VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY, BALLARI-583 105

SYLLABUS

FOR

DEPARTMENT OF P.G. STUDIES AND RESEARCH IN

BIOTECHNOLOGY

CHOICE BASED CREDIT SYSTEM

2019-20 & ONWARDS

JNANA SAGARA CAMPUS, VINAYAKANAGARA, CANTONMENT, BALLLARI – 583 105

VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY, BALLARI-583 105

M.Sc. DEGREE COURSE IN BIOTECHNOLOGY

Under CBCS and CAGP

(APPROVED IN BOS-PG MEETING HELD ON 19.01.2019)

REGULATIONS

(w.e.f. 2019-2020)

NAME OF THE DEGREE

Master of Science in Biotechnology: M.Sc. (Biotechnology), (M.Sc. BT).

AIMS OF THE PROGRAM

The M.Sc. (Biotechnology) program in Biotechnology aims at training students in the areas of modern Biotechnology. This program offer specialized curriculum in various modules of Biotechnology such as Bioprocess Technology, Molecular Biotechnology, Food and Industrial Microbiology and Plant and Animal Biotechnology.

The graduates are expected to carry out both basic and applied research in the areas of Biotechnology having academic and/or industrial relevance. The students would also be trained to assist industry in developing and/or solving problems of Biotechnology. In addition, the program also aims at generating manpower capable of teaching Biotechnology at postgraduate and undergraduate level.

M.Sc. BT. 1:

DURATION OF STUDY: The duration of the study for M.Sc. Biotechnology will be of four semesters spread over two years.

Program starting Date

· First Semester: June,
· Second Semester: November,
· Third Semester: June,
· Fourth Semester: November

M.Sc. BT. 2:

ADMISSION REQUIREMENTS:

R. M.Sc. BT. 2.1: To be eligible for the admission in the M.Sc. program, students must have a Bachelor Degree in Science or Bachelor Degree in allied disciplines of the biological sciences with at least 55% admission. However, in case of candidates belonging to SC/ST

and any other groups classified by the Government of Karnataka, the University Regulations governing PG Program shall be applicable for time to time.

M.Sc. BT. 2.2: The calendar of events in respect of the course shall be fixed by the University/Department from time to time.

M.Sc. BT. 2.3: Provision of transfer: As per the University Regulations governing PG Program.

M.Sc. BT. 3:

TOTAL NUMBER OF STUDENTS: Every year 40 students will be given admission as per rules prescribed by the University. The number may vary as per University norms and conditions.

M.Sc. BT. 4:

FEES STRUCTURE: There will be semester wise fees structure. Students who are getting admission in M.Sc. Biotechnology will have to pay fees per semester. The University as per existing norms and regulations would finally decide the fees amount per semester.

M.Sc. BT. 5:
COMPONENTS OF A PROGRAM

M.Sc. BT. 5.1: Each Program shall consist of the following courses: **A**: Hard Core course, **B**: Soft Core course and **C**: Open Elective course.

M.Sc. BT. 5.2: Credits for Hard Core courses: The number of credits allotted to each hard core course shall be 4. And, for each Practicals the credits shall be 2.

M.Sc. BT. 5.3: In each semester there shall be one or more hard core courses. However, the minimum number of credits either for all hard core courses put together shall be 12 credits.

M.Sc. BT. 5.4: Credits for Soft Core Courses: The number of credits allotted to each soft core course shall be 4.

M.Sc. BT. 5.5: Open Elective Course: The number of credits allotted to each open elective course shall be 4.

Open Elective Courses shall be offered during II & III Semester.

M.Sc. BT. 6:

SEMESTERWISE DISTRIBUTION OF MARKS: * 70 Theory + 30 Internal

SEMESTER-I:

4 Papers (100 Marks each*)	: 400
3 Practical	: 150
Total	: **550 Marks**

SEMESTER-II:

5 Papers (100 Marks each*)	: 500
3 Practical	: 150
Total	: **650 Marks**

SEMESTER-III:

5 Papers (100 Marks each*)	: 500
3 Practical	: 150
Total	: **650 Marks**

SEMESTER-IV:

3 Papers (100 Marks each*)	: 300
3 Practical	: 100
Major Project	: 150
Total	: **550 Marks**

Grand Total : 2400

Total marks in entire program: 2400 (96 Credits)

M.Sc. BT. 6.1: A candidate has a provision to go with a normal pace of 24 credits per semester. However, he/she may opt for a slow pace of not less than 20 credits per semester.

M.Sc. BT. 6.2: A candidate has to earn 86 credits for successful completion of M. Sc in Biotechnology. The 96 credits shall be earned by the candidate by studying hard core, soft core, Major Project and open elective courses as specified in the program.

M.Sc. BT. 7:

The medium of instruction shall be English.

M.Sc. BT. 8:

M.Sc. BT. 8.1: ATTENDANCE

Each course shall be taken as a unit for the calculation of attendance. A student shall be considered to have put in the required attendance for the course, if he/she has attended not less than 75% of the number of working hours/periods in each course.

M.Sc. BT. 8.2: A candidate who does not satisfy the requirement of attendance shall not be eligible to take examination of the concerned course.

M.Sc. BT. 8.3: A candidate who fails to satisfy the requirement of attendance in a course shall repeat that course when offered

M.Sc. BT. 8.4: The Department shall display regularly the status of attendance. The list of such candidates who fall short of attendance shall be displayed on the notice board. There will be no individual correspondence made by the University unless otherwise required for a specific reason.

M.Sc. BT. 9:
Candidates for the examination for the degree of Master of Science must have obtained the degree of Bachelor of Science of this University or a Degree recognized as equivalent there to, at least with second class.

M.Sc. BT. 10:
To pass the whole M. Sc. Examination, student should clear all four semesters' examinations within a period of four years, from the date of his admission.

M.Sc. BT. 11:
Subject to the provisions laid down in Ordinance M. Sc 2, a candidate who has passed the M. Sc. semester I & II of this University and if there is a break in the studies for any reason and if there is a change in the courses from semester system to annual part examination system, the candidate will be admitted to M. Sc. Part II and the marks obtained by the candidate in his previous examination of this university in M Sc. semester and II will be carried forward and the result of the M. Sc.

M.Sc. BT. 12:
To pass the M. Sc. degree examination a candidate shall be required to obtain, separately not less than 40% of the total marks obtainable, in (a) each paper, and (b) practicals if any and (c) viva-voce examination, if any.

M.Sc. BT. 13:

REGISTRATION OF CREDIT MATRIX/PATTERN: It is mandatory for every student, to register officially the courses opted under CBCS system in a Registration Card/Form which contains details of hard core, soft core and open elective courses selected for a semester. Details of the registration of the credits are as per the University Regulations governing PG Program.

M.Sc. BT. 14:

ASSESSMENT AND EVALUATION PROCESS
M.Sc. BT. 14.1: Assessment and evaluation processes happen in a continuous mode. However, for reporting purposes, a semester is divided in to 3 discrete components identified as C_1 C_2, & C_3.

M.Sc. BT. 14.2: The evaluation of the candidate shall be based on continuous assessment. The structure for evaluation is as follows.

M.Sc. BT. 14.3: The performance of a candidate in a course will be assessed for a maximum of 100 marks as explained below.

M.Sc. BT. 14.4: The first component (C_1) of assessment is for 10 marks and assignment for 5 marks. This will be based on test. This assessment and score process should be completed after completing 50 percent of syllabus of the course/ and within 45 days of semester program.

M.Sc. BT. 14.5: The second component (C_2) of assessment is for 10 marks and a seminar for 5 marks. This will be based on test. This assessment and score process should be based on completion of remaining 50 percent of syllabus of the courses of the semester.

The total marks secured by the student in the internal examination in a course will be sum of the marks obtained in two written tests (C_1+C_2) and two seminars.

M.Sc. BT. 14.6: Thus Total Marks for each course shall be, Continuous Assessments, Conduct of Examination for a Total of Hundred Marks for each course.

Continuous assessment (C_1)	15 Marks
Continuous assessment (C_2)	15 Marks
Semester end Examination (C_3)	70 Marks
Total Marks	**100 Marks**

M.Sc. BT. 14.7: During the 18th – 20th week of the semester, a semester-end examination of 3 hours duration shall be conducted by the University for each Course. This forms the third/final component of assessment (C_3) and the maximum marks for the final component will be 70.

M.Sc. BT. 14.8: The consolidated marks statement of C_1 & C_2 is submitted to the Registrar (Evaluation) at least 15 days prior to the commencement of semester end examination.

M.Sc. BT. 14.9: Any other regulations applicable as per the University CBCS guidelines amended from time to time.

M.Sc. BT. 15:
Classes shall be awarded at the M Sc degree in the manner specified here in below, namely.

- Successful candidate who obtains not less than 70 percent of the total marks obtainable in the aggregate of the semester I, II, III and IV examinations shall be placed in the **First class with distinction**.

- A successful candidate who obtains less than 70 percent but not less than 60 percent of the total marks obtainable in the aggregate of the semester I, II, III and IV examinations shall be placed in the **first class**.

- A successful candidate who obtains less than 60 percent but not less than 48 percent of the total mark obtainable in the aggregate of the semester I, II, III and IV examinations shall be placed in the **second class**.

Note:

- *There should be one Professor, 2 Associate professor and 3 Assistant professors should be recruited for smooth running of this program.*

- *The syllabus should be upgrade after every two years so that the theory contents and laboratory exercises can be upgraded according to the new developments in the various areas of Biotechnology.*

M.Sc. BT. 16:
If any difficulty arises in the implementation of these regulations (VSK University's CBCS regulations governing the Master of Science in Biotechnology) the regulations governing the PG degree shall be applicable and appropriate clarifications shall be obtained from the competent authorities.

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(Effective from the academic year 2019-2020)

Course outline and Syllabus for Master of Science in BIOTECHNOLOGY (BT)
Under CBCS and CAGP

The Board has framed and approved the Syllabus/Scheme of examination of Choice Based Credit Based System (CBCS) and recommended for implementation from 2019-20. The following are the core papers and scheme of examination proposed by the Board.

1. M.Sc, Degree in Biotechnology - I and II Semester
2. M.Sc, Degree in Biotechnology- III and IV Semester

The pattern of matrix for two year Master's Degree Program in Biotechnology:

Sl. No	COURSES	I SEM			II SEM			III SEM			IV SEM			TOTAL		
		C	P	M	C	P	M	C	P	M	C	P	M	C	P	M
1.	HARD CORE (Theory)	12	3	300	12	3	300	12	3	300	14	3	350	48	12	1250
2.	HARD CORE (Practical)	6	3	150	6	3	150	6	3	150	4	2	100	22	11	550
3.	SOFT CORE	4	1	100	4	1	100	4	1	100	4	1	100	16	4	400
4.	OPEN ELECTIVE	-	-	-	4	1	100	4	1	100	-	-	-	08	2	200
	TOTAL	**22**	**7**	**550**	**26**	**8**	**650**	**26**	**8**	**650**	**22**	**6**	**550**	**96**	**29**	**2400**

Where, C- Credits, P-Paper, M- Marks

***The M.Sc. Biotechnology students have to choose open elective papers from other disciplines**

COURSE STRUCTURE AND SCHEME OF EXAMINATION

M.Sc. DEGREE IN BIOTECHNOLOGY

Semester	Code	Title of the paper	Semester exam	IA	Total	Credits
First		**Hard Core**				
	BT-HCT 1.1	Biomolecules and Metabolism	70	30	100	4
	BT-HCT 1.2	Molecular biology	70	30	100	4
	BT-HCT 1.3	General Microbiology	70	30	100	4
		Soft core (any one)				
	BT-SCT 1.1	Biochemical analysis and Techniques	70	30	100	4
	BT-SCT 1.2	IPR and Biosaftey	70	30	100	4
		Practicals				
	BT-HCP 1.1	Practicals Based on HCT 1.1	35	15	50	2
	BT-HCP 1.2	Practicals Based on HCT 1.2	35	15	50	2
	BT-HCP 1.3	Practicals Based on HCT 1.3	35	15	50	2
		Total for First semester	**385**	**165**	**550**	**22**

Semester	Code	Title of the paper	Semester exam	IA	Total	Credits
Second		**Hard Core**				
	BT-HCT 2.1	Immunology	70	30	100	4
	BT-HCT 2.2	Genetic engineering	70	30	100	4
	BT-HCT 2.3	Cell biology	70	30	100	4
		Soft core (any one)				
	BT-SCT 2.1	Bioinformatics and Biostatistics	70	30	100	4
	BT-SCT 2.2	Food Biotechnology	70	30	100	4
		Open Elective (any one)				
	BT-OET 2.1	Introduction to Biotechnology	70	30	100	4
	BT-OET 2.2	Environmental Biotechnology	70	30	100	4
		Practicals				
	BT-HCP 2.1	Practicals Based on HCT 2.1	35	15	50	2
	BT-HCP 2.2	Practicals Based on HCT 2.2	35	15	50	2
	BT-HCP 2.3	Practicals Based on HCT 2.3	35	15	50	2
		Total for Second semester	**455**	**195**	**650**	**26**

4 Credits of Theory= per week 4 Hours of Teaching; 2 Credits of Practicals= 4 Hours per week

Note:

1. All hard core papers are **compulsory** for all the students.
2. The students have to select **one** of the two soft core papers.
3. Open elective / cross border-papers are for the other than biotechnology students. Students have to opt one of the two open elective papers. However for the operationlization of such paper, a minimum of ten students are required to opt such a paper

Semester	Code	Title of the paper	Semester exam	IA	Total	Credits
Third		**Hard Core**				
	BT-HCT 3.1	Animal Biotechnology	70	30	100	4
	BT-HCT 3.2	Plant Biotechnology	70	30	100	4
	BT-HCT 3.3	Enzyme technology	70	30	100	4
		Soft core (any one)				
	BT-SCT 3.1	Environmental Biotechnology	70	30	100	4
	BT-SCT 3.2	Techniques in Microbial Biotechnology	70	30	100	4
		Open Elective (any one)				
	BT-OET 3.1	r-DNA technology	70	30	100	4
	BT-OET 3.2	Nanobiotechnology	70	30	100	4
		Practicals				
	BT-HCP 3.1	Practicals Based on HCT 3.1	35	15	50	2
	BT-HCP 3.2	Practicals Based on HCT 3.2	35	15	50	2
	BT-HCP 3.3	Practicals Based on HCT 3.3	35	15	50	2
		Total for Third semester	**455**	**195**	**650**	**26**

Semester	Code	Title of the paper	Semester exam	IA	Total	Credits
Fourth		**Hard Core**				
	BT-HCT 4.1	Bioprocess engineering	70	30	100	4
	BT-HCT 4.2	Medical Biotechnology and Nanobiotechnology	70	30	100	4
		Soft core (any one)				
	BT-SCT 4.1	Research Methodology	70	30	100	4
	BT-SCT 4.2	Genomics and Proteomics	70	30	100	4
		Practicals				
	BT-HCP 4.1	Practicals Based on HCT 4.1	35	15	50	2
	BT-HCP 4.2	Practicals Based on HCT 4.2	35	15	50	2
		Major Project				
	BT-HCMP 4.3	Project dissertation (100 marks)+ Viva voce (25 marks)+ Internal assessment (25 marks)= 150	125	25	150	6
		Total for Fourth semester	**400**	**150**	**550**	**22**
				Grand Total marks and Credits	**2400**	**96**

4 Credits of Theory= per week 4 Hours of Teaching; 2 Credits of Practicals= 4 Hours per week

Note:

1. All hard core papers are **compulsory** for all the students.
2. The students have to select **one** of the two soft core papers.
3. Open elective / cross border-papers are for the other than biotechnology students. Students have to opt one of the two open elective papers. However for the operationlization of such paper, a minimum of ten students are required to opt such a paper.

THEORY AND PRACTICAL QUESTION PAPER FORMAT FOR CBCS SEMESTER EXAMINATION

I/II/III/IV Semester M.Sc. Examination, December/May/June 2019-20

BIOTECHNOLOGY (CBCS)

Paper Code (HCT/SCT/OET …….): Course Title

Time: 3 Hours **Max. Marks: 70**

SECTION-A

I. Write a short note any **Five** of the followings: (05x03=15)

1.
2.
3.
4.
5.
6.
7.

SECTION-B

II. Answer any **Five** of the followings: (05x05=25)

8.
9.
10.
11.
12.
13.
14.

SECTION-C

III. Answer any **Two** of the followings: (15x02=30)

15.
16.
17.
18.

SCHEME FOR PRACTICAL EXAMINATION

I. Major experiment for performance and report writing

----12 Marks

II. Minor experiment for performance or for Principle, procedure and interpretation writing

----08 Marks

III. Identify and comment on spotters (**a and b**)

----2.5x2=5 Marks

IV. Record

----05 Marks

V. Viva-voce **----05Marks**

DEPARTMENT OF P.G. STUDIES AND RESEARCH IN BIOTECHNOLOGY

FIRST SEMESTER

BT-HCT 1.1 BIOMOLECULES AND METABOLISM (4 Credits)
52 Hrs

Preamble:

- *A major goal of biochemistry is to study the cellular processes of living organisms and how these processes relate to the functioning of the organism.*
- *And to provide elementary knowledge/overview of structure, functions and metabolism of biomolecules.*

Unit – I (**13 Hrs)**

Chemical foundations of Biology: pH, pK, acids, bases, buffers, weak bonds and covalent bonds. Carbohydrates: Classification, stereochemistry, general reactions, polysaccharides: structure, function - relation (e.g. Starch and cellulose). Carbohydrate metabolism: Glycolysis, Glycogenolysis, glycogenesis, gluconeogenesis, HMP shunt path way and their regulation. Tricarboxylic acid (TCA) cycle, Glyoxylate cycle and its significance.

Unit-II (**15 Hrs)**

Amino acids: Classification, structure and physico-chemical properties. Amino acids - deamination, transamination, transdeamination, decarboxylation, urea cycle, ketogenic and glucogenic amino acids. Metabolism of aromatic amino acids, histidine, cysteine and serine. Peptide bonds, conformational properties of polypeptides: primary, secondary, tertiary and quaternary structures. Globular and fibrous proteins. Protein structure: α-keratin, silk fibroin, Myoglobin, collagen, hemoglobin. Protein folding: denaturation, effects of temperature and solvent on the thermodynamics of protein folding and unfolding equilibrium.

Lipids: classification, structure and properties of fatty acids, triglycerides, phospholipids, sphingolipids and cholesterol.

Unit – III (**14 Hrs)**

Nucleic acid chemistry: bases, base-pairing rules, Watson-Crick model of DNA, Properties of DNA-denaturation, renaturation, melting temperature, hyperchromicity, different structural forms of DNA. Different types of RNAs, general chemical reactions of RNA and DNA. Nucleic acid metabolism: Biosynthesis - de novo and salvage pathways, catabolism of purines and pyrimidines. Classification, structure and physiological roles of Vitamins

Unit – IV (**10 Hrs)**

Enzyme catalysis: general principles of catalysis; Quantitation of enzyme activity and efficiency; Enzyme characterization and Michaelis-Menten kinetics; Relevance of enzymes in metabolic regulation, activation, inhibition and covalent modification; Single substrate enzymes

BOOKS RECOMMENDED:

1. Principles of Biochemistry by A.L.Lehninger, 2 Ed. (worth), 2015
2. Lehninger Principles of Biochemistry by Nelson, D and Cox, D. Macmillon Pub, 2017
3. Biochemistry by L.Stryer 5 Ed. (Freeman-Toppan), 2015
4. Text Book of Biochemistry by West et. al., (Mac Millan), 2012
5. Principles of Biochemistry by Smith et. al., (Mc Graw Hill), 1983
6. Harper's Biochemistry (Langeman), 2018
7. Biochemistry by D.Voet and J.G.Voet (John weily).
8. Enzymes by Palmer (East), 2008
9. Biochemistry by U. Satyanarayana (Books & Allied (P) Ltd), 2008

BT-HCP 1.1 Practicals: (2 Credits)

1. Good laboratory practices and Safety practices.
2. Qualitative and Quantitative analysis of Carbohydrates.
3. Qualitative and Quantitative analysis of Proteins.
4. Qualitative and Quantitative analysis of Amino acids.
5. Qualitative and Quantitative analysis of Nucleic acids.
6. Estimation of sugars by DNS method.
7. Estimations of proteins by Biuret method.
8. Estimation of ascorbic acid.
9. Determination of Iodine value of oils.
10. Estimation of cholesterol.

BOOKS RECOMMENDED:

1. Hawk's physiological chemistry Ed. by Oser (Mc Graw Hill).
2. Biochemical methods By Sadasivam and Manikam (Wiley Eastern limited).
3. An introduction to practical biochemistry by D.T.Plummer (Mc Graw Hill).
4. Laboratory manual in Biochemistry by J.Jayaraman (Wilety Eastern limited).
5. Biochemistry - a laboratory courses by J.M.Beckar (Academic Press).

BT-HCT 1.2 MOLECULAR BIOLOGY **(4 Credits)**
52 Hrs

Preamble:

- *This course is intended for the student interested in understanding and appreciating common biological topics in the study of the smallest units within biology: molecules and cells.*
- *Molecular biology will help us to make sound decisions in our everyday life that can positively impact our diet and health.*
- *There are thousands of opportunities within the medical, pharmaceutical, agricultural, and industrial fields for a student with a concentrated knowledge of molecular and cellular processes. This course will give you a general introduction of these topics.*

Unit-I **(13 Hrs)**

Genome organization: Organization of bacterial genome; Structure of eukaryotic chromosomes; Role of nuclear matrix in chromosome organization and function; Matrix binding proteins; Heterochromatin and Euchromatin; DNA reassociation kinetics (Cot curve analysis); Repetitive and unique sequences; Satellite DNA; DNA melting and buoyant density; Nucleosome phasing; DNase I hypersensitive regions; DNA methylation & Imprinting.

Unit-II **(13 Hrs)**

DNA Replication; Repair & Recombination: Structure of DNA - A-,B-, Z- and triplex DNA; Electron microscope analysis of DNA structure; Replication initiation, elongation and termination in prokaryotes and eukaryotes; Enzymes and accessory proteins; Fidelity; Replication of single stranded circular DNA; Gene stability and DNA repair- enzymes; Photoreactivation; Nucleotide excision repair; Mismatch correction; SOS repair; Recombination: Homologous and non-homologous; Site specific recombination; Chi sequences in prokaryotes; Gene targeting; Gene disruption; FLP/FRT and Cre/Lox recombination.

Unit-III **(13 Hrs)**

Transcription and Translation: Importance of DNA binding Proteins, RNA polymerase, Mechanism of Transcription in prokaryotes & Eukaryotes, Processing of RNA:- m-RNA processing, 5' capping, 3' polyadenylation, splicing, r-RNA & t- RNA processing.

Genetic code and translation machinery, role of t RNA & ribosome, Mechanism of translation, Post translational modification of proteins such as phosphorylation, adenylation, acylation and glycosylation. Inhibitors of translation

Unit –IV **(13 Hrs)**

Mutations: Oncogenes and Tumor suppressor genes: Nonsense, missense and point mutations; Intragenic and Intergenic suppression; Frameshift mutations; Physical, chemical and biological mutagens; Transposition - Transposable genetic elements in prokaryotes and eukaryotes; Mechanisms of transposition; Role of transposons in mutation; Viral and cellular oncogenes; Tumor suppressor genes from humans; Structure, function and mechanism of action of pRB and p53 tumor suppressor proteins; Activation of oncogenes and dominant negative effect; Suppression of tumor suppressor genes; Oncogenes as transcriptional activators.

BOOKS RECOMMENDED:

1. Robert brooker, 2011. Genetics: analysis and principles, 4 edition, McGraw-Hill.
2. Leland Hartwell, Leroy Hood, Michael Goldberg, Ann Reynolds, Lee Silver, 2010. Genetics: From Genes to Genomes, 4 edition, McGraw Hill.
3. Rastogi Smita and Neelam Pathak., 2010. Genetic engineering, Oxford University press, New Delhi.
4. Karvita B. Ahluwalia., 2010. Genetics. New age international pvt ltd and Publishers, New Delhi.
5. Molecular Biology of Genes. 4th edition by Watson, Hopkins, Roberts, Steitz, Weiner. 2004.
6. The Cell . A molecular approach. 3rd edition by Geoffrey M. Cooper, Robert E. Hausman. 2003.
7. Principles of Genetics. 8th edition by Gardner, Simmons and Snustad. 2002.
8. Human Genetics. Concepts and applications by Lewis, R. 2001.

BT-HCP 1.2 Practicals: (2 Credits)

1. Isolation of DNA from microbial, plant and animal sources.
2. Isolation of plasmid DNA.
3. Estimation of DNA using diphenylamine reagent and by UV spectrophotometry.
4. Estimation of RNA using orcinol reagent and by UV spectrophotometry.
5. Digestion of plasmid DNA with restriction endonucleases.
6. Ligation of DNA fragments.
7. Separation of DNA fragments by Agarose gel electrophoresis.
8. Elution of DNA from agarose gels.
9. Bacterial transformation and identification of transformants.
10. Cloning of green fluorescent protein.
11. Amplification of DNA by PCR.
12. Southern blotting technique.
13. RFLP and RAPD mapping.

BOOKS RECOMMENDED:

1. Biotechnology: A laboratory course by Becker J.M.
2. Molecular Cloning: A laboratory manual Vols. 1-3, Sambrook, J.
3. Lab manual in Biochemistry by J.Jayaraman (Wiley Eastern Limited).
4. Biochemistry – A lab course by J.M.Becker (Academic Press).

BT-HCT 1.3 GENERAL MICROBIOLOGY (4 Credits)

52 Hrs

Preamble:

- *To acquaint the students with history, classification and role of microbiology in agriculture, food and environment.*

Unit-I (**14 Hrs)**

Microbial Taxonomy: systematics, identification: Taxonomical hierarchy species- type strains: culture collections; binomial nomenclature; system of classification- phenetic, numerical taxonomy. General characteristics used in classification- five kingdom, six kingdom and eight kingdom systems. Classification of microbes using DNA analysis, proteins, rRNA analysis and phylogeny.

Unit-II (**10 Hrs)**

Staining methods: Gram, Acid fast, Metachromatic granules, nuclear staining, capsule, silver impregnation, Flagella and other special staining methods. Sterilization and disinfection methods and their quality control. Size, shape, composition and structure of prokaryotic (bacteria, actinomycetes, archaea and blue green algae).

Unit-III (**13 Hrs)**

Size, shape, composition and structure of eukaryotic cells (algae, fungi and protozoans): Nutritional requirements for growth. Growth media and pure culture techniques. Symbiosis, Mutualism, Parasitism, Commensalism and endophyte. Structure of virus and prions. Measurement of growth and enumeration of cells . Techniques of pure culture.

Unit-IV (**15 Hrs)**

Microbial Interactions and Infection: Host–Pathogen interactions; Microbes infecting humans, veterinary animals and plants; Pathogenicity islands and their role in bacterial virulence

Microbes and Environment: Role of microorganisms in natural system and artificial system; Influence of Microbes on the Earth's, Environment and Inhabitants; Ecological impacts of microbes; Symbiosis (Nitrogen fixation and ruminant symbiosis); Microbes and Nutrient cycles; Microbial communication system; Quorum sensing; Microbial fuel cells; Prebiotics and Probiotics; Vaccines.

BOOKS RECOMMENDED:

1. Joanne Willey, 2010. Prescott.s Microbiology, eighth edition, McGraw Hill, Newyork.
2. P.C. Trivedi, S. Pandey, S. Bhadauria, 2010. Text Book of Microbiology, Pointer Publishers, Jaipur, India.
3. Michael J. Pelczar, IR., E;C;S;Chan and Noel R.Kreig., 2004., fifth Ed., 27th reprint. Microbiology, Tata McGRAW . Hill, New Delhi.
4. Presscot, Harley & Klein, 2002, Microbiology, fifth edition, McGraw Hill, Newyork.
5. The microbial world. Stanier, R.Y.et al., Prentice Hall New Delhi, 2008

BT-HCP 1.3 Practicals: (2 Credits)

1. Study of aseptic techniques in Microbiology.
2. Study of Apparatus and Instrumentations use in Microbiology experiments.
3. Microbial culture media and their preparation of various microorganisms.
4. Isolation and Identification of microbes from soil and water samples.
5. Study of growth of a microorganism and growth curve.
6. Study of colony characters of bacteria.
7. Microbial characterization based on biochemical tests.
8. Microbial staining techniques (simple and differential staining, cell wall, endospores, intracellular lipids, acid-fast, flagella, viability)
9. Microbial motility tests by Hanging Drop method
10. Maintenance of microorganisms (stock culture and subculture)
11. Microbiological examination of milk.
12. Studies on symbiotic association of microorganisms.
13. Study of Fungi: *Aspergillus*, *Fusarium*, *Pencillum* and *Candida*

BOOKS RECOMMENDED:

1. Handbook of Microbiological Media by Atlas R.L.
2. Manual of Clinical Microbiology by Lennettee E.H.
3. Manual of Clinical Microbiology by Murray PR.
4. A Laboratory manual of Microbiology: Microbes in action.

BT-SCT 1.1 BIOCHEMICAL ANALYSIS AND TECHNIQUES **(4 Credits)**
52 Hrs

Preamble:

- *This course is introduced to bridge the gap between academics and industry. The number of conventional and modern analytical techniques along with their principle, instrumentation and applications are included in the course.*

Unit-I **(10 Hrs)**

Basic Techniques: Buffers; Methods of cell disintegration; Enzyme assays and controls; Detergents and membrane proteins; Dialysis, Ultrafiltration and other membrane techniques.

Unit-II **(15 Hrs)**

Chromatography: Principle, instrumentation and applications of separation techniques for different biomolecules and applications: Chromatography – paper, TLC, Gel filtration, ion exchange, affinity, HPLC, FPLC and GC.

Electrophoresis: Capillary electrophoresis: Principle and instrumentation. Electrophoresis - gel, agarose-gel, PAGE, SDS-PAGE, Iso-electric focusing. Immuno-electrophoresis and electroblotting and applications.

Unit-III **(14 Hrs)**

Physical techniques in structural analysis of biomolecules and applications: Spectroscopy: principle, instrumentation and application of UV-visible, fluorescent, CD, NMR, ESR spectroscopy, Atomic absorption spectroscopy, Plasma emission spectroscopy, X-ray diffraction, Mass spectroscopy.

Advanced Techniques: Protein crystallization; Theory and methods; API-electrospray and MALDI-TOF; Mass spectrometry; Enzyme and cell immobilization techniques; DNA & Peptide Synthesis.

Unit-IV **(13 Hrs)**

Principle, instrumentation and applications of Centrifugation and ultracentrifugation. Radioisotope techniques - nature of radiation sources, radioactive decay, units of radiation, detection and measurement of radioactivity, GM and scintillation counters and autoradiography. Principles of nanotechnology - Nanostructures, nanoparticles and their properties. Applications. Green synthesis of nanoparticles.

BOOKS RECOMMENDED:

1. Principles of instrumental analysis. Skooge DA., Holler FJ., Crouch SR., Thompson Brooks Publ., 1988
2. Basic concepts of analytical chemistry. Khopkar SM. New Age International Publ. New Delhi, 1998
3. Principles and Techniques of Biochemistry and Molecular Biology, K. Wilson and J. Walker (Eds.) 6th Ed., Cambridge Univ. Press, 2005.
4. D. Holme & H. Peck, Analytical Biochemistry, 3rd Edition, Longman, 1998.
5. R. Scopes, Protein Purification - Principles & Practices, 3rd Edition, Springer Verlag, 1994.
6. Selected readings from Methods in Enzymology, Academic Press.

BT-SCT 1.2 IPR AND BIOSAFTEY

(4 Credits)
52 Hrs

Preamble:

- *This course is will discuss about various aspects of biosafety regulations, IPR and bioethic concerns arising from the commercialization of biotech products.*

Unit-I **(15 Hrs)**

Electromagnetic radiation: Ionizing and non-ionizing radiation. Radiation sources: Natural and artificial sources. Radioactivity: units of radiation, different types of radiation, radioactive decay, half-life, biological half-life and mean life. Radiation detectors and monitors.

Mechanism of direct and indirect action of radiation at cellular level. Nature of radiation damage at molecular, subcellular and cellular level. DNA damage and chromosomal aberrations.Mitotic catastrophe. Radiation damage: Lethal and sublethal damage, Cell survival curves, Effect of different radiation species and radiation dose/dose rate. Radiation effects on important organs of the human body: deterministic and stochastic effects; possible recovery pathways.

Unit-II **(13 Hrs)**

Introduction to Intellectual Property: Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of New GMOs; International framework for the protection of IP.

IP as a factor in R&D: IPs of relevance to Biotechnology and few Case Studies; Introduction to History of GATT, WTO, WIPO and TRIPS

Unit-III **(10 Hrs)**

Basics of Patents: Types of patents; Indian Patent Act 1970; Recent Amendments; Filing of a patent application; Precautions before patenting-disclosure/non-disclosure; WIPO Treaties;

Budapest Treaty; PCT and Implications; Role of a Country Patent Office; Procedure for filing a PCT application.

Unit- IV **(14 Hrs)**

Biosafety: Introduction; Historical Backround; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines - Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartagena Protocol.

BOOKS RECOMMENDED:

1. Radiation Biophysics – EL Alpen, Academic Press, 1997
2. Radiation Biology: Handbook for teachers and Students, IAEA, online
3. Basic and Clinical Radiobiology – Joiner M. and van der Kogel A. (ed) UK, online
4. Sree Krishna, V., 2007. Bioethics and Biosafety in Biotechnology, 1st Ed. New Age International Publishers, New Delhi.
5. Trayror, P.C., Frederic.R. and Koch, M. 2002. Biosafety. Board of Trustees, Michigan State University, USA.
6. Benjamin Lewin, 2000, Genes VII, First edition, Oxford, New York.
7. Paul R.C., 2000.Situations of Human Rights in India. Efficient offset printers.
8. Beauchamp, T.L. and Leroy, W.1999.Contemporary issues in bioethics. Wardsworth publishing Co. Belmont, California.
9. Bishop.M.J and Rawlings, 1987, Nucleic acid and protein sequence analysis, First, IRL Press, England.
10. William, S Klug and Michel, R Cummings, 2003, Concepts of Genetics, Seventh edition, Pearson Education, Singapore.
11. Paul, R.C., 2000.Situations of Human Rights in India, Efficient Offset printers,

Useful Websites:

bioethicsweb.ac.uk/
www.intute.ac.uk/bioethicsweb/
blog.bioethics.net/

SECOND SEMESTER

BT-HCT 2.1 IMMUNOLOGY **(4 Credits)**
52 Hrs

Preamble:

- *The course discusses basic immunology including cellular and molecular processes that represents the human immune system.*
- *Define the central immunological principles and concepts.*
- *And understand the principles of central (antibody-based) immunological methods to an extent that students can set up a theoretical experiment.*

Unit-I **(13 Hrs)**

Histroy and overview of the immune system: Types of immunity - innate, acquired, passive and active, self vs non-self discrimination. Physiology of immune response: HI and CMI specificity and memory. Cells and organs of the immune system . Lymphoid tissue, origin and development. Hematopoiesis, differentiation of lymphocytes.

Unit-II **(13 Hrs)**

Lymphocyte-sub-populations of mouse and man: T and B cells, APC cells, lymphokines, Phagocytic cells, macrophage, dendritic cells, K and NK Cells. Nature and biology of antigens, epitopes, haptens, adjuvents.
Nature of antigens and antibodies. Immunoglobulins- structure, distribution and function, Isotypic, Allotypic and Idiotypic variants, generation of antibody diversity.

Unit-III **(12 Hrs)**

Antigen – antibody interactions: The generation of antibody diversity, antigen receptors on B & T lymphocytes. Major Histocompatibility Complex (MHC). Human leukocyte antigens (HLA), MHC restriction and typing. Lymphokines, effector cell mechanisms, genetic control of immune response.

Complement system, mode of activation, classical and alternate pathway, biological functions of C proteins.

Unit-IV **(14 Hrs)**

Effector mechanisms in immunity: macrophage activation, cell mediated cytotoxicity, cytotoxicity assay. Types of Hypersensitivity, autoimmune diseases, transplantation and immunity, immunity to infectious agents. Tissue transplantation: Types, mechanism and control. Tumour immunology. Vaccines and Vaccination, types of vaccines including new generation vaccines.

Immunological techniques: ELISA, RIA, Western Blot, Immunoblot and Immuno fluorescent techniques. FACS. Hybridoma technology - production and applications of monoclonal antibodies. Antibody engineering, chimeric antibodies.

BOOKS RECOMMENDED:

1. Essentials of Immunology by Roit (ELBS).
2. Immunology by Roit et.al (Harper Row).
3. Text book of Immunology by S.T,Barrot (Mosby).
4. Immunology by Kubay.
5. Principles of Microbiology and Immunology by Davis et.al., (Harper).

BT-HCP 2.1 Practicals: (2 Credits)

1. Determination of A, B, O and Rh blood groups in human beings.
2. WBC counting
3. Identification of various immune cells from human peripheral blood.
4. Lymphocyte separation and identification
5. Determination of lymphocyte viability by trypan blue method
6. Preparation of serum and plasma
7. Ouchterloney double diffusion.
8. Radial immunodiffusion.
9. Quantitative precipitin assay.
10. Immunoelectrophoresis.
11. Latex agglutination test.
12. Enzyme Linked Immunosorbent Assay (ELISA).
13. Western blotting.
14. Diagnostic test for typhoid fever by WIDAL test.
15. VDRL test for syphilis.
16. Pregnancy tests.

BOOKS RECOMMENDED:

1. Hawk's physiological chemistry Ed. by Oser (Mc Graw Hill).
2. Biochemical methods By Sadasivam and Manikam (Wiley Eastern limited).
3. An introduction to practical biochemistry by D.T.Plummer (Mc Graw Hill).
4. Laboratory manual in Biochemistry by J.Jayaraman (Wilety Eastern limited).
5. Biochemistry - a laboratory courses by J.M.Beckar (Academic Press).
6. Immunology methods manual - The comprehensive source book by Lefkovits. I.
7. Manual of clinical laboratory immunology by Rose NR.
8. The experimental foundations of modern immunology by Clark W.R.
9. Laboratory Immunology by Bradshaw LJ.

BT-HCT 2.2 GENETIC ENGINEERING **(4 Credits)**
52 Hrs

Preamble:

- *The aim of this course is to acquaint the students to versatile tools and techniques employed in genetic engineering and recombinant DNA technology.*
- *A sound knowledge on methodological repertoire allows students to innovatively apply these in basic and applied fields of biological research.*
- *This course provides theoretical bases to properties and applications of versatile DNA modifying enzymes, cloning strategies, vector types, host genotype specificities for selection and screening of recombinants and/or recombinant transformants.*

Unit-I **(12 Hrs)**

Isolation of DNA and RNA: Restriction mapping, DNA sequencing by chemical and enzymatic methods. Nucleic acid blotting – southern and northern blotting. DNA cloning. Enzymes used in genetic engineering : Restriction endonucleases - types, nomenclature and properties. DNA polymerase-I, polynucleotide kinase, DNA ligase, terminal nucleotide transferase, Reverse transcriptase, alkaline phosphatase, S1 nuclease.

Unit-II **(14 Hrs)**

Salient features of cloning vectors: types of cloning vectors - plasmids, cosmids, phages (lamda and M13 phages), animal (SV40, Baculo) and plant (CMV) viruses, Artificial chromosomes - YACs and MACs. Ligation of foreign DNA to vectors - cohesive and blunt end methods - homopolymer tailing and adaptors. Preparation of gene libraries and c-DNA libraries.

Techniques of gene transfer: transformation , transfection, micro injection, electroporation, lipofection and biolistics. Selection of r-DNA clones and their expression. Nucleic acid probes, colony and fluorescent in-situ hybridization.

Unit-III **(14 Hrs)**

Nucleic acid hybridization techniques: Molecular probes (Types of probes and its construction); probe labeling. Nick translation, End labeling and Random primer labeling. Polymerase chain reaction and its variants; DNA fingerprinting; DNA sequencing first generation sequencing methods (Maxam and Gilbert sequencing, Sanger's Dideoxy sequencing, Pyrosequencing, PCR based sequencing and hybridization sequencing). Second generation sequencing methods.

Unit-IV **(12 Hrs)**

Site directed mutagenesis; DNA microarray: chromosome walking and jumping. Molecular techniques in prenatal diagnosis gene therapy, Pharmaceutical products (Vaccine, Humulin, etc), Crop improvement. Pesticide resistance, herbicide resistance, transgenic animals and GM foods.

BOOKS RECOMMENDED:

1. Recombinant DNA technology by Watson et. al., (Scientific American Books).
2. Genes-VIII by Benjamin Lewin.(Oxford).
3. Principles of Gene Manipulation by Old and Primrose.(Blackwell).
4. DNA Science by Carolina Publishing Company.
5. From genes to clones by Winneker.
6. From genes to genomes concepts and applications of DNA technology by Jeremy W dale and Malcolm von Scrantz, Weil publications
7. Molecular Biotechnology by Glick.
8. Genetic Engineering by Sandhya Mitra.
9. Genomes by T.A. Brown

BT-HCP 2.2 Practicals: (2 Credits)

1. Preparation of plasmid DNA by alkaline lysis method.
2. Agarose gel electrophoresis
3. Silver staining of gels
4. Methylene blue DNA staining
5. Competent cell preparation
6. Transformation and selection of recombinants.
7. Cloning of fragments in pBR322
8. Insertional inactivation/Blue white screening
9. Determination of molecular weight of DNA.

BOOKS RECOMMENDED:

1. S.J. Vennison. 2009. Laboratory Manual for Genetic Engineering PHI Learning Pvt. Ltd. New Delhi.
2. Aneja.K.R, 2007. Experiments in Microbiology, Plant pathology and Biotechnology, 4th Edition, New Age International Publishers, India.
3. Sue Carson, Dominique Robertson, 2005. Molecular Biology Techniques, Second Edition: A Classroom Laboratory Manual, 2nd Edition, Academic Press.
4. Joe Sambrook, 2001. Molecular Cloning: A Laboratory Manual, Third Edition, Cold Spring Harbor Laboratory Press.

BT-HCT 2.3 CELL BIOLOGY **(4 Credits)**
52 Hrs

Preamble:

- *This course is intended for the student interested in understanding and appreciating common biological topics in the study of the smallest units within biology: cells.*
- *There are thousands of opportunities within the medical, pharmaceutical, agricultural, and industrial fields (just to name a few) for a person with a concentrated knowledge of cellular processes.*
- *In addition to preparing for a diversity of career paths, an understanding of molecular and cell biology will help you make sound decisions in your everyday life that can positively impact your diet and health.*

Unit-I **(13 Hrs)**

Structure of typical bacterial, plant and animal cells and functions of cell organelles: Mechanism of cell division. Ultra structure of plasmamembrane-Components and membrane asymmetry. Transport processes - active transport, ionophores and ion channels. Exo and endocytosis. Phago and pinocytosis.

Unit-II **(13 Hrs)**

Principle and applications of Light: (Phase contrast, differential interference contrast, fluorescence, Confocal) and Electron Microscopy. General morphology and functions of endoplasmic reticulum. Signal hypothesis. Ribosomes - eukaryotic and prokaryotic. Ribosomal proteins. Role of Golgi in protein secretion. Lysosomes and peroxisomes. Cytoskelatal elements. Cell – cell interaction.

Unit-III **(11 Hrs)**

Structure, organization and types of eukaryotic chromosomes: Heterochromatin, euchromatin, telomeres, types of chromosomes, polytene chromosomes and lampbrush chromosomes. Chromosome dynamics during cell division. Cell cycle – Molecular events including cell cycle check points and Cdk–cyclin complexes and their role in cell cycle regulation. Apoptosis.

Unit-IV **(15 Hrs)**

Organic evolution: Origin of life. Species concept, population, dones, races, and subspecies. Mechanisms of speciation. Role of isolating mechanisms. Lamarckism, Darwinism, Neo-Darwinism, synthetic theory of evolution. Micro, macro and mega evolution, sequential and divergent evolution. Natural selection.

BOOKS RECOMMENDED:

1. Molecular Biology of the Cell by B.Alberts et.al (Garland publications incorporation.)
2. The Cell. A Molecular Approach. Cooper, G.M. Sunderland: Sinauer Associates, Inc., 2000
3. Molecular Cell Biology, J. Darnell et. al (Scientific American Books) .
4. Cell Biology by N.O.Thorpe (John wiley & sons).
5. Organic Evolution by Rastogi.
6. Principles of organic evolution by J.L.Stebbins (Prentic Hall).

BT-HCP 2.3 Practicals: **(2 Credits)**

1. Mitosis in onion root tip cells: All phases (Squash method).
2. Meiosis in onion flower buds: All phases including zygotene, diplotene and diakinesis of prophase I (Smear method).
3. Preparation of mitotic chromosomes and karyotyping.
4. Staining techniques: Staining blood cells, total count and differential count.
5. Histology and differential staining (cellular organelles and components).
6. Isolation of RNA and DNA.
7. Estimation of RNA and DNA.

BOOKS RECOMMENDED:

1. Cell and Molecular Biology. Concepts and experiments. Karp, G., John Harris, D., Wiley & sons, 1999.
2. Principles of Cell and Molecular Biology. Kleinsmith, L. J. & Kish, V.M., Harper Collins Publishers, 1995

BT-SCT 2.1 BIOINFORMATICS AND BIOSTATISTICS (4 Credits)
52 Hrs

Preamble:

- *Making students with basic knowledge in computers and mathematics to acquire comprehensive knowledge about the role of computers and applications of statistics for understanding the developments in the fields of life science and to make further advancements in the field of biological research.*

Unit-I **(13 Hrs)**

Scope of computers in current biological research: Basic operations, architecture of computer. Introduction of digital computers. Organization, low level and high level languages, binary number system. The soft side of the computer – Different operating systems – Windows, Linux. Introduction of programming in C. Introduction to Internet and its applications.

Unit-II **(11 Hrs)**

Bioinformatics: Online tools and offline tools. Biological databases. Types of data bases – Gen bank, Swiss port, EMBL, NCBL, and PDB. Database searching using BLAST and FASTA.

Unit-III **(15 Hrs)**

Multiple sequence alignment and Dynamic programming: Gene and Genome annotation – Tools used. Physical map of genomes. Molecular phylogeny - Concept methods of tree construction. Protein secondary structure prediction. Protein 3D structure prediction. Protein docking. Introduction to homology modeling, Computer Aided Drug Design (CADD) in Drug discovery.

Unit-IV **(13 Hrs)**

Brief description and tabulation of data and its graphical representation: Measures of central tendency and dispersion - mean, median, mode, range, standard deviation, variance. Simple linear regression and correlation. Types of errors and level of significance. Tests of significance – F & t-tests, chi-square tests, ANOVA.

BOOKS RECOMMENDED:

1. Bioinformatics – D.Mount
2. Programming in C by Balaguru Swamy.
3. Introduction to Bioinformatics by Arthur M.Lesk, Oxford.
4. Biostatistics – Daniel. (Wiley).
5. Statistics by S.C.Gupta.
6. Statistical Methods by G.W.Snedecor & W.G.Cochran.
7. Fundamentals of Biostatistics – Khan & Khanum.
8. Let us C – Kanetkar.
9. Fundamentals of Biostatistics by U.B.Rastogi (Ame Books Ltd).

BT-SCT 2.2 FOOD BIOTECHNOLOGY **(4 Credits)**
52 Hrs

Preamble:

- *This course will educating students about the relationship of foods with microbes and its positive and negative roles in food processing, production and preservation in order to keep/ produce safe foods needed for a healthy society.*

Unit- I **(13 Hrs)**

Food and microbes: Basics of food and feed**,** Types and Classification of food. Microbes involved in food spoilage. Food preservation – Physical and Chemical and biological methods. Food packaging. Merits and drawbacks of different methods of food preservation.

Unit- II **(13 Hrs)**

Fermented foods: Food and beverage fermentation: of cabbage, soybean (miso, soyu, natto, sofu), milk (kumiss, yoghurt, kefir), fish and meat. Pre- and pro-biotic microorganism: GRAS microorganism. Industrial production of alcohols and organic acids (acetic acid, citric acid and lactic acid) and SCP. Starter culture.

Unit- III **(13 Hrs)**

Commercialization of fermented food: Commercialization of fermented food. Benefits of fermented food products; Nutritional values and safety aspects. Enzymes in food processing industries. Immobilized enzymes and their applications. Genetic improvement of industrially important micro organism.

Unit- IV **(13 Hrs)**

Bioreactor: types, structure and design. Automation in bioreactor. Bioreactor for animal cell culture.
Food ethics: Food safety and food laws. Food regulatory bodies

BOOKS RECOMMENDED:

1. Bisen P.S (1994) Frontiers in Microbial Technology, 1st Edition, CBS Publishers.
2. Glaser A.N and Nilaido.H (1995) Microbial Biotechnology, W.H Freeman and Co.
3. Prescott and Dunn (1987) Industrial Microbiology 4th Edition, CBS Publishers & Distributors. Prescott and Dunn (2002) Industrial Microbiology, Agrobios (India) Publishers.
4. Crueger W. and Crueger A. (2000) A Text of Industrial Microbiology, 2nd Edition, Panima Publishing Corp.
5. Stanbury P.F, Ehitaker H, Hall S.J (1997). Priciples of Fermentation Technology, Aditya Books (P) Ltd.
6. Adams and Moss Food Microbiology 8. Fraizer and Werthoff Food Microbiology –
7. Joshi and Pandey.Food Fermentation – Microbiology, Biochemistry & Technology, Vol. I & II.

BT-OET 2.1 INTRODUCTION TO BIOTECHNOLOGY (4 Credits)
52 Hrs

Preamble:

- *To familiarize the students with the fundamental principles of Biotechnology, various developments in Biotechnology and its potential applications.*

Unit-I **(13 Hrs)**

History & Introduction to Biotechnology: What is Biotechnology? Traditional and Modern Biotechnology, Overview of Branches of Biotechnology: Plant, Animal Biotechnology, Marine Biotechnology, Agriculture, Healthcare, Industrial Biotechnology, Pharmaceutical Biotechnology, Environmental Biotechnology. Overview of Biotechnology Research in India. Overview of Biotechnology Institutions in India (Public and Private Sector) Biotech Success Stories.

Unit –II **(13 Hrs)**

Overview of Applications of Biotechnology in Agriculture: GM Food, GM Papaya, GM Tomato, Fungal and Insect Resistant Plants, BT Crops, BT Cotton and BT Brinjal, Pros and Cons.

Unit –III **(13 Hrs)**

Overview of Biotechnological applications in enhancement of Food Quality: Quality Factors in Pre-processed Food, Microbial role in food products (Yeast and Bacterial based process and products).

Unit –IV **(13 Hrs)**

Fermentation Biotechnology: Definition, Applications of Fermentation Technology Microbial Fermentations Overview of Industrial Production of Chemicals (Acetic Acid), Antibiotic (Penicillin), Enzymes (L-Asparaginase) and Beverages (Beer and Ethanol).

BOOKS RECOMMENDED:

1. McGregor, C.W.; Membrane separation in Biotechnology; Marcel Dekker, Inc, New York. Frieferder, S.; Physical Biochemistry; Freeman and Co., New York.
2. Biotol Series (I - IV); Techniques used in Bioproduct Analysis; Buterworth Heineman,U.K.
3. Work, T.S.; Lab. Techniques in Biochemistry and Molecular Biology, Elsevier, New York.
4. Microbiology: Michael J. Pelczar Jr., E. C. S Chan, Noel R. Krieg.

BT-OET 2.2 ENVIRONMENTAL BIOTECHNOLOGY **(4 Credits)**
52 Hrs

Preamble:

- *This course presents an objective view of the application of biotechnological know-hows in tackling environmental problems. It starts with basic knowledge about molecular biology and later links to application based processes and techniques.*

Unit-I **(13 Hrs)**

Environment and monitoring: Introduction, renewable and non-renewable sources of energy; Environmental pollution- water pollution, soil pollution and air pollution-sources. Xenobiotic compounds and their sources, Biomagnifications, Bioindicators.

Biomining and Biodiesel: Bioleaching of ores to retrieve scarce metals, Bio-mining; Biodiesel production from Jatropa, Pongamia and Castor.

Unit-II **(13 Hrs)**

Bioremediation: Concept and principles, Bioremediation using microbes, *In situ* and *ex situ* bioremediation, biosorption and bioaccumulation of heavy metals; Phytoremediation, bioremediation of xenobiotics (heavy metals, pesticides, oil slicks, plastic). Bioremediation of soil and water contaminated with hydrocarbons and surfactants, biofilms.

Unit-III **(14 Hrs)**

Water Management and waste water treatment: Water as a scarce natural resource, water management including rain water harvesting. Waste water characteristics, waste water treatment-physical, chemical, biological processes. Aerobic processes; Activated sludge, oxidation ditches, trickling filter, oxidation ponds; anaerobic processes; anaerobic digestion, anaerobic filters, anaerobic sludge, membrane bioreactors. Reverse osmosis and ultra filtration. Treatment of industrial effluents.

Unit-IV **(12 Hrs)**

Global environmental problems: Global warming, ozone depletion, UV-B, green house effect and acid rain, their impact and management. Biodiversity and its conservation, status of biodiversity, hotspots, Red data book.

BOOKS RECOMMENDED:

1. Biotechnology by B.D.Singh (Kalyani).
2. Ecology and Environment by PD Sharma.
3. Fundamentals of Ecology, by Odum, EP (Mc Graw Hill)
4. Environmental Biotechnology by Forster, C.F. and Wase D.A.J. (Ellis Horwood).
5. Biotechnological innovations in environmental management by Leach, CK and Van Dam-
6. Mieras, MCE (Butterworth-Herinemann, Oxford (Biotol Series).

THIRD SEMESTER

BT-HCT 3.1 ANIMAL BIOTECHNOLOGY **(4 Credits)**
52 Hrs

Preamble:

- *The course is designed to give students a perspective on recent advances in Animal Biotechnology.*
- *Students will get familiarized with the different approaches to generate transgenic animals for various applications.*
- *The concept of transfer of new genes in animal cells and animal cloning along with gene therapy and its significance will be imparted to the students.*

Unit-I **(13 Hrs)**

Animal tissue culture: history of animal cell culture, advantages and limitations of cell culture, biology of cultured cell (cell adhesion, proliferation and differentiation), basic requirements for animal cell culture (design and layout of cell culture room, equipments), culture media(properties), balanced salt solution, serum and serum free medium, primary culture, secondary culture. Cell lines, stem cells, cloning crypreservation, organotypic culture.

Culturing of specialized cells: crypreservation organotypic culture. Epithelial, mesenchymal, Neuro, ectodermal, hematopoietic, gonad and tumour cells, lymphocyte preparation. culture of amniocytes, stem cell culture, types characterization and its applications.

Unit-II **(13 Hrs)**

Types and causes of male and female infertility: sperm collection, Cryopreservation, artificial insemination, Oocyte recovery, superovulation, oocyte maturation *in vitro*, *In vitro* fertilization in humans and cattle. Embryo culture, embryo transfer in farm animals. Immunocontraception - hormonal methods. Biotechnological approaches for the management of pests, mosquitoes and nematodes. Live stock improvement.

Valuable products from cell culture, vaccines, recombinant proteins, monoclonal antibodies, hybrid antibodies, hybrid antibodies, interferon, insulin, growth hormone.

Unit-III **(11 Hrs)**

Production of transgenic animals: mice, sheep and fish. Molecular pharming and animal cloning. Somatic cell nuclear transfer in humans – Legal and ethical aspects. Potential applications of transgenic animals – Animal models for diseases and disorders. Transgenic poultry and transgenic insects as bioreactor.

Unit-IV **(15 Hrs)**

The concept of aquatic biotechnology and blue revolution: Economically important aquatic resources from fresh water, brackish water and marine habitats – the finfish, shellfish,

lime fish, algae, corals, and holothurians. Bioactive compounds from corals. Fish bioproducts. Pearl culture technology – principles and applications.

Aquaculture - Fresh water fish culture practices and types. Freshwater prawn culture. Brackish water fish, shrimp and crab culture practices. Fresh water fish hatchery and seed production. Hypophysation and induced breeding techniques. Eyestalk oblation. Techniques involved in transgenic fish production. Post harvest technology. Diagnosis of shrimp & fish diseases caused by bacterial, fungal and viral pathogens using molecular methods.

BOOKS RECOMMENDED:

1. Elements of Biotechnology by PK Gupta (Rastogi & Co).
2. Biotechnology by Kashav. T (Wiley Eastern Ltd).
3. Concepts in Biotechnology by Balasubrahmanian et. al.,(University press).
4. Principles and practices of aquaculture by TVR Pillay.
5. Coastal aquaculture by Santhanam.
6. Fisheries of India by CBL Srivatsava.
7. Molecular Biotechnology by Glick.

BT-HCP 3.1 Practicals: (2 Credits)

1. Introduction to Animal Cell culture: Procedure for handling cells and medium.
2. Preparation of animal cell culture media and membrane filtration.
3. Preparation of single cell suspension from chicken liver, spleen and thymus (Primary cell culture).
4. Trypsinization of established cell culture.
5. MTT assay for cell viability and growth.
6. Cell counting and viability - staining of cells a) Vital Staining (Trypan blue, Erythrosin B) b) Giemsa staining.
7. Demonstration of sections of human ovary, testis and aborted human embryos.

BOOKS RECOMMENDED:

1. Animal cell culture – A practical approach Ed. By John R.W. Masters (IRL Press).
2. Animal cell culture techniques, Ed. Martin clyenes (Springer).
3. Jack G.Chirikjian, 2009. Plant Biotechnology, Animal Cell culture, Immunobiotechnology, 1st Edition, CBS Publishers, India.

BT-HCT 3.2 PLANT BIOTECHNOLOGY **(4 Credits)**
52 Hrs

Preamble:

- *To familiarize the students and provide hands on training on various techniques of plant tissue culture, genetic engineering and transformation.*
- *This course will realize the importance of plant Genetic Engineering with its applicative value in pharmaceutical and food industry, agriculture and ecology.*

Unit – I **(15 Hrs)**

Plant tissue culture: Scope and Importance of plant tissue culture- Media composition and types, hormones and growth regulators, explants for organogenesis, somaclonal variation and cell line selection, production of haploid plants and homozygous cell lines. Micro propagation, somatic embryogenesis, protoplast culture and somatic hybridization. Selection and maintaince of cell lines, cryopreservation, germplasm collection and conservation, plant tissue culture certification.

Plant Development: Plant growth regulators, auxin, gibberlins, cytokinins, abscicic acid, acetylene. Biological nitrogen fixation, importance and mechanism.
Biofertilizers-types, production, VAM, Rhizobium, Azotobacter, Mycorhiza, Actinorhiza Vermicomposting technology. Biopesticides.

Unit – II **(11 Hrs)**

Plant transformation techniques: Mechanism of DNA transfer – *Agro bacterium* mediated gene transfer, Ti and Ri plasmids as vectors, role of virulence genes; design of expression vectors; 35S promoter, genetic markers, reporter genes; viral vectors. Direct gene transfer methods-particle bombardment, electroporation and microinjection. Binary vectors, plasmid vectors-pBluescript IIKs, pBin19, pGreen vectors, Transgene stability and gene silencing.

Unit –III **(13 Hrs)**

Metabolic engineering of plants: Plant cell culture for the production of useful chemicals and secondary metabolites (Hairy root culture, Biotransformation, Elicitation) - pigments, flavanoids, alkaloids; mechanism and manipulation of shikimate pathway.

Altering protein and oil quality traits in seeds. Chloroplast transformation – advantages in tobacco and potato, plants for expression of bacterial, viral and eukaryotic genes. Edible vaccines and plantibodies. The genetic manipulation of crop yield by enhancement of photosynthesis.

Production of Industrial enzymes, biodegradable plastics, therapeutic proteins, edible vaccines and antibiotics using transgenic technology.

Unit – IV **(13 Hrs)**

GM Technology: Crop improvement, productivity, performance and fortification of agricultural products–Bt cotton, Bt brinjal. Herbicide resistance, viral resistance, bacterial resistance, fungal resistance crops. Golden rice and transgenic sweet potato.

Post-harvest technology: RNAi and antisense RNA technology for extending shelf life of fruits and flowers (ACC synthase gene and polygalactoronase); delay of softening and ripening of fleshy fruits (tomato, banana, watermelons). Post-harvest protection of cereals, millets and pulses.

BOOKS RECOMMENDED:

1. Plant Biotechnology by A. Slater, N.W. Scott and M.R. Fowler (Oxford University press).
2. Biotechnology in Agriculture by Swaminathan, M.S (Mc. Milllan India Ltd).
3. Biotechnology and its applications to Agriculture, by Copping LG and P.Rodgers (British Crop Projection).
4. Plant Biotechnology, by Kung, S.and C.J.Arntzen (Butterworths).
5. Chrispeels M.J.et al. Plants, Genes and Agriculture-Jones and Bartlett Publishers, Boston.1994.
6. Gamborg O.L. and Philips G.C.Plant cell, tissue and organ culture (2nd Ed.) Narosa Publishing House. New Delhi.1998.
7. Slatu A et al.The genetic manipulation of plant. Oxford University Press.2003
8. Kirakosyan A and Kaufman P.B.Recent Advances in Plant Biotechnology (1st Ed.).Springer Publishers.2009

BT-HCP 3.2 Practicals: **(2 Credits)**

1. Preparation of plant tissue culture media (MS and B5) and Organ culture (Shoot tip, nodal and leaf culture)
2. Callus culture: Initiation and regeneration.
3. Establishment of cell cultures and plating.
4. Anther culture for the production of haploids.
5. Embryo culture of maize/crotalaria
6. Enzymatic isolation of protoplast and culture.
7. Polyethylene glycol (PEG) mediated fusion of protoplasts.
8. Isolation of plant genomic DNA from pea shoot tip/ Cauliflower by CTAB method
9. *Agrobacterium* culture, selection of transformants
10. Suspension culture and production, separation and estimation of secondary metabolites β-carotene from carrot and anthocyanin from beetroot.

BOOKS RECOMMENDED:

1. Plant cell culture – A practical approach by Dixion RA.
2. Plant tissue culture – theory and practice by Bhojwani, S.S.
3. Biotechnology: A laboratory course by Becker, J.M.

BT-HCT 3.3 ENZYME TECHNOLOGY (4 Credits)

52 Hrs

Preamble:

- *This course provides the theory and knowledge relevant to the enzymology principles including fundamental properties of enzymes, enzyme catalytic mechanisms and enzyme kinetics.*
- *Students will also be introduced to the theory as well as applications of enzyme technology in food, medical, and household industries.*

Unit-I (13 Hrs)

Classification of enzymes and enzyme kinetics of single substrate and two substrate catalyzed reactions. Factors affecting rate of enzymatic reactions: temperature, pH, modulators etc and significance of activation energy and free energy in biochemical reactions.

Unit-II (13 Hrs)

Enzyme Cofactors and Mechanism of Enzyme Catalysis: Structure and biological function of a variety of enzyme cofactors. Enzyme substrate complex concept of ES complex binding sites, active site and type of enzyme specificities. Acid Base catalysis, Orientation and Proximity, Covalent Catalysis (Electrophilic and Nucleophilic), Strain and Distortion.

Unit-III (13 Hrs)

Regulation of Enzyme activity: Covalent Modification & Allosteric Regulation. Isozymes and Abzymes. Asymmetric catalysis through enzymes. Methods and principles, Supporting matrix, advantages, and reactor-design for immobilization of enzymes.

Unit-IV (13 Hrs)

Biotransformation through enzymes and Microbes: Non-aqueous enzyme technology. Applications of enzyme technology in environment, Medical, Agricultural, Industrial benefit**s**

BOOKS RECOMMENDED:

1. Enzyme Biochemistry, Biotechnology and Clinical Chemistry. Palmer T., Harwood Pub., 2001
2. Enzyme Technology. Chaplin M.F. &Bucke C., Cambridge Univ. Press, 1990
3. Fundamentals of Enzymology. Price, N.C. & Stevens, L., Oxford Pub., 1999

4. Immobilized Enzymes and Cells. A. Rosevear et al., IOP Pub., 1987
5. Industrial Enzymes and their Applications. Uhlig H. John Wiley and sons, 1998
6. Thermostability of Enzymes. Gupta M.N., Narosa Pub., 1993

BT-HCP 3.3 Practicals: (2 Credits)

1. Assay of amylase from Saliva.
2. Assay of trypsin.
3. Assay of acid-phosphatase from potato.
4. Assay of Lipase from serum.
5. Assay of Catalase from liver.
6. Time course of enzyme activity
7. Effect of pH and determination of optimum pH.
8. Effect of temperature on enzyme activity and calculation of energy of activation.
9. Effect of substrate concentration on enzyme activity and determination of Km.
10. Effect of metal ions on enzyme activity.
11. Purification of an enzyme.

BOOKS RECOMMENDED:

1. Hawk's physiological chemistry Ed. by Oser (Mc Graw Hill).
2. Biochemical methods By Sadasivam and Manikam (Wiley Eastern limited).
3. An introduction to practical biochemistry by D.T.Plummer (Mc Graw Hill).
4. Laboratory manual in Biochemistry by J.Jayaraman (Wilety Eastern limited).
5. Biochemistry - a laboratory courses by J.M.Beckar (Academic Press)

BT-SCT 3.1 ENVIRONMENTAL BIOTECHNOLOGY (4 Credits)

52 Hrs

Preamble:

- *This course presents an objective view of the application of biotechnological know-hows in tackling environmental problems. It starts with basic knowledge about molecular biology and later links to application based processes and techniques.*

Unit-I (10 Hrs)

Bioremediation & Phytoremediation: Biofeasibility, applications of bioremediation, Bioreduction, Phytoremediation.

Unit-II (14 Hrs)

Bioabsorption and Bioleaching of heavy metals: Cadmium, Lead, Mercury, Metal binding targets and organisms, Bioabsorption, Metal microbial interaction, Biomethylation of elements (Methylation of mercury and arsenic), Commercial biosorbants, bioleaching, metal precipitation, advantages and disadvantages of bioleaching.

Unit-III (15 Hrs)

Waste water Treatment: Biological treatment system (Oxidative ponds, aerobic and anaerobic ponds, facultative ponds, aerated ponds), Biological waste treatment, activated sludge treatment, microbial pollution in activated sludge, percolating filters, waste water treatment by biofilms. Treatment scheme of Dairy, Distillery, Tannery, Sugar, Fertilizers, Refinery, Chemical and Antibiotic waste.

Unit-IV (13 Hrs)

Solid waste pollution and its management: Current practice of solid waste management, composting systems, vermicomposting, sewage treatment.

BOOKS RECOMMENDED:

1. Allsopp D and K.J Seal., I ntroduction to Biodeterioration-ELBS/Edward Arnold. 1999
2. Christon, J. Harst Manual of Environment Microbiology, ASM Press, Washington DC.1997.
3. Ericksson Ed., Biotechnology in the pulp and paper industry, Springer –Verleg.1997
4. Hurst CJ et al. eds., Environmental Microbiology, ASM Press, Washington, D.C. 1997
5. Larry Anderson and David A. Tilman., Fuels from waste, Academic Press. 1997.
6. Whitaker J R and S.Philip. Biocatalysis in agricultural Biotechnology, Washington ACS.1989
7. Jordening H J and Josef Winter Environmental biotechnology: concepts and applications (2 nd Ed.) Wiley & Sons Publishers.UK.2005
8. Daniel Vallero., Environmental Biotechnology: A Biosystems Approach (1 st Ed.) Academic press. New York.2010
9. Wang LK. Handbook of Environmental Engineering (1st Ed.) Springer Publishers.2010
10. Evans G G and Judy Furlong., Environmental Biotechnology: Theory and Application (2nd Ed.).Wiley publishers. 2011
11. Wang L.K., Ivanov V., Tay J.H., HungY.T (2010) Handbook of Environmental Engineering (1st Ed.) Springer Publishers
12. Gareth G. Evans, Judy Furlong (2010) Environmental Biotechnology: Theory and Application (2nd Ed.).Wiley publishers.

BT-SCT 3.2 TECHNIQUES IN MICROBIAL BIOTECHNOLOGY (4 Credits) 52 Hrs

Preamble:

- *This course is like an intensive hands on training imparting technical knowledge and entrepreneurial skills in areas of microbial biotechnology*

Unit-I **(11 Hrs)**

Sterilisation: Pure cultures and aseptic techniques; Nutritional Types; Bacterial growth curve, Metagenomics for the isolation of genes for novel enzymes; Types of PCR, Light microscopy.

Unit-II **(15 Hrs)**

Purification of microbial protein: Electrophoretic separation of protein; Characterization using- PAGE/ gel filtration method, native and SDS-PAGE; 2D-PAGE; capillary electrophoresis; IEF; Differential centrifugation and purification by density gradient centrifugation; Chromatographic methods of separation; Principles and applications of Paper; Thin layer; Gas-liquid; HPLC and FPLC; Spectrophotometry- Principles and applications UV-Visible, Mass Spectrometry, MALDI-TOF, Atomic Absorption Spectrometer.

Unit-III **(13 Hrs)**

Antisense and RNAi technology: Protein and DNA sequencing techniques- Maxam– Gilbert sequencing, Chain-termination methods, Massively Parallel Signature Sequencing (MPSS), Pyrosequencing, Illumina (Solexa) sequencing, Solid sequencing; Genomic and cDNA library preparation; RFLP; RAPD and AFLP techniques.

Unit-IV **(13 Hrs)**

Tracer techniques in biology: Concept of radioactivity; radioactivity counting methods with principles of different types of counters; Concept of α, β and γ emitters, scintillation counters; γ -ray spectrometers; autoradiography; applications of radioactive tracers in biology, FACS.

BOOKS RECOMMENDED:

1. Friefelder. D. (1982) Physical Biochemistry, Application to Biochemistry and Molecular Biology, 2 nd ed. W.H. Freemen and Company, San Fransisco.
2. Griffiths, O. M. (1983). Techniques of Preparative, Zonal and Continuous Flow Ultracentrifugation.
3. William, B.L. and Wilson, K. (1986). A Biologist Guide to Principles and Techniques Practical Biochemistry, 3 rd ed., Edward Arnold Publisher, Baltimore, Maryland (USA).
4. Slater, R.J. (1990).Radioisotopes in Biology-A Practical Approach, Oxford University Press, NewYork.

BT-OET 3.1 r-DNA TECHNOLOGY **(4 Credits)**
52 Hrs

Preamble:

- *The aim of this course is to acquaint the students to versatile tools and techniques employed in genetic engineering and recombinant DNA technology.*
- *A sound knowledge on methodological repertoire allows students to innovatively apply these in basic and applied fields of biological research.*
- *This course provides theoretical bases to properties and applications of versatile DNA modifying enzymes, cloning strategies, vector types, host genotype specificities for selection and screening of recombinants and/or recombinant transformants.*

Unit-I **(13 Hrs)**

Characterization of Nucleic acid (DNA and RNA): Introduction to nucleic acid, Quantification, Radiolabelling of nucleic acids, labelling by primer extension, DNA sequencing: Maxam-Gilbert (Chemical) and Sanger- Nicolson (dideoxy/ enzymatic) sequencing method.

Unit-II **(13 Hrs)**

Vectors: Plasmid vectors, Bacteriophage, expression vectors, other vectors, Construction of genomic and c-DNA libraries, Joining of DNA Fragments to vectors, cohesive and blunt end Ligation, adaptors, and linkers.
Restriction Enzymes: Types and uses of restriction endonuclease, classification Restriction mapping. DNA modifying enzymes: Nucleases, Polymerases, Phosphatases and ligases.

Unit-III **(13 Hrs)**

Principal and applications in analysis of recombinants: Principle of hybridization. Northern blotting, Southern blotting, Western blotting. Polymerase chain reaction, selection and screening of recombinants.

Unit-IV **(13 Hrs)**

Expression systems: methods of Transformation, host engineering. Strategies of gene delivery, in vitro translation, expression in bacteria, yeast.

BOOKS RECOMMENDED:

1. Principles of Gene manipulation (1994) Old R.N. and Primrose S.B.
2. From Genes to Clones (1987) Winnaeker E.L.
3. Recombinant DNA (1992) Watson J.D., Witreowski J., Gilman M. and Zooller M.
4. An Introduction to Genetic Engineering: Nicholl, D.S.T. 5. Molecular Biotechnology (1996) Pasternak
5. The Biochemistry of Nucleic acid(1996)Adam et al 7. Genetic Engineering (1998)Janke k. swtlow

BT-OET 3.2 NANOBIOTECHNOLOGY **(4 Credits)**
52 Hrs

Preamble:

- *The aim of this course is to give an introduction to different nanomaterials and their sensing and biomedical applications.*
- *The fundamental concepts of the unique properties of nanomaterials compared to those of bulk materials will be discussed in details. Since nanotechnology allures students from different backgrounds, the course will enable them to understand the nano-biointerface and how nanotechnology can be useful in several biotechnological applications.*
- *The course will essentially serve as a platform to interlink students from non-biology background at all levels.*

Unit-I **(13 Hrs)**

Nanotechnology: concept of Nanotechnology-advances, Nanochemistry- classification of nanomaterials, Nanostructures and dynamics of biocompatible materials -fullerenes-nanoparticles-nanotubescolloidal gold- nanostructures. Nanophysics- quantum dot- quantum wire quantum point contact- nanocrystals.

Unit –II **(13 Hrs)**

Synthesis of Nanostructures: Natural in organism, chemical and physical methods- Sol process, Micelle, Chemical Precipitation, Hydrothermal method, Pyrolysis, Bio-based protocol, Chemical Vapor Deposition, Sputtering etc, Applications in various fields viz. Physical, Chemical, Materials and Life sciences.

Unit –III **(11 Hrs)**

Nanomedicine and Nanobiology: Nanaomaterials and drug deliverycancer diagnosis and therapy- surgery- *in vivo* therapy- neuro- electronic interface- cell repair machines-nanotechnology devices-nanoparticles dendimers- nanorobots- nubot- nanoshell.

Unit-IV **(15 Hrs)**

Molecular nanotechnology: Biosensors, Nanorobots, nanobiosensor . DNA sensor- optical Biosensor Biochips and their application. Nanofibers and their application in tissue engineering.

Industry applications: Nanomaterials in consumer markets, Electronics, photonics, nano-opto, MEMS, Microarray, nano-bio applications, Computing technologies - present and future , Carbon Nanotube Technologies (CNT). Environment and social issues.

BOOKS RECOMMENDED:

1. Niemeyer, C.M., Mirkin, C.A. (Eds). 2004. Nanobiotechnology Concepts, Applications and Perspectives, Wiley-VCH, Weinheim.
2. Challa S.S.R.Kumar (Ed). 2006. Biologicals and pharmaceutical nanomaterials, Wiley-VCH Verlag Gmbh & Co, KgaA.
3. Oded Shoseyov (Editor), Ilan Levy, 2010. NanoBioTechnology: BioInspired Devices and Materials of the Future, Humana Press.
4. Chad A. Mirkin and Christof M. Niemeyer, 2007. Nanobiotechnology II: More Concepts and Applications, Wiley-VCH.
5. Handbook of carbon nanomaterials. Francis D souza, Karl M. Kadish. World scientific publishing co. pte. ltd. 2011.

FOURTH SEMESTER

BT-HCT 4.1 BIOPROCESS ENGINEERING **(4 Credits)**

52 Hrs

Preamble:

- *To develop skill of the students in the area of Bioprocess technology. This course will be very helpful in understanding Bioreactor design and its application, simulation of different models etc.*

Unit-I **(13 Hrs)**

Heterologous Expression: Expression vectors and hosts Generally Regarded As Safe (GRAS) organisms. Production of active recombinant proteins of mammalian/Eukaryotic origin in prokaryotes. Large scale production of proteins from recombinant microorganisms. Principles of microbial growth – Batch fermentation, feed-batch fermentation – continuous fermentation, high density cell cultures – Bioreactors – Large scale fermentation system – tandem Airlift reactors – Single stirred tank reactors.

Unit-II **(13 Hrs)**

Down stream processing: Harvesting microbial cells – Membrane filtration system, high speed semi continuous centrifugation – disrupting microbial cells. Gram scale purification of recombinant proteins – Chromatography systems and analytical methods for large scale purification. Stabilization of the proteins.

Unit-III **(13 Hrs)**

Processing technology: Microbial metabolites - Organic solvents (Alcohol, Acetone, Butanol), Organic acids (Citric acid, lactic acid), Wines and beers, Antibiotics (penicillin, streptomycin, tetracycline, semi synthetic penicillins), Vitamins (Vitamin B12 and Riboflavin), Amino acids (lysine, glutamic acid). Production of single cell proteins.

Unit-IV **(13 Hrs)**

Enzyme technology: Sources production, isolation and purification of enzymes for the industrial use. Application of enzymes in pharmaceutical, food processing and other industries. Different techniques of immobilization of enzymes, applications and kinetics of immobilized enzymes. Design and operation of immobilized enzyme systems and bioreactors. Whole cell immobilization. Biosensors - principle and types.

BOOKS RECOMMENDED:

1. Biotechnology – Volumes 1 to 5 by Rehem.
2. Industrial Microbiology by LE Casida Jr.
3. Industrial Microbiology by Presscot and Dunn.
4. Immobilized enzymes by Messing.
5. Biochemical engineering fundamentals by Bailey and Ollis.
6. Biotechnology by BD Singh (Kalyani).

BT-HCP 4.1 Practicals: **(2 Credits)**

1. Production of protease/amylase by batch fermentation.
2. Immobilization of an enzyme (invertase/lipase/amylase) by gel entrapment.
3. Immobilization of whole cells for enzyme/antibiotic production by gel entrapment.
4. Microbiological assay of an antibiotic including the construction of standard curve.
5. UV survival curve.
6. Production of alcohol by *S.cerevisiae* and its estimation.
7. Production of streptomycin by fermentation.
8. Production of citric acid by *A.niger*.
9. Production of red wine from grapes.
10. Production of Glutamic acid by *M. glutamicus*.

BOOKS RECOMMENDED:

1. A manual of Industrial Microbiology and Biotechnology by Demain A.L.
2. Immobilization of enzymes and cells: Methods in Biotechnology vol.1 by Bickerstaff G.F.
3. Principle of fermentation technology by Stanbury.
4. Biotechnology: A laboratory course by Becker J.M.

BT-HCT 4.2 MEDICAL BIOTECHNOLOGY AND NANOBIOTECHNOLOGY

(4 Credits)
52 Hrs

Preamble:

- *The course contains an overview, scope and benefits of medical biotechnology, infectious diseases, and mechanism of drugs against the diseases and future of medical biotechnology.*
- *Another aim of this course is to give an introduction to different nanomaterials and their sensing and biomedical applications.*
- *This paper provides excellent opening for students to carry research work in medical biotechnology and Nanobiotechnology at reputed institutions.*

MEDICAL BIOTECHNOLOGY

Unit – I **(13 Hrs)**

Microbial Diseases of Humans: Normal micro-flora of human body, host-microbe interaction, mode of infection, infection and infectious process.

Symptoms, detection, epidemiology and control measures of disease caused in human by
Viruses (AIDS, Hepatitis- B, Rabies, HSV-1)
Bacteria (Typhoid, STD, TB, Plague)
Fungi (Aspergillosis, Histoplasmosis, Cryptococcosis)
Protozoa (Malaraia, Amoebiasis)

Unit – II **(13 Hrs)**

Chemotherapy: Principles of chemotherapy, mode of antibiotics action: Antibacterial drugs (pencillin, streptomycin, sulphonamides), Antifungal drugs, Antiviral agents. Problems of drug resistance and Drug sensitivity. Multi-drug Resistant pathogens (MDRs).

Molecular therapeutics: Drugs, drug receptors, Relationship between drug concentration and response, agonists, drug clearance. Gene therapy, barriers to gene delivery, overview of inherited and acquired diseases for gene therapy; Retro and adeno virus mediated gene transfer; Liposome mediated gene delivery. Cellular therapy; use of stem cells.

Unit – III **(13 Hrs)**

Human Diseases: Symptoms and treatment of the Genetically inherited diseases: PKU, Alkaptonuria, Galactosemia, Von‟Gierke disease, Lesch-Nyhan syndrome, Gout, Sickle cell aneamia, Beta Thalesimia and Diabetes.
Evaluation of organ functions: liver, kidney, cardiac and gastric function tests. Significance of biochemical markers-amino transferases, creatine kinase, LDH, amylase and γ-glutamyl trans-peptidase.

NANOBIOTECHNOLOGY

Unit – IV **(13 Hrs)**

Nanobiotechnology: Introduction, types and synthesis of nanomaterials, protein-based nano structures, DNA-based nano structures, Applications of nanomaterials, drug and gene delivery, disease diagnostics and therapy, risk potential of nanomaterials.

Molecular nanotechnology, molecular assemble, nanofactories, self replication, DNA based artificial nanostructures. Biosensors, Nanorobots, nanobiosensor. DNA sensor, Optical biosensor,bBiochips and their application. Nanofibers and their application in tissue engineering.

BOOKS RECOMMENDED:

1. Judit Pongracz and Mary Keen, Medical Biotechnology 1st Edition, Elsevier publications, 2008
2. S N Jogdand Medical Biotechnology 2nd Edition Himalaya publishers 2008.
3. Warren Levinson, Ernest Jawetz, Medical Microbiology and Immunology: Examination and Board Review 7th edn. McGraw Hill Publications 2003
4. Jawetz, Melnuk and Adelgerg, Medical Microbiology, Appleton & Lange pub 1971.
5. Niemeyer, C.M., Mirkin, C.A. (Eds). 2004. Nanobiotechnology Concepts, Applications and Perspectives, Wiley-VCH, Weinheim.
6. Challa S.S.R.Kumar (Ed). 2006. Biologicals and pharmaceutical nanomaterials, Wiley-VCH Verlag Gmbh & Co, KgaA.

BT-HCP 4.2 Practicals: (2 Credits)

1. Preparation of selective and differential media used in diagnostic microbiology.
2. Laboratory examination of sputum: Collection of sputum, Microbiological examination of Sputum by differential staining.
3. Normal microflora of saliva, throat and skin on Blood agar/Nutrient agar/Chocolate agar.
4. Micrological examination of urine and blood sample.
5. Estimation of serum cholesterol.
6. Blood sugar analysis by Folin -Wu method.
7. Estimation of Creatine and Creatinine from urine samples
8. Diagnostic test for typhoid fever by WIDAL test.
9. VDRL test for syphilis.
10. Synthesis of nanoparticles using biological process - (2-3methods).
11. Synthesis of Al_2O_3 nanoparticles using sol gel method.
12. Synthesis of Fe_2O_3, $AuCl_2$ and AgO_2, nanoparticles by chemical method.
13. Detection of nanoparticles in colloidal solutions using UV-Visible absorption techniques.
14. Functionalization of nanoparticles for biological application - (4-5 methods).
15. Biological sample preparation for SEM.

BOOKS RECOMMENDED:

1. Practical Medical Microbiology by Mackie & Mc Carteny.
2. Baclerial Discases by Wilson and Topley.
3. Handbook of Nanostructured Biomaterials and Their Applicalions in Nanobiotechnology by Flari Singh Naiwa.
4. Nanobiotechnology; ed. C.M.Niemreyer., C.A. Mirkin.

BT-SCT 4.1 RESEARCH METHODOLOGY (4 Credits)

52 Hrs

Preamble:

- *This course providing opportunity for students with a thirst in research to get well acquainted with research methodology which includes different skill developments in scientific writing, data handling and processing, development of research ideas and planning / designing of research projects.*

Unit – I **(14 Hrs)**

Fundamentals of Research Methodology

1. Definition and Objectives of Research.
2. Types (Descriptive, Analytical, Applied, Fundamental, Qualitative, Quantitave, Conceptual and Empirical) and Significance of Research.
3. Research Approaches. Research Methods versus Methodology.
4. Criteria of a Good Research. Problems encountered by Researchers in India.

Research Problem

1. Definition of Research Problem. Necessity of defining Research Problem.
2. Techniques involved in Defining a Research Problem.
3. Methods of selecting a Research Problem.

Unit – II **(12 Hrs)**

Research Design

1. Meaning and Need of Research Design.
2. Important concepts related to Research Design. Features of a Good Design.
3. Different Research Designs.
4. Basic Principles of Experimental Designs.

Unit – III **(13 Hrs)**

Data Analysis

1. Processing and Analysis of Data; processing operations, problems in processing.
2. Types of analysis, statistics in research, importance of statistical analysis.
3. Measure of relationship- simple regression, multiple correlation and regression analysis.
4. T-test: application of this test.
5. Analysis of variation and co-variations; what is ANOVA, basic principle of ANOVA.

Unit – IV **(13 Hrs)**

Data Interpretation and Report Writing

1. Meaning and Importance of Interpretation.
2. Techniques of Interpretation. Precaution in Interpretation.
3. Significance of Report Writing. Different steps in Report Writing.
4. Layout of the Research Report. Types of Report.
5. Mechanics and Precaution in Writing a Research Report.

BOOKS RECOMMENDED:

1. Montgomery, Douglas C. (2007), 5/e, Design and Analysis of Experiments, (Wiley India).
2. Montgomery, Douglas C. & Runger, George C. (2007), 3/e, Applied Statistics & Probability for Engineers (Wiley India).
3. Kothari C.K. (2004), 2/e, Research Methodology- Methods and Techniques (New Age International, New Delhi).
4. Krishnaswamy, K.N., Sivakumar, Appa Iyer and Mathiranjan M. (2006), Management Resarach Methodology; Integration of Principles, Methods and Techniques (Pearson Education, New Delhi).
5. The complete reference Office Xp . Stephan L. Nelson, Gujulia Kelly (TMH).
6. Basic Computer Science and Communication Engineering . R. Rajaram (SCITECH).

BT-SCT 4.2 GENOMICS AND PROTEOMICS (4 Credits)
52 Hrs

Preamble:

- *The course aims to appraise the students to basic and high throughput techniques in Genomics and Proteomics and their applications.*

Unit-I **(12 Hrs)**

Introduction: Concept of genomics, structural genomics, Functional Genomics, Transcriptomics, RNAmics proteomics, and metabolomics.

Unit-II **(12 Hrs)**

Genomics: Genome sequencing, Fluorescence method, automated sequencing, shot-gun approach. Clone contig method, Genome sequencing projects of *E.coli*., yeast, and human genome project.

Unit-III **(15 Hrs)**

Genome Analysis: Genome Organization and Structure: C-Values of genomes, Repetitive and coding sequences, Genetic and physical maps, Methods of physical mapping**.** Molecular markers, Hybridization based markers restriction fragment length polymorphism (RFLP's), random amplification of polymorphic DNA (RAPD's) and amplified fragment length polymorphisms (AFLP). Multiple arbitrary amplicon profiling using short oligonucleotide primers, SCAR, micro satellites and other markers, length polymorphisms in simple sequences repeats (SSR and ISSR).

Approaches to mapping, fluorescence *in-situ* hybridization (FISH) - DNA amplification markers; Telomerase as molecular markers.

Unit-IV **(13 Hrs)**

Protein–protein interactions: genetic, comparative genomic, biochemical approaches. Large scale analysis of protein intreractions-yeast two hybrid interaction screens, post-translational modification analysis, proteomics databases & analysis.

BOOKS RECOMMENDED:

1. Peter M Gresshoff .Plant Genome Analysis (1st Ed.), CRC Press.UK.1994
2. John R S Finchman. Genetic Analysis – Principles, Scope and Objectives (1st Ed.).
3. Blackwell Science. Singapore.1994.
4. Smith D.W. Biocomputing Informatics and the Genome Projects (1st Ed.) Academic
5. Press.USA.1993.
6. Benjamin Lewis. Genes VIII (7th Ed.). Oxford University & Cell Press.UK.1999
7. Benjamin Lewis. Genes IX (9 th Ed.). Jones and Bartlett publishres.USA. 2007
8. Principles of Gene manipulation and Genomics, SB Primrose and RM. Twyman,7th Ed.). Blackwell publishers.UK.2007
9. Liebler D C. Introduction to Proteomics-Tools for the New Biology (2nd Ed.).John R. Humana Press Totowa. NJ. 2002

BT-HCMP 4.3 MAJOR PROJECT **(6 Credits)**

Preamble:

- *This course will help the students to address and assess the diverse problems associated with various fields relevant to biotechnology through the techniques learnt to design managerial measures for a healthy environment.*

The candidate should submit an independent project report by the end of final year course on a topic relevant Biotechnology, based on the laboratory experiments/case studies/field studies carried out in a Biotechnology/related industry, it will be evaluated by external and internal examiners. It will be carried out 4th semester, but will be started in the 3rd semester. Three copies of the project report shall be submitted to the chairman, Department of Biotechnology before one week of the theory examination of fourth semester.

The assignment of marks for Project is as follows:

Project dissertation	100 marks
Viva-voce	25 marks
Internal assessment	25 marks
Total	**150 marks**