KRISHNA INSTITUTE OF MEDICAL SCIENCES "DEEMED TO BE UNIVERSITY", KARAD

Accredited By NAAC With 'A' Grade

Revised Syllabus(CBCS) For

Master of Science Biotechnology

To be implemented from 2019-20

(In a Phase Manner)

Prologue

The Faculty Allied Sciences (Then Krishna Institute of Biotechnology and Bioinformatics) was established in 2007 with Two Post graduate courses Microbiology, Biotechnology. Currently Five faculty members are engaged in Academic functions.

The seemingly overwhelming and ever expanding state of knowledge about microorganisms, their genetic material, Molecular Biology and Recombinant DNA Technology increases the scope of Biotechnology. This newly emerging branch of science offers something for everyone and it cultivates informed citizens who can make perceptive decisions on important events. Many discoveries made by Microbiologists and Biotechnologists have spawned new fields of science such as molecular Biology, Genetics, Enzyme Technology, Fermentation Technology, Bioengineering, Genetic Engineering, Immunology etc. Many studies have been made using Science and Biotechnology to understand the principles that govern life.

New developments are occurring constantly in these areas and thus Biotechnologies have become the mainstays of many technologies. This has necessitated the formation of the Biotechnology courses for the development of competent, smart and dynamic Biotechnologists that are required in Academic Institutes, Research organizations, Professional organizations and in various industries such as Pharmaceutical Industries, Enzyme Industries, Food and Dairy Industries, Wine and Alcohol Industries, Agro based Industries. **The Choice –Based Credits System(CBCS)** provides for a framework within which there is flexibility in the design of courses and their content ,simultaneously also providing the students a choice of the courses he/she wishes to study. The courses are assigned credits based on teaching hours, which in turn is linked to courses content and structure

The rapid pace of discovery and their application dictates a somewhat selective inclusion of theory paper / topics and practical and proper training of the students. The course is designed in such a way that students remain constantly busy with their studies through the Lecture and Practical periods, Seminar periods, Home assignments, Mid – term examinations (Periodic tests), Preliminary or term end examinations and also gets exposure to outside world through visits to Research Laboratories / Science Institutes / Industries of Biotechnological interest. The course also makes the provision for training in research through the research project (during one or two semesters) and / or Industrial training in organization of Microbiological interest. (During one semester / one summer vacation.)

Over all it is aimed to design **Two year post graduate (M.Sc.) course in Biotechnology** with a balanced coverage of traditional and "cutting edge technology" along with the necessary courses (Communication skills, Biostatistics, Computer science, Scientific writing and Presentation, Research training / Industrial training) as per the UGC guidelines and produce competent Biotechnologists to meet the demand of Industries, Research organizations and Academic Institutes in the country and abroad.

Process of Curriculum Design

The Choice-Based Credit System (CBCS) provides a framework within which there is flexibility in the design of courses and their content. At the same time it also provides the student a choice of the courses he/she wishes to study. The courses are assigned credits based on teaching hours, which in turn is linked to course content and structure.

Curriculum Designing Process

Following procedure was adopted for curriculum designing: For curriculum development first need analysis was done and then based on need analysis draft syllabus was prepared in the Departmental Curriculum Committee meeting and it was subsequently discussed in College Curriculum Committee meeting were all faculty members participated in the discussion and debated over the draft syllabus. The draft syllabus approved in the College Curriculum Committee meeting was sent to BOS were given by external subject experts were considered and incorporated in the final draft. The draft syllabus finalized in BOS was sent to Academic Council for it's approval.

When revising the syllabi for the courses, the courses to be implemented as well as the content of each course was extensively discussed and debated on, feedback obtained from students, faculty, subject experts from academic institutes, industry experts, alumni were extensively discussed and debated in the meetings of curriculum committees and BOS and the inputs were considered. Thus for the development of syllabus contributions came from external subject experts, faculty members, feedback obtained from students, alumni, external experts and members of industry.

M.Sc. Biotechnology program objectives

After completion of the M. Sc. Biotechnology program the students are expected to understand the:

(a) Basic principles, working and applications of various Biochemical, Biophysical and Biotechnological Techniques.

(b) Basic aspects of Biomolecules and Molecular Biology, Cell physiology and Metabolism.
(c) Basic and applied aspects of Plant Tissue Culture, Animal Tissue Culture, Recombinant DNA Technology, Fermentation Technology, Pharmaceutical Biotechnology.
(d)General characteristics of various groups of microorganisms – Bacteria, Clamidra Rickettsiac, viruses, Actinomycets, Archaea, fungi.
(e) Causes of environmental pollution, methods of wastewater treatments.
(f) Basics of computer & Bioinformatics, Applications of Bioinformatics.
(g)Basic concepts of enzyme, enzyme kinetics, regulation of enzyme activity, Therapeutic, diagnostic and applications of industrial enzymes.

Structure of M.Sc. program in Biotechnology

M.Sc. Biotechnology program is of two years duration and is conducted in four semesters. As recommended by UGC university has adopted a outcome-based education approach. The various courses of the program are designed to include classroom teaching, laboratory work, project work, seminars, home assignments, industrial visit etc.

Program Educational Objectives:

The objectives of the **M. Sc. Programme in Biotechnology** is:

(i) To equip the students with the basic and applied knowledge of molecular mechanisms of cellular processes in living systems including microbes, plants, animals and humans.
(ii) To provide the students with laboratory (experimental) training so that they are competent enough to work in industries.
(iii) To provide the students with the current updates in the areas of Analytical Techniques , Industrial Fermentations, Environmental Biotechnology.
(iv) To train students with research work methodology through small project work.
(v)To generate competent skilled human resource for industries and research organization.

Eligibility

Candidates must have passed B.Sc. With minimum 50% marks with Biotechnology/ Microbiology/ Industrial Microbiology/ Zoology/Botany as principal subject or with Biochemistry/ Microbiology/ Botany/ Zoology as subsidiary subjects at B.Sc. II level

Course fees

As shown in Admission Broacher of respective year (Subject to change as and when required)

Duration

The duration of M.Sc. (Biotechnology) degree program shall consist of two academic years divided in to four semesters. Each Semester consist of 90 working days. Each theory and practical course must be completed in 60 lectures/Practical periods, respectively of 60 min duration.

Medium of instruction

The medium of instruction and examination for each course shall be English.

Credit to contact hour

One credit is equivalent to 15 periods of 60 minutes each for theory course lecture. While credit weightage for self-learning based on e-content shall be 50% or less than that for lectures.

Attendance

The student enrolled for M.Sc. Biotechnology must have 75% attendance in each course in order to appear for term end examinations, otherwise the candidate may not be allowed to appear for term end examination as per ordinance.

1. The entire M.Sc. course in Biotechnology shall be covered in 16 [sixteen] theory papers, 7 [seven] practical course [semester I, II, III] and a project work / Industrial training [in lieu of one practical courses of semester IV] each semester there shall be four theory papers each carrying 100 marks and for first three semesters viz. semester I, II and III, there shall be two practical courses each practical course shall carry 100 marks. However, for semester IV there shall be a research project work / Industrial training of 100 [one hundred] marks in lieu of one practical course in addition to four-theory paper and one practical course.

   Semester I: Four theory papers and two practical courses.
   Semester II: Four theory papers and two practical courses.
   Semester III: Four theory papers and two practical courses.
   Semester IV: Four-theory papers. One practical course and a project work / Industrial training practical course for every student.

2] Each theory paper will be covered in four lectures of 60 minutes each per week.
   Practical course shall be covered in 04 practical turns of 04 clock hours practical periods per week.

3] A practical batch shall be of 12 [twelve] to 15 [fifteen] students.

4] For university practical examination the duration should be as shown below,
   For every semester there shall be two / three days practical examination for not less than 5 ½ hours.

5] Each candidate must produce a certificate from the Head of the Department in his/her college / Institute / University stating that he/she has completed, in a satisfactory manner, a practical course on the lines laid down from time to time by Academic Council on the recommendations of Board of studies and that the laboratory journal has been properly maintained. Every candidate must have recorded his/her observation in the laboratory journal and a written report on each exercise performed. Every journal is to be checked and signed periodically by a member of teaching staff and certified by the Head Of the Department at the end of each semester. Candidates are to produce their journal at the time of practical examination.

6] There shall be one compulsory seminar of minimum 15 min. delivery per paper per semester for each student and there shall be two marks for each seminar in Internal evaluation.

During semester I & II students shall have to undertake an academic tour to visit a minimum one place of academic interests like Academic Institute/ Research Institution / R&D Department/Industry. The student should submit the report of their visit at the time of practical examination. The report should be duly certified by the Head of the Department of Microbiology, Biotechnology.

7] During semester Student is to undertake a research project [as part of the semester IV] which is to be started in the beginning of semester III so as to give enough time for duly completion of project. In the project student is to study research methodology Information collection (reference work) selection of topic, outline of the work, thinking and planning, project report writing in the form of dissertation or small Project Report and the submission of the project report [Introduction, Aims and objectives, Material and method, Results and Discussions, summary, Conclusions and Bibliography] For the research project work out of one hundred marks, fifty marks shall be given by university examiners though assessment of Project Report at the time of semester IV practical examination. The remaining fifty marks shall be given by the Committee for Internal Evaluation of Projects (CIEP) as an internal evaluation. CIEP is to be constituted by the Principal (and which shall be consisting of HOD, Guide / Teacher in - charge and at least one other faculty members). The method and process of Internal evaluation is to be worked out by the CIEP.

**1) The Institute or guide of student should locate the industry and depute the student in the industry for the period of one month

2) Student should complete its industrial training cum industrial project in the vacation period after semester II

3) Student should study biotechnological and/or microbiological aspects in industry and submit its report in the form of dissertation or small Project Report duly signet by industry authority, concerned guide and Head of the Department of Microbiology, Biotechnology.

Two year M.Sc. Biotechnology Programme (Programme Code: 5101)

Course Structure

M. Sc. Part I Semester I

		M. Sc. Biotechnology CBCS w. e. f. 2019-20(Revised)							
	Sr. No.	Course Code	Course Title	Teaching Hours/ Week			Marks (Total 100)		Credits
				T	P	Total	Internal	Externa	

									I		
							T	P	T	P	
		Theory									
CGPA	1	5101-11 CC	Foundation of Biochemistry for Biotechnologist	4	--	4	20	--	80	--	4
	2	5101-12 CC	Cell Biology and Biostatistics	4	-	4	20	--	80	--	4
	3	5101-13 DSE	Microbiology and Immunology-I	4	--	4	20	--	80	--	4
	4	5101-14 CCS	Biochemical, Biophysical, Immunochemical and Biotechnological Techniques	4	--	4	20	--	80	--	4
		Practicals									
	5	5101-15 CC	Practical Course I	---	4+4	8	-	20	--	80	4
	6	5101-16 CC	Practical Course II	---	4+4	8	--	20	--	80	4
		Mandatory Non CGPA Course									
NON CGPA (No Weightage in CGPA calculations)	7	01 AECC	Yoga and Meditation	2	2	2	50		--	--	2
	Total Credit for Semester I: 26 (T = Theory : 16, P = Practical : 8;) AECC= Ability Enhancement Compulsory Course: 2), CC: Core Course, CCS : Core course specialization DSE: Discipline Specific Elective Total Credits for Semester I CGPA course = 24 credits										

M. Sc. Part I Semester II

		M. Sc. Biotechnology CBCS w. e. f. 2019-20(Revised)									
	Sr. No.	Courser Code	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
				T	P	Total	Internal		External		
							T	P	T	P	

		Theory									
CGPA	**1**	5101-21 **CC**	Cell Physiology and Metabolism	4	--	4	20	--	80	--	4
	2	5101-22 **CCS**	Molecular Biology and Biotechnology	4	**--**	4	20	--	80	--	4
	3	5101-23 **DSE**	Microbiology and Immunology-II	4	--	4	20	--	80	--	4
	4	5101-24 **CC**	Foundation for use of Computers, Communications, Scientific Writing and Presentation	4	--	4	20	--	80	--	4
		Practicals									
	5	5101-25 **CC**	Practical Course III	---	4+4	8	--	20	--	80	4
	6	5101-26 **CC**	Practical Course IV	---	4+4	8	--	20	--	80	4
		Mandatory Non CGPA Course									
NON CGPA (No Weightage in CGPA calcuions)	**7**	**02 SECC**	A Soft Skills and Personality Development	2	2	2	50		--	--	2
		Total Credit for Semester II: 26 (T = Theory : 16) P = Practical : 8; SECC= Skill Enhancement Compulsory Course : 2), CC: Core Course, CCS : Core course specialization DSE: Discipline Specific Elective Total Credits for Semester II CGPA course = 24 credits									

M. Sc. Part II Semester III

		M. Sc. Biotechnology CBCS w. e. f. 2020-21(Revised)									
		Course Code	**Course Title**	**Teaching Hours/ Week**			**Marks (Total 100)**				**Credits**
				T	**P**	**Total**	**Internal**		**External**		
							T	**P**	**T**	**P**	

CGPA		**Theory**									
	1	5101-31 **CC**	Environmental Biotechnology	4	--	4	20	--	80	--	4
	2	5101-32 **GE**	Plant Tissue culture	4	--	4	20	--	80	--	4
	3	5101-33 **DSE**	Industrial Fermentations	4	--	4	20	--	80	--	4
	4	5101-34 **CCS**	Bioinformatics for Biotechnologist	4	--	4	20	--	80	--	4
		Practicals									
	5	5101-35 **CC**	Practical Course V		8	8	--		80		4
	6	5101-36 **CC**	Practical Course VI	---	4+4	8	--	20	--	80	4
		Mandatory Non CGPA Course									
NON CGPA (No Weightage in CGPA calculations)	**7**	**03 AECC**	Leadership Development	2	2	2	50		--	--	2
	8	**Elective Course (EC)**									
		EC	SWAYAM/ MOOC course								4
		Total Credit for Semester III: 30 (T = Theory : 16; P = Practical : 8) **AECC =Ability Enhancement Compulsory Course:(02 +04)=06 ,** **CC: Core Course, CCS : Core course specialization DSE: Discipline Specific Elective, GE: Generic Elective** **Total Credits for Semester III CGPA course = 24 credits**									

M. Sc. Part II Semester IV

		M. Sc. Biotechnology CBCS w. e. f. 2020-21(Revised)										
	Sr. No.	**Course Code**	**Course Title**	**Teaching Hours/ Week**			**Marks (Total 100)**					**Credits**
				T	**P**	**Total**	**Internal**		**External**			
							T	**P**	**T**	**P**		
		Theory										
CGPA	**1**	5101-41 **CC**	Enzyme Technology	4	--	4	20	--	80	--		4
	2	5101-42 **GE**	Animal Tissue Culture	4	--	4	20	--	80	--		4
	3	5101-43 **CC**	Recombinant DNA Technology	4	--	4	20	--	80	--		4
	4	5101-44 **CCS**	Pharmaceutical Microbiology and Biotechnology	4	--	4	20	--	80	--		4
		Practicals										
	5	5101-45 **CC**	Practical Course VII	--	4+4	8	--	20	--	80		4
	6	5101-46 **CC**	Project work **OR**	---	4+4	8	--	50	--	50		4
	7	5101-47 **CC**	Vocational Training (Industrial Training)	----	*	*	-	50		50		4
		***- Minimum one month Vocational Training/ Industrial Training**										
		Mandatory Non CGPA Course										
NON CGPA(No Weightage in CGPA calculations)	**8**	**04 SECC**	Biotechnology Data Care Management	2	2	2	50		--	--		2
		Total Credit for Semester IV: 26 T = Theory: 16; P = Practical : 8; SECC = Skill Enhancement Compulsory Course: 2), CC: Core Course, CCS : Core course specialization DSE: Discipline Specific Elective, GE: Generic Elective, Total Credits for Semester IV CGPA course = 24 credits										

I CGPA Courses :

There shall be in all 24 courses per programme out of these there shall be

1. There shall be 16 core courses per program.
2. There shall be 04 Core course Specialization per programme.
3. There shall be 02 Discipline Specific Elective courses
4. There shall be 02 Generic Elective Courses.
5. Total credits for CGPA courses shall be of 96 credits per program.

II Mandatory Non-CGPA Courses:

1. There shall be 02 mandatory non CGPA Ability Enhancement Course (AEC) of 02 credits each per program.
2. There shall be 02 mandatory non CGPA Skill Enhancement Course (SEC) of 02 credits per program.
3. There shall be 01 Elective Course (EC) SWAYAM/MOOC. The credits of the course shall be as specified on SWAYAM/MOOC portal.
4. The total credits for Non CGPA course shall be of 08 +04 credits.

(To be introduced with effect from academic year 2019-2020 for M. Sc. Part I (Semester I & II))
and
(To be introduced with effect from academic year 2020-2021 for M. Sc. Part II (Semester III & IV))

M.Sc. Part I Semester I

Course Code: 5101-11 Foundation of Biochemistry for Biotechnologist (04 credits)

Course Objective:

1) To make the students understand thoroughly about the important biomolecules like Protein, Carbohydrates, Lipids, Nucleic acids, Porphyrins.
2) To converse the students with the vitamins, enzymes, hormones with their structures, functions & properties.
3) To give students the knowledge of chemistry of cell walls of Bacteria, Actinomycetes & Yeasts.

Course Outcome:

1) Students would be well versed on the fundamental principles of Biochemistry.
2) Students would have through knowledge of structures and functions of Bio-macromolecules like proteins, carbohydrates, lipids, Nucleic acids (DNA and RNA) .
3) Student would also be well versed with structure and functions of vitamins as well as chemistry bacterial cell wall.

Unit I (12)

Protein Chemistry: Structure, Function, Relationships in model proteins like Ribonuclease,

A Myoglobin, Hemoglobin, Chymotrypsin etc.

Protein folding: Anfinsen's Dogma, Levinthal paradox, cooperativity in protein folding, free energy landscape of protein folding, and pathways of protein folding, molten globule state, chaperons, diseases associated with protein folding, introduction to molecular dynamic simulation.

i)Amino acids: properties structures, functions and classifications of common amino acids, uncommon amino acids.

ii) Peptides and proteins: peptides bond formation, types of peptides, lengths of peptides chain, conjugated proteins and their classification.

iii) Protein structure : Levels of organization of protein structures – primary, secondary, tertiary and quaternary structures. The three dimensional structure of proteins determination of sequence of amino acids in peptides or protein.

Unit II **(12)**

Carbohydrate chemistry :

i) Nomenclature Types : (a) Monosaccharides & disaccharides
(b) Polysaccharides
(c)Glycoconjugates

ii) Carbohydrate as informational molecules – the sugar code.

iii) An outline of methods of carbohydrate analysis.

Unit III **(12)**

Lipid chemistry :

i) Storage lipids: fatty acids – nomenclature structure and properties of some naturally occurring fatty acids, Triacylglycerols and their functions as storage lipids.

ii) Structural lipids in membrane: Glycerophospholipids, galactolipids, sulfolipids, sphingolipids, sterols lipids as signals, cofactors and pigments.

Phosphatidyl inositols and sphingosine derivatives as intracellular signals Eicosanoids, prostaglandins (PG) thromboxanes, Leukotrienes, Vitamins A, D, E and K.

An outline of method of the extraction, separation and identification of cellular lipids.

Unit IV **(12)**

Nucleic acid chemistry :

Nucleotides (the building blocks of nucleic acids) – components, structures and nomenclature.

Nucleic acid structures –

(a) DNA : Watson – Crick Model, Three dimensional forms of DNA (comparison of A, B and Z from of DNA)

Unusual DNA structures – palindromes, mirror repeats, inverted repeats, hairpin (or cruciform), Hoagsteen pairing, triplex DNA's, G tetraplex DNA, H - DNA.

(b) RNA : monocistronic and polycistronic on RNA base – paired helical structure in an RNA.

(c) Denaturation and renaturation of double stranded DNA & RNA, DNA hybridization, Chemical synthesis of DNA (Automated). Methods of DNA sequencing , Large scale DNA sequencing

Unit V **(12)**

Chemistry of porphyrins : Chlorophylls, Cytochromes, Hemoglobin.

Vitamins : (Water soluble and fat soluble vitamins) : Structure and functions of :

(a) Water soluble Vitamins – Vitamins B1, B6, B12, Folic acid, Pantothenic acid, Niacin and Biotin.

(b) Fat soluble Vitamins – Vitamins A, D, E and K.

Hormones : Definitions, General properties and functions, Chemistry and function of some important molecules (for Biotechnologist and Medical Practitioners) - Human growth hormone, Insulin, Bovine growth hormone, Thyroids stimulating hormone.

.**Reference Books :**

1. "Biological Chemistry", by Mehlar, H. R., and E. H.Orders, 1968, Harper & Row Publishers Inc, New York.
2. "Biochemistry", by Stryer, L., 1981, 2nd edition, W. H. Freeman and Company, San Francisco.
3. "Principles of Biochemistry", by Lehninger, A. L., 1984, 1st Indian Edition, LBS Publishers and Distributors Pvt. Ltd., New Delhi.
4. "Biochemistry", by Stryer, L., 1988, 3rd edition, W. H. Freeman and Company, San Francisco.
5. "Principles of Biotechnology", edited by Wiseman, Alan, 1988, Chapman and Hall, New York, USA.
6. "Biochemistry", by Menlo Park : Benjamin / Lummings.
7. "Modern Concepts in Biochemistry", 5th edition, Boston.
8. "Biochemistry", by Lehninger, A. L., 1993, Kalyani Publishers, New Delhi.
9. "Industrial Enzymology", edited by Godfrey, T. and West, s., 1996, Stockton Press, New York, USA.
10. "Food Processing : Biotechnological applications", edited by S. S. Marwaha and J. K. Arora, 1st edition, 2000, Asiatech Publishing Inc., New Delhi.
11. "Elements of Biotechnology", by P. K. Gupta, 1st edition, 2004,
12. "Introduction to Applied Biology and Biotechnology", by Veedyanath reddy and Prasad, B.S. Publication, Hyderabad.
13. "Recombinant DNA", by Watson, J. D. et al., 2nd edition, 1992, Scientific American Books, New York.
14. "Molecular Biotechnology", by Glick, B. R., and Pastorate, J. J., 3rd edition, ASM Press, Washington D. C.

Course Code: 5101-12 Cell Biology and Biostatistics (04 credits)

Course Objectives:

1) To make students familiar with the various anatomical parts of typical prokaryotic and eukaryotic cells.
2) To give students a brief knowledge about the various methods of organization of statistical data and it's presentation.
3) To give them concept of regression and probability.
4) To give them insight in biochemical cell membrane, membrane transport mechanisms, cell biosignalling and cell differentiation.

Course Outcome:

1) Students would have through knowledge of structural organization of prokaryotic and eukaryotic cells.
2) Students would gain knowledge of structure and functions of biological membranes and solute transport through them.
3) Students would also be well versed with the fundamental principles and examples of cell biosignalling and cell differentiation processes.
4) Students would be able to apply statistical methods to handle biological bulky data and will be able to interpret the results.

Unit I (12)

- **Cell Biology** : Early History, Modern History, Latest significant events in cell biology.

- **Methods for determining microbial evolution**

Unit II (12)

- **Prokaryotic cells** :

(i) Cell shape, cell size and examples of Prokaryotic cells.

(ii) Structural organization of Prokaryotic cell - of a typical Bacterial cell: Capsule or slime layer, flagella, Pili, cell wall, plasma membrane, cytoplasm, reserved food materials, Nucleoid, plasmids.

- **Eukaryotic cell :**

(i) Cell shape, cell size, cell volume, cell number and examples of Eukaryotic cells.

(ii) Structural organization of Eukaryotic cell : Cell wall, plasma (cell) membrane, cytoplasm, matrix or cytosol – cytoskeleton and Microtrabecular lattice, cytoplasmic structures – cytoplasmic inclusions, Cytoplasmic Organelles – Endoplasmic reticulum (ER) Golgi apparatus, cytoplasmic vacuoles, Glyoxysomes, peroxisomes, Lysozomes, mitochondria, plastids, ribosomes microtubules and micro tubular organelles, Nucleus – Chromatin, nuclear envelope and nucleoplasm.

Unit III (12)

- **Biological membrane:**
  Molecular constituents of membrane supra molecular architecture of membrane.

- **Membrane transport**: Various mechanisms of transport of solutes across the membrane.

- **Cell Biosignalling**:
  Signal transduction, molecular mechanism of signal transduction, general features of signal transduction, receptor enzymes.

- **Cell differentiation**:
  Definition and type of differentiation, factors that operate in control of differentiation. Examples of differentiations (Endospore formation in Bacteria and plasma cell (Antibody forming cell) formation from B - Lymphocyte).

Unit IV **(12)**

- **Vital statistics –** Death rate and ratio, measures of morbidity measures of mortality**.**
- Study of Statistical softwares –Excel SPSS
- Sampling : Advantage of sampling over census, sampling methods – Random sampling, non- random Sampling, Limitations of sampling.

Unit V **(12)**

- **Handling of bulky data :**
  (i) Measures of central tendency – mean, mode and median.
  (ii) Measure of dispersion – Concept of dispersion, range, measures of dispersions – variance Grouped data and ungrouped data combined variance for two groups merits and demerits.
  (iii) Preparation of table of frequency distribution, cumulative frequency distribution and relative frequency distribution.
  (iv) Graphical representation of statistical data – Construction of histogram and frequency polygon.
  (v) Representing the normal curve as straight line.

- **Regression :** Concept of regression, types of regression – Simple, multiple, linear and non-linear, Regression lines, regression equation.

Reference Books :

1. "Cell Biology and Molecular Biology", by S. C. Rastogi, 2nd edition, 2003, New age International (p) Ltd., New Delhi.
2. "Principles of Biochemistry", by A. L. Nelson and M. M Cox, First Indian edition, 1993, CBS Publishers and Distributors, Delhi.
3. "Biostatistics", by P. G. Dixit, V. R. Prayag and P. S. Karpe, 2002, Nirali Prakashan, Pune.
4. "Cell Biology, Genetics, Molecular Biology, Evolution and Ecology", by P. S. Verma and V. K. Agarwal first multicolor edition, 2004, S. Chand and Company Ltd.
5. "Fundamentals of Biostatistics", by Rastogi, V. B., 2007, Ane Books.
6. "Biostatistics : A foundation for Analysis in Health Sciences", by Wayne, W. Daniel, John Wiley and Sons Inc.
7. "Statistics for Biologists", by R. C. Campbell,
8. "Biostatistics in Theory and Practice", by T. K. Saha, Emkay Publications, New Delhi.

Course Code: 5101-13 Microbiology and Immunology – I (04 credits)

Course Objectives:

1) To give the students knowledge about the landmarks in the field of Microbiology and the scope of microbiology.
2) To give them of knowledge of different types of microorganisms, their isolation techniques and different methods of controlling growth of microorganisms,different bacterial and vital staining procedures.
3) To make them understand the role of various components of immune system and defense mechanism.

Course Outcome:

1) Students would learn about the landmarks in the field of Microbiology and would gain knowledge regarding scope of microbiology.
2) Students would know different types of microorganisms, their isolation techniques and different methods of controlling growth of microorganisms.
3) Students would also gain knowledge regarding different bacterial and vital staining procedures
4) Students would also have knowledge regarding various components of immune system and defense mechanism.

Unit I (12)

- **History and Scope of Microbiology** :

Early history, modern history and latest significant events in Microbiology. Introduction to various branches of Microbiology.

- **General characteristic of Microorganisms Various groups of Microorganisms**:

General characteristics of various groups of microorganisms: Eubacteria, Archaebacteria, Actinomycetes, Rickettsiae, Mycoplasma, Chlamydia, Viruses, Algae, Fungi and Protozoa.

- **Systematics of Prokaryotic Microorganisms:**

Systematics, Taxonomy Nomenclature,

Classification of Microorganisms –Hierarchical organization of classification system,

Approaches to the classification of Microorganism – Phenetic phylogenetic, numerical taxonomy criteria for classifying, microorganisms – phenotypic characters, genetic characters.

Identification of microorganisms identification keys and diagnostic tables, computer – assisted identification.

Commercial systems for rapid identification of bacteria – (e.g. Enterotube, API, Minitek, Micro -ID).

Unit II (12)

- **Microbial Nutrition :**

Nutritional requirements of Microorganisms. Nutritional classification of Microorganisms based upon their types of carbon and energy sources.

- **Pure culture Techniques :**
  Culture, culture media, general procedure of preparation of media, types of media, cultivation conditions (e.g. temp, pH, presence of O_2 etc.), Techniques of isolation of bacteria in pure culture forms.
- **Techniques of isolation of yeast and molds.**
- **Techniques of isolation of anaerobic bacteria**.
- **Stains and staining procedures:**
  Simple, negative, differential, special, and vital stainings.

Unit III **(12)**

- **Control of Microorganisms :**
  Physical methods of control: Heat, cold, desiccation, filtration, ultrasonication and radiations.
  Chemical methods of control: Alcohols, Phenols and Phenolic compounds, heavy metals, Halogen compounds, Gaseous sterilization.

- **Medical Microbiology :**
  Types of Diseases: Definitions and examples of Epidemic, Endemic, Pandemic and Sporadic diseases.
  Types of infections: Definition and examples of Primary, Secondary, Acute, Chronic, Congenital, Local and generalized infections.

- **Host defense mechanisms :**
  Non specific defense mechanisms - Physico chemical barriers, Phagocytosis – process and mechanisms of killing the organisms, antimicrobials present in tissue fluids, inflammation, fever.
  Specific defense mechanisms – Primary and secondary antibody response, mechanism of antibody production and sensitization of T-lymphocytes.

- Effect of sex hormones, nutrition and aging on the immune response.

Unit IV **(12)**

- Antigen processing and presentation.
- **Antibody diversity**: Mechanisms of generation of antibody diversity.
- **Monoclonal Antibodies** – Definition, production by Hybridoma technology and applications.
- **Complement system :**

Components, activation of complement – classical and alternate pathways, regulation of complement pathways, biological consequences of complement activation, significans

of complement activation.

Unit V (12)

- **Lymphocytes and lymphoid tissues :**

  Lymphocytes, development of lymphocytes proportion of lymphoid cell types in normal human tissues, B cells, T cells, third population cells, primary and secondary lymphoid organs.

- **Cell Signaling and Trafficking**

1) Cell Signaling

i) Cell signaling: Signal transdactive in T cell & B cell.

ii) IL_2 signaling pathways, Chemokine signaling pathways.

2) Cell Trafficking

i) Introduction, cell adhesion molecules, chemikines extravasation of nutrofiles, homing of lymphocyte.

- **Cytokines, Chemokines and their receptors**

Cytokines: General characteristics and their actions, Molecular characterization and their functions, Role in regulation of immune response.

Chemokines: Chemokines and their structures, function of chemikines and their receptors.

Reference Books :

1. "Microbial Ecology – Fundamentals and applications", by Ronald M. Atlas and Richard Bartha, 3rd edition, 1993, the Benjamin / Cummings Publishing Company, Inc. Redwood City, California.
2. "Principles of Microbiology", by Ronald M. Atlas, 1st edition, 1995, Mosby – Yearbook Inc., St. Louis, Missouri.
3. "Microbiology", by Pelczar, Chan and Krieg, 5th edition, 1986, McGraw – Hill Inc.
4. "Microbiology", by Prescott, L.M. Harley, J.P.Klein, D.A., " International edition", 5th edition, 2003, McGraw – Hill Publications, New York.
5. "Microbiology – Concepts and Applications", by Pelczar, Chan and Krieg, 1993, McGraw – Hill Inc.
6. "Foundation of Microbiology", by K Talaro and A Talaro, 2nd edition 1996. Wm. C. Brown Publishers, Dubuque, IA.
7. "Basic and Clinical Immunology", edited by D. P. Stites and A. I. Teer, 7th edition, 1991, Appleton and Lange, Norwalk, CT.
8 "Essential Immunology", by Roitt I. M., 6th edition, 1988, and 7th edition, 1991, Blackwell Scientific Publications, Oxford, England.
9 "Essential Immunology", by Roitt I. M., 8th edition, 1994, Blackwell Scientific Publications, Oxford,England.
10 "Immunology", by Roitt I. M., J. Brostoff and Male, D.K., 4th edition, 1996.
11 "Medical Immunology", edited by Stites et al., 9th edition, 1997.
12 "Handbook of Experimental Immunology", Vol. I, (Vol. II and Vol. III) edited by D. M. Weir, 1978.
13. "Fundamentals of Immunology", edited by Myrvik, Q. N., 1984, Lea and Febiger, Philadelphi

Course Code: 5101-14 Biochemical, Biophysical, Immunochemical and Biotechnological Techniques (04 credits)

Course Objectives:

1) To make the students conversant about the various Microbiological, Physicochemical and Biochemical techniques used in research laboratories, industries and diagnostics.
2) To give the students knowledge about operative procedures, applications of the techniques.

3) To give the students a brief introduction about biotechnological applications of the different techniques used in research laboratories, industries and diagnostics.

Course Outcome:

1) Student would be able to understand the difference between UV visible and fluorescence spectroscopy & colorimetry.
2) Student would be able to describe the basic principle, technique and applications of different types chromatographic techniques like paper, ion exchange and affinity chromatography.
3) Student would gain knowledge regarding fundamental principles behind centrifugation and electrophoresis.
4) Student would be able to get the thorough knowledge of ESR, NMR and various principles and instrumentation behind them.
5) Student would be well versed with the knowledge of x- ray and radioisotopes, radiography and the dangers, safety precautions associated with them.
6) Student would understand the principles and applications of SDS- PAGE, Southern blotting .

Unit I (12)

- **Chromatographic Techniques :**

Paper and thin layer Chromatography – Principle, material, methods and applications.

Column Chromatography :

(i) Adsorption Chromatography –
  (a) Ion exchange Chromatography- Principle, material, ion exchange gels, media, kinetics, operative procedures, applications.
  (b) Affinity Chromatography- Principle, material, methods, Industrial and Medical applications.

(ii) Molecular exclusion Chromatography (Gel filtration) – Types of Gels, Technique and Applications.

(iii) Gas Liquid Chromatography (GLC) – Principle, Equipment, Evaluation of performance, comparison of with traditional Chromatography and with HPLC.

(iv) High Performance Liquid Chromatography (HPLC) – Principle, basic instrumentation and applications.

- **Centrifugation Techniques :**

Principles of Centrifugation, different types of centrifuges, types of rotors, usages of rotors. Density gradient centrifugation – rate zonal technique, Isopycnic centrifugation, performing density gradient centrifugation – Discontinuous and continuous techniques, applications of preparative centrifuges.

Unit II (12)

- **Electrophoretic Techniques :**

(i) Principles of Electrophoresis, moving boundary and zonal electrophoresis,

(ii) Paper Electrophoresis – Principle and procedures involved, and applications.

(iii) Gel Electrophoresis :
  (a) Protein Electrophoresis – Polyacrylamide Gel Electrophoresis (PAGE) – SDS – PAGE and 2-D PAGE, Isoelectrofocussing.
  (b) Nucleic acid Electrophoresis – DNA sequencing gels, pulse field gel Electrophoresis (PFGE), RNA Electrophoresis.

- **Microfilm Ultra filtration :**

Principles, material and methods, and applications ; Reverse osmosis, nanofilters.

- **Manometric techniques :**

Principles, apparatus operative procedure and applications.

Unit III (12)

- **Spectroscopic technique :**

General principles of electromagnetic radiation spectroscopy, principles, procedures and applications UV – visible spectrometry, turbidometry and nephalometry, fluorimetry, luminometry, atomic absorption and mass spectroscopy.

- **Radioisotopic Techniques :**

Radioisotopes and units of radioactivity, methods of detection and measurement of radioactivity- Geiger – Muller counters, scintillation counting, Autoradiography, salient features of scintillation counting. Applications of radioisotopes – diagnostic, therapeutic, systematic and other uses.

Unit IV (12)

- **Biophysical Techniques :**

(i) Infra red and Raman spectroscopy.

(ii) X ray diffraction analysis and crystallography.

(iii) Electron spin and nuclear magnetic resonance spectroscopy.

- **Immunochemical Techniques :**

(i) Antigen antibody reaction - visualization by agglutination, precipitation, gel diffusion, complement fixation.

(ii) Radioimmunoassays.

(iii) Enzyme linked immunosorbent assays (ELISA).

(iv) Isolation of sub population of lymphocytes by fluorescent activated cell sorter (FACS).

(v) Western blot analysis and its application.

Unit V (12)

- **Biotechnological Techniques :**

(i) Techniques of extraction and purification of enzymes – Extraction of soluble enzymes, extraction of membrane bound enzymes, purification of enzymes – preliminary and further procedures, criteria of purity of enzymes.

(ii) Immobilization of enzymes – Preparation of Immobilized enzymes, properties of immobilized enzymes, applications of immobilized enzymes.

(iii) Hybridoma formation technique and its application in the production of monoclonal antibodies.
(iv) Nucleic acid based analytical methods 16 s and 18 s rRNA sequencing.

- **Analysis of Gene Expression**

Reference Books:

1. "Principles and Techniques of Biochemistry and Molecular Biology", edited by Keith Wilson and John Walker, 6th edition, 2005, Cambridge University Press, New York.
2. "Understanding enzymes", by T. Palmer, 2nd edition, 1985, Ellis Horwood Limited, West Sussex, England.
3. "Basic and Clinical Immunology", edited by Stites et al., 5th edition, 1984.
4. "Essential Immunology", by Roitt I. M., 6th edition, 1988.
5. "Essential Immunology", by Roitt I. M., 8th edition, 1994.
6. "Immunology", by Roitt et al., 4th edition, 1996.
7. 'Medical Immunology", edited by Stites et al., 9th edition, 1997.
8. "Handbook of Experimental Immunology", Vol. I, (Vol. II and Vol. III) edited by D. M. Weir, 1978.
9. "Elements of Biotechnology", by P. K. Gupta, 1st edition, 2004.
10. "Outline of plant Biotechnology", by E. John, Jothi Prakash, 1st edition, 1997.
11. "Biotechnology – Foundation course", by Anant N. Rao, 2007, Jaypee Brothers Medical Publishers (p) Ltd, New Delhi.
12. "Biophysical Chemistry – Principles and Techniques", by A. Upadhya and K. Upadhya and N. Nath, 4th revised edition, 2007, Himalaya Publishing House, Delhi.

Course Code: 5101-15 Practical Course – I (04 credits)

Course Objective:

1) To make the students able to perform to prepare the various nutrient media, sugar media and media for biochemical tests.
2) To make the students able to perform the endospores staining, nuclear material staining and capsule staining.
3) To make the students able to perform the various techniques of isolation, biochemical characterization and enumeration of microorganisms.

Course Outcomes:

1) Students would be able to prepare the various nutrient media, sugar media and media for Biochemical tests.
2) Students would be able to perform the staining of endospores, nuclear material and capsule of bacteria.
3) Students will be able to perform the various techniques of isolation , biochemical characterization and enumeration of microorganisms.
4) Students will get insight of industrial work culture by visiting industry.

1. Capsule staining

2. Characterization of bacterial culture by special test – IMViC test, Gelatin hydrolysis test, Starch hydrolysis test, Fat hydrolysis test, Casein hydrolysis test, H_2S production, Urea hydrolysis test**.**

3. Gram's staining.

4. Bacterial endospore staining.

5. Bacterial nuclear material staining.

6. Yeast nuclear material staining.

7. Fungal mounting and identification of genera of some common fungi.

8. Preparation of nutrient media for isolation and cultivation of bacteria, yeasts and molds- Nutrient broth, Mac Conkey's broth, Nutrient agar, Mac Conkey's agar, standard plate count (SPC agar), Rose Bengal - Aeuromycin agar, Yeast nitrogen base with 1% and 20% glucose, Glucose yeast extract agar, Glucose yeast extract malt extract agar.

9. Isolation of bacteria by streak plate method, pour plate method and spread plate method.

10. Isolation of fungi by dilution plate method.

11. Viable count of bacteria by standard plate count (SPC) method and by most probable number (MPN) method.

12. Viable count of yeast and molds by standard plate count method (SPC).

13. Characterization of bacterial culture by various biochemical test – Catalase, Oxidase, fermentative (sugars etc.) tests and by serological tests – e.g. slide and tube agglutination.
14. Fermentative production of Ethanol from sugary materials (e.g. molasses, banana pulp etc.)
15. Preparation of bacterial protoplast.

16. Preparation of yeast protoplast.

17. Aseptic Technique and good cell culture practice.

18. Visit to Industry / Science Institute / Research Laboratories. Report of the visit to be submitted.

Course Code: 5101-16 Practical Course – II (04 credits)

Course Objective:

1) To make the students able to perform the qualitative and quantitative estimation of proteins, lipids, carbohydrates, DNA, RNA.
2) To make the students able to statistically analyze biological data and interpret the results.
3) To make the students able to perform the electrophoresis and chromatographic techniques.

Course Outcome:

1) Students will know the techniques of qualitative and quantitative estimation of proteins, lipids, carbohydrates, DNA, RNA and will be carry out the estimations independently.
2) Students will learn to apply the statistical methods on biological data and interpret the results.
3) Students will be able to perform the electrophoresis and chromatographic techniques.

1. Preparation of Buffers- Preparation of Molar and Normal solutions commonly required in biotechnology laboratory
2. Determination of proteins by Bradford's method.
3. Estimation of proteins by Lawry's method.
4. Determination of Proline content in plant leaves.
5. Estimation of lysine.
6. Estimation of tryptophan.
7. Determination of : Carbohydrate, protein and lipid contents of microorganisms (bacteria) / food and feed Samples.
8. Determination of DNA and RNA content of the sample.
9. Extraction, isolation and purification of Lysozyme from hen's egg white.
10. Separation of dyes, plant pigments by column chromatography.
11. Separation of amino acids by paper and thin layer chromatography.
12. Electrophoretic separation of serum proteins by Agarose and Polyacrylamide gel electrophoresis (PAGE).
13. Electrophoretic separation of nucleic acids by Agarose and Polyacrylamide gel electrophoresis.
14. T- Rosette test for detection of human T- lymphocytes.
15. Precipitation of immunoglobulins from serum.
16. Measures of central tendency – Mean, mode and median.
17. Measurement of dispersion – Variance and standard deviation.
18. Organization of data frequency distribution tables.
19. Construction of histogram and frequency polygon
20. ANOVA – CRD and CBD.

Reference Books for Practical course I and Practical course II

1. "Laboratory manual in Biochemistry", by Jayraman, J., 1998, New age International Publishers, New Delhi.
2. "Experiments in Microbiology, Plant Pathology and Tissue Culture" by Aneja, K. R., 1993, Wishwa Prakashan.
3. "Practical Biotechnology" by P. Ramadass and A. Wilson Aruni, 2007, Jaypee Brothers Medical Publishers (p) Ltd. New Delhi.
4. "Medical Microbiology" Vol. 2, 12th edition, 1975 by Cruickshank, R. Duguid, J. P. Marriman, B. P. and R. A. Swan, Churchill Livingstone, London.
5. "Hand book of microbiological media", by Atlas, R. M., 1993, CRC Press, Inc. Florida.

6. "Manual of laboratory techniques", by Rghumulla, N., Nair, K. M., and Kalyansundaram, S., 2nd edition, 2003, National Institute of Nutrition Press, Hyderabad.

7. "Official methods of analysis of association of official analytical chemists", 15th edition, Association of Official Analytical Chemists, Inc., Virginia, USA.

8. "Illustrated genera of imperfect fungi", by Barnett, H. L., and Hunter, B. B., 3rd edition, 1972, Burgess Publishing Company, Minneapolis, Minnesota.

9. "Compendium of soil fungi", by Domsch, K. H., Gams, W. and Anderson, T. H., 1980, Academic Press, London.

10. "Standard methods for the examination of water and waste water", 20th edition, edited by Greenberg, et al., 1998, APHA, AWWA, WEF, Washington, DC.
11. "An Introduction to practical Biochemistry", by D. T. Plummer, 2005, Tata McGraw – Hill Publication.
12. "Microbiological applications", by Benson, H. J., 6th edition, 1994, Wm. C. Brown Publishers, Dubuque, Iowa.
13. "Identification methods for Microbiologists", edited by Gibbs, G. M. and Shapton, D. A., 1968, Academic Press, London.
14. "Microbiological applications", by H. J. Benson, 6th edition, 1994.
15. "Methods in Microbiology", Vol. 5 edited by Norris and Ribbons, Academic Press, London.
16. "Biostatistics", by P. G. Dixit, V. R. Prayag and P. S. Karpe, 2002, Nirali Prakashan, Pune.
17. "Biostatistics : A foundation n for Analysis in Health Sciences", by Wayne, W. Daniel, John Wiley and Sons Inc.
18. "Biostatistics in Theory and Practice", by T. K. Saha, Emkay Publications, New Delhi.
19. "Text book of Practical Microbiology", by Subhashchandra Parija first edition 2007, Ahuja publishing House, Delhi.

Ability Enhancement Compulsory Course (AECC)

01 Yoga and Meditation (02 Credits)

PREAMBLE:

The ultimate aim of Yoga is to experience the truth, by realizing the true nature of our self and universe. Yoga education helps in self discipline and self control, leading to immense amount of awareness, concentration and higher level of consciousness. Experience based Yoga education can be integrated in higher education to enhance Academic social activities of students.

OBJECTIVES:

1) To enable the students to have good health
2) To learn to maintain the mental hygiene by performing yoga posture and meditation.

Unit I

- **Ashtangyoga**
  Introduction, Meaning, definition, Objectives
  Performing Yogabhyasa
- **Pranayamas**
  Anulom Vilom, Bhramari, Kapalbhati and Bhasrika Omkar Sadhana, Prayer and Guruvandana

Unit II

- **Suryanamaskar**
  Introduction, Postures, Benefits and practice

Unit III

- **Asanas**
  Vajrasan, Padmasan, Vakrasan, Uttan Padmasan, Pawanmuktasan, Shavasan, Bhujangasan, Shalabhasan, Makrasan, Tadasan, Verasan, Ardhachakrasan- Introduction, Postures, Benefits and practice.

Unit IV

- **Meditation**:
  Types of meditation techniques commonly practiced, benefits of meditations.

Reference Books :

1. Yoga for Beginners by Emily Oddo
2. Yog Sadhana v Yog Chikitsa Rahasya by Swami Ramdeo
3. Yoga and Meditation by Ann Wilde
4. Yoga for Beginners by Denise Flow

M. Sc. Part I Semester II

Course Code: 5101-21 Cell Physiology and Metabolism (04 credits)

Course Objectives:

1) To give students the knowledge about the metabolic pathways & their functions.
2) To give students knowledge of protein catabolism.
3) To give students the knowledge of various metabolic reactions and their role in metabolic pathways and ATP synthesis

Course Outcomes:

1) Students would know the basic concept of metabolism and understand the metabolic pathway and their functioning in the body .

2) Students would be able to illustrate the metabolism of carbohydrate through various anabolic and catabolic pathways like glycolysis, Kreb's cycle, glycogen metabolism etc.
3) Students will learn how amino acid and proteins are catabolized
4) Students would be well versed with entropy to law of thermodynamics and free energy and it's relation to chemical
5) Students would be able to understand, able to describe coupled reactions and their role in metabolism and chemiosmotic hypothesis of ATP synthesis.

Unit I (12)

- **Principle of Bioenergetics:**

Law of thermodynamics, entropy, standard free energy change, phosphoryl group transfer and ATP: Standard free energies of hydrolysis of ATP and other phosphorylated compounds and thioesters (Acetyl CoA).

Role of ATP as energy currency of the cell.

Biological oxidation – Reduction reactions : the standard reduction potential, E^o, Measurement of the standard reduction potential (E'^o) of a redox pair, standard reduction potentials of some biologically important half reactions.

- **Glycolysis and catabolism of hexoses:**

Glycolysis: Catabolism of glucose to pyruvate, catabolic fate of pyruvate, Substrate level phosphorylation and ATP synthesis, Pentose phosphate pathway of glucose oxidation

Unit II (12)

- **Fermentations:** Basic concept of fermentation (Dfferentiation between fermentation, aerobic respiration and anaerobic respiration) Microbial fermentation of Glucose – Ethanolic, Mixed acid ,Butyric acid and Propionic acid fermentations.
- **The citric acid cycle: Tri carboxylic acid cycle (TCA)**

Production of acetyl CoA, reaction of citric acid cycle, energetics, Anaplerotic reactions, regulation of the citric acid cycle, The glyoxylate cycle, coordinated regulation of glyoxylate and citric acid cycle.

Unit III (12)

- **Oxidation of fatty acids:**

Mobilisation of stored triacylglycerols, Activation and transportation of fatly acids into mitochondria, Beta (β) and omega (ω) oxidation of fatly acids.

- **Protein Catabolism** – Protelysis, putrefaction, catabolism of amino acid

Unit IV (12)

Oxidative phosphorylation and ATP formation

Electron transport chain – components (carriers), their organization into large functional complexes, the path of electron flow through them, Proton gradient, Proton motive force. ATP synthesis – Mechanisms : chemiosmotic model proposed by Peter Mitchell, ATP synthase complex of mitochondria, Binding change mechanism (rotational catalysis mechanism) proposed by Paul Boyer, Shuttle systems to convey cytosolic NADH into mitochondria for oxidation – malate aspartate shuttle, glycerol – 3 – phosphate shuttle Regulation of oxidative phosphorylation.

Mitochondrial genes : their origin and the effects of mutations. Role of mitochondria in Apoptosis and oxidative stress.

Unit V (12)

- **Photophosphorylation and ATP Formation**

General features of photophosphorylations, light absorption, primary Light absorbing pigment – Chlorophylls, Secondary Light absorbing pigments or accessory pigment, organization of photo system (PS) Photophosphorylation in bacteria:

Type II reaction center in purple bacteria

Type I reaction center in Green sulfur bacteria

Photosynthesis in cyanobacteria, algae and vascular plants –

Photosystem II (PS II) and photosystem I (PS I) integration in chloroplast

Dual roles of cytochrome b6f and cytochrome C6 in cyanobacteria.

Photophosphorylation in halophilic bacterium *Halobacterium salinarum*

ATP synthesis : Mechanisms : Chemiosmotic coupling electron flow and phosphorylation

ATP synthase complex of chloroplast.

Reference books:

1. "Physiology of the Bacterial cell : A molecular approach", by Neidhardt FC, JL Ingraham, in scratchier: 1990, sinauer, Sunderland, MA.

2. "Microbial physiology", by moat AG and JW Foster, 1988, John Wiley and sons, New York.

3. "Principles of microbiology", by R.M. Atlas, 1995, mosby year bwk, Inc. St. Louis, Missouri 631146 (USA).

4. "Lehninger principles of Biochemistry", by David L Nelson And Michael M Cox, 4th edition, W.H. Freeman and Co.

5. "General Microbiology", by Stanier R . et al. Macmillan Co. 2005.

6. "Communication skill", by Anjali Ghanekar, 1996, Everest publishing house.

7. "How to write and publish a scientific paper", by Day R. A. 4th edition 194, phoenix, Oryx Press.

8. "The New York public Library Writer's guide to style and usage" – published by Mac Millan India Ltd. 1999.

9. "Writing a thesis", by George Watson, Longman Inc. New York.

10. "General Microbiology", by Schlegel H.G. Cambridge University Press 2004.

Course Code: 5101-22 Molecular Biology and Biotechnology (04 credits)

Course Objectives:

1) To give students the knowledge about the DNA replication, translation, transcription in prokaryotes and eukaryotes.
2) To give students the knowledge about gene, gene regulation, gene expression.
3) To give students the knowledge of mutagens, mutations and DNA transformation methods.

Course Outcomes:

1) Students will get thorough knowledge of mechanisms of DNA application, transcription and translation in prokaryotes and eukaryotes.

2) Students will have a deep insight into the genetic code and regulation of gene expression giving emphasis on operon models, in prokaryotes and chromatic remolding, DNA binding transactivators and coactivators with intracellular signaling in eukaryotes.

3) Students will know about various types of DNA damage and DNA repair mechanisms that occur in prokaryotic and eukaryotic cells.

4) Students will also able to understand mutations, types of mutations and methods of detection of mutation, recombination and DNA transfer methods like transformation, conjugation, transduction, electroporation, transfection. Students will also know about protoplast and spheroplast fusions etc.

5) Students will also know about Archaebacteria and will be able to understand Archaebacterial genetics.

Unit I

(12)

- **DNA replication and Transcription in prokaryotes and Eukaryotes**

i) **DNA replication in prokaryotes and Eukaryotes**: comparison, Enzymes involved in DNA replication and their Topoisomerases (I&II) Helicases, DNA polymerases in prokaryotic cells DNA (pol) I, II and III, DNA polymerases of Eukaryotic cells – Alpha (α) Beta (β) gamma (γ) and delta (δ) DNA Ligases, Post – Replication Modification of DNA –DNA methylation by DNA methylases.

ii) **Transcription in Prokaryotes and Eukaryotes**: RNA processing:
Post transcriptional modification of RNA

iii) **Genomes of Eucoryotic organelles :**

Organelle DNA replication – chloroplasts and mitochondria.

iv)**Inhibitors of DNA replications and transcription and their mode of action**

Unit II **(12)**

- **The Genetic code:** Deciphering of genetic code, important features of genetic code.
- The translation machinery in prokaryotes and Eukaryotes.
- **Translation**: Initiation of translation of mRNA, role of tRNA, Elongation of peptide, Termination of protein synthesis.
- Inhibitors of DNA replications and translation of RNA and their mode of action

Unit III **(12)**

- **Regulation of gene expressions**:

i) Principles of gene regulation: RNA polymerate, promoters, regulation of transcription initiation and its common patterns, operons model of regulation, Regulation proteins.

ii) Regulation of gene expression in prokaryotes: Regulation, Lactose, Trytophan and Arabinose operons, regulation by genetic recombination.

iii)Regulation of gene expression in Eukaryotes: chromatic remodeling, promoters and regulatory proteins –DNA binding transactivators and coactivators, transcriptional activation. Signals Regulation of genes of galactose metabolism in yeasts, gene regulation by inter cellular and intracellular signal, translational regulation of Eucaryotic mRNA, Post – transcriptional gene silencing – RNA Interference.

Unit IV (12)

- **DNA damage and repair:**

Types of damages, damaging agents, Repair mechanisms – mismatch repair, excision repair, photoreactivation, dark repair, recombination repair, SOS system in role of DNA repair system in conservation of genome integrity, relationships to life span and aging processes.

- **Gene Transfer: in Prokaryotes and Eukaryotes:**

Transformation, transduction, conjugation, transfection, protoplast and spheroplast fusions, electroporation.

- **Recombination** :

Types of recombination processes: Homologous – molecular basis of recombination, Non – homologous – molecular Mechanism of recombination.

- **Gene Transfer in Aechaebacteria**: Archaebacterial genetics

Genome sequences and Gene numbers

Genetics of population with reference to Hardy-Weinberg principle and it's applications

Unit V (12)

- **Basic Tools and Techniques in Recombinant DNA Biotechnology**

i) Cutting enzymes: Restriction endonucleases – types, nomenclature, recognition sequences, cleavage pattern.

ii) Joining enzymes: Ligases – types, joining pattern

iii) Polymerases, types and Mode of action.

iv)Victors: General characteristics, Types: Phages, plasmids, cosmids, phagemids, shuttle vectors, ARS, mini chromosomes, yeast artificial chromosome vectors (YAC).

v) DNA cloning strategies: Cloning and selection of individual gene, gene libraries, c DNA and genomic libraries, cosmid, shot gun library, Agrobacterium mediated gene transfer.

Reference Book:

1. "Leninger Principles of Biochemistry", by David L. Nelson Michael M.Cox 2005 4th edition W.H. Freeman and company. New York.
2. "DNA Replication", by Adams R.L.P., 1992, IPL Oxford, England.
3. "Genes VII", by Lewin 2002, Oxford University Press.
4. "Recombinant DNA and Biotechnology", by Singh, 2007.
5. "Biotechnology", by B.D. Singh, 1998 kalyani publishers, New Delhi.
6. "Recombinant DNA", by Watson, J.D. et al., 2nd and 3rd editions scientific American Books, New York.
7. "Cell Biology, Genetics, Molecular Biology, evolution and ecology", by Verma.
8. "Elements of Biotechnology", by P.K. Gupta, first edition, 2004.

Course Code: 5101-23 Microbiology and Immunology – II (04 credits)

Course Objectives:

1) To give students the knowledge of branches of microbiology.
2) To give the students knowledge of immune responses & autoimmune diseases
3) To give students the knowledge of vaccines and types of vaccines.

Course Outcomes:

1) Students will gain knowledge regarding basics of food and milk microbiology, virology and medical microbiology.
2) Students will also be well versed regarding abnormal manifestation of immune response like autoimmune diseases.

3) Students will understand role of HLA antigens in transplantation and graft rejection.

4) Students will also gain knowledge regarding role of immune modulators, vaccines and types of vaccines.

Unit I (12)

- **Dynamics of bacterial growth:**
  Growth phases, Synchronous, growth, Continuous growth and Diaxic growth, Measurement of growth.

- **Food and Milk Microbiology:**
  (i) Food spoilage and preservations: Spoilage organisms preservation methods, Food intoxications.
  (ii) Milk spoilage and preservation: spoilage organisms preservation, fermented milk products.

Unit II (12)

- **Major histo compatibility complex :**
  Arrangement of MHC genes, Cellular distribution, structure and function of MHC antigens (class I & II molecules).
- **Transplantation :**
  Types of graft and their fate, mechanism of graft rejection, prevention of graft rejection, GVH reaction
- **Immunological Tolerance:**
  Historical aspect, General features of tolerance, mechanisms of development of tolerance

Unit III (12)

- **Immunomodulators:**
  Concept of Immunomodulation, Immunomodulators (Biological response modifiers):
  (i) Compounds derived from bacteria,
  (ii) Compounds derived from eukaryotic organisms – Thymic harmones, cytokines, cytokine antagonists monoclonal antibodies, biochemical agents.
- **Tumor Immunology –**
  Properties of tumor cells, Tumor associated antigens, Tumor specific antigen, immune response to tumor, immune escape mechanisms, immunosurveillance, natural immunity, to tumors, immunodiagnosis of tumors – detection of tumor markers, alpha feto proteins, carcinoemryonic antigen, and immunotherapy.

- **Vaccine technology** – General methods, Disease specific vaccine, Design – Tuberculosis vaccine, Malaria vaccine, HIV/AIDS vaccine**.**

Unit IV **(12)**

- **Hypersensitivity:**

  Definition, classification of hypersensitivity reactions, mechanisms and examples of Type I, Type II, Type III, and Type IV hypersensitivity reactions.

- **Autoimmune diseases :**

  Auto antigens and auto immunization, The spectrum of auto – immune diseases, Etiology (possible causes or mechanisms), pathogenesis, treatment

Unit V **(12)**

- **Virology:**

  (i) Viruses of animal and plants: Classification schemes of animal viruses, virus multiplication, viruses and tumors in animal and humans, viruses and plant diseases.

  (ii) Bacterial viruses – (Bacteriophages) Types, multiplication, Lysogeny.

  (iii) Sub viral infectious agents.

- **Medical Microbiology:**

  (i) Virulence: Factors governing virulence – enzymes, antiphagocytic factors, toxins

  (ii) Pattern of diseases: Sign and symploms of diseases, stages

  (iii) Anaerobic infections of human being: Gas gangrene, Tentanus, Balteroid pseudomembranous colisis.

  (iv) Dental caries and periodontal diseases – etiology, pathogenesis and prevention and control.

  (v) AIDS – etiology, pathogenesis, diagnosis, transmission, prevention and control.

Reference Books:

1. "Microbiology", by Pelczar, Chan and Krieg, 5th edition, 1986, McGraw – Hill Inc.
2. "Microbiology", by Prescott, L.M. Harley, J.P. Klein, D.A., "International edition", 5th edition, 2003, McGraw – Hill Publications, New York.
3. "Principles of Microbiology", by Atlas R.M., 1st edition, 1995, Mosby – YearBook Inc. St. Louis, Missouri.
4. "Microbial physiology", by Moat A.C. 4th edition, 2006.
5. "Microbiology – Concepts and Applications", by Pelczar, Chan and Krieg, 1993, McGraw – Hill Inc.

6. "Foundation of Microbiology", by K. Talaro and A. Talaro, 2nd edition 1996, Wrn. C. Brown Publishers, Dubuque, IA.
7. "Essential Immunology", by Roitt I. M., 6th edition, 1988, and 7th edition, 1991, Blackwell Scientific Publications, Oxford, England.
8. "Essential Immunology", by Roitt I. M., 8th edition, 1994, Blackwell Scientific Publications, Oxford, England.
9. "Immunology", by Roitt I. M.,J. Brostoff and Male, D.K., 4th edition, 1996.
10. "Medical Immunology", edited by Stites et al., 9th edition, 1997.
11. "Immunology and serology", by Carpenter, P.L., 3rd edition, 1975, W.B. Saunders company, Philadelphia.

Course Code: 5101-24 Foundation for use of Computers, Communications, Scientific Writing and Presentation (04 credits)

Course Objectives:

1) To give students the knowledge about the computer hardware & software.
2) To make students conversant to writing and publishing scientific paper.
3) To give students the knowledge of communication skills.

Course Outcomes:

1) Students would know the fundamentals of computer hardware & software.
2) Students would be well versed with how to write and publish the scientific paper/ document.
3) Students would gain information about communication cycle, types of communication, verbal & nonverbal communication, writing skills.

Unit I (12)

- **Computers:**

1. General Introduction to Computers:

2. Hardware : Different components of a computer – Input unit, Arithmetic Logic unit (ALU), control unit, memory, secondary storage devices, output unit.

3. Software – Application programs, The Binary number systems, system programs, utility programs programming,

4. Introduction to Computer programming Languages operating systems : Batch operating System, Personal operating systems (PCS) , MS WORD, MS Access, MS Excel, MS Power Point.

Unit II **(12)**

- **Communication Skills :**

1. Principles of Communication, Types of Communication, Principles of effective communication.

2. Nature, scope and functions of communications**.**

3. Interview skill

Unit III **(12)**

- **Scientific writing and presentation:**

1. Introduction: Language as a means of communication, English Language

2. Scientific writing versus Unscientific writing, Scientific writing in English Language.

3. Good English and grammar in scientific writing : Use and misuse of words, Jargo and Avoiding Jargon, use of abbreviations, accepted abbreviations and symbols. Common errors in style and in spelling.

4. Programme of writing: Selection of topic and outline, Thinking and planning Information collection, Paragraph writing: Paragraph, Order of paragraph, writing and revising of paragraph.

5. Main requirements of a scientific document:
Reader as the target of document: Accuracy, Appropriateness, Clarity, Simplicity, Brevity, Precision, Balance, consistency, Impartiality, Sincerity, Objectivity, Control of interest and in Scientific Writing.

Unit IV **(12)**

- **Writing a scientific paper**: Title, Listing the authors and addresses, Abstract, Introduction, Materials and Methods, Results and Discussion, Summary and Conclusions, stating the acknowledgements and citing the references. Keyboarding the manuscript, submission of the manuscript, the Review process reports.

- Designing of effective table, graphs, diagrams and illustrations (dealing with editors), The publishing process (dealing with proofs).

- Writing review papers, Conference reports, Book reviews, Project and project reports and thesis.

- Legal aspects of scientific authorship: Copyright considerations, Plagiarism

Unit V **(12)**

- **Scientific paper** – Definitions and Organization of a scientific paper, History, IMRAD system.
- **Presentation of scientific paper**: Oral presentation, Preparation and presentation of a poster.
- **Project proposal, preparation-** selection of research topics, review of literature, writing a research proposal and Presentation.

Reference Books:

1. "Communication skill", by B. V. Pathak First edition, Nirali Prakashan, Pune (India) 2006
2. "A Handbook of Communication skills in English", by R. A. Kulkarni, First edition, Phadke Prakashan, Kolhapur (India) 2001.
3. "Written communication in English", by sarah freeman.
4. "English for Communication (Science)" Book I, First edition, 1996 Shivaji University.
5. "Communication skill", by Anjali Ghanekar, 1996, Everest publishing house.
6. "How to write and publish a scientific paper", by Day R. A. 4th edition 194, phoenix, Oryx press.
7. "The New York public Library Writer's guide to style and usage", – published by Mac Millan India Ltd. 1999.
8. "Writing a thesis", by George Watson, Longman Inc. New York.

9. "Bioinformatics", – Modern approach by Srinivas, 2007.

10. "Introduction to Computers", by Leon A. and Leon M. Leon Techworld, Vikas Publishing House Pvt. Ltd., New Delhi.

11. "Fundamentals of Computers" by Rajaraman V. Prentice Hall of India, New Delhi.

12. "Bioinformatics", by Baldi P. Affiliated East West Press 2003.

13. "Bioinformatics", by Lacroix Z. Elsevier Applied Science Pub. 2004.

14. "Basic Bioinformatics", by lgncimuthu S.J. Narosa 2005.

15. "Bioinformatics Computing", by Bergeron B. Prentice Hall of India 2003.

Course Code: 5101-25 Practical Course III (04 credits)

Course Objectives:

1) To make the students able to perform various serological diagnostic tests.
2) To make students able to isolate and identify some heterotrophic bacteria.
3) To make students able to determine growth patterns of microbial cells.

Course Outcomes:

1) Students will be able to perform and know the applications of various serological diagnostic tests viz. RA, ASO, CRP, SLE etc.
2) Students will be able to isolate and identify some heterotrophic bacteria.
3) Students will be able to study the various growth patterns of microbialcells.

1. Growth curve of bacteria
2. Continuous growth of bacteria

3. Diauxic growth phenomenon in bacteria
4. Synchronous growth of yeast (*Saccharomyces cerevisiae*)
5. Study of :
    - *(i) Escherichia coli*
    - *(ii) Staphylococcus aureus*
    - *(iii) Pseudomonas aerugenosa*
    - *(iv) Proteus vulgaris*
    - *(v) Bacillus spp.*
    - *(vi) Streptococcus species*
    - *(vii) Micrococcus spp.*
7. Detection of β – Lactamase activity in bacterial isolates.
8. Isolation of Fluroscence producing bacteria from marine environment / Fish
9. Detection of HCG in urine.
10. C – reactive protein test (CRP) test.
11. Rheumatoid arthritis (RA) test.
12. Systemic Lupus erythematosus (SLE) test.
13. Anti Streptolysin – O (ASO) test.
14. Complement Fixation (CF) test.
15. Isolation yeasts from fruits.

Course Code: 5101-26 Practical Course IV (04 credits)

Course Objectives:

1) To make students able to isolate and identify different components of living cells and macromolecules.
2) To make students able to isolate drug resistant and nutritionally deficient mutants.
3) To make students able to carry out immobilization of enzymes, microbial cells.

Course Outcomes:

1) Students will be able to identify different components of living cells and macromolecules like DNA, RNA, plasmids and their extraction procedures.
2) Students will be able to perform the isolation of drug resistant and nutritionally deficient mutants.
3) Students will be able to carry out immobilization of enzymes, microbial cells.

1. Isolation of chromosomat DNA from bacteria (*Bacillus megaterium*) by J. Marmer's Method
3. Isolation of RNA from yeast

4. Isolation of DNA from yeast
5. Technique of protoplast fusion in bacteria and plant cells
6. Isolation of auxotrophic mutants in bacteria
7. Transformation in bacteria.
8. Isolation of drug resistant mutants in bacteria
9. Isolation of genomic DNA from E. coli
10. Isolation of chloroplast.
11. Isolation of M itochondria
12. Immobilization of yeast cell
13. Immobilization of yeast enzyme- invertase
14. Synthesis of inducible enzyme Beta galactosidase in ***E.coli***
15. Spectrophotometric determination of nucleic acid purity and concentration .
16. Conjugation in bacteria
17. Preparing Abstract for a given scientific paper
18. Writing a 'Summary and Conclusion for a given Scientific Paper
19. Writing a 'Bibliography' for a given Scientific Paper

Reference Books for Practical course III and Practical course IV

1. "Laboratory manual in Biochemistry", by Jayraman, J., 1998, New age International Publishers, New Delhi.
2. "Experiments in Microbiology, Plant Pathology and Tissue Culture" by Aneja, K. R., 1993, Wishwa Prakashan.
3. "Practical Biotechnology" by P. Ramadass and A. Wilson Aruni, 2007, Jaypee Brothers Medical Publishers (p) Ltd. New Delhi.
4. "Medical Microbiology" Vol. 2, 12th edition, 1975 by Cruickshank, R. Duguid, J. P. Marriman, B. P. and R. A. Swan, Churchill Livingstone, London.
5. "Hand book of microbiological media", by Atlas, R. M., 1993, CRC Press, Inc. Florida.
6. "Manual of laboratory techniques", by Rghumulla, N., Nair, K. M., and Kalyansundaram, S., 2nd edition, 2003, National Institute of Nutrition Press, Hyderabad.
7. "Official methods of analysis of association of official analytical chemists", 15th edition, Association of Official Analytical Chemists, Inc., Virginia, USA.

8. "Illustrated genera of imperfect fungi", by Barnett, H. L., and Hunter, B. B., 3rd edition, 1972, Burgess Publishing Company, Minneapolis, Minnesota.

9. "Compendium of soil fungi", by Domsch, K. H., Gams, W. and Anderson, T. H., 1980, Academic Press, London.

10. "Standard methods for the examination of water and waste water", 20th edition, edited by Greenberg, et al., 1998, APHA, AWWA, WEF, Washington, DC.

11. "An Introduction to practical Biochemistry", by D. T. Plummer, 2005, Tata McGraw – Hill Publication.

12. "Microbiological applications", by Benson, H. J., 6th edition, 1994, Wm. C. Brown Publishers, Dubuque, Iowa.

13. "Identification methods for Microbiologists", edited by Gibbs, G. M. and Shapton, D. A., 1968, Academic Press, London.

14. "Microbiological applications", by H. J. Benson, 6th edition, 1994.

15. "Methods in Microbiology", Vol. 5 edited by Norris and Ribbons, Academic Press, London.

16. "Text book of Practical Microbiology", by Subhashchandra Parija first edition 2007, Ahuja publishing House, Delhi.
17. "Practical Biotechnology", by S. Janarthanan, S. Vincent, 2007, University Press pvt. Ltd., Hydrabad.
18. "Practical Microbiology", by R. C. Dubey, D. K. Maheshwari, 1st edition, 2002, S. Chand & Company Ltd.

Skill Enhancement Compulsory Course (SECC)

02 A Soft Skills and Personality Development (02 Credits)

PREAMBLE:

Soft skills comprise pleasant and appealing personality traits as self confidence, positive attitude, emotional intelligence, social grace flexibility, friendliness and effective communication skills. Personality development is the relatively enduring pattern of the thoughts, feelings and behaviors that distinguish individuals from each other.

OBJECTIVES:

1) To motivate and guide students towards goal setting and planning of career.
2) To make students able to cope up with the stress rescuing from conflicts.
3) To enhance student's communicative abilities.
4) To enhance student's presentation skills.

Unit I

- **Planning and Goal setting:**

  Five skills needed to achieve carrier goals: Human perceptions, Understanding people types of soft skills.Types of soft skills

Need for achievement and Spiritual Intelligence, Developing potential and self actualization

Unit II

- **Conflicts and stress:** Types of conflicts, conflict resolution skills, Types of stress, causes of stress, effects of stress and regulating the stress Habits – Good and Bad habits, Forming Habits of success, Breaking bad habits.

Unit III

- **Communication skills**- Communication cycle advanced and essentials,
  Basic telephonic skills.
  Communication barriers- Interpersonal transactions, mis communication
  Technology and Communication- E-mail- Principle, Netiquettes, E-mail etiquettes

Unit IV

- Presentation skills: Overcomimg fear, Becoming a professional, the role of body language, effective reading and using visuals.

Reference Books

1) Personality development and Soft skills by Barun K Mitra, second edition, Oxford Higher Education.2.
2) "Communication skill", by B.V. Pathak First edition, Nirali Prakashan, Pune (India) 2006
3) "A Handbook of Communication skills in English" by R.A.Kulkarni, First edition, Phadke Prakashan, Kolhapur (India) 2001.
4) "Communication skill" by Anjali Ghanekar, 1996, Everest publishing house.

M. Sc. Part II Semester III

Course Code: 5101-31 Environmental Biotechnology (04 Credits)

Course Objectives:

1) To make the students understand the various methods of Biomagnification and Eutrophication, microbial bioleaching of ores, bioremediation processes by microorganisms and their applications in degradation of xenobiotics.

2) To make the students familiar with basic concepts and basic design of biosensors.

3) To give the students detail knowledge about the solid waste treatment methods and liquid waste treatment methods & various aspects of waste disposal & control and ISI standards and CPCB(Central pollution control board)standards for discharge of treated of waste water effluents.
4) To make the students competent in various aspects of environmental microbiology and make them familiar with current research in environmental microbiology.

Course Outcomes:

1) Competently explain various aspects of environmental microbiology and microbial ecology to become familiar with current research in environmental microbiology

2) Student will be able to understand the various methods of microbial bioleaching of ores, bioremediation processes, microbial degradation of xenobiotics and their environmental hazards.
3) Students will be well versed with basic concepts and basic design of biosensors, their principles and their applications.
4) Students will have detail knowledge about the solid waste treatment methods and liquid waste treatment methods & various aspects of waste disposal & control.

Unit I (12)

- **Ecology : The interconnecting web of Life**

  The organization of ecosystems , Energy and nutritional flow in ecosystem – Food chain (Energy Pyramid) and food web.

- **Biosensors & their applications in** monitoring environment : Basic concepts, basic design and principles involved, Types of biosensors, Applications of biosensors in monitoring environment.
- **Microbial degradation of Xenobiotics.**

Unit II (12)

- **Treatment of industrial effluents and municipal waste:**

i) Biological treatment of Industrial waste and Pollutants

Solid Waste disposal - microbiology of land fills, backyard & commercial composting

Treatment of Liquid waste- Primary and secondary treatment of waste- Aerobic, Oxidation ponds, anaerobic lagoons, anaerobic digesters, trickling filter system, rotating biological contactor (Biodisc systems), Activated sludge process.

Tertiary treatment of waste – Use of chemicals, activated carbon filters, reverse osmosis.

Final treatment of Waste – Disinfection.

Unit III (12)

- **Energy and Fuel :**

i) Renewable and Non renewable resource of energy.

ii) Conventional fuels and their environmental impact

iii) Modern fuels and their environmental impact – Biogas (Methane), Microbial Hydrogen Production, Bioethanol, Bio diesel.

- Applications of Nonconventional and renewable energy sources.

- **Nanotechnology and it's application in environmental and health & energy management :**

Introduction, Fundamentals concepts, Applications in Environmental and Health Management Microorganisms of interest to Nanotechnologist Diatomus, Magentotactic bacteria, Nanobiotechnology and viruses

Unit IV (12)

- **Bioleaching**

i) Recovery of Metals: Copper bio leaching, Uranium bioleaching and Gold Bioleaching.

ii) Oil recovery

- **Bioremediation:**

i)Principal Approaches in bioremediation of environment.

Stimulating biodegradation: Stimulating hydrocarbon degradation in water and soil.

ii) Use of microorganisms in bioremediation :

iii)Phytoremediation : phytoextraction, phytodegradation, Rhizofiltration, Phytostabilization, Phytovolatilization.

Unit V (12)

- **Waste Disposal control and regulations.**

i) Regulatory bodies- state level, national level and international level

ii) Water Pollution control, board regulation- Limits for disposal of waste into lakes, rivers, Oceans and Land.

iii) Environmental impact assessment (EIA) and environmental audit (EA).

- ISI (Indian Standard Institute) Specification for drinking water.
- CPCB (Central pollution control board)standards for discharge of treated of waste water effluents.

Reference Books:

1. "Microbial degradation of Xenobiotic and Recalcitrant compounds", edited by Lehninger T.et al. 1982, Academic press, New York.

2. "Microbial Ecology: Priciples, methods and applications", by Levin MA, RJ Seidler,M Rogne: 1991, Mc Graw-Hill, New York.

3. "Microbial Ecology", by Lynch JM and J.E Hobbie, 1988, Blackwell scientific, Boston.

1. "Biotechnology for Biological Control of Pests and Vectors",, 1991 CRC press, Boca Raton, FL.

2. "Environmental microbiology" edited by Mitchell, R., 1992, John Wiley, New York.

3. " Methods in Microbiology " vol. 22, - Techniques in microbial Ecology" edited by Norris JR and Grigorova, 1990.

4. "Aquatic Microbiology" by Rheinheimer, G. 4th edition, 1991, John Wiley and Sons, New York.

5. "Environmental Biotechnology for Waste treatment", by Sayler G.S., R.Fox, J .W. Blackburn, 1991, Plenum Press, New York.

6. "Principles of Microbiology", by Atlas, R.M., 1995, mosby-year book, inc. St. Louis, Missouri.

7. "Petroleum Microbiology", by Atlas, R.M. 1983, Macmillan, New York.

8. "Microbial Mineral Recovery", edited by Ehrlich H.L. and C.L. Brierley 1990, McGraw-Hill, New York.

9. "Prescott, Harley and Klein's Microbiology" by Wlley J.M, Sherwood L.M, and Woolverton C.J, 2008, Mc Graw- Hill companies Inc. New York

10. "Bacterial Biogeochemistry: The ecophysiology of mineral cycling" by Fenchel, T.; King, G .M ; and Blackburn, T .H 1998, academic press, New York.

11. "Environmental Biotechnology: principles and application" by Rittmann, B E and Mc Carty, P L 2001, Mc Graw- Hill, New York.

12. " Manual of Environmental Microbiology" by Hurst, C J ; Crawford, R.L.,R L , Knudsen, G. R., Mc Inerney, M. J. ; and Stetzenbach , L.D. 2002, ASM press, Washington, D. C.

Course Code: 5101-32 Plant Tissue culture (04 Credits)

Course Objectives:

1) To make the students understand the basic concepts of plant tissue culture , asceptic techniques ,cell growth requirements and principles of plant tissue culture
2) To give the students knowledge about micropropagation techniques in plant tissue culture.
3) To make the students conversant with the basic layout and design ,equipment requirements of plant tissue culture laboratory and contamination problems in plant tissue culture and their control and make them trained in the required expertise for working in a commercial plant tissue culture laboratory.

Course Outcomes:

1) Students will get thorough knowledge about the basic concepts of plant tissue culture , asceptic techniques ,cell growth requirements and principles of plant tissue culture
2) students will know the basics of micropropagation technique in plant tissue culture.
3) students will become conversant with the basic layout and design ,equipment requirements of plant tissue culture laboratory and contamination problems in plant tissue culture and their control
4) students will get trained in the required expertise for working in a commercial plant tissue culture laboratory
5) Students will know about different plant transformation technologies.

Unit I (12)

- **Plant cell and Tissue culture Technology:**

Introduction, Practical aspects of Plant Tissue Culture, Preliminary design of a plant tissue culture Laboratory, General Laboratory design of plant tissue culture, Equipments, Glassware and plastic ware. General information about tissue culture as a technique to produce novel plants and hybrids.

- **Cell and Tissue culture Techniques :**

Plant Tissue Culture: Media preparation, components, sterilization, Aseptic Techniques. Contaminants and their sources, detection of contaminants, Laboratory safety. Different types of culture - Embryo culture, organ culture, Callus culture, Meristem culture, Cell suspension culture, Anther, Pollen and Ovary culture.

Unit II (12)

- **Micropropagation : Principles and practices :**

Introduction, methods of Micropropagation, *in vivo* propagation, advantages and disadvantages of micropropagation, stages of micropropagation, commercial micropropagation. Advantages of tissue culture techniques over conventional methods for crop improvement.

- **Anther Pollen and Ovary culture :**

Anther and Pollen culture, Parameters to be consider for successful anther culture, General Anther culture procedure, *In vitro* pathways of Androgenesis, Applications of haploids in agriculture, Ovule / Ovary culture

- **Protoplast culture and somatic hybridization :**

Introduction, Isolation and culture of plant protoplast, Protoplast isolation, Protoplast fusion, Somatic cell hybridization (cybrid). Practical applications of protoplast technology.

Unit III (12)

- **Chromosome Analysis in Plant Tissue Culture:**

Introduction, Pretreatment, Fixation, Staining, Preparation of stains, General Protocol for Chromosome study, Preparation of Permanent Slides, Nuclear Staining Protocol for Plant Protoplasts, Chromosome Preparation from Cell Suspension Culture, Technical Terms – Squash and Smear, Karyotype, Karyogram and Idiogram.

- **Molecular markers and their applications in plant species :**

Morphological markers, Biochemical markers, DNA – Based markers – hybridization based markers ; RFLP, Hybridization using multilocus probes, PCR based markers – RAPD,

AFLP, Transposon markers, Specific sequence based markers (STS / SCAR / STMS) .
Markers for the future. Application of molecular markers.

Unit IV **(12)**

- **Plant Transformation Technology and It's Applications:**

(i)Vector mediated gene transfer – *Agrobacterium* mediated transformation, Virus mediated gene transfer, vectorless or direct gene transfer – Chemical gene transfer methods, Physical gene transfer methods

(ii) Laser micropuncture and whole tissue electroporation

Transgenic research in India, Biosafety – Definition of GMOs , Advanced informed agreement Procedure (AIA), Labeling and segregation, Commodities, Transit, Pharmaceutical LMOs.The Miami group. Regulatory mechanisms in India. Categories of genetic engineering experiments on plants.

(iii) Genes and traits – Increased crop yield, Tolerance to abiotic stress, Resistance to biotic stress, Better crop characteristics. Other applications – Plant based drugs, Edible vaccines and plantibodies, therapeutic proteins. Genes for novel traits: Production of secondary metabolites, Toxin free castor oil, Low lignin wood for paper production, Transgenic plants as biosensors

(iv)Transgenics - Introduction, Benefits and important achievements, Horizontal gene transfer, Molecular farming, Green fluorescent protein (GFP)

Unit V **(12)**

- **Synthetic seeds :** Encapsulation agents and Encapsulation methodologies, Applications.
- **GM Technology and biosafety regulations :** Need, Benefits and Risks of GM Technology, GM food crops, GM non food crops

Reference Books :

1. "Biotechnology – Principles and Applications", by S.C. Rastogi, 2007, Narosa publishing house Pvt. Ltd., New Delhi.
2. "Pharmaceutical Biotechnology", by S. S. Purohit, N. H. Kakrani and A.K. Saluja, 2007, Agrobios (India) Jodhpur.
3. "Plant tissue culture – Basic and Applied " by Timir Baran Jha and Biswajit Ghosh, 2005, Universities press (India) Pvt. Ltd. Hyderabad.
4. "Plant Biotechnology: Methods in tissue culture and gene transfer", Edited by R. Keshavachandran and K.V. Peter, 2008, Universities Press, Hyderabad
5. "Elements of Biotechnology", by P. K. Gupta, 2008, Rastogi Publications, Meerut.

6. “Molecular Biotechnology – Principles and Practices”, by Channarayappa, 2007, Universities Press (India) Pvt. Ltd. Hyderabad.

Course Code: 5101-33 Industrial Fermentations (04 Credits)

Course Objectives:

1) To make the students well versed with the screening techniques, Microbial assays, Primary & secondary metabolites.
2) To make the students gain the knowledge of design of fermentors, types of fermentors , equipments, instruments used, sterilization processes, fermentation media, innoculum preparation, Scale up processes
3) To make the students know about the various downstream processes of fermentation industries

Course Outcomes:

1) Students will get introduced with protein structure prediction and drug designing.
2) Students will be well versed with the screening techniques, Microbial assays, Primary & secondary metabolites.
3) Students will gain the knowledge of design of fermentors, types of fermentors , equipments, instruments used, sterilization processes.
4) Students will well versed with fermentation media, innoculum preparation, Scale up processes
5) Students will be well versed with the various downstream processes of fermentation industries

Unit I (12)

- **Screening Programmes in fermentation industries:**

  Primary screening and secondary screening; lab scale, pilot plant, scale up

- **Industrially important metabolites of microorganisms**:

  Primary metabolites and Secondary metabolites.

- **Introduction to fermentation technology**:

  Fermentation – Definition and concept,

  Fermentation products produced and microorganisms used in fermentation Industry: Primary metabolites, secondary metabolites, enzymes, other metabolites.

  Batch fermentation and Continuous fermentation- Process, advantages and disadvantages.

  Overview of important metabolic pathways of microorganisms-EMP, PPP, EDP.

Unit II (12)

- **Designing of fermentation media in fermentation industry:**

Raw materials (Principal Substrates): Carbon and nitrogen sources, Nutrient supplementation, Inducers, Repressors, Precursors.

- **Design of a Typical Industrial Fermenter:**

  (i) Common features of typical (conventional) fermenters, ancillary equipments required for fermentation process.

  (ii) **Newly developed fermenters**: Airlift fermenter, modified Airlift fermenter, Hollow fiber fermenter, fluidized bed fermenter, bubble column fermenter.

- **Computer application in fermentation technology**

Unit III (12)

- **Inoculums Preparation:** Steps in inoculum development, critical factors- quantity and reproducibility Detections and contamination.
- **Fermentation process:** Factors controlling fermentation, fermenter operation.
- **Contamination problems in fermentation industry, and their control**.

Unit IV **(12)**

- **Typical fermentation processes:**

Industrial fermentations of: Ethanol, Lactic acid, L-lysine, Streptomycin, Gibberellins.

- **Economics of fermentation processes**

Unit V **(12)**

- **Microbiological Assays:**

Agar diffusion methods, Liquid culture (turbidity measurement) methods, metabolic activity measurement methods.

- **Downstream processing**

Introduction, Stages in the isolation and purification of products – Solid Liquid separation – Filtration, centrifugation, Pretreatment release of intracellular components – Disruption of microbial cells, homogenization of animal /plant tissues Concentration of biological products-Evaporation, liquid - liquid extraction, membrane filtration, precipitation, adsorption of chromatographic particles, purification by chromatography, product formulation, monitoring of downstream processing ,process integration.

Reference Books:

1. "Prescott and Dunn's Industrial microbiology" edited by Reed, G., 4th edition, 1982." Industrial microbiology" by Miller,B.M., and W. Litsky, 1976 Mc Graw-hill, New York.

2. "Pharmaceutical microbiology" edited by Hugo, W.B. and A.D. Russell 1977, Blackwell scientific, oxford.

3. "Biotechnology:A textbook of industrial microbiology" by Crueger, W.and A. Crueger,1982, Sinauer Associates, Inc., Sunderland, Mass.

4. "Biotechnology and its applications in pharmacy" by Giriraj Kulkarni T, 1st edition, 2002, Jaypee Brothers medical Publishers (P) Ltd, New Delhi.

5. "Methods in Industrial Microbiology" by B. Sikya , 1983 Ellis Horwood ltd.

6. "Industrial Microbiology" by L.E. Casida,John Witey and Sons Inc.

7. Industrial Microbiology by A.H Patel, Mac millan India ltd.

8. Microbial Technology vol I&II by M.J Peppler and D. Perlman, Academic Press, London.

Course Code: 5101-34 Bioinformatics for Biotechnologist (04 Credits)

Course Objectives:

1) To give the students the basic knowledge about computers, operating system, internet resources.
2) To acquaint the students with the various important tools and techniques of information technology, Metabolimics and Phylogenetic analysis .
3) To make the students understand the basics of biological databases, Methods of sequence alignment, Genomics & Proteomics, Protein structure prediction & drug designing.

Course Outcomes:

1) Students will acquire the knowledge of computers, operating system, internet resources
2) Students will get introduced with tools and techniques of information technology, Metabolimics and Phylogenetic analysis .
3) Students will acquire the knowledge of biological databases, Methods of sequence alignment, Genomics and Proteomics
4) Students will get introduced with basic of 'C' language and structured query language.

Unit I (12)

- **Fundamentals of Computers:**

i. Internet: Resources, World Wide Web, Tools associated and terminologies.

ii. Computer Viruses: Overview, Transmission and Precautions.

- **Introduction to Bioinformatics**
- **Introduction to databases:**

Databases: Primary, Secondary; Relational and Non relational; Redundant and Non Redundant.

1. E-R Model

a. Entity and Entity sets
b. E-R Diagrams
c. Reducing E-R diagram to tables

2. Introduction to SQL

a. Select statement
b. Data definition Statements
c. Data manipulation statements

Unit II (12)

- **Biological Databases:**

1. Bioinformatics Resources: NCBI, EBI, ExPASY
2. Biological search Engines: SRS and ENTREZ
3. Biological Databanks: PDB, MMDB.
4. Derived, Databases: PROSITE, Pfam, PRINTS, CATH, SCOP, DSSP, FSSP, DALI.
5. Nucleic Acid databases and Protein databases:
6. Immunoinformatics databases.

Unit III (12)

- **Biological Data Analysis:**

1. Overview, Concepts and tools.
2. Sequence comparision by DotMatrix and Dynamic Programming.
3. Pairwise Sequence Analysis by Needleman and Wunch algorithm
4. Scoring Matrices: PAM, BLOSSUM
5. Database Search: BLAST and FASTA

6. Multiple Sequence Alignment: Basic concepts, Progressive and Hierarchial approaches CLUSTAL-W, Applications.

Unit IV (12)

- **Genomics** – Objectives, overview of genome comparison.
- **Proteomics** – Introduction, Objectives and applications**.**
- **Metabolimics: -** Introduction**,** Objectives and applications**.**
- **Introduction to Phylogenetic analysis**

Unit V (12)

- **Protein structure prediction:**
  i. Necessity of Protein structure Prediction
  ii. Secondary structure prediction
  iii. Fold Recognition
  iv. Homology Modeling
  v. Ab-initio Methods
- **Structure based Drug Design:**
  i. Process of Drug design and Development
  ii. Molecular Docking
  iii. Virtual screening
  iv. QSAR Pharmacophore mapping

Reference books:

1**.** "Fundamental concepts of Bioinformatics", by Krane, D.E. and Raymer, M.L.2003, Benjamin cunning, San Francisco, Calif.

2. "Discovering genomics, proteomics and Bioinformatics", by Campbell, A.M, and Heyer, L.J., 2003, Benjamin cunnings, San Francisco, CA.

3."Introduction to SQL and PLSQL", by Ivan Dayross".

4. "Bioinformatics", by C.S.V. murthy, 2003, Himalaya Publishing House, Mumbai.

5. "Introduction to computers", by Leon A. and Leon M. Vikas Publishing House Pvt., New Delhi.

6. Fundamentals of computers by Rajaraman, V. Printice Hall of India, New Delhi.

Course Code: 5101-35 Practical Course V (04 Credits)

Course Outcomes:

1) Students will be able to understand the setting up and operating a plant tissue culture laboratory.
2) Students will get acquainted with basic hands on skills for in vitro plantlet manipulation in micropropagation techniques.
3) Students will be able to independently search, store, retrieve and analyze the biological data.

Course Objectives:

1) To make the students understand the setting up and operating a plant tissue culture laboratory
2) To make the students get acquainted with basic hands on skills for in vitro plantlet manipulation in micropropagation techniques
3) To allow the students independently search, store, retrieve and analyze the biological data.

1. Computer :

(i) Introduction to Computer system – components and function.

(ii) Introduction to word processing and spreed sheet application – M.S. Word, M.S. Excel, Power Point.

(iii) Getting started with Internet and search Engines - creating personal E. Mail, using Google.

2. Bioinformatics :

(i) Creating and Populating data base- M.S. Access.
(ii) Retrieving protein and nucleic acid databases
(iii) Single and Multiple sequence alignment using BLAST / CLUSTAL / CLUSTAL W
(iv) Constructing phylogenetic Trees
(v) Retrieving protein and nucleic acid databases
(vi) Data base searching – Using Blast.

3. Plant Tissue Culture:

(i) Laboratory equipments for plant tissue culture
(ii) Study of asceptic techniques in plant tissue culture laboratory
(iii) Preparation of media for plant tissue culture
(iv) Callus Culture
(v) Suspension Culture
(vi) Isolation of plant protoplast and culture
(vii) Anther culture
(viii) Protoplast Fusion
(ix) Micropropogation
(x) Isolation of plant DNA using CTAB extraction method.

Course Code: 5101-36 Practical Course VI (04 Credits)

Course Objectives:

1) To make the students perform the screening of industrially important microbial strains like organic acid producers, antibiotic producers, amine producers, enzyme producers .
2) To enable the students determine BOD and COD removal efficiency of waste water treatment plant
3) To make the students produce biofertilizer (Azo, Rhizo) on the laboratory scale.
4) To make the students able to work in fermentation industry particularly in production units, micro-labs and Quality Control departments.

Course Outcomes:

1) Students will be able to screen out industrially important microbial strains like organic acid producers, antibiotic producers, amine producers, enzyme producers .
2) Students will be able to determine BOD and COD removal efficiency of waste water treatment plant
3) Students will be able to produce biofertilizer (Azo, Rhizo) on the laboratory scale.
4) Students will be able to work in fermentation industry particularly in production units, micro-labs and Quality Control departments.

1. Isolation of ***Azotobacter Spp*** and ***Rhizobium Spp.***
2. Isolation of phosphate solubilizing bacteria from their natural habitat.
3. Screening of antibiotic producers.
4. Screening of organic acid producers.
5. Biomass production-Production of Azotobacter and Rhizobium fertilizers.
6. Determination of BOD.
7. Determination of COD.
8. Digested slurry analysis –
   i) pH
   ii) Total volatile solids.
   iii) Total acidity.
   iv) Total alkalinity
   v) Volatile acid.
   vi) Organic carbon.
   vii) Phosphoric acid.
9. Bioassay of vitamin B_{12}
10. Production of Vitamin B 12.
11. Production of Tannase by solid state fermentation
12. Production of Probiotics.
13. Demonstration of indole acetic acid(IAA) production by soil fungi.

Reference Books for Practical Courses

1. "Bioinformatics", by C.S.V. Murthy 1st edition publishers Himalaya Publishing House, Mumbai.

2. "Fundamentals of Computers" by Rajaraman, V. Printice Hall of India, New Delhi.

3. Computer Fundamentals by Pradeep k Sinha and Priti Sinha, 2003 (Reprint 2005) BPB Publications, New Delhi.

4. "Bioinformatics" Methods and Applications by S. C. Rastogi, N. Mendiratta, and P.Rastogi,2008, PHI Learning Private Ltd, New Delhi.

5. "Experiment in Microbiology, Plant Pathology and Biotechnology" by K. R. Aneja, First edition, 2003 (Reprint 2008), New age International (p) Limited, Publishers, New Delhi.

6. "Practical Biotechnology" by S. Janarthanan and S. Vincent 2007, Iniversities Press (India) Pvt. Ltd., Hyderabad.

7."Practical Biotechnology" by P. Ramadass and A. Wilson Aruni, 2007 Jaypee brothers Medical Publishers (P) Ltd., New Delhi.

8. "Plant tissue culture – Basic and Applied" by Timir Baran Jha and Biswajit Ghosh, 2005, Universities press (India) Pvt. Ltd. Hyderabad.

9. "Molecular Biotechnology – Principles and Practices" by Channarayappa, 2007, Universities Press (India) Pvt. Ltd. Hyderabad.

10. Laboratory Manual in "Industrial Biotechnology" by P. Chellapandi, 2000, Pointer Publishers, Jaipur.

11. "Practical Microbiology" by R. C. Dubey and D. K. Maheshwari, 1st edition, 2007,S. Chand and Company Pvt. Ltd., Ramnagar, New Delhi.

Ability Enhancement Compulsory Course (AECC)

03 Leadership Development (02 Credits)

PREAMBLE:

Leadership is important to the success of organizations and socities. Leaders are made, not born, for the situation at hand. Leadership is the ability to get people together to solve the problems.

OBJECTIVES:

) To give students knowledge about how to do team work & lead the team.

2) To train the students for wise and prompt decision making ability.

3) To develop the student's to handle the workload effectively.

Unit I

- Introduction to leadership, functions of leadership, theories.

Unit II

- Leadership types- Effective leadership, successful management, leadership behaviors- Emergence, leadership and trust, Transformation leadership.

Unit III

- Leadership Skills- leadership and management, competencies and skills of leaders, leaders in action.

Unit IV

- Institution Building in framework and issues Institution building.

Reference Books:

1. Leaders Eat Last (Hardcover) by Simon Sinek (Goodreads Author) published 2013

2. The 7 Habits of Highly Effective People: Powerful Lessons in Personal Change (Paperback) by Stephen R. Covey published 1988

3. Leading Change (Audiobook) by John P. Kotter (Goodreads Author) published 1988

M. Sc. Part II Semester IV

Course Code: 5101-41 Enzyme Technology (04 Credits)

Course Objectives:

1) To make the students conversant about enzymes, enzyme catalysis, rate of reactions, order of reactions, kinetics of enzyme catalysed reactions and enzyme inhibitions and their regulatory processes.
2) To give the students knowledge about immobilization of enzyme applications of enzymes and future potential uses of enzymes.
3) To make the students gain the knowledge of enzymes in wide variety of fields.

Course Outcomes:

1) Student would able to describe structure, functions and the mechanism of action of enzymes, kinetics of enzyme catalysed reactions and enzyme inhibitions and their regulatory process.
2) Students would understand the methods of immobilization of enzyme and applications Of immobilized enzymes.
3) Students would be well versed with methods of large scale production of enzymes.
4) Students will have thorough understanding of the rate of reactions, order of reactions , inhibitions and their kinetics.
5) Students would gain the knowledge of enzyme catalysis, isoenzymes, multienzymes and multienzyme complexes

Unit I (12)

- **Enzymes –** Structure, Function , Mechanism of action and Nomenclature and Classification of enzymes
- **Active site of enzyme and the investigation of active site structure :**

The active site of enzyme, The identification of binding site and catalytic sites, The investigation of three dimensional structures of active site and mechanisms of action of enzymes on the substrates.

- **Artificial Enzymes.**

Unit II (12)

- **Enzyme Kinetics** :

Introduction of chemical kinetics, Basic concept of catalysis activation energy barrier and the transition state theory. Kinetics of single substrate enzyme catalysed reactions, kinetics of multi substrate enzyme catalysed reactions, sigmoidal kinetics and allosteric enzymes, the significance of sigmoidal behaviour. Enzyme inhibition – Types of inhibitions : Competitive, non-competitive and uncompetitive, modes of action of inhibitors.

Unit III (12)

- **Structure function relationships of enzymes:** Lysozyme, ribonuclease, trypsin, carboxypeptidase, phosphorylase aspartate transcarbamylase, glutamine synthetase and phosphofructo kinase, multi enzyme complexes – pyruvate dehydrogenase and fatty acid synthetase.

- **Regulation of Enzymes:** Enzyme induction and repression, feed back inhibition, covalent modification, Allosteric regulation of enzymes, models proposed to explain the mechanisms.

Unit IV (12)

- **Productions of Enzymes by fermentation :**
  (i) Introduction, sources of enzymes–enzymes from plant and animal sources, and enzymes from microbial sources.
  (ii) Large scale production of enzymes: Solid-state fermentations and submerged fermentations, Glycosidase : Bacterial α amylases and fungal α amylase, Glucose Oxidase, Glycosyl transferases, Glucose isomerase
  (iii)Recovery of enzymes: Recovery of extra cellular and intracellular enzymes, isolation of soluble enzymes.
  (iv) Purification of enzymes: Enzymes precipitation, chromatographic separation of enzymes.

Unit V (12)

- **Enzyme Engineering:** Methods, Recent advances in rationale approaches for enzyme engineering

- **Genetic Engineering in enzyme technology:** Applications of genetic engineering in enzyme technology, Legislative and safety aspects of genetically modified (GM) enzymes.

Application of enzymes :

Enzymes in medical diagnosis : Lactate dehydrogenase, Malate dehydrogenase, Glu–6–biphosphatases, acid and alkaline phosphatase, Glu–6–phosphate dehydrogenase .

i. Enzyme in therapy : Cancer and genetic diseases, clotting disorders, respiratory disorders,
ii. Enzyme in industry - synthesis of chemicals using enzymes.
iii. Enzymes and Biosensors.
iv. Applications of Enzymes in food industry.

Reference Books :

1. “Understanding Enzymes”, by T. Palmer, Ellis Horwood limited.
2. Lehninger “Principles of Biochemistry”, by David L. Nelson and Michel M. Cox, 4th edition, 2005 W. H. Freeman and Co. New York.
3. “Pharmaceutical Biotechnology” by S.S. Purohit, H.N. Kakarni and A.K. Saluja, Agrobios (India).
4. “Basic Biotechnology” edited by Colin Ratledge and Bjorn Kristiansen, 2001, Cambrige University, Press, New York.
5. “Enzyme Biotechnology” by G. Tripathi.
6. “Fundamentals of Enzymology”, 2nd edition, by Nicholas C. Price and Lewis Stevens, 1989, Oxford University press, New York.
7. “Enzymes – Biochemistry, Biotechnology and Clinical Chemistry”, by Trevor
8. Palmer and Philip Borner, First East – West Press edition, 2008, Affiliated East – West Press Private Limited, New Delhi.

Course Code:5101-42 **Animal Tissue Culture** **(04 Credits)**

Course Objectives:

1) To introduce the students about the basics of animal tissue culture techniques, chemically defined and serum free media, techniques of maintenance & preservation of animal cell cultures & various types of cultures.
2) To give the students thorough knowledge about primary and secondary cell line, safety measures in laminar hood with levels of safety.
3) To make the students understand about stem cells, types of stem cells and applications of stem cells and IVF technology.
4) To give students knowledge about laboratory design & layout and equipments of Animal tissue culture laboratory.

Course Outcomes:

1) Student will get introduced to basics of animal tissue culture techniques, media used in Animal cell cultures
2) Students will get conversant with the techniques of maintenance & preservation of animal cell cultures, cell separation methods and cell quantitations.
3) Students will also gain thorough knowledge about primary and secondary cell line, safety measures in laminar hood with levels of safety.
4) Students will learn about laboratory equipments and laboratory design, stem cell technology and IVF technology.

Unit I (12)

- **Design and Layout of the Laboratory:**

Sterile handling area (Laminar flow), Incubation (Hot room), Service Bench, Preparation, Wash –up , Storage, Construction and Layout.

- **Equipping the Laboratory :**

i) Essential equipments: Incubator, Incubation temperature, sterilizer, Refrigerators and freezers, Microscope, Washing-up Equipment, Sterilizing and Drying Oven, water purification, centrifuge, cell freezing.

ii) Beneficial Equipments : Laminar flow hood, cell counter, Vacuum pump, CO_2 incubator, Preparation and quality control, Upright microscope, Temperature recording, magnetic stirrer , Roller racks, pipette aids and automatic pipetting , Mechanical aids and Automation.

iii) Useful additional Equipment: Low- temperature freezer , Glassware washing machine, closed circuit TV , colony counters, cell sizing, Time-Lapse cinemicrography/ Time Laps recording, confocal microscopy, controlled –rate cooler, centrifugal Elutriator, Flow cytophotometer.

iv) Consumable items: pipettes, culture vessels.

- **Aseptic technique:**

Objectives of aseptic techniques, quiet area, work surface, personal hygiene,

pipetting, Sterile handling (swabbing, capping, flaming, pouring) , Laminar flow, standard procedure.

Unit II (10)

- **Laboratory safety and Biohazards:**

  General safety Glassware and sharp items, chemical toxicity, gases, liquid N_2, Fire, radiation, Biohazard.

- **Bioethics –** Animal tissue, Human tissue, Validation

- **The culture environment, Substrate, Gas phase, Medium, Temperature.**

  The substrate, The gas phase, Media and supplements, Physical properties, Constituents of media, Defined media, serum, Serum-free media, Selection of medium and serum.

Unit III (12)

- **Disaggregation of the Tissue and primary culture:**

  Isolation of the tissue, Primary culture.

- **Cloning and selection of Specific Cell Types:**

  Cell Cloning, Stimulation of plating efficiency, Suspension cloning, Isolation of clones, Replica plating, Selective media, Selective inhibitors, Isolation of Genetic Variants, Interaction with substrate.

Unit IV (12)

- **Three dimensional culture Systems (Techniques):**

  Introduction, Organ Culture- Historical development of organ culture, organ culture, Histotypic culture, filter wells, Embryo culture, Applications of IVF and embryo transfer

- **The Transformed Phenotype and Culture of tumor tissue:**

  (i) Transformed Phenotype: Anchorage independence, Genetic abnormalities, cell products and serum dependence, Invasiveness, Tumorigenesis.

  (ii) Culture of Tumor tissue : Sampling, Disaggregation, Primary culture, Characterization, Development of cell lines, General method, Selective culture.

- **Contamination Problems and their Control**

Unit V (12)

- **Quantitation, Measurement of Cytotoxicity and Viability:**

  (i) Quantitation: Cell counting, Cell weight, DNA and protein content

  (ii) Measurement of Cytotoxicity and Viability: Viability, Toxicity and survival, Invitro Limitations, Nature of the Assay, Application of Cytotoxicity Assays, Transformation and Mutagenesis, Inflamation.

- **Application of Animal Cell Culture:**

i) Stem cell technologies :General and Historical, Properties of stem cells, Types of stem cells- Embryonic stem cells, Human Embryonic Germ Cells(HGCs),Adult Stem Cells(ASCs), Role of stem cells in Tissue Homeostasis, Advantages and Disadvantages of ASCs, Stem Cell Divisions, Role of stem cells in medicines, Ethical concerns of stem cell research, guidelines for use of stem cells, Future of stem cell research.

ii) Tissue Engineering**:** Historical, Strategies-cells, Engineering materials, Development in Tissue Engineering

iii) Pharmaceutical useful products.

Reference Books:

1. "Pharmaceutical biotechnology", by S.S. Purohit, H. N. Kakarani and A.K. saliya, 2007, Agrobios (India) Jodhpur.
2. "Biotechnology - Principles and applications", by S.C. Rastogi, 2007, Narosa Publishing house Pvt. Ltd. New Delhi
3. "Culture of animal cells A manual of Basic Technique", R. Ian Freshney, second edition, 1987, Wiley – Liss, Inc., New York.
4. "Principles and Techniques of Biochemistry and Molecular Biology", edited by Keith Wilson and John Walker, Sixth edition, 2006, Cambridge University press, New York.
5. "Molecular Biology", by Glick, B. R. and Pasternak J. J. 3rd edition, 2003, ASM Press, Washington D.C.
6. "Biotechnology-Principles and applications", by Rastogi, S.C., 2007, Narosa Publishing House, Pvt. Ltd. New Delhi.
7. "Culture of animal cells A manual of Basic Technique", R. Ian Freshney, fifth edition, 2005, Wiley – Liss, Inc., New York.
8. "Essentials of Biotechnology", by R.C. Sobti and Suparna Pachauri ,2009, ANE Books PVt. Ltd. New Delhi.
9. "In Vitro cultivation of Animal cells", (A book in BIOTOL – series) published by Butterworth – Heinemann an print of Elsevier.

Course Code: 5101-43 Recombinant DNA Technology (04 Credits)

Course Objectives:

1) To give the students the knowledge of basic principles and methods of recombinant DNA technology, construction and screening of genome libraries and c DNA libraries.
2) To give the students thorough knowledge about advanced techniques used in rDNA technology like PFGE, RFLP, RAPD etc.
3) To make the students acquire knowledge about applications of recombinant DNA technology in the field of medicine and industry
4) To impart the basic understanding of gene therapy systems, protein engineering and metabolic engineering and ethical issues involved in genetic engineering to the students.

Course Outcomes:

1) Students will be imparted with the knowledge of basic recombinant DNA technology.
2) Students would get knowledge about construction and screening of genome libraries and c DNA libraries.
3) Students will get a thorough knowledge about advanced techniques used in rDNA technology like PFGE, RFLP, RAPD etc.
4) Students would know about applications of recombinant DNA technology in the field of medicine and industry
5) Students will have the basic understanding of gene therapy systems, protein engineering and metabolic engineering
6) Students will also have a insight into the ethical issues involved in genetic engineering

Unit I (12)

- **Basics of recombinant DNA technology:**

- **Construction of genome and c DNA Libraries and Screening of gene Libraries**

(a) Construction of genome and c DNA Libraries:

(i) Aspect of gene Libraries.
(ii) Genome DNA Library.
(iii) c DNA Library.

(b) Screening of gene Libraries:

Colony and plaque hybridization, PCR screening of gene Libraries, Hybrid select / arrest translation, screening expression c DNA Libraries.

Unit II **(12)**

- **Advanced Techniques used in r DNA Technology:**

(i) Blotting Techniques: Southern Blotting, Northern Blotting, Western Blotting, Dot Blots and Slot Blots.
(ii) Restriction fragment length polymorphism (RFLP) analysis.
(iii) Rapid amplification polymorphic DNA (RAPDs)
(iv) Polymerase chain reaction (PCR) and it's applications.
(v) DNA Microarrays analysis and it's applications.
(vi) DNA Finger printing.

Unit III **(12)**

- **Application of gene cloning:**

Sequencing cloned DNA, In vitro mutagenesis and rational design, oligonucleotide –directed mutagenesis, PCR based mutagenesis.

- **Expression of foreign genes :**

(i) Production of fusion proteins
(ii) Phage display techniques

Unit IV **(12)**

- **Recombinant DNA Technology in Medicine and Industry:**

(i) Production Insulin as recombinant drug
(ii) r–DNA vaccines
(iii) Monoclonal antibodies, Monospecific and bispecific.
(iv) Production of recombinant proteins.
(v) Production of Bovine growth hormone
(vi) Soluble CD_4 molecules and usc of CD_4 – toxin conjugates.

- **Gene Therapy :**

Gene transfer systems : Viral vector systems, Non viral approach, physical methods, development and future prospects. Types of gene therapy: Somatic cell gene therapy and it's applications (kidney, pulmonary, malignant, metabolic disorders, cardiovascular diseases, hematological diseases, gastrointestinal, nervous system diseases, AIDS), Germline cell

Therapy, Stem cell therapy. General Gene therapy strategies–Gene Augmentation Therapy (GAT), Targeted gene therapy.

Unit V **(12)**

- **Protein Engineering:**
  Introduction, Improving therapeutic proteins with single amino acid changes, Improving enzymes, Methods for engineering proteins.

- **Metabolic Engineering:**
  Introduction, Designing over production of phenylalanine, New routes to small molecules, combinational biosynthesis, Engineering metabolic control over recombinant pathway, Metabolic engineering in plant cells.

- **Transgenic Animals -** Transgenic mice methodology and applications
- **Ethical issues in genetic engineering**
- **Industrial designs :** Designs of gadgets used in Biotechnology

Reference Books :

1. "Recombinant DNA", by J.D. Watson et al 2nd edition.
2. "Principles of Gene manipulation", by R.W. Old and S.B. Primrose.
3. "Recombinant DNA: Genes and genomes – a short course", by Watson J.D. Myers, R.M., Caudy A.A. and Witkowski, J.A., 3rd edition 2007, W.H. Freeman and Company, New York.
4. "Molecular Biotechnology : Principles and practices", by Channarayappa 2006, Universities Press (India) Pvt. Ltd. Hydrabad.
5. "Molecular Biology", by Glick B.R. and Pasternak J.J. 3rd edition, 2003. ASM press, Washington, DC.
6. "Biotechnology : Principles and Applications", by S.C. Rastogi ,2007 ,Narosa Publishing House,New Delhi.
7. "Principles and Techniques of Biochemistry and Molecular Biology", edited by Keith Wilson and John Walker, Sixth edition, 2005, Cambridge University press, New York.

Course Code: 5101-44 Pharmaceutical Microbiology and Biotechnology (04 Credits)

Course Objectives:

1) To give the students knowledge regarding role of microorganisms in pharmaceutical and biotech industries, biotransformation and steroids productions, production of Recombinant DNA drugs and designing of drug delivery system.
2) To give the students thorough knowledge about production of various types of amino acids, vitamins and secondary plant metabolites.
3) To give the students deep insight of the production of antibiotics, ergot, alkaloids.
4) To give the students knowledge about good manufacturing practices.

Course Outcomes:

1) Students will gain the knowledge regarding role of microorganisms in pharmaceutical and biotech industries, biotransformation and steroids productions.
2) Students would gain knowledge about production of Recombinant DNA drugs and designing of drug delivery system.
3) Students will get knowledge about production of various types of amino acids, vitamins and secondary plant metabolites.
4) Students will have a deep insight into the production of antibiotics, ergot, alkaloids .
5) Students would get the basic knowledge about

Unit I (12)

- **Microbes in pharmaceutical Industry:**

Single cell protein (SCP), Microbes in organic acid production, Microbes in enzyme production, Microbes in medicine, Microbes as tools for biological research.

Role of fungi in Biotechnology (Mycotechnology)

- **Introduction to Pharmaceutical Microbiology and Biotechnology:** Scope importance and opportunities for research.

Unit II (12)

- **Drug discovery and drug development-** Pharmacogenomics- Introduction, Investigative tools and role of pharmacogenomics in selective systems phormocogenemics and drug development.

- **Biotechnologically produced drugs :**

Introduction, Biotechnological drugs in market – Hormones, Monoclonal antibodies, Vaccines, Thrombolytics and factor VIII, Tumor necrosis factors, DNAase, Lymphokines, Cellular and Molecular medicines.

- **The role of Biotechnology in pharmaceutical drug design :**

Introduction, stability aspects of Biotechnological products, Methods to improve the

Stability of polypeptides, Consideration of routes of administration.

Biopolymers and their applications in Pharmaceutical sciences.

Unit III (12)

- **Biotransformation and steroid production :**

Introduction, Methods used in biotransformation, Biotransformation process with special reference to (i) Hydroxylation, dehydrogenation, Hydrogenation, Epoxidation, Aromatisation, Synthetic route.

- **Biotechnology production of secondary plant metabolites :**

Production of secondary metabolite in plants, stages secondary metabolite production, uses of tissue culture techniques for production of secondary metabolites, Applications of new culture methods for the production of secondary metabolites–Hairy root culture, Elicitation of product accumulation.

Unit IV (12)

- **Production of Pharmaceuticals**

(i) Production of Antibiotics :

Tetracycline, chloramphenicol, Griseofulvin, Erythromycin, Rifamycin, Daunorubicin

(ii) Production of Vitamins : Vitamin B_2 (Riboflavin), Biotin.

(iii) Production of Amino acids : L – Threonine, L–Tryptophan,

- **Production of Ergot Alkaloids :** Introduction, Microorganisms used , physiology of alkaloids formation, commercial production in bioreactors.

Unit V (12)

- **Production of mammalian Cells (Mammalian cell culture) :**

Introduction, mammalian cell lines and their characteristics, commercial products, protein glycosylation, media for cultivation of mammalian cells, metabolism, large scale cultivation of mammalian cells, genetic Engineering of mammalian cells.

Synthesis of Lycopene and Indigo by microbial technology.

Good Laboratory and Manufacturing practices: Good Laboratory practices (GLP) and Good Manufacturing Practices (GMP), Current Good Manufacturing Practices (cGMP) practices for pharmaceuticals production , validation and regulatory affairs.

Reference Books:

1. Pharmaceutical Biotechnology by S.S. Purohit, H.N. Kakarni and A.K. Saluja, 2007, Agrobios (India).

2. Basic Biotechnology edited by Colin Ratledge and Bjorn Kristiansen, 2001, Cambrige University Press, New York.

3. Prescott and Dunn's Industrial Microbiology, edited by Reed, G., 4th edition, 1982. CBS publishers and distributors, New Delhi.

4. Molecular Biology by Glick B.R. and Pasternak J.J. 3rd edition, 2003. ASM press, Washington, DC.

5. Biotechnology and its Applications in pharmacy by Giriraj Kulkarni T, 2002,Japee Brothers Medical publishers (P) Ltd, New Delhi.

Course Code: 5101-45 Practical Course: VII (04 Credits)

Course Objectives:

1) To make the students able to isolate purify and quantify the industrial important enzymes.

2) To make the students acquire knowledge and skills of enzymatic assays – protease, lipase, cellulase, amylase and invertase and would able to carry out enzymatic assays independently in the laboratory.
3) To enable the students with the basic knowledge of safety measures to be taken in while working in ATC laboratory, cell quantification, animal cell culture techniques, establishing primary animal cell lines
4) To converse the students with the use of PCR techniques through the demonstration.

Course Outcomes:

1) Students will be able to isolate purify and quantify the industrial important enzymes.
2) Students will acquire knowledge and skills of enzymatic assays – protease, lipase, cellulase, amylase and invertase and would able to carry out enzymatic assays independently in the laboratory
3) Students will get basic knowledge of safety measures to be taken in while working in ATC laboratory, cell quantification, animal cell culture techniques, establishing primary animal cell lines
4) Students will get conversant with the use of PCR techniques through the demonstration.

1. Production of Amylase by solid state fermentation method (Koji culture).
2. Precipitation and partial purification of Amylase. .
3. Immobilization of Amylase.
4. Quantitative estimation of : Amylase, Protease and Invertase.
5. Studies on the effect of various factors on enzyme activity :
   (i) Substrate concentration (ii) Enzyme concentration (iii) P^H (iv) Temperature (v) Metal ions.
6. Production of Vitamin B_{12} by using *Bacillus megaterium.*
7. Production of amino acid (Lysine) by fermentation.
8. Restriction enzyme digestion of DNA.
9. DNA ligation.
10. Elusion of DNA fragments from agarose.
11. Cell quantification.
12. PCR.
13. Southern blotting **.**
14. Northern blotting **.**
15. Electrophoresis of RNA.
16. Gluconic acid Production
17. Kojic acid production
18. Fermentative production of Amylase by *Aspergillus niger*

Reference Books :

1. "Practical Biotechnology", by S. Janarthanan and S. Vincent 2007, Iniversities Press (India) Pvt. Ltd., Hyderabad.
2. "Practical Biotechnology", by P. Ramadass and A. Wilson Aruni, 2007 Jaypee brothers Medical Publishers (P) Ltd., New Delhi.
3. "Laboratory manual in Biochemistry", by J. Jayaraman, first edition, (Reprint 2007) New Age International (P) Ltd., Publishers, New Delhi.
4. "An Introduction to practical Biochemistry", by David T. Plummer, 3rd edition (30th reprint 2007), Tata Mc Graw – Hill Publishing company Ltd., New Delhi.
5. "Experiment in Microbiology, Plant pathology and Tissue culture", by Aneja, K. R., 1993, Wishwa Prakashan.

Course Code: 5101-46 Project Work * (In lieu of Practical course VIII) (04 Credits)

Course Objectives:

1) To make the students prepare for selection of the project topic, carry out literature survey.
2) To make the students enable to set up experimental design, to investigate the problem and record the results and interpret.
3) To make the students able to write the project report in the IMRAD format – Title, Introduction, Aims & Objectives, Materials & Methods, Results & Discussion, Summary and Conclusion, citing references and preparation of bibliography.
4) To impart the students with the skills of presentation and defending the project report orally.

Course Outcomes:

After completion of project work, writing project report and presentation of project work student will be well versed with:

1) How to select the project topic.
2) How to make literature survey.
3) How to set up experimental design to investigate the problem and able to record and interpret the results.
4) How to write the project report in the proper format – Title, Introduction, Aims & Objectives, Materials & Methods, Results & Discussion, Summary and Conclusion.
5) How to cite references and to prepare bibliography.
6) How to write acknowledgements.
7) How to present and defend the project report orally.
8) Students will have all the basic knowledge of writing a scientific paper in proper format.

Project Work

*Student is to undertake a project work (as part of the semester IV in lieu of practical course VIII) In the project students is to study research methodology and project report writing (Introduction, Aims and Objectives, Materials and Methods, Results and Discussion, Conclusions and Bibliography). Student should submit Project Report in the form of a small dissertation duly signed by Guide / Teacher In - Charge, Head of the Department and or Dean/Principal/ Head of the Institute. For the project work, out of one hundred marks, fifty marks shall be given by university examiners through assessment of the project report at the time of semester IV practical examination. The remaining fifty marks shall be given by the Committee for Internal Evaluation of Projects (CIEP) as an internal evaluation. CIEP is to be constituted by the Principal (and which shall be consisting of HOD, Guide / Teacher in - charge and at least one other faculty members). The method and process of Internal evaluation is to be worked out by the CIEP.

Course Code: 5101-47 Vocational Training (Industrial Training) (04 Credits)

(Minimum 01 month training)

Course Objectives:

1) To provide students opportunity to get exposure to industrial work culture.
2) To make the students enable to understand hands-on experience to industrial set up with experimental design and practical training.
3) To make the students aware about the various sections in the industries viz. quality control, quality assurance, research work etc.
4) To impart the students with the skills of working in different industries.

Course Outcomes:

1) Students will get hands-on training to work in the reputed industries before getting placed.
2) The students will be exposed to all the industrial work culture so as to adopt all the skills required for working in the industry.
3) The students will be imparted with the knowledge of soft skills, communication skills, professional attitude while working in the industries.

Vocational Training (Industrial Training) :

*Student is to work in the industry for a minimum of one month in lieu of project work. Student should submit the industrial report in the form of a dissertation duly signed by the competent authority of the concerned industry. He/She shall also produce a certificate issued by the competent authority for the completion of his/her work. Out of one hundred marks, fifty marks shall be given by university examiners through assessment of dissertation at the time of semester IV practical examination. The remaining fifty marks shall be given by the Committee for Internal Evaluation of as an internal evaluation. This committee is to be constituted by the Principal/Dean (and which shall be consisting of HOD, Guide / Teacher in - charge and at least one other faculty members). The method and process of Internal evaluation is to be worked out by the committee.

Skill Enhancement Compulsory Course (SECC)

04 Biotechnology Data Care Management (02 Credits)

PREAMBLE:
To nurture high quality biotechnologist/ microbiologist with the potential to innovate /invent and desseminate knowledge for the benefit of society and environment.

Objectives:
To understand the types of databases and their data formats.

To study the importance of various omics, data generation techniques, data management strategies.

Unit I

1) Databases: Format and Annotations Conventions for database indexing and specification of search terms, common sequence file formats, sequence databases.

2) Types of Biological databases: Nucleic and protein databases, organism specific databases, data Access, retrieval and submission. Standard search engines, data retrieval tools.

Unit II

3) Biological data acquisition: The form of biological information, retrieval methods for DNA sequence Protein sequence and protein structure information.

Unit III

4) Data structures: Introduction, the concept of Abstract Data Type (ADT), Tables, records, strings staeks, lists, trees Binary trees, Balanced trees graphs Introduction to object oriented programming.

Unit IV

5) **Importance of omic technologies**: Data collection and bioinformatics principles. Data standards for omic data, the basics of data sharing and reuse. Omic data management and annotation, Data and knowledge management in cross omics research projects. Bioinformatics for RNomics, the ENCODE project consortium, mining for specific applications.

Reference Books:

1) “Bioinformatics: genes, proteins and computers” by Christine Orengo, David Jones and Janet Thornton (editors), 2003, Published by Taylor and francis, New York.
2) “Elementary Bioinformatics” by Imtiyaz Alam Khan, Published by Pharma Book Syndicate, Hyderabad.
3) “Biological Data mining and it’s applications in health care” Volume 8 : by Xiaoli Li See- Kiong Ng & Jason T.L.Wang, editors: Jason T. L. Wang , Science, Engineering and Biology Informatics.
4) “Bioinformatics: Managing Scientific data” by Zoe Lacroix and Ternce Critchlow, 2003, © Elsevier Science.
5) “Biological Data storage, Access and sharing policy” National health portal https://www.nhp.gov.in

CBCS FOR M. Sc Biotechnology

Program: M.Sc. Department: KIAS Subject: Biotechnology Scheme: CBCS

Subject		Sem-I			Sem-II			Sem-III			Sem-IV			Total		
		T	P	Total	T	P	Total	T	P	Total	T	P	Total	T	P	Total
Core-I	Hr	60	120	180	60	120	180	60	120	180	60	120	180	**240**	**480**	**720**
	Cr	4	4	8	4	4	8	4	4	8	4	4	8	**16**	**16**	**32**
Core-II	Hr	60	120	180	60	120	180	---	120	120	---	120	120	**120**	**480**	**600**
	Cr	4	4	8	4	4	8	---	4	4	---	4	4	**8**	**16**	**24**
Core-III	Hr	60	---	60	---	---	---	---	---	---	60	---	60	**120**	**---**	**120**
	Cr	4	---	4	---	---	---	---	---	---	4	---	4	**8**	**---**	**8**
Core-IV	Hr	60	---	60	60	---	60	60	---	60	60	---	60	**240**	**---**	**240**
	Cr	4	---	4	4	---	4	4	---	4	4	---	4	**16**	**---**	**16**
Total	**Hr**	**240**	**240**	**480**	**180**	**240**	**420**	**120**	**240**	**360**	**180**	**240**	**420**	**720**	**960**	**1320**
	Cr	**16**	**8**	**24**	**12**	**8**	**20**	**8**	**8**	**16**	**12**	**8**	**20**	**48**	**32**	**80**

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CBCS FOR M. Sc Biotechnology

Program: M.Sc. Department: KIAS Subject: Biotechnology Scheme: CBCS

Subject		Sem-I			Sem-II			Sem-III			Sem-IV			Total		
		T	P	Total	T	P	Total	T	P	Total	T	P	Total	T	P	Total
DSE	Hr	---	---	---	60	---	60	60	---	60	---	---	---	**120**	---	**120**
	Cr	---	---	---	4	---	4	4	---	4	---	---	---	**8**	---	**8**
Generic	Hr	---	---	---	---	---	---	60	---	60	60	---	60	**120**	---	**120**
	Cr	---	---	---	---	---	---	4	---	4	4	---	4	**8**	---	**8**
Grand Total CGPA	**Hr**	**240**	**240**	**480**	**240**	**240**	**480**	**240**	**240**	**480**	**240**	**240**	**480**	**1230**	**960**	**2190**
	Cr	**16**	**8**	**24**	**16**	**8**	**24**	**16**	**8**	**24**	**16**	**8**	**24**	**64**	**32**	**96**
AECC/SEC C Non CGPA	Hr	30	---	30	30	---	30	30+ 60	-	90	30	---	30	**180**	---	**180**
	Cr	2	---	2	2	---	2	2+4	-	6	2	---	2	**12**	---	**12**

DSE Sem I - Microbiology and Immunology I
DSE Sem II - Microbiology and Immunology II
DSE Sem III - Industrial Fermentations
GE Sem III - Plant Tissue culture
GE Sem IV - Animal Tissue culture

AECC Sem I : Yoga and Meditation
SECC Sem II : A Soft Skills and Personality Development
AECC Sem III : Leadership Development
SECC Sem IV : Biotechnology Data Care Management