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

Accredited By NAAC With 'A+' Grade

Syllabus (CBCS) For

Master of Science Pharmaceutical Microbiology

To be implemented from 2020-21

(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 Pharmaceutical Microbiology** 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. Pharmaceutical Microbiology program objectives

After completion, the students are expected to understand the:

(a) Basic and applied aspects of microbial diversity and systematic taxonomy, Physiology, biochemistry and applications of basic aspects of microbial diversity.

(b) Principles, working and application of bioinstruments used in isolation and identification of microbes and structural determination of biomolecules,

(d) characteristics and significance of archea, algae, fungi, viruses,

(e) Impact of various groups of microbes on earth atmosphere, human, plant and animal health and technology development,

(f) structure, properties, pathways, significance and applications of microbial biomolecules,

(g) basic and applied aspects of Genetic makeup of bacteria, algae, fungi and viruses,

(h) causes, mechanisms and consequences of defect in gene/genome of microorganisms, and

(i) basic concepts of microbial enzymes, enzyme kinetics, regulation of enzyme activity, industrial applications of enzymes, enzyme function in non-aqueous environment.

Structure of M.Sc. program in Pharmaceutical Microbiology

M.Sc. Pharmaceutical Microbiology 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 Pharmaceutical Microbiology** 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. (Pharmaceutical Microbiology) 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. Pharmaceutical Microbiology 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 Pharmaceutical Microbiology 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 microbiological and / or biotechnological aspects in industry and submit its report in the form of dissertation or small Project Report duly signed by industry authority, concerned guide and Head of the Department of Microbiology, Biotechnology.

Two year M.Sc. Pharmaceutical Microbiology Programme(Programme Code:5401)
Course Structure
M. Sc. Part I Semester I

		M. Sc. Pharmaceutical Microbiology CBCS w. e. f. 2020-21										
	Sr. No.	**Course Code**	**Course Title**	**Teaching Hours/ Week**			**Marks (Total 100)**				**Credits**
				T	**P**	**Total**	**Internal**		**External**		
							T	**P**	**T**	**P**	
CGPA		**Theory**									
	1	5401-11 **CC**	Foundation of Cell Biochemistry and Macromolecules	4	--	4	20	--	80	--	4
	2	5401-12 **CC**	Fundamentals of Cell Biology and Biostatistics	4	--	4	20	--	80	--	4
	3	5401-13 **DSE**	Essentials of Microbiology and Immunology	4	--	4	20	--	80	--	4
	4	5401-14 **CCS**	Tools and Techniques in Biosciences	4	--	4	20	--	80	--	4
		Practicals									
	5	5401-15 **CC**	Practical Course I	---	4+4	8	--	20	--	80	4
	6	5401-16 **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. Pharmaceutical Microbiology CBCS w. e. f. 2020-21									
	Sr. No.	**Course Code**	**Course Title**	**Teaching Hours/ Week**			**Marks (Total 100)**				**Credits**
				T	**P**	**Total**	**Internal**		**External**		
							T	**P**	**T**	**P**	
		Theory									
	1	5401-21 **CC**	Cell Physiology and Metabolism	4	--	4	20	--	80	--	4
	2	5401-22 **CC**	Molecular Biology	4	--	4	20	--	80	--	4
	3	5401-23 **DSE**	Medical Microbiology	4	--	4	20	--	80	--	4
CGPA	4	5401-24 **CC**	Fundamentals for communication skills & scientific writing and presentation	4	--	4	20	--	80	--	4
		Practicals									
	5	5401-25 **CC**	Practical Course III	---	4+4	8	--	20	--	80	4
	6	5401-26 **CC**	Practical Course IV	---	4+4	8	--	20	--	80	4
		Mandatory Non CGPA Course									
NON CGPA (No Weightage in CGPA calculations)	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. Pharmaceutical Microbiology CBCS w. e. f. 2020-21									
	Sr. No.	**Course Code**	**Course Title**	**Teaching Hours/ Week**			**Marks (Total 100)**				**Credits**
				T	**P**	**Total**	**Internal**		**External**		
							T	**P**	**T**	**P**	
CGPA		**Theory**									
	1	5401-31 **DSE**	Immunology	4	--	4	20	--	80	--	4
	2	5401-32 **CC**	Fermentation Technology & Process Design	4	--	4	20	--	80	--	4
	3	5401-33 **CCS**	Microbial Diversity and Extremophiles	4	--	4	20	--	80	--	4
	4	5401-34 **GE**	Bioinformatics	4	--	4	20	--	80	--	4
		Practicals									
	5	5401-35 **CC**	Practical Course V	---	4+4	8	--	20	--	80	4
	6	5401-36 **CC**	Practical Course VI	---	4+4	8	--	20	--	80	4
NON CGPA (No Weightage in CGPA calculations)		**Mandatory Non CGPA Course**									
	7	**03 AECC**	Leadership Development	2	2	2	50		--	--	2
	8	**Elective Course (EC)**									
		EC	SWAYAM / MOOC courses								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. Pharmaceutical Microbiology CBCS w. e. f. 2020-21										
	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	5401-41 CC	Enzymology	4	--	4	20	--	80	--	4
	2	5401-42 CC	Quality Management & IPR	4	--	4	20	--	80	--	4
	3	5401-43 GE	Genetic Engineering	4	--	4	20	--	80	--	4
	4	5401-44 CCS	Pharmaceutical Microbiology	4	--	4	20	--	80	--	4
		Practicals									
	5	5401-45 CC	Practical Course VII	---	4+4	8	--	20	--	80	4
	6	5401-46 CC	Project Work **OR** Vocational Training (Industrial Training)	---	4+4	8	--	50	--	50	4
	7	5401-47 CC		----	*	*	50		---	50	4
		*- Minimum one month Vocational Training/ Industrial Training									
NON CGPA (No Weightage in CGPA calculations)		Mandatory Non CGPA Course									
	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.

M. Sc. Pharmaceutical Microbiology Syllabus (CBCS)

(To be introduced with effect from academic year 2020-2021 for M. Sc. Part I (Semester I & II)
and
(To be introduced with effect from academic year 2021-2022 for M. Sc. Part II (Semester III & IV)

M.Sc. Part I Semester I

Course Code: 5401-11 Foundation of Cell Biochemistry and Macromolecules (04 credits)

Course Objectives:

1) To give students the knowledge about the important biomolecules like Protein, Carbohydrates, Lipids, Nucleic acids, Porphyrins.
2) To make students familiar with the vitamins and their structures & functions.
3) To give students the concept of enzyme cofactors and vitamins and their role in cellular metabolism.

Course Outcomes:

1) Students would be well versed on the fundamental principles of Biochemistry.
2) Students will have through knowledge of structures and functions of Bio-macromolecules like proteins, carbohydrates, lipids, Nucleic acids (DNA and RNA). Students will be well versed with the functions of vitamins of cofactors and vitamins.

Unit I (12)

- **Water :** Weak Interactions in aqueous systems , ionization of Water **,** Weak acids and weak bases**,** Buffering against pH changes in biological systems, water as a reactant and the fitness of aqueous environment for living organisms.
- **Chemical Foundation:**
  Introduction to chemical bonds, covalent bonds, ionic bonds, hydrogen bond, coordinate bond, metallic bond, Vander Walls forces, Hydrophobic interactions, London dispersion forces.

- **Enzymes, Cofactors and Vitamins**: Concept of apoenzyme, Coenzyme, prosthetic group, Holoenzyme, Cofactors, Vitamins.
  Role of cofactors and water soluble and fat soluble vitamins in cell metabolism and in nutritional deficiency.

Unit II (12)

- **Carbohydrates**: Introduction**,** Nomenclature and Classification of carbohydrates
  (a) Monosaccharides & disaccharides
  (b) Polysaccharides: Homopolysaccharides and Heteropolysaccharides
  Homopolysaccharides – Starch, Glycogen, Dextran, Cellulose and Chitin
  Heteropolysaccharides – Agar, Agarose, Glycosaminoglycans
  (c) Glycoconjugates: Proteoglycan, Glycoprotein, Glycolipid
  Carbohydrate as informational molecules – the sugar code

Unit III (12)

- **Proteins:**
  Amino acids: Properties, structures, functions and classification of common amino acids. Uncommon amino acids.

- **Peptides and Proteins**: Peptides bond formation, types of peptides, and lengths of peptides chain, conjugated proteins and their classification.
- **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.
- **Protein Functions**: Dynamics of protein folding, Role of molecular chaperones in protein folding, Lysosomal and membrane proteins, Potassium ion channel, Structure function relationship- myoglobin and hemoglobin.

Unit IV (12)

- **Lipids:**
  Introduction, nomenculture and classification of some naturally occurring fatty acids,
- **Storage lipids**: Triacylglycerols (Triglycerides, fats) and their functions, Waxes and their functions.
- **Membrane lipids**: : Glycerophospholipids, galactolipids, sulfolipids, sphingolipids and sterols.
- **Archaebacterial ether lipids**: Isopranyl glycerol ether.
- **Specialized functions of lipids -Lipids as signals, cofactors and pigments:**
  Phosphatidyl inositols and sphingosine derivatives as intracellular signals Eicosanoids, Prostaglandins (PG), Thromboxanes (TBX), Leukotrienes (LT), Vitamins: A, D, E and K, Lipid quinones
- An outline of method of the extraction, separation and identification of cellular lipids.

Unit V (12)

- **Nucleic acids:**
  Introduction and types: Nucleotides (the building blocks of nucleic acids): components, structures and nomenclature.
  Nucleic acid structures,
- DNA: Structure, base pairing and types
  Molecular model of DNA, Comparison of A, B and Z form of DNA
  Unusual DNA structures – palindromes, mirror repeats, inverted repeats, hairpin (or cruciform), Hoagsteen pairing, triplex DNA's, G tetraplex DNA, H - DNA.
- RNA: rRNA, mRNA, tRNA, SnRNA, HnRNA, miRNA, Signal Recognition Particle (SRP) RNA,
- Denaturation and renaturation of double stranded DNA and RNA, DNA hybridization,
  DNA sequencing by Sanger method. Chemical synthesis of DNA (Automated)-Principle and major steps involved.

Reference Books:

1. "Biological Chemistry", by Mehlar, H. R., and E. H. Cord, 1968, Harper & Row Publishers Inc, New York.

2. "Principles of Biochemistry", by Lehninger, A. L., 1984, 1st Indian Edition, LBS Publishers and Distributors Pvt. Ltd., New Delhi.

3. "Biochemistry", by Stryer, L., 1988, 3rd edition, W. H. Freeman and Company, San Francisco.

4. "Biochemistry", by Menlo Park: Benjamin / Cummings.

5. "Biochemistry", by Lehninger, A. L., 1993, Kalyani Publishers, New Delhi.

6. "Principles of Microbiology", by Atlas R.M., 1st edition, 1995,Mosby–YearBook Inc. St.Louis, Missouri.

7. "Microbiology–Concepts and Applications", by Pelczar, Chan and Krieg, 1993, McGraw – Hill Inc.

8. "Lehninger Principles of Biochemistry", David L. Nelson & Michael M. Cox. 4 th edition, W.H. Freeman & Co.

9. " Biochemistry" by U Satyanarayana & U. Chakrapani 3rd revised edition (Multicolour) 2006 Books & Allied (P) Ltd. Kolkatta (India)

10. Prescott, Harley and Kleins's Microbiology by Joanne M. Willey, Linda M. Sherwoud and Christopher J. Woolverton, 7th edition, 2008, McGraw-Hill Co. Inc. New York.

Course Code: **5401-12 Fundamentals of 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 knowledge about the various methods of organization of statistical data and it's presentation.
3) To give them concept of regression and probability, Correlation.
4) To give them insight in biochemical cell membrane, membrane transport mechanisms, cell signaling.

Course Outcomes:

1) Students will have through knowledge of structural organization of prokaryotic and eukaryotic cells
2) Students will gain knowledge of structure and function of biological membranes and solute transport through them.
3) Students will also be well versed with the fundamental principles and examples of cell signaling.
4) Students will 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.
- **The cell:** Definitions of the cell, cell theory, exception to the cell theory.
- **Prokaryotic cells:**

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

(ii) Structural organization of a Prokaryotic cell – Of a typical bacterial cell: capsule Or slime layer, cell wall, flagella, Pili, cell membrane, cytoplasm, reserved food Materials (inclusion bodies), Nucleoid and plasmids. Structural organization of cell walls of gram positive and gram negative bacteria Actinomycetes and Archaebacteria.

Unit II (12)

- **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): Protien sorting Golgy apparatus, Lysozomes, Cytoplasmic Vacuoles, Peroxisomes, Glyoxysomes, Mitochondria, Plastids, ribosomes microtubules and microtubular organelles, Nucleus – Chromatin, nuclear envelope and nucleoplasm.
Structural organization of cell walls of yeasts.

Unit III (12)

- **Biological Membranes and transport of solutes across the membrane**:

Molecular constituents of membrane, supra molecular architecture of membrane. Structural features of membrane protein relating to their functions.

Various mechanisms of transport of solutes across the membrane – Simple diffusion,
Facilitated diffusion (passive transport) and active transport, carriers, Ion channels, Transport of ions – Uniport, symport, antiport, sodium and potassium ions in cells.

- **Signal Transduction:**

Definition, Steps, Molecular mechanisms, General features, Examples of Signal transduction (apoptosis), receptor enzymes.

Unit IV **(12)**

- **Sampling:**

  Advantage of sampling over census, sampling methods – Random sampling, non- random Sampling, Limitations of sampling.

- **Handling of bulky data:**
- Measures of central tendency.
- Measures of dispersion
- Grouped data and ungrouped data, combined variance for two groups, merits and demerits.
- Frequency distribution, cumulative frequency distribution and relative frequency distribution.
- Diagramatic and graphical representation of statistical data.

Unit V **(12)**

- **Correlation: Concept of** Correlation and Correlation coefficient
- **Regression:**

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

- **Probability:**

Concept of Probability, basic laws and its applications to Mendelian segregation. Concept of Probability distribution, Binomial and Poisson distributions. Normal distribution and their application to biology, Bayesian theorem

- **Vital statistics** : Death rate and death ratio, measures of morbidity and measures of mortality.

Applications of statistical techniques in pharmaceutical industries : Use of ANOVA, Statistical Process Control (SPC), Six Sigma, Lean manufacturing, Quality by Design(QbD), Part Average Testing (PAT)

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 D. 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) "Biostatistics in Theory and Practice", by T. K. Saha, Emkay Publications, New Delhi.
8) "Lehninger Principles of Biochemistry", by David L. Nelson and Michael M. Cox 2005, 4th edition W.H. Freeman and company. New York.
9) "Prescott, Harley and Kleins's Microbiology", by Joanne M. Willey, Linda M. Sherwoud and Christopher J. Woolverton, 7th edition, 2008, McGraw-Hill Co. Inc. New York.
10) " Biology", by Kenneth A. Mason, Jonathan B. Losos and Susan R. Singer, 9th edition, 2008, McGraw-Hill Co. Inc. New York.

Course Code: 5401-13 Essentials of Microbiology and Immunology (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.

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

Unit I (12)

- **History and Scope of Microbiology** :

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

- **Enrichment Culture Techniques**: Principles involved, selective factors employed and applications for isolation of Chemoautotrophs, Chemoheterotrophs, Photoautotrophs and Photoheterotrophs.
- Isolation of yeast and molds.
- **Preservation of Bacteria:** Various methods of preservations and their principles.

Unit III (12)

- **Microbial Growth:**
  Definition of growth, Mathematical expression of growth, Growth phases, Synchronous, growth, Continuous growth and Diaxic growth, Measurement of growth and growth yield.
  Cultivation of viruses in cell culture, embryonated eggs and animals
- **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. Microbial contamination, control and sterility testing.
- **Medical Microbiology :**

  Types of Diseases: Concepts of Infection, Disease and Immunity, Pathogenicity and Virulence of Microorganims, Epidemic, Endemic, Pandemic and Sporadic diseases.

  Types of infections: Primary, Secondary, Acute, Chronic, Congenital, Local and generalized infections.

Unit IV (12)

- **Antigen and Antibodies**
  Concepts of Antigen, Antibody and antigen-antibody reactions, Applications of Antigen Antibody reactions .
- **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.
- **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.
- **Complement system :**
  Components, activation of complement – classical and alternate pathways, regulation of complement pathways, biological consequences of complement activation, significance of complement activation.

Unit V (12)

- **Cell Signaling**
  i) Cell signaling: Signal transdactive in T cell & B cell.
  ii) IL_2 signaling pathways, Chemokine signaling pathways.
- **Cell Trafficking**
  i) Introduction, cell adhesion molecules, chemikines extravasation of neutrophils, homing of lymphocyte.
- **Cytokines and Chemokines.**

  Cytokines: General characteristics and their actions, Molecular characterization and their functions, Role in regulation of immune response.
  Chemokines: Chemokines and their structures, function of chemokines and their receptors.
- **Monoclonal Antibodies** – Definition, production by Hybridoma technology and applications.

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. "Principles of Microbiology", by Atlas R.M., 1st edition, 1995, Mosby – YearBook Inc. St. Louis, Missouri.
8. "Microbial physiology", by Moat A.C. 4th edition, 2006.

Course Code: 5401-14 Tools and Techniques in Biosciences (04 credits)

Course Objectives:

1) To give students the knowledge about the principles various Microbiological, Physicochemical and Biochemical techniques used in Pharmaceutical industries / fermentation industries and research laboratories.

2) To make students know the operative procedures and applications of the techniques in biotech / pharmaceutical industries / research laboratories.

Course Outcomes:

1) Student would be able to understand the difference between UV visible and fluorescence spectroscopy & colorimetry.
2) Student will be able to describe the basic principle, technique and applications of different types of chromatographic techniques like ion exchange, HPLC, RPLC and various spectroscopic, electrophotetic and centrifugation technique.
3) Student will be able to get the thorough knowledge of ESR, NMR and various principles and instrumentation behind them.
4) Student would be well versed with the knowledge of x- ray diffraction and radioisotopic radiographic technique.

Unit I (12)

- **Chromatographic Techniques: Basic principle, technique and applications of**
  (1) Paper chromatography,
  (2) Thin layer Chromatography,
  (3) High performance Thin layer chromatography
  (4) Ion exchange Chromatography
  (5) Affinity Chromatography
  (6) Molecular exclusion Chromatography (Gel filtration)
  (7) Gas Liquid Chromatography (GLC)
  (8) High performance liquid Chromatography (HPLC),
  (9) Ultra High Performance Liquid Chromatography (UHPLC)
  (10) **Reverse Phase Chromatography** (RPLC)

Unit II (12)

- **Electrophoretic Techniques:**

  Gel Electrophoresis:
  Starch and Agarose Gel Electrophoresis, Polyacrylamide Gel Electrophoresis (PAGE), SDS – PAGE and 2-D PAGE, Isoelectrofocussing, Pulse field gel Electrophoresis (PFGE), RNA Electrophoresis
- **Centrifugation Techniques:**
  Principles of Centrifugation, different types of centrifuges and types of rotors and their usages. Density gradient centrifugation – rate zonal technique, Isopycnic centrifugation, performing

density gradient centrifugation – Discontinuous and continuous techniques, applications of preparative centrifuges, Ultra centrifugation – Velocity and buoyed density determination, Molecular Weight determination

Unit III **(12)**

- **Electrochemical Techniques:** Voltametry and Coulametry
- **Spectroscopic Technique –** Spectrophotometry, Near Infrared Spectroscopy(NIRS), Nuclear Magnetic Resonance Spectroscopy (NMR), Fluorimetry and Phosphoremetry General principles of electromagnetic radiation spectroscopy, principles, procedures and applications UV – visible spectrometry, atomic absorption and mass spectroscopy.
- **Hyphenated Techniques:** LC – MS, GC-MS, LC- NMR
- **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.

Unit IV **(12)**

- **Biophysical Techniques:**
  (i) X ray diffraction analysis and crystallography.
  (ii) Infra red and Raman spectroscopy.
  (iii) Electron spin and nuclear magnetic resonance spectroscopy.
- **Immunochemical Techniques:**
  (i) Radioimmunoassays.
  (ii) Enzyme linked immunosorbent assays (ELISA).

Unit V **(12)**

- **Microbiological Techniques:**
  - Techniques of isolation of pathogenic bacteria
  - Techniques of quantitative estimation(enumeration) of bacteria, yeast and molds
  - Techniques of isolation of anaerobic organisms
  - Staining techniques for microorganisms – sample , negative differential special and vital staining

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) "Biotechnology – Foundation course",by Anant N. Rao, 2007, Jaypee Brothers Medical Publishers (p) Ltd, New Delhi.
4) "Isolation of anaerobes", by Shapton D. A., 1971
5) "Methods in Microbiology",, Vol. 3A and 3B, edited by J. R. Norris and D. W. Ribbons, 1969 Academic Press, London.
6) "Methods in Microbiology",, Vol. 4, edited by Booth, C., 1970, Academic Press, London
7) "Biophysical Chemistry – Principles and Techniques", by A. Upadhya K. Upadhya & N. Nath 4th revised edition 2007 Himalaya Publishing House.
8) "Anaerobic Bacteria", by K. T. Holland, J. S. Knapp & J. G. Shoesmith , 1987, Chapman & Hall, New York.

Course Code:5401-15 Practical Course – I (04 credits)

Course Objectives:

1) To make the students well acquainted with some commonly used staining techniques.
2) To acquaint the students with the techniques of isolation of various types of bacteria, yeast, molds and bacteriophages.
3) To make the students able to carry out isolation of pathogens.
4) To train the students to be able to carry out enrichment and isolation of Psychrophilic, Osmophilic, Thermophilic and Halophilic microorganisms and phototrophic organisms.
5) To train the students to be able to carry out antibiotic sensitivity tests & sterility test.

Course Outcomes:

1) Students will be able to carry out certain commonly used staining techniques.
2) Students will be able to carry out isolation of various types of bacteria, yeast, molds and bacteriophages.
3) Students will also be able to carry out isolation of pathogens.
4) Students will be able to carry out enrichment and isolation of Psychrophilic, Osmophilic, Thermophilic and Halophilic microorganisms.
5) Students will be able to perform sterility tests as well as antibiotic sensitivity tests.
6) Students will be able to perform SPC of bacteria and fungi.

Practicals:

1. Simple staining and Gram staining of bacteria
2. Staining of nuclear materials of bacteria and yeasts.
3. Spore staining of bacteria.
4. Capsule staining of bacteria.
5. Isolation of some common contaminating microorganisms and their cultural and Morphological Characterization and identification:
   (i) Bacteria – *Bacillus, Micrococcus, Proteus, Clostridium species.*
   (ii) Fungi – *Aspergillus, Fusarium, Mucor, Penicillium, Rhizopus, Saccharomycesspecies.*
6. Isolation of some commonly encountered enteric pathogenic bacteria.
7. Isolation of bacteriophages -***E. coli***. phages
8. Preparation of bacterial protoplasts.
9. Determination of SPC of bacteria of water/raw material samples.
10. Determination of SPC of Fungi
11. Isolation of psychrophilic bacteria.
12. Isolation of osmophilic yeast and bacteria.
13. Isolation of yeast from natural sources (Fruits / Flowers / Honey).
14. Isolation of Halophilic bacteria from Saline soils / Sea water.
15. Isolation of Thermophilic bacteria.
16. Enrichment and isolation of Chemoheterotrophic and Photoautotrophic organisms from their natural habitats.
17. Sterility test.
18. Antibiotic/drug susceptibility test
19. Visit to Industry / Science Institute / Research Laboratories. Report of the visit to be submitted.

Course Code: 5401-16 Practical Course – II (04 credits)

Course Objectives:

1) To train the students properly to be able to prepare normal, molar and buffer solutions and perform the quantitative estimation of proteins, lipids, carbohydrates, DNA, RNA, Sodium and Potassium.
2) To make the students able to statistically analyze biological data and interpret the results.
3) To give the students enough demonstration and practices so as to enable them to perform the electrophoretic and chromatographic techniques
4) To make students conversant with the methods of determination of acid and saponification values and iodine number of fats.

Course Outcomes:

1) Students will know and able to prepare buffers & molar solutions and perform the techniques of quantitative estimation of proteins, lipids, carbohydrates, DNA, RNA, Sodium & Potassium and shall be able to 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
4) Students will able to determine the acid value, saponification value and iodine number of fats independently.

Practicals:

1. Preparation of Normal and Molar solutions
2. Preparation of Buffers
3. Estimation of concentration of Carbohydrates.
4. Estimation of concentration of Proteins.
5. Estimation of concentration of Lipids.
6. Estimation of concentration of DNA.
7. Estimation of concentration of RNA.
8. Separation of amino acids by paper chromatography.
9. Separation of amino acids by thin layer chromatography
10. Electrophoretic separation of proteins by Agarose and Polyacrylamide gel electrophoresis (PAGE).
11. Electrophoretic separation of nucleic acids by Agarose and Polyacrylamide gel electrophoresis.
12. Determination of acid value of fat
13. Determination of saponification value of fat
14. Determination of iodine number of fat
15. Measures of central tendency – Mean, mode and median.
16. Measurement of dispersion – Variance and standard deviation.
17. Construction of histogram and frequency polygon.
18. ANOVA – CRD and CBD.
19. Estimination of Sodium Potassium by flame photometry.

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. "Illustrated genera of imperfect fungi", by Barnett, H. L., and Hunter, B. B., 3rd edition, 1972, Burgess Publishing Company, Minneapolis, Minnesota.
8. "Compendium of soil fungi", by Domsch, K. H., Gams, W. and Anderson, T. H., 1980, Academic Press, London.
9. "Standard methods for the examination of water and waste water", 20th edition, edited by Greenberg, et al., 1998, APHA, AWWA, Washington, DC.
11. "Methods in Microbiology", Vol.3A and Vol.3B edited by Norris and Ribbons, Academic Press, London.
12. "Methods in Microbiology", Vol.4 edited by Booth, C., Academic Press, London.
13. "Methods in Microbiology", Vol.5 edited by Norris and Ribbons, Academic Press, London.
14. "Microbiological applications", by Benson, H. J., 6th edition, 1994, Wm. C. Brown Publishers, Dubuque, Iowa.
15. "Identification methods for Microbiologists", edited by Gibbs, G. M. and Shapton, D. A., 1968, Academic Press, London.
16. "Biostatistics", by P. G. Dixit, V. R. Prayag and P. S. Karpe, 2002, Nirali Prakashan, Pune.
17. "Biostatistics: A foundation 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.

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 hygine 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, 2018.
2) "Yog Sadhana v Yog Chikitsa Rahasya", by Swami Ramdeo, Divya Prakashan (English version).
3) "Yoga and Meditation: Guide to Spiritual, Physical, and Mental Growth", by Ann Wilde, Kindal edition.
4) "Yoga for Beginners: The best guide to yoga practice", by Denise Flow, Kindle edition.

M. Sc. Pharmaceutical Microbiology Part I Semester II

Course Code: 5401-21 Cell Physiology and Metabolism (04 Credits)

Course Objectives:

1) To give students the knowledge about the microbial heterotrophic metabolic pathways & their functions.
2) To give the students knowledge about the autotrophic mode of microbial metabolism.
3) To give students the knowledge of various metabolic reactions and their role.
4) To introduce the students with the phenomenon of chemotaxis, phototaxis and magnetotaxis.

Course Outcomes:

1) Students will be able to illustrate various anabolic and catabolic pathways of carbohydrates, lipids, proteins and amino acids.
2) Students would be able to illustrate the various catabolic pathways of carbohydrate proteins and amino acids.
3) Students would be able to understand, able to describe various mechanisms of ATP synthesis by metabolism and chemiosmotic hypothesis of ATP synthesis.
4) Students will have knowledge about phototactic, chemotactic and magnetotactic bacteria.

Unit I (12)

- **Chemotaxis, magnetotaxis and phototaxis**:

i) Chemotaxis : Chemotactic behavior of bacteria, molecular mechanism of chemotaxis.

ii) Magnetotaxis: Magnetotactic bacteria, mechanism of magnotaxis.

iii) Phototaxis: Phototactic organisms, mechanism of phototaxis.

- **Autotrophic Metabolism:**

(i) **Chemoautotrophic metabolism:**

Concept of chemoautotrophy Hydrogen oxidation, Autotrophic methanogenesis, sulfur and Iron oxidation Ammonium and nitrite Oxidation – Nitrification

(ii) **Photoautotrophic metabolism :**

Characteristic of photoautotrophic microorganisms, Photophosphorylation, comparison of oxygenic and anoxygonic photosynthesis.

Unit II (12)

- **Heterotrophic metabolism :**

(i) **Conversion of carbohydrates to pyruvate** -Glycolytic pathways, Embden Meyerhof pathway, Entner – Doudoroff pathway, Pentose phosphate pathway, methyl glyoxal pathway, Archaebacterial Glycolytic pathways – modified Entner – Doudoroff pathway

(ii) **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.

(iii) **Fermentations :** Mixed acid fermentations, Propionic and butyric acid fermentations, Amino acid fermentation, Fermentation of acetate to methane : Methanogenesis

Unit III (12)

- Conversion of Lipids to acetyl-CoA Fatty acid oxidation - Beta,(β) and Omega (ω)
- Conversion of proteins to amino acids and oxidation of amino acids.
- **Protein Metabolism –** Biosynthesis of amino acids
- **Purine andpyrimidine–** de novo and salvage pathway

Unit IV (12)

- **Oxidative Phosphorylation** :

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:**

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. "Bacterial Metabolism", by Doelle H.W. Academic Press 2005.
7. "General Microbiology", by Schlegel H.G. Cambridge University Press 2004.

Course Code: 5401-22 Molecular biology (04 Credits)

Course Objectives:

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

Course Outcomes:

1) Students will get thorough knowledge of mechanisms of DNA replication, 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:**

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

- **Inhibitors of DNA replications**: Transcription and translation of RNA and their mode of action.
- **Transcription in Prokaryotes and Eukaryotes: RNA processing**: Post transcriptional modification of RNA

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.

Unit III (12)

- **Regulation of Gene expressions:**

Principles of gene regulation: RNA polymerase, promoters, regulation of transcription initiation and its common patterns, operons model of regulation, Regulation proteins. Regulation of gene expression in prokaryotes: Regulation, Lactose, Trytophan and Arabinose operons, regulation by genetic recombination.

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, recombinational repair, SOS system, Role of DNA repair system in conservation of genome integrity, relationships to life span and aging processes.

- **Mutations :**

(i) **Detection of mutations**: Replical planting, complementantation
(ii) **Mutation rates and mutagenic agents** : Mutation rate, physical mutagens, chemical mutagens, Detection of chemical mutagens and carcinogens (Ames test)
(iii) Site directed mutagenesis.

Unit V (12)

- **Recombination:**

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

- **DNA transfer in prokaryotesand Eukaryotes:**
  Transformation, transduction, conjugation, transfection, protoplast and spheroplast fusions, electroporation.
- Gene Transfer in Aechaebacteria: Archaebacterial genetics
- Catalytic RNA
- Genetics of population with reference to Hardy-Weimberg principle and it's applications.
- Metabolism of nucleotides – synthesis and degradation.

Reference Books:

1. "DNA Replication", by Adams R.L.P., 1992, IPL Oxford, England.

2. "Genes VII", by Lewin 2002, Oxford University Press.
3. "Recombinant DNA and Biotechnology", by Singh, 2007.
4. "Biotechnology", by B.D. Singh, 1998 kalyani publishers, New Delhi.
5. "Recombinant DNA", by Watson, J.D. et al., 2nd and 3rd editions scientific American Books, New York.
6. "Cell Biology, Genetics, Molecular Biology, evolution and ecology", by P.S. Verma. And V.K. Agarwal, First multicolour edition, 2004, S. Chand and company Ltd.
7. "Elements of Biotechnology", by P.K. Gupta, first edition, 2004.
8. "Microbial Genetics", by Freiffeldor David, 10th edition, 2004, Naroja publishing house, New Delhi.
9. "Molecular Genetics of Bacteria", by Dale, J.W. 1994, John Wiley & sons.
10. "General Microbiology", by Stainier et. al.
11. "Principle of Microbiology", by Atlas R.M. 1995.
12. "Principle of gene manipulation", by R.W. Old & S.B.Primrose 5th edition, 1994.

Course Code: 5401-23 Medical Microbiology (04 Credits)

Course Objectives:

1) To give students the knowledge about the etiology, epidemiology, prevention and control and diagnostic techniques of various microbial diseases.
2) To give students the knowledge of autoimmune diseases and immunodeficiency diseases
3) To give students the knowledge about the recently emerged viruses and current developments in disease specific vaccines.

Course Outcomes:

1) Students will gain knowledge regarding various microbial diseases - etiology, epidemiology, prevention and control and diagnostic techniques.
2) Students will also have knowledge about how immune responses are given by host to viral, bacterial and fungal infections and to tumors.
3) Students would also have knowledge regarding role of HLA antigens in transplantation and graft rejection. Students will be able to understand abnormal manifestations of immune response in the form of autoimmune diseases.
4) Students will also gain knowledge regarding immune deficiency diseases.
5) Students will gain knowledge regarding recently emerged viral diseases like Ebola, Swine-flu.

Unit I (12)

- **Infection and Diseases**
  Bacterial Pathogenesis-
  Pathogenic Mechanism:
  Bacterial infectivity, Host resistance, Genetic and molecular basis for virulence, Host mediated pathogenesis, Intracellular growth, Specific Virulence factors, Adherence and colorization factors, Invasion factors, Capsules and other surface components, Endotoxins, Exotoxins.
- Tissue damage
- Spread of pathogen in the body
- Viral pathogenesis – mechanism of viral cellular pathogenesis.
- Quorums sensing in bacteria and it's mechanism, quorum sensing & pathogennicity.

Unit II (12)

- **Epidemiology:** Definition, Principles of epidemiology, Spread of certain infections in population. Role of socioeconomic conditions in spread of disease.

- **Epidemiological methods:** Descriptive, analytical and experimental epidemiology. Measurement of infection (incidence) rate, Mortality rate and prevalence rate.
- **Vaccine Technology:** General methods, Disease specific vaccine, Design-Tuberculosis vaccine, Malaria vaccine, HIV/AIDS vaccine

Unit III (12)

- **Microbial Diseases**

i) Bacterial diseases:

Etiology, Epidemiology, characteristic signs and symptoms, Laboratory diagnosis, Mode of transmission, Prevention and control of the diseases : *Diptheria, Tetanus, Pertusis, Tuberculosis, Helicobacter pylori*

ii) Fungal Diseases:

Etiology, Epidemiology, characteristic signs and symptoms, Laboratory diagnosis, Mode of transmission, Prevention and control of the diseases: ***Aspergillosis, Candiasis*, *Candida auris* infections**

iii) Viral Diseases:

Etiology, Epidemiology, characteristic signs and symptoms, Laboratory diagnosis, Mode of transmission, Prevention and control of the diseases: Rabies, Polio, Swine flu, AIDS, Measles, Mumps, Rubella, COVID-19, yellow fever virus, Dengue fever virus.

iv) Protozoa Diseases:

Etiology, Epidemiology, characteristic signs and symptoms, Laboratory diagnosis, Mode of transmission, Prevention and control of the diseases: Malaria, Filiaria

Unit IV (12)

- **Clinical Microbiology**
  - **Diagnostic Medical Microbiology**:
    (a) Collection and transport of clinical specimens, preliminary processing of specimens
    (b) Serological test – Widal test, ASO test Cold heamagglutination test, Paul – Bunnel test, Weil – Felix test, Streptococcus – MG test, Tuberculin test, Immuno - PCR.
    (c) Rapid methods of identification of infectious microorganisms: Commercial systems for rapid identification of bacteria (e.g. Enterotube, API, Minitech, Micro - ID), FAT, RIA, and western blot techniques.
  - Advanced Techniques in Molecular Diagnostic microbiology**.**
  - **Nucleic acid based methods:** i) Hybridization methods (ii) Amplification methods (iii) Sequencing and enzymatic digestion of nucleic acids method.
  - **Application of Nucleic acid – based methods:**

(i) Direct detection of microorganisms: Advantages and disadvantages, Applications for direct detection of microorganisms.

(ii) Characterization of microorganisms beyond identification: Detection of antimicrobial resistance, Determination of strain relatedness.

Unit V (12)

- **Therapeutic agents and drug resistance**

  Antibiotic and drugs- Used in infectious of diseases and their mode of action**.**
- Development of drug and antibiotic resistance in pathogenic microorganisms causes and consequences**.**
- **Multiple drug resistance –** Causes & consequences
- Molecular mechanisms responsible for drug resistance
- **Chemotherapy:**

Reference Books:

1. "Medical Immunology", edited by Stites et al., 2nd edition, 1997.
2. "Medical Microbiology", by Mims et al., 2nd edition, 1998.
3. "Principles of Microbiology", by Atlas, R.M., first edition, 1995. Mosby-year book, Inc. St. Louis, Mission.
4. "Foundation in Microbiology", by K. Talaro and A. Talaro 2nd edition, 1996, Wm. C. Brown publishers, Dubuque, IA.
5. "Topley and Wilson's Principles of Bacteriology, Virology and Immunology", 8th edition, Vol. 4 (Virology).
6. "Mechanism of Microbial disease", by Schaechter et al. (editors), 1989.
7. "Anantnarayan and Paniker's – Text book of Microbiology", 7th edition, 2005 edited by C.K.J. Paniker orient Longmar (P) Ltd.

Course Code: 5401-24 Fundamentals for communication skills & 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 will become well versed with how to write and publish the scientific paper/ document.
3) Students shall gain information about communication cycle, types of communication, verbal & nonverbal communication, writing skills.

Unit I (12)

Computers:

- **General Introduction to Computers**: Definition, computer tasks, classification of computers.
- **Hardware** - Different components of a computer – Input unit, Arithmetic Logic unit (ALU), Control unit, Memory, Secondary storage devices, output unit.
- **Software** – Application programs, The Binary number systems, system programs, utility programs programming,

Unit II (12)

- **Introduction to Computer programming Languages**

Operating systems: Batch operating system , Personal operating systems , MS Word MS Access, MS Excel, MS Power Point.

- **Introduction to Bioinformatics:**
  Concept of Bioinformatics, Data base, Types of data base, major biological data bases with website addresses, Applications of Bioinformatics

Unit III (12)

Communication Skills:

- **Language** – A means of communication, principles of Communication, Types of Communication, Principles of effective Communication – Definitions, communication barriers and overcoming the barriers, developing effective messages.
- **Formal written skills :**
  Office drafting job applications, report writing, academic correspondence, Leave applications,

- **Communication skills –** Interview skills

Unit IV (12)

Scientific writing and presentation:

- **Good English and grammar in scientific writing**: Use and misuse of words, Jargon and Avoiding Jargon, Abbreviations –Guidelines for use of abbreviations, accepted abbreviations and symbols. Common errors in style and in spelling.

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

- **Main requirements of a scientific document**:

Accuracy, Appropriateness, Clarity, Simplicity, Brevity, Precision, Balance, consistency, Impartiality, Sincerity, Objectivity, Control of interest and in Scientific Writing

- **Scientific paper –** Definitions and Organization of a scientific paper, History, IMRAD system.

Unit V (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, The publishing process.

- **Designing of effective table, graphs, diagrams and illustrations**
- **Legal aspects of scientific authorship**: Copyright considerations, Plagiarism
- **Presentation of scientific paper**: Oral presentation, Preparation and presentation of a poster.
- Writing review papers, Conference reports, Book reviews, Project and Project reports, and a Thesis.

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 1994, 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: 5401-25 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 perform immobilization technique.
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 carry out immobilization of enzymes, microbial cells.

3) Students will be able to study the various growth patterns of microbial cells

1. Synchronous growth of yeast (*Saccharomyces cerevisiae*)
2. Continuous growth of bacteria.
3. Immobilization of microbial cells (Yeast cells)
4. Synthesis of inducible enzyme Beta galactosidase in ***E.coli***
5. Detection of β – Lactamase activity in bacterial isolates.
6. Demonstration of chemotaxis in bacteria
7. Immobilization of Yeast enzyme – Invertase.
8. Immubilization of bacterial enzymes – Amylase
9. Techniques of egg inoculations.
10. Separation of Lymphocytes from periperal blood
11. C- reactive protein test (CRP) test.
12. Rheumatoid arthritis (RA) test
13. Systemic Lupus erythematosus (SLE) test.
14. Anti Strptomycin – O (zASO) test.
15. Australia Antigen test.
16. Complement Fixation (CF) test.
17. Preparing 'Abstract' for a given scientific paper
18. Writing a 'Summary and Conclusion' for a given Scientific Paper
19. Writing 'Result & Discussion' part of the paper using given data

Course Code:5401-26 Practical course IV (04 Credits)

Course Objectives:

1) To give students knowledge of isolating the DNA and plasmids from bacteria/ yeast.

2) To train students in mutants isolation technique.

3) To equip students with the knowledge the mutagenecity testing.

Course Outcomes:

1) Upon competition of this course students will be able to carry out independently isolation of DNA as well as plasmids from bacteria and yeasts.

2) Students will be able to perform the isolation of drug resistant and nutritionally deficient mutants.

1. Isolation of DNA from Bacteria.
2. Isolation of DNA from Yeast.
3. Isolation of Bacterial palsmids
4. Isolation of yeast palsmids.
5. Isolation of RNA from yeasts.
6. Determination of base composition of nucleic acids.
7. Bacterial conjugation
8. Isolation of drug resistant mutant
9. Estimation of mutation rate in Bacteria
10. Fluctuation test
11. Isolation of plaque morphology mutants of coliphages.
12. Obtaining mutant of *Aspergillus terreus* by using chemical and physical mutagens.
13. Isolation of antibiotic resistant mutant of bacteria.
14. Nitrous acid mutagenesis in *Aspergillus nidulans*

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.

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) "Communication skill" by Anjali Ghanekar, 1996, Everest publishing house.
2) "Personality Development and Soft Skills" by Barun K Mitra, second edition, Oxford Higher Education, 2019.
3) "Communication skill", by B.V. Pathak First edition, Nirali Prakashan, Pune (India), 2006.
4) "A Handbook of Communication skills in English", by R. A. Kulkarni, First edition, Phadke Prakashan, Kolhapur (India), 2001.

M. Sc. Pharmaceutical Microbiology Part II Semester III

Course Code: 5401-31 Immunology (04 credits)

Course Objectives:

1) To make them understand the role of various components immune system and defense mechanism.
2) To give the students the knowledge of autoimmune diseases and immunodeficiency diseases .
3) To give the students knowledge of immune responses maintained by host to various viral, bacterial and fungal infections.

Course Outcomes:

1) Students will able to describe components of immune system and how cells and organs of immune system play and important role in immune responses of the host.
2) Students will also gain the knowledge regarding immunodeficiency diseases.

UNIT I (12)

- Overview of the immune system and innate immunity.
- **Adoptive immune responses**: T-cell receptors and major histocompatibility complex.
- Antigen presentation, B-cell development and antibody response.
- **Immunological tolerance:** Mechanism of tolerance, T cell tolerance, B cell tolerance

Unit II (12)

- **Hypersensitivity :** Definition, Classification of hypersensitivity reactions, Mechanisms and examples of Type I, Type II, Type III and Type IV hypersensitivity reactions.
- **Allergic diseases :** Allergic respiratory diseases, Allergic skin disorder, Food and drug allergy.

Unit III (12)

- **Immunity to viral infection:** Antigenic drift and shift. Interferon, Interleukins, Humoral and cell mediated Immunity.
- **Immunity to Bacterial infections:**
  Phagocytosis, role of complement and antibody, Role of CMI and activated macrophages, bacterial strategies to avoid phagocytosis.

- **Immunity to fungal infections:** Innate immune responses, T-cell mediated immunity**.**
- **Immunity to protozoa and worms :** Parasitic infections, Innate immunity, T- cell mediated and B-cell mediated immune responses.

Unit IV (12)

- **Tumor Immunology:**
  Tumor associated antigens, Tumor specific antigens, immune response to tumor, immune escape mechanisms, Immunosurveillance, Natural immunity, to tumors, Immunodiagnosis of tumors – detection of tumor markers: alpha feto proteins, carcinoemryonic antigen, Immunotherapy.

Unit V **(12)**

- **Immunodeficiency disorders:**

(i) B cell immunodeficiency disorders.

(ii) T cell immunodeficiency disorders: congenital thymic aplasia (Digorge syndrome), chronic mucocutaneous candidiasis, AIDS.

(iii) Phagocytic dysfunction diseases (polymorphonuclear leucocytes and mononuclear leucocytes), CGD Chronic granulomatous disease, (CGD) Lazy leukocyte syndrome (LLS).

(iv) Complement disorder, - Hereditary angioneurotic edema, deficiencies of complement components

- **Autoimmune diseases:**

Autoantigens and autoimmunization, Types of autoimmune diseases, spectrum of autoimmune diseases, genetic factors in autoimmune diseases, pathogenesis, etiology (mechanisms) and approaches to the treatment of autoimmune diseases.

Course Code: 5401-32 Fermentation Technology and process Design (04 Credits)

Course Objectives:

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

Course Outcomes:

1) Students will be well versed with the screening techniques, Microbial assays, Primary & secondary metabolites.
2) Students will gain the knowledge of design of fermentors, types of fermentors , equipments, instruments used, sterilization processers.
3) Students will be well versed with fermentation media, inoculum preparation, Scale up Processes and with the various downstream processes of fermentation industries.

Unit I (12)

- **Screening, strain improvement Programmes and maintenance of stock cultures of microbial strains in industry – An overview.**
- **Industrially important metabolites of microorganisms**: Primary metabolites and Secondary metabolites.
- **Maximizing the efficiency of fermentation process:** Monitoring and controlling of parameters such as $_P$H, temp, dissolved O_2 concentration etc.
- **Microbial process kinetics:** Introduction, kinetic modeling of cell growth,mass balances for ideal bioreactors.

Unit II (12)

- **Fermentor Design:**

(i) Bioreactors configurations-Stirred tanks, Bubble column, Airlift, fluidized bed, packed bed, hollow fiber, Novel seesaw bioreactor.
(ii) Bioreactor design features: Principal features of a typical (conventional) bioreactor.
(iii) Bioreactor design for sterile operation – sterilization in place, Clean in place considerations.
(iv) Photo bioreactors: Configurations –continuous run tubular loop, multiple parallel tube, helical wound tubular loop, flat panel
(v) Heat Transfer.
(vi)Shear effects in culture.

Fermentation process control: Knowledge based system(KBS), Genetic Algortithm (GA),Artificial neural Networks(ANN), Flux control Analysis and Biosensors, Modeling of fermentation process.

Unit III (12)

- **Designing of Fermentation Media**: Sources of Carbon, Nitrogen, Minerals ,Trace elements, growth factors (Vitamins, amino acids), Use of buffering agents, antifoam agents, inducers, repressors and precursors.

- **Sterilization of Fermentation media and fermentation vessel.**

- **Inoculum development and fermentation process** – Steps in inoculum development, Critical factors- quantity and reproducibility, mutation problems, Operation of fermentor, Detection of contamination.

Unit IV (12)

- **Mass Transfer** – Mass transfer steps, Mass transfer equations, Determining the volumetric mass transfer coefficient, effect of scale on mass transfer .

- **Contamination problems in fermentation industry and their control.**

- **Computer application in fermentation technology -** Introduction, History, General specific applications, System configuration

Unit V (12)

- **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 to 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.

2. "Industrial microbiology", by Miller B. M., and W. Litsky, 1976 Mc Graw-hill, New York.

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

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

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

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

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

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

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

10. "Basic Biotechnology", edited by Colin Ratledge and Bjorn Kristiasen 2nd edition ,2001(Reprint 2004) Cambridge University press, New york.

11. "Pharmaceutical Biotechnology", by Purohit S. S., Karkarni H.N. and Saluja A. K., Agrobios (India).

12. "Molecular Biotechnology", by Glick B.R. and Pasternak J.J., 3rd edition, 2003 (Third Indian Reprint 2007), ASM Press, Washington, D.C.

Course Code: 5401-03 Microbial Diversity and Extremophiles (04 Credits)

Course Objectives:

1) This course will provide a sound basis in principle features of extremophilic microbial life including their habitats characteristics modes of adaptation of extreme environment and their applications This course will emphasize the adaptability of microbes in extreme environments.
2) This course will facilitate to understand the various types of microbial interactions that occur in the nature .
3) To give students knowledge of microbial diversity.

Course Outcomes:

1) Students will have the knowledge of extreme environments and the microbes of extreme environments
2) Students will acquire knowledge on some of the remarkable physiological adaptations that helps microorganisms to succeed in extreme conditions.
3) Students will have the knowledge of the origin and diversity of microbes adapted to extreme environments.
4) Students will have the knowledge of biotechnological applications of extremophiles.
5) Students will be well versed with the various types of microbial interaction that occur in nature.
6) Students will know about the diversity of microorganism.

Unit-I (12)

- **Extreme environments**: Characteristics, Common extreme environments, Classification of extreme environments. Types of microorganism found in various extreme environments and their characteristics.
- **Microorganisms in extreme temperature** (Psychrophiles, Thermophiles and Hyperthermophiles):

Psychrophiles: Definition, Characteristics, Mode of adaptation, Examples and applications

Thermophiles: Definition, Characteristics, Mode of adaptation, Examples and applications

Hyperthermophiles: Definition, Characteristics, Mode of adaptation, Examples and applications

Unit-II (12)

- **Microorganisms in extreme pH (** Acidophiles and Alkaliphiles**), extreme radiation (**Radiophiles) **and extreme in heavy metals** (Metalotolerant):

Acidophiles: Definition, Characteristics, Mode of adaptation, Examples.

Alkaliphiles: Definition, Characteristics, Mode of adaptation, Examples.

Radiophiles: Definition, Characteristics, Mode of adaptation, Examples and applications

Metalotolerant organisms : Definition, Characteristics, Mode of adaptation, Examples

- **Microorganisms in extreme salinity (** Halophiles**), extreme pressure (**Barophiles):

Halophiles: Definition, Characteristics, Mode of adaptation, Examples.

Barophiles: Definition, Characteristics, Mode of adaptation, Examples.

Unit-III (12)

- **Microorganisms in extreme low humidity/ water activity (**Xerophiles**), extreme sugar concentration** (Osmophiles):

Xerophiles: Definition, Characteristics, Mode of adaptation, Examples.

Osmophiles: Definition, Characteristics, Mode of adaptation, Examples.

Unit -IV (12)

- **Microbial Diversity:** Basic concept, Revealing microbial diversity, Concept of microbial species, Diversity of microorganisms of soil, water and air , Significance of study of Microbial diversity**.**
- **Microbial Ecology :**
  i) **Communities and ecosystems Population interactions**: Types of interactions, Commensalism, Synergism, mutualism, competition, Ammensalism, Parasitism.
  ii) **Invertebrate microbes interaction:**
  a*) Vibriofischeri* &*squideuprymna* mutualistic interactions.
  b) Hydrothermal vents – metabolic interactions – *Rifetia*& its bacterial endosymbionts.
  c) Bacterium – Aphid symbiosis – *Buchnera aphidicola* – Aphid symbiosis
- **Phototrophic microbes** – Food source for planet earth

Unit V (12)

- **Applications of extremophiles of various types:** Thermophiles, Hyperthermophiles, Psychrophiles, Acidophiles, Alkilophilesm Halophiles.

- **Applications of microorganisms in**

i) Microbial leaching of ores - Copper, Uranium and Gold Mercury and heavy metal transformation.
ii) Use of bacteria for detecting pollutants and pathogens pollutants and pathogens.
iii) Recovery of oil
iv) Production of pharmaceutical products.

References

1. Brock, T. D. 2012. Thermophilic microorganisms and life at high temperatures, Springer, New York.

2. Rainey, F. A., Oren, A. 2004. Extremophile microorganisms and the methods to handle them. In: Extremophiles, Methods in Microbiology, vol. 35, Elsevier, Amsterdam.

3. Horikoshi, K., Grant, W. D., 1998. Extremophiles-microbial life in extreme environments, Wiley, New York.

4. Johri, B.N. 2000. Extremophiles, 1st edition, Springer Verlag. , New York

5. Ventosa, A., Nieto, J.J., Oren, A. 1998. Biology of moderately halophilic aerobic bacteria. Microbiology and Molecular Biology Reviews, 62, 504–544. 6. Kushner, D. J. 1978. Microbial Life in Extreme Environments, Academic Press.

6. Clive Edward 1990. Microbiology of Extreme Environments, Open University Press.

7. Milton Keynes. Microbiology of Extreme Environments and its potential for Biotechnology. Edited by Da Costa, M.S., Duarate, J.C., Williams, R.A. D. Elsiever Applied Science, Low Extreme Environment. Mechanism of Microbial Adaptation. Edited by Milton R. Heinrich, Academic Press.

8. Da Costa, M.S., Duarate, J.C., Williams, R.A. D. 1989. Microbiology of Extreme Environments and its potential for Biotechnology, Springer, Netherlands.

9. Milton R. Heinrich 1976. Extreme Environment. Mechanism of Microbial Adaptation Academic Press.

10. Thomas D. Brock 1986. Thermophiles. General, Molecular and Applied Microbiology, Wiley Interscience Publication.

11. Jerome J. Perry, James T. Staley 1996. Microbiology: Dynamics and Diversity, Saunders College Pub.

12. Ronald M. Atlas 2005. Microbial Ecology. Fundamentals and Applications. Pearson Education Limited.

13. Campbell, R. 2009. Microbial Ecology, 2nd edition, Blackwell Scientifc Publication.

14. Michael T. Madigan, John M. Martinko, Jack Parker 2015. Brocks Biology of Microorganisms, 14th edition, Prentice Hall Internation Inc.

15. Wayne W. Umbreit, Pearlman, D., 1981. Advances in Applied Microbiology, Vol. 26, Academic Press.

16. Microbiomes of extreme environment, Volume I edited by, Ajar Nath Yadav et. Al. Published by CRC press.

17 Extremophiles Microbial Life in Extreme Environment, edited by Koki Horikosshi, Willium D. Grant, published by Willey- LISS; 1st edition (January 30, 1998).

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

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

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

Course Code: 5401-34 Bioinformatics (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.
5) Students will get introduced with protein structure prediction and drug designing.

Unit I (12)

- **Fundamentals of Computers:**
  i. Internet: Resources, World Wide Web, Tools associated and terminologies.
  ii. Computer Viruses: Overview, Transmission and Precautions.
- **Arrays and strings**

Unit II (12)

- **Introduction to databases:**
  1. **Databases:** Primary, Secondary; Relational and Non relational; Redundant and Non Redundant.
  2. **E-R Model**
     a. Entity and Entity sets
     b. E-R Diagrams
     c. Reducing E-R diagram to tables
  3. **Introduction to SQL**
     a. Select statement
     b. Data definition Statements
     c. Data manipulation statements

Unit III (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:

Unit IV (12)

- **Biological Data Analysis:**
  1. Overview, Concepts and tools.
  2. Sequence comparison by Dot Matrix and Dynamic Programming.
  3. Pair wise Sequence Analysis by Needle man and Wunch algorithm
  4. Scoring Matrices: PAM, BLOSSUM
  5. Database Search: BLAST and FASTA
  6. Multiple Sequence Alignment: Basic concepts, Progressive and Hierarchical approaches CLUSTAL-W, Applications.

7. Immunoinformatics databases

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

- **Microbial Genomics and Proteomics** :

a) Genomics:

i) Functional genomics and comparative genomics.
ii) Insight from microbial Genomes- Identification of genes with unknown function, Genomic analysis of pathogenic microbes and extremophiles, Environmental genomics (metagenomics)

b) Proteomics: Functional proteomics, structural proteomics, protein modeling

- **Metabolimics:**

1. Metabolic Pathway databases

a. KEGG
b. EcoCyc and MetaCyc

2. Enzyme compounds and Reaction Databases

a. LIGAND-Biochemical and Reaction Databases
b. ENZYME- Enzymes
c. BRENDA
d. Metabolic Pathway Prediction.

- **Programming Language: Basics of "C"**

1.Fundamentals of programming

a. Designing Flow charts / Algorithms
b. Pseudocodes

2.Fundamentals of C

5)Data types,
6)Operators and Expressions,
7)Hierarchy of operations, C instructions

3.Control statements

a. Decision (if, if-else)
b. Loops control (while, do-while, For)
c. **Functions**

- **Structure based Drug Design :** Introduction

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.

7. "Prescott, Harley and Klein's microbiology", by Willey, Sherwood and Woolverton, 2008, Mc Graw- Hil companies, Inc, New york.

Course Code:5401-35 Practical Course V (04 Credits)

Course Objectives:

1) To give the students training and practice of carrying out physicochemical analysis of milk and food, microbiological examination of food, milk and milk products.

2) To enable the students to carry out examination of canned foods

3) To make the students independently search, store, retrieve and analyze the biological data.

4) To give the students all the basic background needed for working in Food and Dairy industry.

Course Outcomes:

1) Students will be able to carry out physicochemical analysis of milk and food
2) Students will know how to carry out the microbiological examination of food, milk and milk products.
3) Students shall be able to independently search, store, retrieve and analyze the biological data
4) Student will get acquainted with all the basic background needed for working in Food and Dairy industry.

1. Rapid identification methods of bacteria.

2. Maintenance and handling of cultures.

3. Standard plate count of yeast and moulds.

4. Determination of heterotrophic bacterial count of the give samples.

5. Determination of phagocytic index

6. Enrichment, isolation and characterization of theromophilic and thermoduric bacteria

7. Enrichment, isolation and characterization of Osomophilic bacteria.

8. Enrichment, isolation and characterization of Acidophilic bacteria.

9. Enrichment, isolation and characterization of halophilic and halotolerant bacteria.

10. ELISA test.

11. Computer and Bioinformatics:

(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.
(iv) Creating and Populating data base- M.S. Access.
(v) Data base searching – Using Blast.
(vi) Bioinformatics recourses - NCBI, EMBL, ExPassy
(vii) Using nucleic acid databases - DDBJ, GenBank
(viii) Using protein databases- Swiss prot, TrEMBL, Uniprot
(ix) Construction phylogenetic trees

Course Code: 5401-36 Practical Course VI (04 Credits)

Course Objectives:

1) To make the students learn about by way of demonstratation the various microbial interactions such as commensalism, ammensalism , mutualism etc.

2) To make the students perform screening out industrially important microbial strains like organic acid producers, antibiotic producers, protease producers, enzyme producers.

3) To acquaint the students with the determination of BOD and COD removal efficiency of waste water treatment plant

4) To make the students know about producing biofertilizer(Azo, Rhizo) on the laboratory scale.

5) To make the students gain the knowledge of working in fermentation industry particularly in production units, micro-labs and Quality Control departments.

Course Outcomes:

1) Students will be able to demonstrate various microbial interactions such as commensalism, ammensalism , mutualism etc.

2) Students will be able to screen out industrially important microbial strains like organic acid producers, antibiotic producers, protease producers, enzyme producers.

3) Students will be able to determine BOD and COD removal efficiency of waste water treatment plant

4) Students will be able to produce biofertilizer(Azo, Rhizo) on the laboratory scale.

5) Students will be able to work in fermentation industry particularly in production units, micro-labs and Quality Control departments.

1) Screening of antibiotic producers
2) Screening of amino acid producers
3) Screening of protease producers.
4) Screening of organic acid producers.
5) Screening of Vitamin producers.
6) Determination of potability of water
7) Determination of BOD and COD removal efficiency of a waste treatment plant.
8) Production of Yoghurt.
9) Demonstration of Microbial interactions
    a. Mutualism
    b. Commensalism
    c. Syntrophism
    d. Amensalism (Antagonism)
    e. Parasitism
    f. Synergism (Protocooperation)

Reference Books for Practical Course

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

5. "Manual of laboratory techniques", by Rghumulla, N., Nair, K. M., and Kalyansundaram, S., 2nd edition, 2003, National Institute of Nutrition Press, Hyderabad.
6. Official methods of analysis of association of official analytical chemists, 15th edition, Association of Official Analytical Chemists, Inc., Virginia, USA.
7. " Bioinformatics", by C.S.V. Murthy 1st edition publishers Himalaya Publishing House, Mumbai.
8. "Standard methods for the examination of water and waste water", 20th edition, edited by Greenberg, et al., 1998, APHA, AWWA, WEF, Washington, DC.
9. "Laboratory Manual in Industrial Biotechnology", by P. Chellapandi 2007, Pointer Publishers, Jaipur.
10. "Mackie and Mc Cartney Practical Medical Microbiology", 14th edition 2007, by J.G. Collee, A.G. Fraser, B.P. Marmion, A. Simmons, Publisher Churchill living stone elsevier – New Delhi.
6. 'Pharmaceutical Biotechnology", by Purohit, Kakrani, Saluja 1st edition Publishers, Agrobios (India) Jodhpur.

03 Leadership Development (02 Credits)

PREAMBLE:

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

OBJECTIVES:

1) To increase the morale and retention of the students.
2) To improve the productivity.
3) To promote the students for better decisions making.

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.

References:

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 Pharmaceutical Microbiology Semester IV

Course Code: 5401-41 Enzymology (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 the extraction, purification, immobilization and biotechnological applications of enzymes.

3) To make the students gain the knowledge of isoenzymes, multi enzymes and multi enzyme complexes.

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 have the knowledge of immobilization of enzyme and exposure of wide applications of enzymes and future potential uses of enzymes.

3) Students would be well versed with kinetics of soluble and immobilized enzymes.

4) Students would gain the knowledge of enzyme catalysis, isoenzymes, multi enzymes and multi enzyme complexes.

Unit I

Introduction to catalysis and Kinetics : Enzymes Definition , types and Classification - IUB system, rationale, overview and specific examples. Characteristics of enzymes, enzyme substrate complex. Concept of active centre, binding sites, stereospecificity and ES complex formation. Effect of temperature, pH and substrate concentration on reaction rate. Activation energy. Transition state theory.

Enzyme Catalysis

Factors affecting catalytic efficiency - proximity and orientation effects , distortion or strain, acid - base and nucleophilic catalysis. Methods for studying fast reactions. Chemical modification of enzymes. Isoenzymes and multiple forms of enzymes.

Unit II

Enzyme Kinetics

Michaelis - Menten Equation - form and derivation, steady state enzyme kinetics. Significance of Vmax and Km. Bisubstrate reactions. Graphical procedures in enzymology - advantages and disadvantages of alternate plotting.

- **The Significance of Sigmoidal Behaviour :**

(i) The Physiological Importance of Cooperative Oxygen – Binding by Haemoglobin

(ii) Allosteric Enzyme Metabolic Regulation – Introduction, Characteristics of Steady – State Metabolic Pathways , Regulation of Steady – State Metabolic Pathways by control of enzyme activity, Allosteric enzymes and the Amplification of Metabolic regulation.

(iii) Other Mechanisms of Metabolic regulation, Some examples of Allosteric enzymes involved in metabolic regulation

- **Enzyme Inhibition:**

Introduction, Reversible Inhibition – Competitive Inhibition, Uncompetitive Inhibition,

Non – Competitive Inhibition, Mixed Inhibition, Partial Inhibition, Substrate Inhibition, Allosteric Inhibition, Irreversible Inhibition.

Enzyme activity, international units, specific activity, turnover number, end point kinetic assay

Unit III

Structure Function Relations

Lysozyme, ribonuclease, trypsin, carboxypeptidase, phosphorylase, aspartate transcarbamylase, glutamine synthetase and phosphofructo kinase. Multi enzyme complexes - pyruvate dehydrogenase and fatty acid synthetase; Na - K ATPase.

Unit IV

Allosteric Interactions

Protein ligand binding including measurements, analysis of binding isotherms, co-operativity**,** Hill and Scatchard plots and kinetics of allosteric enzymes.

Enzyme Regulation

Product inhibition, feedback control, enzyme induction and repression and covalent modification. Allosteric regulation.

Unit V (12)

- **Enhancement of enzyme activity & thermostability using nanotechnology**
- **Enzymes – Production, immobilization and Applications:**

Large-Scale production of Enzymes, Immobilised Enzymes – Preparation of

Immobilised Enzymes, Properties of Immobilised Enzymes, Applications of Immobilised Enzymes : General Principles.

Applications of enzymes in Industries .

Application of Enzymes in Medicine and Diagnostics.

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, 2007, 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.

Course Code: 5401-42 Quality Management and IPR (04 Credits)

Course Objectives:

1) To make the students familiar with the various aspects of intellectual property rights like patents, copyright, industrial designs and trademarks.

2) To give the students basic knowledge about the types of patents, patent filling and patent infringement

3) To introduce students with types of biosafety cabinet, various biosafety levels,

biosafety committees, biosafety guidelines, risk assessment and risk management process.

4) To introduce the students with the concept of Quality management -Quality control and quality assurance in Pharma industries

Course Outcomes:

1) Students will have knowledge about the process of patent filling and patent infringement.

2) Students will have knowledge about the patent design.

3) Students will have knowledge about the rules and regulations of biosafety.

4) Students will get the knowledge of quality management system in pharma Industry.

Unit I (12)

Quality Assurance:

Introduction of quality assurance, GMP for: building (premises) for manufacture of drugs, Packaging material, Personnel, hygiene, sanitation, waste and disposal. Quality assurance and regulatory aspect for: import, export, manufacture and sale of drug and formulation clinical and nonclinical testing, animal trials. Records and documents: Records related to products release, Quality review, and Quality audits. Complains and recalls.

Quality Control :

Definition - Quality control basics. Quality control for: all instruments, clothing's, packing,

processing line. Quality control of processes and products: pharmaceutical products including sterile injectibles, non injectibles, ophthalmic preparations and implants modified release products (controlled release, sustained release products, etc), parenterals.

Quality Management in pharmaceutical:

Production Management and Documentation: ICH, ISO 9000 series, total quality management, validation for tablets and parenterals, practice of WHO GMP. Industrial Safety: Industrial hazards and their prevention, fire, accidents, mechanical and electrical equipments, industrial effluent testing.

Drug stability: Solution stability, solid stability, parameters for physical stability testing, protocol for physical stability testing program, accelerated studies and shelf life assignment

Unit II (12)

- **Introduction to Intellectual Property**

Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of New GMOs; International framework for the protection of IP. IP as a factor in R&D; IPs of relevance to Biotechnology and few Case Studies; Introduction to History of GATT. WTO, WIPO and TRIPS.

Basics of Patents

Types of patents; Indian Patent Act 1970; Recent Amendments; Filing of a patent application; Precautions before patenting-disclosure/non-disclosure; WIPO Treaties; Budapest Treaty;
Pct and Implications; Role of a Country Patent Office: Procedure for filing a PCT application

- **Concept of prior Art**

Invention in context of "prior art"; Patent databases; Searching International Databases, Country-wise patent searches (USPTO, EPO, India etc.); Analysis and report formation.

Unit III (12)

- **Legal protection & IPR**

Legal protection & IPR regulations IPP, IPR, process of patenting, Indian and international agencies involved in IPR & patenting, Global scenario of patents and India's position, patenting of biological material, GLP, GMP.

Unit IV (12)

- **IPR regulations**

General Introduction to IPR (Patents, Plant Breeders Rights) – Trade Marks, Industrial Design, Trade Secrets; Copy Right and right related to copy right; Patent – Patent Principle, International Standards and Patent Validity, Recent developments in patent system and patentability of invention IPR issues of the Indian context.

Unit V (12)

- **Patent filing and Infringement**

Patent application- forms and guidelines, fee structure, time frames; Types of patent applications: provisional and complete specifications. PCT and convention patent applications; international patenting-requirement procedures and costs; Financial assistance for patenting-introduction to existing schemes; Publication of patents-gazette of India, status in Europe and US Patenting by research students, lecturers and scientists-University/organizational rules in India and abroad, credit sharing by workers, financial incentives Patent infringement- meaning, scope, litigation, case studies and examples.

Reference Books:

1. "Law relating to patents, trade marks, copyright designs & geographical indications" by Wadehra, B. L. 2nd edition, Universal Law Publishing, 2000.
2. "Law of Intellectual Property", by Myneni, S. R., Asia Law House, Hyderabad, 2001.
3. "Intellectual Property Law in India", by Narayan, P. S., Gogia Law Agency, Hyderabad, 2001.
4. "Intellectual Property rights the WTO and Developing Countries: The TRIPS Agreement and Policy options" by Correa, Carlos M, Zed Books, New York, 2000.
5. " Global Dimensions of Intellectual Property rights in Science and Technology", by Wallerstein, Mitchel B.; Mog Mary Ellen and Schoen, R. A. Gross, Califford M.; Reischl, and Abercrombie, Paul, National Academy Washington, 1993.

6. "Biosafety in the Laboratory: Prudent Practices for Handling and Disposal of Infectious Material", The National Academics Press, 1939.
7. "Biological Safety: Principles and Practices", 4th edition, edited by Diane O. Fleming and Debra L. Hunt, ASM Press.
8. "Textbook of Biotechnology", by H. K. Das, 3rd edition, Willey India (P) Ltd., 2007.
9. "Essentials of Biotechnology", by R. C. Sobati, Suparna S. Pachauri, Ane Books Pvt. Ltd., 2009.
10. Quality control in the Pharmaceutical Industry - Edt. by Murray S.Cooper Vol.2. Academic Press New York.
11. Sidney H Willing, Murray M, Tuckerman. Williams Hitchings IV, Good manufacturing of pharmaceuticals (A Plan for total quality control) 3rd Edition. Bhalani publishing house Mumbai.
12. Quality Assurance of Pharmaceuticals- A compedium of Guide lines and Related materials Vol I & II, 2nd edition, WHO Publications, 1999.
13. Good laboratory Practice Regulations – Allen F. Hirsch, Volume 38, Marcel Dekker Series, 1989.
14. The International Pharmacopoeia – vol I, II, III, IV & V - General Methods of Analysis and Quality specification for Pharmaceutical Substances, Expedients and Dosage forms, 3rd edition, WHO, Geneva, 2005

Course Code: 5401-43 Genetic Engineering (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 ethical issues involved in genetic engineering to the students.

Course Outcomes:

1) Students would have the knowledge of basic principles and methods of recombinant DNA technology.

2) Students will get thorough 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 will acquire knowledge 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)**

Introduction to Recombinant DNA Technology

Overview of Restriction analysis

Labeling of DNA: Nick translation, random priming, radioactive and non-radioactive probes, use of Klenow enzyme, T4 DNA polymerase, bacterial alkaline phosphatase, polynucleotide kinase. Hybridization techniques: Northern, Southern, Western and Colony hybridization, Fluorescence in situ hybridization, Restriction maps and mapping techniques, DNA fingerprinting, chromosome walking & chromosome jumping.

DNA-Protein Interactions: Electro mobility shift assay, DNase Ifootprinting, methyl interference

Unit II **(12)**

Cloning Vectors

Overview of commonly employed cloning vectors. Gene Cloning Vectors: Plasmids (Natural and synthetic), bacteriophages, M13,MP vectors, phagemids, Lambda vectors; insertion and replacement vectors, EMBL, λDASH, λgt10/11, λZAP etc. Cosmid vectors. Artificial chromosome vectors (YACs, BACs), Animal Virus derived vectors- SV-40, vaccinia/bacculo& retroviral vectors. Expression vectors; pMal, GST, pET-based vectorsBaculovirus and *Pichia* vectors system.

Applications: His-tag, GST-tag, MBP-tag etc. Restriction proteases, intein-based vectors. Inclusion bodies, methodologies toreduce formation of inclusion bodies.

Unit III **(12)**

Methods of DNA Cloning

Insertion of Foreign DNA into Host Cells: Transformation, Transduction, Conjugation, Transfection: Chemical and physical methods, liposomes, microinjection, macroinjection, electroporation, biolistics, somatic cell fusion, gene transfer by pronuclear microinjection.

Plant transformation technology: Basis of tumor formation, hairy root, features of Ti and Ri plasmids, mechanism of DNA transfer, role of virulence genes, use of Ti and Ri as vectors.

Cloning and expression in yeasts (Saccharomyces, Pichia etc.), animal and plants cells, methods of selection and screening, cDNA and genomic cloning, expression cloning, yeast two hybrid system, phage display.

DNA Libraries: Construction of cDNA libraries in plasmids and screening methodologies, Construction of cDNA and genomic

DNA libraries in lambda vector, jumping libraries or junction fragment libraries

Unit IV **(12)**

PCR

Primer design, Fidelity of thermostable enzymes, DNA polymerases, Types of PCR: multiplex, nested, reverse transcriptase, real time, touchdown, hot start, colony, cloning of PCR products, T-vectors, proof reading enzymes, PCR in gene recombination, deletion, addition, overlap extension, and SOEing, site directed mutagenesis, PCR in molecular diagnostics, viral and bacterial detection, PCR based mutagenesis.

Applications

Sequencing methods: Enzymatic DNA sequencing, Chemical sequencing of DNA, principle of automated DNA sequencing, Next Gene DNA sequencing Methods (SOLiD, Ilumina and pyrosequencing), RNA sequencing, Chemical Synthesis of oligonucleotides.

Gene silencing techniques: Introduction to siRNA and siRNA technology, micro RNA, construction of siRNA vectors, principle and application of gene silencing. CRISPR, CRISPR/Cas9 technology.

Gene Therapy : Creation of knockout mice, disease model, somatic and germ-line therapy in vivo and ex-vivo,suicide gene therapy, gene replacement, gene targeting.

Other applications of genetic engineering : Transgenics, Genome projects and their implications, application in global gene expression analysis. Applications of recombinant DNA technology in medicine,agriculture, veterinary sciences and protein engineering.

Unit V **(12)**

Applications of Gene Cloning :

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

Expression of forign genes

Production of fusion proteins

Phage display techniques

Applications in medicine and Industry

Production of insulin as a recombinant drug.

r- DNA Vaccines

Monoclonal antibodies, monospecific and bispecific

Production of recombinant proteins

Production of bovine growth hormone

Soluble CD4 molecules and use of CD4 toxin conjugates.

Suggested readings:

1. Sambrook J, Fritsch E. F. and Maniatis (1989) Molecular cloning, vol. I, II, III, II nd edition,Cold spring harbor laboratory press, New York.
2. DNA Cloning : A practical approach D.M. Glover and D.B. Hames, RL Press, Oxford, 1995
3. Molecular and cellular methods in Biology and Medicine, P.B. Kaufman, W. Wu , D. Kim and L.J. Cseke, CRC Press Florida 1995
4. Methods in Enzymology Guide to Molecular Cloning Techniques, Vol. 152 S.L. Berger and A. R. Kimmel, Academic Press Inc, San Diego, 1996
5. Methods in Enzymology Gene Expression Technology, Vol. 185D. V. Goedel, Academic PressInc, San Diego, 1990
6. DNA Science: A First Course in Recombinant Technology, D. A. Mickloss and G. A Freyer,Cold Spring Harbor Laboratory Press, New York, 1990
7. Molecular Biotechnology, 2nd Ed. S. B. Primrose, Blackwell Scientific publishers, Oxford, 1994
8. Milestones in Biotechnology, Classic Papers on Genetic Engineering, J. A. Davis and W. S.Reznikoff, Butterworth-Heinemann Boston 1992
9. Route Maps in Gene Technology, M. R. Walker, and R. Rapley, Blakwell Science, Oxford, 1997
10. Genetic Engineering : An Introduction to Gene Analysis and Exploitation in Eukaryotes, S. M.Kingsman, Blackwell Scientific Publications, Oxford, 1998

Course Code: 5401-44 Pharmaceutical Microbiology (04 Credits)

Course Objectives:

1) To make the students to understand the Drug discovery and drug development
2) To impart the knowledge to the students about the production of various types of enzymes, amino acids, vitamins, and organic acids and probiotics to the students.
3) To give the students deep insight into the antibiotics, antimicrobial agents and their mode of action.
4) To give the students knowledge about good manufacturing practices.

Course Outcomes:

1) Students will gain the knowledge regarding Drug discovery and drug development
2) Students will get knowledge about production of various types of enzymes, amino acids, vitamins, and organic acids.
3) Students will have a deep insight into the antimicrobial agents and their mode of action.

Unit I **(12)**

Introduction to chemotherapeutic agents:

History and development of chemotherapeutic agent, Properties of antimicrobial agents, Types of chemotherapeutic agents – Synthetic, Semisynthetic, Natural Antibiotics

Antimicrobial agents: antibacterial, antifungal, antiviral, antiprotozoal and anti cancer antibiotics and drugs and their mode of action.

Unit II **(12)**

Antibiotic resistance and development of new therapeutics: Development of antibiotic resistance, Mechanism of antibioticresistance,
Antimicrobial Peptides: History, properties, sources, mode of action, application.
Phage therapy: introduction to phages, lytic cycle, types of phagesinvolved in phage therapy
Plant based therapeutic agents.

Unit III **(12)**

Microbial spoilage and sterilization of pharma products:
Microbial contamination spoilage and hazard: Sources of contamination, factors affecting survival and growth, breakdownof active ingredient and general formulations.
Principles of sterilizations with respect to pharmaceuticalindustries.
Methods of sterilizations: Steam, dry heat, Radiation, Gaseous and Filtration, sterility testing of pharmaceutical products.

Unit IV **(12)**

Preservatives in Pharmaceutical Products:
Principles of preservation: objectives of preservation, the ideal preservative, rational development of a product preservative system etc.
Antimicrobial preservatives and their properties: antimicrobial activity, factors affecting antimicrobial activity, preservativemonographs.
Preservative stability and efficacy.
methods of Preservative evaluation and testing

(i) Microbial production specific amino acids: L – Lysine, L - Glutamic acid, L – Leucine,L – Isoleucine
(ii) **Production of Probiotics –** *Lactobacillus acidophilus, Lactobacillus casei*
Production of microbial enzyme by fermentation : Oxidoreductases, Oxidases, Hydrolases, Transferases, Kinases, Isomerases.

Unit V **(12)**

Regulatory aspects in pharmaceutical industries

Introduction to pharmacopoeia: Food and Drug Administration (FDA) regulation and India Pharmacopoeia (IP), British Pharmacopoeia (BP), United States Pharmacopoeia(USP) Good Laboratory Practices (GLP) Good Manufacturing Practices (GMP) and Current Good Manufacturing Practices (cGMP), Reimbursement of drugs and biological.

Reference Books :

1. "Pharmaceutical Biotechnology", by S.S. Purohit, H.N. Kakarni and A.K. Saluja, Agrobios (India).
2. "Basic Biotechnology", edited by colin Ratledge and Bjorn Kristiansen, 2001, Cambridge University, Press, New York.
3. "Biotechnology : A Text Book of Industrial Microbiology", 2nd edition by Wulf Crueger and Anneliese Crueger (Third Indian reprint 2005), Panima Publishing Corporation New Delhi / Banglore.
4. "Microbial Technology", 2nd edition, volume I, edited by Peppler, H. J. and Perlman, D. 1979 Academic Press, New York.
5. "Microbial Technology", 2nd edition, volume II, edited by Peppler, H. J. and Perlman, D. 1979 Academic Press, New York.