENETICS AND MOLECULAR BIOLOGY

L	T	P	C
3	0	1	4

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

Instructions for setting end semester examination question paper:

The examiner will set nine questions in all. Q.No. 1 will be compulsory, objective type and covering entire syllabus. There will be 2 questions from each unit and each question will have 3-4 parts. Students will attempt one question from each unit including compulsory question and each question will carry 8 marks.

Unit-I

Nature of genetic material, nucleic acids, DNA replication

Organization of Chromosomes: Genome size and complexity, the supercoiling of DNA, the structure of prokaryotic and eukaryotic chromosome, Polytene chromosomes, euchromatin and heterochromatin, satellite DNA, centromere and telomere structure.

Unit-II

Gene organization and expression in prokaryotes and eukaryotes. Introduction to Genes and Proteins, Genome Sequences, ORFs, Genes, Introns, Exons, Splice Variants, DNA/RNA, Secondary structure, Triplet Coding, Protein sequences, Protein Structure, Secondary, Tertiary and Quaternary structures.

Unit-III

Mendelian Laws of inheritance, gene interactions. Extrachromosomal inheritance, mitochondrial and chloroplast genetic systems: sex linked inheritance.

Gene linkage and chromosome mapping: Linkage and recombination of genes in chromosomes, crossing over and its molecular mechanism, gene mapping by three point test crosses, mapping by tetrad analysis, somatic cell hybridization for gene linkage studies, recombination within genes.

Unit-IV

Mutation: Spontaneous versus induced mutations, types of mutations, the molecular basis of mutations, mechanisms of DNA repair, mutations, frequency, correlation between mutagenicity and carcinogenicity, mutagenic agents, chemical and radiation.

Population Genetics: Hardy-Weinberg equilibrium, gene and genotypic frequencies, introduction of eugenics.

Basic microbial genetics: Conjugation, transduction, transformation, isolation of auxotrophs, replica plating techniques, analysis of mutations in biochemical pathway, one gene– one enzyme hypothesis.

Recommended Books:

1. Microbial Genetics- **Maloy, S.R. Crown, J.E., and Freifelder, D.**
2. Genetics- **Hartl, D.L.**
3. Genetics: Analysis and Principles- **Brooker, R.J.**
4. The Science of Genetics- **Antherly A.G. Girton, J.R.**
5. Microbial Genetics- **Freifelder, D.**
6. Genetics: Analysis of Genes and Genomes- **Hartl, D.L. Jones, E.W.**

List of Practicals:

1. Demonstration of Law of segregation and Independent assortment (use of coloured beads, capsules etc.) Numericals for segregation and independent assortment. Use of Chi2 for prediction of phenotype/genotype frequencies of parents from progeny and vice-versa, Epistasis.
2. Segregation demonstration in preserved material (Maize)
3. Detection of Blood groups (A B O & Rh factors)
4. Inheritance of other human characteristics, ability to test PTC, Thiourea
5. Calculation of variance in respect of pod length and number of seeds/pod
6. Calculation of gene frequencies and random mating (coloured beads, capsules)
7. Paternity disputes (blood groups)
8. Preparation and study of mitosis slides from buccal mucosa and onion root tips by squash method.
9. Demonstration of sex chromatin from buccal smear using thionin stain.

COURSE: B.SC.BT203
FOOD BIOTECHNOLOGY

L	T	P	C
3	0	1	4

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

Theory: 36 Credit Hours (9 Credit Hours/Unit)
Practical: 12 Credit Hours

Instructions for setting end semester examination question paper

The examiner will set nine questions in all. Q. No. 1 will be compulsory, objective type and shall cover entire syllabus. There will be 2 questions from each unit and each question will have 3-4 parts. Students will attempt one question from each of the units including compulsory question. All questions will carry equal (8 marks) marks.

Unit-I

Historical Background, Composition of Food, Improvement of food resources through Biotechnology (*e.g*. Golden Rice, Potato *etc*.).

Unit-II

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

Unit-III

Value addition products like High Fructose Syrup, Invert Sugars etc. SCPs (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

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.

Recommended books:

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*.
7. Modern Food Micro-Biology - J. M. Jay

List of practicals:

1. Estimation of Total Plate Count in any food sample.
2. Detection of *Salmonella* and *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- B.SC.BT301
CONCEPTS IN IMMUNOLOGY

L	T	P	C
3	0	1	4

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

Instructions for setting end semester examination question paper:

The examiner will set nine questions in all. Q.No. 1 will be compulsory, objective type and covering entire syllabus. There will be 2 questions from each unit and each question will have 3-4 parts. Students will attempt one question from each unit including compulsory question and each question will carry 8 marks.

Unit-I

Introduction: Types of immunity-innate and adaptive; features of immune response-memory. Specificity and recognition of self and non-self; terminology and approaches to the study of immune system; immunity to viruses bacteria; fungi and tumours; vaccines.

Unit-II

Cells and organs of the immune system.

Lymphoid cells, heterogeneity of lymphoid cells, T-cells, B-cells, Null cells; Monocytes, Polymorphs, primary and secondary lymphoid organs-thymus, Bursa of fabricius, spleen, lymph nodes, lymphatic system, Mucosa Associated Lymphoid Tissue (MALT), Lymphocyte traffic

Unit-III

Humoral Immunity

Antigen-antibody interactions; affinity and avidity; high and low affinity antibodies, immuno-globulins, classes and structure, molecular mechanism of generation of antibody diversity, complement fixing antibodies and complement cascade.

Cell Mediated Immunity

T-cell subsets and surface markers, T-dependent and T-independent antigens, recognition of antigens by T-cells and role of MHC, structure of T-cell antigen receptors.

Unit-IV

Immunodiagnostic Procedures.

Various types of immunodiffusion and immunoelectrphoretic procedures, Immunblot, ELISA, RIA, Agglutination of pathogenic bacteria, Haemagglutination and Haemagglutination inhibition.

Suggested books:

1. Immunology- **Roitt, I.M. Brostoff, J. and Male, D.K.**
2. Immunology- **Kuby, J.**
3. Principles of Cellular and Molecular Immunology- **Austyn, J.M. and Wood, K.J.**
4. Fundamental Immunology- **Paul, W.E.**
5. Monoclonal Antibodies Principles and Application- **Britch, J.R. and Lennox, E.S.**
6. Medical Immunology- **Strites, D.P.Terr, A.I. & Oparslow T.G.**
7. Clinical Immunology and Serology: A laboratory perspective- **Steverns, C.D.**
8. Cell Biology: A Laboratory Handbook- **Celies, J.E.**

List of Practical:

1. To perform ELISA.
2. To perform single radial immunodiffusion (Mancini's technique) using antigen and antibody.
3. To perform precipitation test
   a). Ring test
   b). Slide test
   in solution given an antigen and antibody.
4. Determination of titer if antisera.
5. To perform immunoelectrophoresis.
6. Purification of antigen and immunoglobulins.

COURSE: B.SC.BT302
BASICS OF RECOMBINANT DNA TECHNOLOGY

L	T	P	C
3	0	1	4

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

Instructions for setting end semester examination question paper:

The examiner will set nine questions in all. Q.No. 1 will be compulsory, objective type and covering entire syllabus. There will be 2 questions from each unit and each question will have 3-4 parts. Students will attempt one question from each unit including compulsory question and each question will carry 8 marks.

Unit-I

Introduction, Historical Enzymes Restriction enzymes, Ligases, DNA polymerase, kinases, Reverse transcriptase, Endonucleases, Phosphatase.

Unit-II

Vectors: Plasmid, Cosmids, Lambda, Vectors (Intentional and Replacement vectors) M-13, Phagemids

Unit-III

Radioactive and non-radioactive DNA and RNA labelling techniques: Nick translation, random priming, Sequencing

Unit-IV

Southern and Northern blotting, hybridization
Introduction to site directed mutagenesis
PCR and its Applications
Transformation of *E.coli* Yeast, animal and plant cells, Genomic cloning, cDNA cloning and colony hybridization.
Application of rDNA technology to medicine, agriculture and environment.

Recommended Books:

1. Molecular cloning: A Laboratory Manual- **J.Sambrook, E.F. Fritsch and T.Maniatis**
2. Principles of Gene Manipulation: An introduction to Genetic Engineering- **R.W. Old and S.B. Primrose**
3. Gene Probes I.A. Practical Approach- **B.D.Hames and S.J.Higginis**
4. Recombinant Gene Expression Protocols- **Tuan Rockey S**
5. PCR Cloning Protocols- **White Bruce A**

List of Practical:

1. DNA isolation from plants
2. DNA isolation from E.coli
3. Spectrophotometer analysis of DNA
4. Agarose gel electrophoresis of DNA
5. Plasmid DNA isolation
6. Restriction digestion of DNA
7. Southern Blotting
8. Making competent cells
9. Transformation of competent cells.

COURSE: B.SC.BT401
INSTRUMENTAL METHODS AND ANALYSIS

L	T	P	C
3	0	1	4

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

Instructions for setting end semester examination question paper:

The examiner will set nine questions in all. Q.No. 1 will be compulsory, objective type and covering entire syllabus. There will be 2 questions from each unit and each question will have 3-4 parts. Students will attempt one question from each unit including compulsory question and each question will carry 8 marks.

Unit I

Centrifugation: Principle, types, application
Electrophoresis: Principle, types, application
PCR techniques and DNA isolation

Unit II

Spectrophotometry (UV & Visible) and spectroflourimetry, Atomic absorption spectrophotometry Infrared and Raman spectroscopy, ORD and circular dichroism, Nuclear magnetic Resonance and Electron Spin Resonance spectroscopy, Magnetic Resonance Imaging.
Concepts of microscopy-sections

Unit III

Crystallography and X-Ray diffraction, Electron diffraction, Neutron diffraction.

Unit IV

Radioisotope techniques: radiotracers GM Counter, Proportional and Scintillation counters, autoradiography, Mass spectrometry-GCMS and LCMS.

Recommended Books:

1. Principles and Techniques of Practical Biochemistry- **Keith Wilson & John Walker (Eds.)**
2. Spectroscopy of Biological Molecules: Modern Trends- **P. Carmona, R. Navarro, A. Hernanz (Eds.)**
3. Molecular Fluorescence: Principles and Application- **Bernard Valeur**
4. Protein NMR for the Millennium (Biological Magnetic Resonance)- **N. Rama Krishna, Lawrence J. Berliner (Eds.)**

List of Practical:

1. Verification of Beer – Lambert Law by Biuret Method.
2. To perform salting out for partial purification of protein(s) in a given mixture.
3. Preparation of serum by centrifugation.
4. To separate a mixture of amino acids by Ascending Paper Chromatography.
5. To separate a mixture of amino acids by Thin Layer Chromatography.
6. Agarose Gel electrophoresis of DNA.
7. SDS-PAGE of proteins.
8. Polymerase Chain reaction.
9. Sandwich ELISA.
10. To check the purity of DNA by UV Spectrophotometry

COURSE: B.SC.BT402
INTRODUCTION TO BIOINFORMATICS

L	T	P	C
3	0	1	4

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

Instructions for setting end semester examination question paper:

The examiner will set nine questions in all. Q.No. 1 will be compulsory, objective type and covering entire syllabus. There will be 2 questions from each unit and each question will have 3-4 parts. Students will attempt one question from each unit including compulsory question and each question will carry 8 marks.

UNIT I

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

Protein Information Sources, PDB, SWISSPROT, TREMBL, Understanding the structure of each source and using it on the web.
Introduction of Data Generating Techniques, Restriction Enzymes, Gel Electrophoresis, Chromatograms, Blots, PCR, Microarrays, Mass Spectrometry, What data each generates and what Bioinformatics problems they pose.

UNIT III

Sequence and Phylogeny analysis, Detecting Open Reading Frames, Outline of sequence Assembly, Mutation Matrices, Pairwise Alignments, Introduction to BLAST, using it on the web, Interpreting results, Multiple Sequence Alignment Phylogenetic Analysis.
Searching Databases: SRS, Entrez, Sequence Similarity Searches-BLST, FASTA, DATA Submission**.**

UNIT IV

Protein Structure: Protein structure classification, Structure Analysis, Secondary structure prediction methods, Comparative modeling
Genome Annotation: Pattern and repeat finding, Gene identification tools.

Suggested books:

1. Bioinformatics: The Machine Learning Approach-**Pierre Baldi and Soren Brunak**
2. Bioinformatics: A practical guide to the analysis of genes and proteins- **Baxvanis (Ed.)**
3. Bioinformatics online (Methods in Enzymology V. 266 Computer methods for macromolecular sequence)- **Doolittle (Ed.)**
4. Molecular Evolution: a phylogenetic approach, -**Page, ROM and Holmas EC**
5. Bioinformatics: Sequences, structure and databanks-**Des Higgins and Willie Taylor**

List of Practical:

1. Sequence information resource
2. Understanding and using on web:
3. EMBL, Genbank, Entrez,Unigene, Protein information resource
4. Understanding and using on web:
5. PDB, Swissprot, TrEMBL
6. Using BLAST and interpretation of results.
7. Multiple sequence alignment using Clustal W
8. PAGE

COURSE: B.SC.BT403
FERMENTATION TECHNOLOGY

L	T	P	C
3	0	1	4

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

Theory: 36 Credit Hours (9 Credit Hours/Unit)
Practical: 12 Credit Hours

Instructions for setting end semester examination question paper

The examiner will set nine questions in all. Q. No. 1 will be compulsory, objective type and shall cover entire syllabus. There will be 2 questions from each unit and each question will have 3-4 parts. Students will attempt one question from each of the units including compulsory question. All questions will carry equal (8 marks) marks.

UNIT I

Fermentation

Definition and scope of fermentation, Biochemical basis and overview of products based on enzyme catalysis and cell metabolism, Basic design and operation of fermenter, Economics of fermentation processes.

UNIT II

Solid state fermentation

Advantages and disadvantages of solid state fermentation, effect of environmental parameters on kinetics and growth of product formation and cellular physiology, Process variables and process control, Principles of solid state bioreactor design and operation and product leaching, Integrated process analysis of a few bio-process technology products like baker's yeast and enzymes.

UNIT III

Bio-process technology

Bio-process technology for the production of recombinant vaccines, therapeutic proteins, antibiotics and diagnostics; Energy forming bio-processes for the production of liquid fuel (ethanol), and gaseous fuel (methane), Microbial production of hydrogen.

UNIT IV

Advanced control strategies

Monitoring and control of environmental parameters in fermentation process, enzyme and microbial cell based bio-sensors.

List of books:

1. Biochemical Engineering - Aiba and Hemphery
2. Principles of Microbes and Cell Cultivation - S. John Pirt
4. Industrial Microbiology - L. E. Casida
4. Industrial Microbiology - Prescott and Dunn
5. Principles of Fermentation Technology - P. F. Stanbury and A. Whitaker

List of practicals:

1. Basic design of a laboratory fermenter.
2. Cleaning and sterilization of fermenter vessel.
3. Determination growth curve in a batch culture.

4. Determination of viability of cells in a yeast culture by Methylene Blue staining, Plate count and Haemocytometer methods
5. Production of Ethanol by simple/complex carbohydrate sources (media) using *Saccharomyces cerevisiae.*
6. Production of wine from apple / grape juice by Saccharomyces cerevisiae.
7. Production of citric acid by solid-state-fermentation using *Aspergillus niger.*

COURSE: B.SC.BT501
ANIMAL CELL CULTURE

L	T	P	C
3	0	1	4

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

Instructions for setting end semester examination question paper:

The examiner will set nine questions in all. Q.No. 1 will be compulsory, objective type and covering entire syllabus. There will be 2 questions from each unit and each question will have 3-4 parts. Students will attempt one question from each unit including compulsory question and each question will carry 8 marks.

Unit-I

History of development of cell cultures, the natural surroundings of animal cells, stimulating natural conditions for animal cells, metabolic capabilities of animal cells.

Sterilization techniques: Aseptic techniques in animal tissue culture; sterilization of culture media, glassware and tissue culture laboratory, detection of contamination, safety considerations in ATC laboratory.

Unit-II

Animal Cell Culture Techniques: Dispersion and disruption of tissues; primary cultures, anchorage and non-anchorage dependent cells; secondary cultures, transformed animal cells, established/continuous cell lines; measurement of growth and viability of cells in culture, tissue culture media: Components their importance. Serum free media.

Unit-III

Commonly used animal cell lines, their origin and characteristic, growth kinetics of cells in culture, differentiation of cells, organ culture, expressing cloned protein genes in animal cell cultures.

Applications: Cell fusion and production of monoclonal antibodies; scale up methods for propagation of anchorage dependent and suspension cell culture; Bioreactors for large scale culture of cells, micro carrier culture, transplanting cultured cells.

Unit-IV

Genetic Engineering in animal cells: Transformation of animal cells, vectors and expression vectors, Genetic Engineering in production or regulatory proteins, blood products, vaccines and hormones, Transgenic animals and production of useful products in transgenic animals.

In vitro fertilization, embryo transfer, cloning: methodology and its applications, ethics in cloning.

Recommended Books:

1. Mammalian Cell Biotechnology – A Practical Approach- **Butler, M.**
2. Culture of Animal Cells- **Freshney, R. T.**
3. Human Cell Culture Protocols- **Gareth, E.J.**
4. The Animal Cell Culture and Technology- **Butler, M.**
5. Cell Biology-A Laboratory hand books- **Julio, E., Celis**
6. Gene Therapeutics- **Wolff, J.E.D.**
7. Genes in Medicine- **Rasko, I., and Downes, C.S.**
8. Molecular Biotechnology Therapeutic Application and Strategies- **Maulik S. and Patel, S.D.**
9. Mammalian Cell Biotechnology. A practical approach- **Butler, M.C.**
10. Culture of Animal Cells- **Freshney, R.T.**

List of Practical:

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. Isolation of rat macrophages from peritoneum for culturing
7. Primary Lymphoid culture
8. DNA isolation from animal tissue
9. Quantification of isolated DNA
10. Resolving DNA on Agarose Gel.

COURSE: B.SC.BT502
PLANT CELL CULTURE

L	T	P	C
3	0	1	4

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

Instructions for setting end semester examination question paper:

The examiner will set nine questions in all. Q.No. 1 will be compulsory, objective type and covering entire syllabus. There will be 2 questions from each unit and each question will have 3-4 parts. Students will attempt one question from each unit including compulsory question and each question will carry 8 marks.

Unit-I

Plant nutrition and deficiency symptoms, Plant growth regulators and their physiological functions and role in morphogenesis, plant water relationships.

Unit-II

Culture media, culture techniques
Sterilization techniques: for glassware, tissue and media.

Unit-III

Totipotency, somatic embryogenesis, micropropagation and somaclonal variation.
Protoplast culture and somatic cell hybridization, Induction of haploids and polyploidy through tissue culture, embryo rescue embryo culture, Production of secondary metabolites by plant tissue culture.

Unit-IV

Gene transfer in plant cells their application production of transgenics.

Recommended Books:

1. An introduction of Plant Tissue Culture- **Razdan, M.K.**
2. Plant Cell and Tissue Culture- **Narayanaswamy, S.**
3. Plant Cell Biotechnology- **Rudolf, E.**
4. Plant Tissue Culture theory and practice a Revised edition- **Bhojwani, S.S. and Razdan, M.K.**
5. Plant Cell Tissue and Organ Culture- **Gemborg, O.L. and Phillips, G.C.**

List of Practical:

1. Sources of contamination and decontamination measures.
2. How to clean glass/plastic ware
3. Operational use of an autoclave.
4. Functions and operations of a Laminar Air Flow Hood
5. Preparation of simple growth nutrient (knop's medium), full strength, half strength, solid and liquid.
6. Preparation of complex nutrient medium (Murashige & Skoog's medium)
7. Laboratory design set up for a PTC laboratory.
8. Plugging and sealing of culture vessels.
9. To selection, Prune, sterilize and prepare an explant for culture.
10. Significance of growth hormones in culture medium.
11. To culture different explants for raising callus cultures.
12. To demonstrate various steps of Micropropagation.

COURSE: B.SC.BT503
ENZYMES TECHNOLOGY

L	T	P	C
3	0	1	4

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

Instructions for setting end semester examination question paper:

The examiner will set nine questions in all. Q.No. 1 will be compulsory, objective type and covering entire syllabus. There will be 2 questions from each unit and each question will have 3-4 parts. Students will attempt one question from each unit including compulsory question and each question will carry 8 marks.

Unit-I

Introduction to Enzymology : definition of enzymes. The nature of enzyme molecules. Experimental evidence to the proteion nature of enzymes. Holoenzyme, coenzyme and prosthetic groups, zymogens. Role of metals in enzyme activity. Apoenzyme cofactor association. Nature of active site. Units and international units of enzyme activity. Specific activity and its calculation, turn over number of enzymes. Nomenclature and classification of enzymes. Isoenzyme and multienzyme system,ribozymes.

Purification of enzymes: objectives and strategy in enzyme purification. Judging the success of purification procedure. Criteira of enzyme purity.

Unit-II

Enzyme kinetics: Order of reaction and its improtance in enzymology. Effect of substrate concentration on enzyme catalyes reactions. One –substarte reactions. Michealis-Menten equation. Steady state kinetics. Km and Vmax determination. Introduction to multi-substrate reactions. Effect of enzyme concentration, pH and temperature on enzyme catalysed reactions.

Enzyme catalysis : Transition state theory, role of co-enzymes as a cofactor-NAD/ NADP+, FMN/FAD, coenzymeA, biocytin, cobalamide, lipoamide,TPP, pyridoxal phosphate and tetrahydrofolate, metal ions in enzyme catalysis, covalent catalysis, acid-base catalysis, proximity and orientation effects, strain and distortation theory. Structure and mehanism of chymotrypsin, carboxypeptidases, ribonuclease, lysosyme, glutathione reductase, aconitase and papain.

Unit-III

Enzyme Inhibitions: irreversible and reversible enzyme inhibitions. Competitive, non competitive enzyme inhibitions.Suicide inhibitors.Changes in kinetic parameters by various types of inhibitors.Specific enzyme inhibitors and their mode of action. Side chain specific reagents. Affinity reagents.

Regulation of Enzyme activity: Allosteric enzymes. Control of activity by changes in covalent structure of enzymes.Ligand induced coformational changes in enzymes.Contro of metabolic pathway- General consideration. Amplification of signals. Theories for the control of metabolic pathways.

Unit-IV

Concepts of Bioenergetics: Principles of thermodynamics and their applications in Biochemistry-Introduction, thermodynamic system, thermodynamic state functions, first and second law of thermodynamics, concept of free energy, standard free energy, determination of ΔG for a reaction, relation between equilibrium constant and standard free energy change, Biological standard state and standard free energy change in coupled reactions. Biological oxidation – reduction reactions –introduction, redox potential, relation between standard reduction potentials and free energy change(Derivations and numerical included).High energy phosphate compounds- introduction, phosphate group transfers-free energy of hydrolysis of ATP and sugar phosphates along with reasons for high ΔG.

Suggested books:

1. Fundamentals of Enzymology, 2 edition, By **Nicholas C. Price and Lewis Stevens.**
2. Principle of Enzymology for food science By **J.R.Whitaker, 1972, Marcel Dekkers Inc.,.**
3. Biochemistry- **Stryer, L**
4. Enzyme structure and mechanisms By **Alan Ferst., W.N. Freeman and Company, New York.**
5. Understanding enzymes By **Trevor Palmer Prentice Hall/ Ellis Horwwod 4th Ed., 1995.**

List of Practical:

1. Assay of salivary amylase.
2. Assay of serum phosphotase.
3. Isolation and Purification and assay of invertase.
4. Effect of pH and temperature on enzyme activity.
5. Assay of amylases, proteases.

COURSE: B.SC.BT601
ENVIRONMENTAL BIOTECHNOLOGY

L	T	P	C
3	0	1	4

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

Instructions for setting end semester examination question paper:

The examiner will set nine questions in all. Q.No. 1 will be compulsory, objective type and covering entire syllabus. There will be 2 questions from each unit and each question will have 3-4 parts. Students will attempt one question from each unit including compulsory question and each question will carry 8 marks.

Unit -I

Introduction: Historical importance, Environment pollution and its types, Impact of pollution on health

Unit-II

Introduction to toxicology including genetic toxicology, common assays to detect genetic toxicology, mutagenesis, carcinogenesis, Use of genetic engineering techniques in genetic toxicology.

Unit-III

Biodegradation of organic compounds, Bioremediation, Biosorportion of heavy metals, Waste water treatment, Methanogenesis, Composting, Volatile toxic gases and biofilteration

Unit-IV

Biomining and bioleaching, Biocides, Biosafety levels, Plastic menace, biodegradable plastics, Biofertilizers

Recommended Books:

1. Wastewater Engineering – Treatment, Disposal and Reuse- **Metcalf and Eddy**
2. Comprehensive Biotechnology-**M. Moo-Young.**
3. Environmental Chemistry- **A.K. De**
4. Introduction to Biodeterioration- **D. Allsopp and K.J. Seal**
5. Recombinant Microbes for Industrial and Agricultural Application-**Yoshikatsu M. and Tadayuki, I**.
6. Genetic Control of Environmental Pollutants- **Gilbert S. Omenn and Allexander, H.**
7. Experimental Toxicology-**Anderson, D. & Conning, D.M.**
8. Microbial Degradation of Organic Compunds- **David T.G.**
9. Environmental Biotechnology- **Omenn, G.E.**

List of Practical

1. Detection of coliforms for determination of the purity of potable water.
2. Determination of total dissolved solids of water.
3. Determination of dissolved oxygen concentration of water sample.
4. Determination of biological oxygen demand (BOD) of a sewage sample.
5. Determination of chemical oxygen demand (COD) of sewage sample.
6. Survey of degradative plasmids in microbes growing in polluted environment.

COURSE: B.SC.BT602
BIOPROCESS TECHNOLOGY

L	T	P	C
3	0	1	4

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

Instructions for setting end semester examination question paper:

The examiner will set nine questions in all. Q.No. 1 will be compulsory, objective type and covering entire syllabus. There will be 2 questions from each unit and each question will have 3-4 parts. Students will attempt one question from each unit including compulsory question and each question will carry 8 marks.

Unit-I

Introduction: Fundamental principles of Chemical Engineering and biochemical engineering. Applications of physical and chemical laws on biological samples *e.g.*, light reaction, photolysis of water, enzymatic reaction and simple kinetics.

Unit-II

Microbial Growth Kinetics: Simple kinetics of microbial growth, yield coefficient, doubling time, specific growth rate, substrate inhibition kinetics, product inhibition kinetics, internal and external feed back systems, metabolic and biomass productivities, effect of temperature, pH and inducer on product synthesis.

Sterilization: Introduction air and media sterilizations, design of batch sterilization process, Del factor, sterilization cycle, continuous sterilization process, sterilization of fermenters.

Unit-III

Design of fermenter: Introduction, fermenter for microbial, animal and plant cell culture, Aseptic operation of fermenter, control and measurement equipments of fermenter, pH and D.O. probes, impeller and spargers, batch, fed batch, C.S.T.B.R. plug flow and air loop bioreactors, operation and agitation and its kinetics.

Unit-IV

Down stream processing: Introduction, removal of microbial cells and other solid matters. Foam separation, filtration, industrial filters and its principles, centrifugation and industrial centrifuges, cell disruption, aqueous two phase extraction system, super critical fluid extraction, whole broth processing, effluent treatment, aerobic and anaerobic slug treatment process, fermentation economics.

Recommended Books:

1. Comprehensive Biotechnology, Vol. 104- **Young M.Y.**
2. Environmental Biotechnology- Principles & Applications- **Young M.Y.**
3. Principles of Fermentation Technology- **Stanbury, P.F., Whitaker, A. and Hall, S.J.**
4. Biochemical Engineering Fundamentals- **Bailary, J.E. and Ollis, D.F.**
5. Principles of Microbes and Cell Cultivations- **S.J.Pirt**
6. Bioprocess Engineering: Basic Concepts,-**Shuler, M.L. and Kargi, F.**

List of Practical:

1. Isolation of industrially important microorganisms for microbial processes.
2. Determination of thermal death point (TDP) and thermal death time (TDT) of microorganism for design of a sterilizer.
3. (a) Determination of growth curve of a supplied microorganism and also determine substrate degradation profile.
   (b) Compute specific growth rate (m), growth yield (Yx/s) from the above.
4. Production and estimation of Alkaline Protease.

COURSE: B.SC.BT603
INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS & ENTREPRENEURSHIP

L	T	P	C
3	1		4

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

Instructions for setting end semester examination question paper:

The examiner will set nine questions in all. Q. No. 1 will be compulsory, objective type and covering entire syllabus. There will be 2 questions from each unit and each question will have 3-4 parts. Students will attempt one question from each unit including compulsory question and each question will carry 8 marks.

Unit-I

Introduction to Indian Patent Law. World Trade Organization and its related intellectual property provisions.

Unit-II

Intellectual/Industrial property and its legal protection in research, design and development.

Unit-III

Patenting in Biotechnology, economic, ethical and depository considerations.
Patentable subject matter and legal aspects of transfer of Biotechnology in India. Writing a patent specification.
Information sources in Patent Literature search.

Unit-IV

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.

Recommended Books:

1. Agriculture and Intellectual Property Rights: Economic, Institutional and Implementation Issue in Biotechnology-**V Santaniello, R E Evenson, d Zilberman, G A Carlson**