

# **SHIVAJI UNIVERSITY, KOLHAPUR**



**Accredited By NAAC with 'A++' Grade**

**Syllabus for  
M.Sc. Programme structure M.Sc. Part-II(Level-9)  
M.Sc. General Microbiology, CBCS**

**(NEP-2020 PATTERN)**

**SEMESTER III to IV**

**Syllabus to be implemented From**

**June, 2023 onwards**

### Theory Question paper format

M.Sc. General Microbiology (CBCS-NEP 2020)

Total Marks:80

Instructions: 1) Question no.1 is compulsory and carries 16 marks

2) Attempt any two questions from each section

3) All questions carry equal marks

Q.1 Objective/multiple choice/one line sentence type 16 questions

(16 Marks)

1.  
2.  
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16

#### Section-I

Q.2 long answer question

(16 Marks)

Q.3 long answer question

(16 Marks)

Q.4 long answer question

(16 Marks)

#### Section-II

Q.5 short answer questions

(16 Marks)

i)

ii)

Q.6 Short note answer questions

16 Marks)

i)

ii)

iii)

iv)

Q.7 Short note answer questions

(16 Marks)

i)

ii)

iii)

iv)

**Choice Based Credit System with Multiple Entry and Multiple Exit Option (NEP-2020) M.Sc. Programme Structure (Other than Mathematics and Statistics)**  
**M.Sc. Part–II-General Microbiology(Level-9)**

SEMESTER-III(Duration-Six Month)											
	Sr. No.	Course Code	Teaching Scheme			Examination Scheme					
			Theory and Practical			University Assessment(UA)			Internal Assessment(IA)		
			Lectures (Per week)	Hours (Per week)	Credit	Maximum Marks	Minimum Marks	Exam. Hours	Maximum Marks	Minimum Marks	Exam. Hours
CGPA	1	CC-301	4	4	4	80	32	3	20	8	1
	2	CCS-302	4	4	4	80	32	3	20	8	1
	3	CCS-303	4	4	4	80	32	3	20	8	1
	4	DSE-304	4	4	4	80	32	3	20	8	1
	5	CCPR-305	16	16	8	200	80	--	--	--	*
Total(C)			--	--	24	520	--	--	80	--	
Non-CGPA	1	AEC-306	2	2	2	--	--	--	50	20	2
	2	EC(SWM MOOC)-307	Number of lectures and credit shall be as specified on SWAYAM MOOC								
SEMESTER-IV(Duration-Six Month)											
CGPA	1	CC-401	4	4	4	80	32	3	20	8	1
	2	CCS-402	4	4	4	80	32	3	20	8	1
	3	CCS-403	4	4	4	80	32	3	20	8	1
	4	DSE-404	4	4	4	80	32	3	20	8	1
	5	CCPR-405	16	16	8	200	80	--	--	--	*
Total(D)			--	--	24	520	--	--	80	--	--
Non-CGPA	1	SEC-406	2	2	2	--	--	--	50	20	2
	2	GE-407	2	2	2	--	--	--	50	20	2
Total(C+D)					48	1040	--	--	160	--	--

<ul style="list-style-type: none"> <li>Student contact hours per week:<b>32</b> Hours (Min.)</li> </ul>	<ul style="list-style-type: none"> <li>Total Marks for M.Sc.-II :<b>1200</b></li> </ul>
<ul style="list-style-type: none"> <li>TheoryandPracticalLectures:<b>60</b> Minutes Each</li> </ul>	<ul style="list-style-type: none"> <li>Total Credits for M.Sc.-II (Semester III&amp;IV):<b>48</b></li> </ul>
<ul style="list-style-type: none"> <li>CC-Core Course</li> <li>CCS-Core Course Specialization</li> <li>CCPR-Core Course Practical and Project</li> <li>DSE-Discipline Specific Elective</li> <li>AEC-Mandatory Non-CGPA compulsory Ability Enhancement Course</li> <li>SEC-Mandatory Non-CGPA compulsory Skill Enhancement Course</li> <li>EC(SWMMOOC)-Non-CGPA Elective Course</li> <li>GE-Multidisciplinary Generic Elective</li> </ul>	<ul style="list-style-type: none"> <li>Practical Examination is annual.</li> <li>Examination for CCPR-305shall be based on Semester III Practicals.</li> <li>Examination for CCPR-405shall be based on Semester IV Practicals.</li> <li>*Duration of Practical Examination as per respective BOS guidelines</li> <li><i>Separate passing is mandatory for Theory, Internal and Practical Examination</i></li> </ul>
<ul style="list-style-type: none"> <li><b>Requirement for Entry at Level 9:</b> <b>Completed all requirements of the relevant Post Graduate Diploma (Level 8)in Microbiology</b></li> </ul>	
<ul style="list-style-type: none"> <li><b>Exit at Level 9:</b>Students will exit after Level 9 with <b>Master's Degree in Microbiology</b>if he/she completes the courses equivalent to minimum of 96 credits.</li> </ul>	

	<b>M.Sc.-I</b>	<b>M.Sc.-II</b>	<b>Total</b>
<b>Marks</b>	<b>1200</b>	<b>1200</b>	<b>2400</b>
<b>Credits</b>	<b>48</b>	<b>48</b>	<b>96</b>

#### I. CGPA course:

1. There shall be 14Core Courses(CC)per programme.
2. There shall be 04Core Course Specialization(CCS) of 16 credits per programme.
3. There shall be 02 Discipline Specific Elective (DSE)courses of 08 credits per programme
4. Total credits for CGPA courses shall be of 96 credits per programme

#### II. Mandatory Non-CGPA Courses:

1. There shall be 02 Mandatory Non-CGPA compulsory Ability Enhancement Courses(AEC) of 02credits each per programme.
2. There shall be 01 Mandatory Non-CGPA compulsory Skill Enhancement Course(SEC)of 02 credits per programme.
3. There shall be one Elective Course (EC) (SWAYAM MOOC). The credits of this course shall be as specified on SWAYAM MOOC.
4. There shall be one Generic Elective (GE) course of

02 credits per programme. Each student has to take generic elective from the department other than parent department.

5. The total credits for Non-CGPA course shall be of 08 credits+2-4credits of EC as per availability.
6. The credits assigned to the course and the programme are to be earned by the students and shall not have any relevance with the work load of the teacher.

**New Revised (CBCS-NEP 2020) Syllabus for  
M.Sc. - II (General Microbiology) Syllabus  
Semester-III**

**600 Marks**

**Titles of theory and practical courses**

**Theory Papers:**

**SEMESTER – III**

Paper-IX, CC-301- Biostatistics, Bioinformatics and Scientific Writing

Paper-X, CCS-302- Enzymology and Enzyme Technology

Paper-XI, CCS-303- Fermentation Technology

Paper-XII, DSE-304- Quality Control Microbiology-I

**Practical course-CCPR-305- Laboratory course.**

AEC-306 : Mandatory Non-CGPA compulsory ability enhancement Course

EC-307(SWMMOOC)-Quality Control in Pharmaceutical Industry.

**Semester-IV**

**600 Marks**

Paper-XIII, CC-401- Food and Dairy Microbiology

Paper-XIV, CCS-402- Industrial waste management

Paper-XV, CCS-403- Recombinant DNA Technology

Paper-XVI, DSE-404- Quality Control Microbiology-II

**Practical course-CCPR-405- A-Laboratory Course. B-Research Project**

SEC-406: Mandatory Non-CGPA Compulsory Skill Enhancement Course.

GE-407: Modern techniques in Microbiology and Molecular Microbiology

## **SEMESTER – III**

**Paper-IX (CC-301),: BIOSTATISTICS, BIOINFORMATICS AND SCIENTIFIC WRITING -60 Hrs**

### **UNIT – I**

**(15)**

Biostatistics

1. Basic concepts: definitions – statistics and biostatistics, population, sample, variable and the various types, statistic and parameter.
2. Collection and presentation of data: primary and secondary data, collection of data – enumeration and measurement, significant digits, rounding of data, accuracy and precision, recording of data. Tabular and diagrammatic presentation – arrays, frequency distribution, bar diagrams, histograms and frequency polygons.
3. Descriptive statistics: measures of central tendency, dispersion, skewness and kurtosis
4. Probability: definition, elementary properties, types, rules, applications to biological problems, distributions – Binomial, Poisson, Normal, chi-square ( $\chi^2$ ) distribution and test.
5. Sampling methods: principles of sampling, necessity – merits and demerits, random sampling – lottery, geographical arrangement random number; deliberate or non-random sampling, stratified sampling, cluster sampling.

### **UNIT – II**

**(15)**

1. Inference about populations: sample size, sampling distribution, standard error, estimation of population mean - confidence interval, Student's  $t$ - distribution and its applications ( $t$ - test).
2. Hypothesis testing: definition of hypothesis, hypotheses - null and alternate hypotheses, general procedure, decision about  $H_0$ : – one-tailed and two-tailed tests, type I and type II errors

3. Analysis of Variance (ANOVA): basic concepts, experimental designs – CRD, RBD, factorial experiment, repeated measures, other designs, general method, F – test, multiple comparison tests.
4. Correlation: introduction, types, methods of study – scatter diagram, correlation graph, Karl Pearson's coefficient of correlation and its interpretation, test of significance.
5. Regression: introduction, simple linear regression - model, equation, least-squares line, evaluating and using the equation, multiple regression – model, obtaining, evaluating and using the multiple regression equation.

### **UNIT – III**

**(15)**

#### **Bioinformatics**

1. Definition, components, objectives, databases – definition, biological databases, types and examples, database management systems (DBMS)
2. Applications of bioinformatics – I: Data visualisation – sequence and structure of nucleic acids and proteins, data visualisation tools.
3. Applications of bioinformatics – II: Pattern matching and sequence alignment of nucleic acids and proteins – fundamental principles of pairwise sequence alignment, local and global alignment, multiple sequence alignment, sequence alignment tools and databases.
4. Applications of bioinformatics – III: Modeling and Simulation – components and process of modeling and simulation, algorithms – Monte Carlo, Metropolis, methods and tools used for proteins structure (secondary, motifs and domains).
5. Applications of bioinformatics – IV:
  - 5.1 Phylogenetic analysis: basic principles and methods of preparation of phylogenetic trees.
  - 5.2 Drug discovery and development: fundamental principles, rational drug design, chemoinformatics and pharmainformatics resources, pharmacogenomics.

### **UNIT – IV**

**(15)**

#### **Scientific Writing**

1. Basic concepts of Scientific writing: Language - good English and grammar, use and misuse of words, jargon, abbreviations, literary ornaments, Main requirements of a scientific document.
2. Scientific Document: definition and types – research papers, review papers, proceedings, project reports, theses, book reviews.
3. Compilation of experimental record and programme of writing, Structure of a scientific paper: the AIMRAD system – writing a paper according to the system, preparing effective tables, graphs and photographs
4. Presenting and publishing research:
  - 4.1 Publishing in journals – printed and electronic journals; selection of a journal, preparation and submission of the manuscript
  - 4.2 Presenting in conferences: oral and poster presentations
  - 4.3 Legal aspects of scientific authorship: copyright considerations, Plagiarism- definition, types, causes and detection of plagiarism.

### **REFERENCE BOOKS**

#### **BIOSTATISTICS**

1. Biostatistics A foundation for Analysis in the Health Sciences, by Wayne Daniel (7<sup>th</sup> Ed) Wiley- India edition
2. Biostatistics by N. Gurumani MJP Publishers



3. Statistical Methods for the Analysis of Repeated Measurements by C. S. Davis
3. Statistical Method in Biological Assays by D. J. Finney
4. Statistical Methods for Rates and Proportions by Fleiss, Joseph L., Levin Bruce and Paik Myunghee Cho
5. Fundamentals of Biostatistics (2nd Ed) Irfan Ali Khan and Atiya Khanum, Ukaaz Publications, Hyderabad.
6. Design and analysis of experiments by D.C. Montgomery, John Wiley & Sons.
7. Sampling methods by M.N. Murthy, Indian Statistical Institute, Kolkata.

#### BIOINFORMATICS

1. I Bioinformatics: A Beginner's Guide by Jean-Michel Claverie and C. Notredame (2003), Wiley Dreamtech India (P) Ltd., New Delhi – 110 002
2. Elementary Bioinformatics by I. A. Khan (2005), Pharma Book Syndicate, Hyderabad
3. Bioinformatics Computing by B. Bergeron (2003), Prentice-Hall of India Private Limited, New Delhi – 110 001
4. Bioinformatics (Instant Notes Series) by D. R. Westhead, J. H. Parish and R. M. Twyman (2003), Viva Books Private Limited, New Delhi, Mumbai, Chennai, Kolkata
5. Bioinformatics a Primer by P. Narayanan (2005), New Age International (P) Limited, Publishers, New Delhi – 110 002
6. Bioinformatics: A practical guide to the analysis of genes and proteins (2<sup>nd</sup> Ed) by A. D. Baxevanis and B. F. F. Ouellette (2001), John Wiley & Sons, New York.
7. Bioinformatics. Managing Scientific Data by Z. Lacroix and T. Critchlow (2003), Morgan Kaufmann Publishers
8. Bioinformatics: sequence and genome analysis by D. W. Mount (2001), Cold Spring Harbor Laboratory Press, New York.
9. Bioinformatics: Managing Scientific Data by L. Zoe and C. Terence (2004), Morgan Kaufmann Publishers, New Delhi

#### SCIENTIFIC WRITING

1. How to write and publish a scientific paper by R. A. Day
2. Writing Scientific Research Articles – Strategy and Steps by Margaret Cargill and Patrick O'Connor. Wiley Black well
3. From Research to Manuscript – A Guide to Scientific Writing by Michael Jay Katz, Springer.

### **Paper-X (CCS-302), ENZYMOLOGY AND ENZYME TECHNOLOGY- UNIT – I**

**60Hrs  
(15)**

1. History and special properties of enzymes as catalysts
2. IUB system of nomenclature and classification of enzymes
3. Specificity of enzymes:
  - 3.1 Types:- substrate and product, group or relative, absolute – stereochemical and spatial specificity
  - 3.2 Modern methods of enzyme purification (Solvent based)
4. Structure of enzymes: monomeric and oligomeric enzymes, Ogsten's experiment and the concept of the Active Site
5. Methods employed to identify functional groups in the active site – trapping of the intermediate, use of substrate analogues, modification of amino acid side chains, some common functional groups and amino acids, chemistry of the active site

6. Co-factors in enzyme action:

6.1 Organic – prosthetic groups, coenzymes and cosubstrates

6.2 Inorganic – metal ions in enzyme function, metal activated enzymes and metallo-enzymes, ternary complexes

## **UNIT – II**

**(15)**

1. Kinetics of single-substrate enzyme catalysed reactions – Wilhelmy's and Brown's work, Henri and Michaelis-Menten relationships, Briggs and Haldane assumption and derivation, Lineweaver-Burk, Eadie-Hofstee, Hanes and Eisenthal and Cornish-Bowden modifications of the M-M equation to derive  $K_M$ , Significance of the M-M equation and  $K_M$

2. Kinetics of multisubstrate reactions

3. Haldane's relationship for reversible reactions

4. Sigmoid kinetics – Hill and Adair equations for cooperativity

5. Enzyme inhibition: basic concepts, kinetics, examples and significance of reversible and irreversible inhibition

## **UNIT – III**

**(15)**

1. Covalent modification of enzyme structure – irreversible and reversible modification

2. Ligand induced conformational changes – basic concepts of allosterism and allosteric enzymes, models proposed to explain the mechanism of functioning (MWC and KNF); structural aspects of aspartate carbamoyltransferase, role of allosteric enzymes in metabolic regulation – feedback inhibition

4. Multienzyme systems – basic concepts, types with examples, structural and functional aspects of pyruvate dehydrogenase, fatty acid synthetase, 'Arom' complex and tryptophan synthetase

5. Membrane bound enzymes in metabolic regulation

6. Isoenzymes – basic concepts, method of detection, examples and their metabolic significance

## **UNIT – IV**

**(15)**

1. Applications of enzymes in medicine:

1.1 In diagnosis – general principles and use of alanine amino transferase, aspartate amino transferase, lactate dehydrogenase, creatine kinase, acid and alkaline phosphatase

1.2 In therapy – specific applications of few selected enzymes, prodrug activation with examples, enzyme replacement therapy

2. Industrial applications of enzymes – catalysts in the manufacturing and other conversion processes

3. Enzymes as analytical tools

4. Immobilisation of enzymes: basic concepts, methods used, properties of IME and their applications in industry, medicine, enzyme electrodes

5. Newer approaches to the application of enzymes – reactions in organic solvents

## **REFERENCE BOOKS**

1. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry by T. Palmer Affiliated East-West Press Pvt. Ltd. New Delhi

2. Fundamentals of Enzymology – N. C. Price and L. Stevens, Oxford University Press

3. Nature of Enzymology – R. L. Foster, Croom Helm Applied Biology Series, London

4. Enzyme Technology – Pandey, Webb, Soccol and Larroche. Asiatech Publishers, INC New Delhi

5. Enzyme Nomenclature by IUBMB Academic Press Inc.

6. Enzyme structure and function – A. Fuerst, Freeman, USA

7. Immobilised Enzymes – M. D. Trevan
8. Enzymes – Boyer, Academic Press
9. Advances in Enzymology – Series edited by N. O. Kaplan, Academic Press
10. Enzyme Biotechnology by G. Tripathi, Technoscience Publications
11. Enzyme Reaction Engineering by T. P. Jayadev Reddy, Biotech Books, Delhi
12. Enzymes and Immobilised Cells in Biotechnology by A. Laskin Butterworths Biotechnology Series

## **Paper-XI (CCS-303): FERMENTATION TECHNOLOGY**

**60Hrs**

### **UNIT – I**

**(15)**

Fermentation equipment and its use:

1. Basic functions of a fermenter, body construction, aeration, Agitation, baffles, etc.
2. Design of other fermentation vessels: Airlift fermenter, tower fermenter Continuous fermenter, fed batch fermenter, Waldhof type fermenter
3. Sterilization of fermentation equipment, air and media
4. Fermentation broth rheology and power requirements, concepts of Newtonian and non-Newtonian fluids, plastic fluids, effect of rheology on heat and oxygen transfer, Reynold's number, power number, aeration number and apparent viscosity

### **UNIT – II**

**(15)**

1. Fermentation media- Types of fermentation media, sources of carbon, nitrogen trace elements, growth factors, precursors, buffers, antifoam agents, sterilization of media, screening for fermentation media.
2. Fermentation economics – A case study, market potential for product and fermentation, product recovery cost, Entrepreneurship, plan for industry, product selection process, site selection, finance, feasibility, excise and legal aspects
3. Patents – Introduction, composition of patent, background, patent practice and problems

### **UNIT – III**

**(15)**

1. Environmental control of metabolic pathways
2. Genetic Control of Metabolic pathways
3. Growth and product formation: Concept of primary and secondary metabolites and their control, kinetics of growth and product formation (growth rate, yield coefficient, efficiency), economics
4. Contamination problems in fermentation industry
5. Computer applications in fermentation technology- General applications and specific applications

### **UNIT-IV (15)**

Industrial production of:

1. Lactic starter culture for food fermentations
2. Vitamin- B12
3. Gluconic acid
4. Distilled alcoholic beverages – Whisky and Brandy
5. Bacterial vaccines

## REFERENCE BOOKS

1. Industrial Microbiology by L. E. Casida, John Wiley and Sons INC
2. Annual Reports on Fermentation processes Vol. I and II by D. Perlman, Academic press INC
3. Prescott and Dunn's Industrial Microbiology, 4th edition (1982) by Gerald Reed
4. Food processing: Biotechnological applications by S. S. Marwaha and J. K. Arora (2000), Asiatech publishers INC
5. Microbial technology Vol. I and II by H. J. Peppler and D. Perlman Academic Press INC
6. Principals of Fermentation Technology by P. Stanbury and A. Whitaker, Pergamon Press
7. Essays in Applied Microbiology by J. R. Norris and M. H. Richmond, John Wiley and Sons, Chicester, New York
8. Biology of Industrial Microorganisms by A. Demain and N. Solomon Butterworths Biotechnology Series
9. Overproduction of Microbial Metabolites: Strain Improvement and Process Control strategies by Z. Vanek and Z. Hostalek Butterworths Biotechnology Series
10. Fermentation Microbiology and Biotechnology by E. M. T. El-Mansi and C. F. A. Bryce Taylor and Francis Ltd. London
11. Legal protection for Microbiological and Genetic Engineering Inventions by R. Saliwanchik Butterworths Biotechnology Series
12. Methods in Industrial Microbiology by B. Sikyta, Ellis Horwood Ltd. Chichester (1983)
- Industrial Microbiology by A. H. Patel, MacMillan India Ltd.
13. Principals of fermentation technology by P. Stanbury and A. Whitaker, Pergamon Press
14. Advances in Applied Microbiology Vols. 9 and 13, by W. W. Umbreit, Academic Press, New York
15. Essays in Applied Microbiology by J. R. Norris and M. H. Richmond, John Wiley and Sons, Chicester, New York

## Paper-XII (DSE-304): QUALITY CONTROL MICROBIOLOGY – I

**60Hrs**

### UNIT I

**(15)**

**Design of Basic laboratories** – Biosafety Levels 1 and 2 - Code of practice; Laboratory design and facilities; Laboratory equipment; Health and medical surveillance; Training; Waste handling; Chemical, fire, electrical, radiation and equipment safety; The containment laboratory – Biosafety Level 3 - Code of practice; Laboratory design and facilities; Laboratory equipment; Health and medical surveillance; The maximum containment laboratory – Biosafety Level 4 - Code of practice; Laboratory design and facilities

### UNIT II

**(15)**

**Good microbiological techniques** - Good microbiological laboratory techniques - Safe handling of specimens in the laboratory; Use of pipettes; Avoiding the dispersal of infectious materials; Use of biological safety cabinets; Avoiding ingestion of infectious materials and contact with skin and eyes; Opening of ampoules containing lyophilized infectious materials; Storage of ampoules containing infectious materials; Standard precautions with blood and other body fluids, tissues and excreta; Contingency plans and Emergency procedures for microbiological laboratories.

### UNIT III

**(15)**

**Sterilization and sterility assurance** - Microbial Control by Physical and Chemical Methods- Introduction; Physical Methods; Chemical Methods; Experimental Parameters Influencing the Antimicrobial Agent Activity; Sterilization monitors - Physical indicators, Chemical indicators, Biological indicators; Sterility assurance and the sterility assurance level; Sterility Testing of Pharmaceutical Products – Introduction; Test for Sterility: Pharmaceutical Products - Membrane Filtration; Direct Inoculation - Nutrient Broth; Cooked Meat Medium and Thioglycolate Medium; Sabouraud Medium; Sterile products; Sterilization Factors affecting sterilization effectiveness

#### **UNIT IV**

**(15)**

**Biosafety Guidelines** - Microbiological risk assessment; Biological safety cabinets - Class I biological safety cabinet; Class II biological safety cabinets; Class III biological safety cabinet; Biological safety cabinet air connection; Selection of a biological safety cabinet; Using biological safety cabinets in the laboratory. Safety equipment - Negative-pressure flexible-film isolators; Pipetting aids; Homogenizers, shakers, blenders and sonicators; Disposable transfer loops; Micro incinerators; Personal protective equipment and clothing.

#### **REFERENCES**

1. Geoff Hanlon and Norman Hodges - Essential Microbiology for Pharmacy and Pharmaceutical Science, John Wiley & Sons, Ltd.
2. Tim Sandle - Pharmaceutical Microbiology - Essentials for Quality Assurance and Quality Control, Woodhead Publishing publications, Elsevier.
3. Laboratory biosafety manual. – 3rd ed. WHO Library Cataloguing-in-Publication Data ISBN 9241546506.
4. Environmental Monitoring for cleanrooms and Controlled environments by Anne Marie Dixon, Informa Healthcare Newyork, London, ISBN 13;978-0-8247-2359-0.
5. Cleanroom Microbiology for the non-Microbiologists, Second Ed, by Devid M. Carlberg, CRC Press, USA

**CCPR – 305 PRACTICAL COURSE – ( (120 hrs)**

**200 Marks**

#### **Part-A**

#### **UNIT – I**

#### **1. BIOSTATISTICS**

- 1.1 Measures of central tendency – Mean, median and mode
- 1.2 Measures of dispersion – variance and standard deviation
- 1.3 Estimation of confidence interval for a normal distribution
- 1.4 Plotting of Histograms and frequency polygons
- 1.5 Analysis of Variance (ANOVA) – CRD, RBD
- 1.6 Student's t-test and chi-square test on sample data

## **2. BIOINFORMATICS**

- 2.1 Using PubMed/Medline for biological information
- 2.2 Retrieving protein and nucleic acid sequences from databases
- 2.3 Single and multiple Sequence alignment using BLAST, Clustal and ClustalW
- 2.4 Construction of Phylogenetic trees
- 2.5 Study of GenBank genomic entries

## **UNIT - II**

### **1. SCIENTIFIC WRITING**

- 1.1 Preparing tables and charts using MS Excel
- 1.2 Preparing a PowerPoint presentation
- 1.3 Writing a Results and Discussion Chapter for the given data

### **2. ENZYMOLOGY AND ENZYME TECHNOLOGY**

- 2.1 Quantitative estimation and determination of specific activity of  $\alpha$ -amylase
- 2.2 Salt (ammonium sulphate) precipitation of  $\alpha$ -amylase
- 2.3 Study of the effect of:
  - 2.3.1 Substrate concentration [S<sub>0</sub>] on  $\alpha$ -amylase and determination of V<sub>max</sub> and K<sub>M</sub>
  - 2.3.2 Hydrogen Ion concentration (pH) and determination of optimum pH for activity of  $\alpha$ -amylase
  - 2.3.3 Temperature – determination of optimum temperature for activity of  $\alpha$ -amylase
  - 2.3.4 Metal ions on  $\alpha$ -amylase
- 2.4 Immobilisation of  $\alpha$ -amylase by entrapment in alginate gel and determination of loading efficiency
- 2.5 Assay of Invertase, Protease and Lipase

## **REFERENCE BOOKS**

- 1. Biostatistics A foundation for Analysis in the Health Sciences, by Wayne Daniel (7<sup>th</sup> Ed) Wiley-India edition
- 2. Biostatistics by N. Gurumani. MJP Publishers
- 3. Bioinformatics: A practical guide to the analysis of genes and proteins (2<sup>nd</sup> Ed) by A. D. Baxevanis and B. F. F. Ouellette (2001), John Wiley & Sons, New York.
- 4. Bioinformatics. Managing Scientific Data by Z. Lacroix and T. Critchlow (2003), Morgan Kaufmann Publishers
- 5. Bioinformatics: A Beginner's Guide by Jean-Michel Claverie and C. Notredame (2003), Wiley Dreamtech India (P) Ltd., New Delhi – 110 002
- 6. Operate Computers yourself Part – 2 by D. S. Minhas and G. Minhas, Dreamland Publications, j-128, Kirti Nagar, New Delhi – 110 015
- 7. Writing Scientific Research Articles – Strategy and Steps by Margaret Cargill and Patrick O'Connor. Wiley Blackwell
- 8. From Research to Manuscript – A Guide to Scientific Writing by Michael Jay Katz, Springer
- 9. Laboratory Manual in Biochemistry by J. Jayaraman. New Age International Publishers
- 10. An Introduction to Practical Biochemistry by D. T. Plummer TMH Publishers
- 11. Immobilised Enzymes – M. D. Trevan
- 12. Advances in Enzymology – Series edited by N. O. Kaplan, Academic Press

## Part- B

### Unit-I

1. Calibration of Colorimeter, Weighing balance, Thermometer
2. Validation of Refrigerator, Autoclave, Incubator,
3. Preparation of SOP for Laboratory instruments – hot air oven, incubator, pH Meter,
4. Preparation of SOP for sterilisation of media (autoclave) /glassware (hot air oven),
5. Preparation of HACCP flow chart
6. Preparation of dilutions
7. Disinfectant preparation and validation (70% Alcohol, 10% Glycerol, 20% Water)

### Unit-II

1. Microbial Examination of Non-Sterile Products - Endotoxin Testing by LAL Test
2. Antibiotic Potency Testing by Diffusion method and detection of MBC
3. Detection of air microflora,
4. Detection of surface microflora of working place (contact method),
5. Finger disinfection microbiological testing,
6. Sterility testing of Pharmaceuticals (I.V Fluids)

Reference:

Indian Pharmacopoeia

US pharmacopeia

## AEC-306 : Mandatory Non-CGPA compulsory ability enhancement Course

	<b>AEC306: Ability Enhancement Course</b>	<b>30 Hrs</b>
Unit-I	Quality control in Food Industry- A) Basic concepts of:- 1. Regulation as per PFA, FDA, FPO. Standards & Norms as per ISO, BIS, AGMARK  C) Introduction of GMP, GLP, Introduction to HACCP (Hazard Analysis Critical Control Points). D) TQMS (Total Quality Management System) of milk and milk products- 1. Raw material acceptance. 2. Process control. 3. Packaging. 4. Finished product storage. 5. Transport and Distribution E) ICMSF (International Commission on the Microbiological Specification of Foods) 1. Introduction 2. ICMSF–Sampling plans a. The two class plan The three class plan	15
Unit-II	Quality Management in Pharmaceutical Industry- <b>Quality Management in pharmaceutical:</b> Production Management and Documentation: ICH, ISO 9000 series, total	15

	<p>quality management, validation for tablets and parenterals, practice of WHO GMP.</p> <p>Industrial Safety: Industrial hazards and their prevention, fire, accidents, mechanical and electrical equipments, industrial effluent testing.</p> <p>Drug stability: Solution stability, solid stability, parameters for physical stability testing, protocol for physical stability testing program, accelerated studies and shelf life assignment</p>	
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**Suggested Reading:**

1. Food Microbiology by Frazier.
2. Food Microbiology by H.A .Modi. ( Vol. I&II)
3. Industrial Microbiology by A.H.Patel.
4. Industrial Microbiology by Prescott & Dunn.
5. Soil Microbiology by Subbarao.
6. Agriculture Microbiology by Rangaswamy.
7. Methods in Food and Dairy Microbiology by Harrigon.
8. Pharmaceutical Microbiology–Hugo & Russell.
9. Industrial Microbiology–Agrawal / Parihar
10. Pharmaceutical Biotechnology–Purohit / Kakrani / Saluja.
11. Practical Microbiology–R. C. Dubey and D. K. Maheshwari
12. Experimental Microbiology–Rakesh J. Patel & Kiran R. Patel. (Vol. I&II)

	<b>EC (SWMMOOC) 307: Food Microbiology and Food Safety</b>	<b>30Hrs</b>
Unit-I	Syllabus and nature of paper will be opted as per SWAYAM portal	15
Unit-II		15



## **SEMESTER – IV**

**60 Hrs**

### **Paper-XIII (CC-401): FOOD AND DAIRY MICROBIOLOGY**

#### **UNIT – I**

**(15)**

1. Food as a substrate for Microorganisms
2. General principles underlying microbial spoilage of food
3. Microbial spoilage of meat, fruits and vegetables
4. Microbial spoilage of heated canned food
5. General principles of Preservation of food: Asepsis, Removal of microorganisms, killing of microorganisms, reducing the growth rate of microorganisms
6. Methods of food preservation: Thermal processing, cold preservation, Preservation by using chemical preservatives, Food dehydration, Preservation by using Irradiation, Canning of food

#### **UNIT – II**

**(15)**

1. Milk: Definition, composition, Factors affecting composition, Nutritive value of milk
2. Spoilage of milk and milk products:
  - 2.1 Milk as a substrate for microorganisms
  - 2.2 Microbial contamination of milk - sources of contamination, types of microorganisms present in milk
  - 2.3 Biochemical activities during microbial spoilage of milk
3. Fermented foods: Microbiology and biochemistry of
  - 3.1 Fermented cereal foods: Amboli, Jalebi
  - 3.2 Fermented cereal legume foods: Idli, Dhokla

- 3.3 Fermented vegetable products: Sauerkraut, Pickles
- 3.4 Fermented milk products: Yoghurt, Cultured butter milk

**UNIT – III (15)**

- 1. Food born diseases:-Food born intoxications: Botulism and staphylococcal intoxication and Food borne infections
- 2. Prevention and control of food borne diseases
- 3. Fermented dairy products and their role in controlling food borne diseases:
  - 3.1 Types of fermented dairy products, methods of preparation
  - 3.2 Therapeutic significance and their health properties - mode of action of lactic acid bacteria on enteric pathogens
  - 3.3 Fermented dairy products and their role in controlling gastro intestinal tract disorders

**UNIT – IV (15)**

- 1. Probiotics: probiotic microbial strains, role of probiotics in gastrointestinal disorders, probiotics in reducing risks of cancer, immunogenic effects of probiotics
- 2. Enzymes in food processing: Need of enzymes, sources of enzymes
- 3. Applications of enzymes in:
  - 3.1 Production of high fructose syrup
  - 3.2 Fruit juice industry, Baking industry, Oils and fat processing
- 4. Food safety and standards: Food safety issues, Food adulteration, Contaminations with harmful microbes, Metallic contamination, Food Laws and standards, Industrial food safety Laws and standards, HACCP, Indian Food Laws and standards

**REFERENCE BOOKS**

- 1. Food processing Biotechnological application (2000) by S. S. Marwaha & K. Arora, Asiatech Publishers INC, New Delhi
- 2. Food science, Fifth Edition, Norman N. Potter 1996, CBS publishers and distributors
- 3. The technology of food preservation, Fourth Edition, Norman W. Desrosier BI Publisher and Distributors, Delhi (1987)
- 4. Food Microbiology - Adams & Moss
- 5. Dairy Microbiology by Robinson
- 6. Outlines of Dairy technology by Sukumar De
- 7. Milk and Milk Products – Clarence
- 8. Food Science (5<sup>th</sup> ed) Norman N. Potter, Joseph N. Hotchkiss

**Paper-XIV (CCS-402): INDUSTRIAL WASTE MANAGEMENT**

**60 Hrs**

**UNIT – I (15)**

- 1. Types and Characterization of industrial wastes:
  - 1.1 Types of industrial wastes
  - 1.2 General characteristics of different industrial wastes, pH, suspended solids, volatile solids, COD, BOD and organic carbon
- 2. Effects of industrial wastes on aquatic life- Effects of industrial wastes of high BOD, effects of waste with toxicants
- 3. Self purification in natural waters: Introduction, physical process, chemical process, biological process

**UNIT – II (15)**

- 1. Microbiology and biochemistry of wastewater treatment: introduction

1.1 Cell physiology and important microorganisms – important microorganisms, role of enzymes, principles of growth, plasmid borne metabolic activities

1.2 Impact of pollutants on biotreatment

2. Methods of industrial waste treatment: Part-I:- Physico-chemical Methods - neutralization, oxidation of cyanides, Chromium reduction, reverse osmosis, carbon adsorption, destruction of phenolic compounds

### **UNIT – III (12)**

1. Methods of industrial waste treatment: Part-II:- Biological methods - I

1.1 Activated sludge process- Process, microbiology, sludge bulking

1.2 Trickling filters- Process, Microbiology and applications

2. Methods of industrial waste treatment: Part-III:- Biological methods - II

2.1 Lagooning- Aerobic and anaerobic, applications

2.2 Anaerobic digestion- Process, microbiology of bio-gas formation, applications

### **UNIT – IV (15)**

1. Biomangement of industrial waste: technological options for treatment of liquid and solid wastes – bioaugmentation, packaged microorganisms, use of genetically engineered microorganisms in wastewater treatment

2. Industrial waste treatment: methods of treatment of wastes from Dairies, Distilleries, paper and pulp industries, fertilizer industries and Pharmaceutical industries.

3. Zero waste discharge concept in industries.

4. Waste disposal control and regulations: Water pollution control, Regulation and limits for disposal into lakes, rivers, oceans and land.

### **REFERENCE BOOKS**

1. Industrial Pollution Control Vol. - I by E. J. Middlebrooks

2. The treatment of industrial wastes. (2<sup>nd</sup> ed) by E. B. Besselièvre and M. Schwartz

3. Environmental Biotechnology (Industrial pollution management) by S. N. Jogdand, Himalaya Publishing House

4. Water and water pollution Handbook Vol. – I by Leonard L. Ciaccio

5. Wastewater Treatment by M.N. Rao and A. K. Datta

6. Industrial Pollution by N. L. Sax. Van Nostrand Reinhold Company

7. Encyclopaedia of Environmental Science and Technology Vol. – II by Ram Kumar

8. Water Pollution Microbiology by R. Mitchell

9. Handbook of Water Resources and Pollution Control by H.W. Gehm and J. I. Bregman

11. Environmental Microbiology by P. D. Sharma, Narosa Publishing House, New Delhi

## **Paper-XV (CCS-403): RECOMBINANT DNA TECHNOLOGY**

**60 Hrs**

### **UNIT – I**

**(15)**

Basic tools of rDNA Technology

1. Enzymes: restriction endonucleases, exonucleases – Dna and RNA; DNA polymerases, DNA ligases, alkaline phosphatase, terminal transferase, reverse transcriptase,

2. Linkers and adaptors

3. Cloning vehicles (vectors): desirable features of ideal cloning vehicles

3.1 Plasmids:- pUC, pBR322 and its derivatives, IncP-group,

3.2 Viral based:-  $\lambda$  phage – basic and derivative vectors, M13, f1, fd viruses, other viruses - addition, self- inactivating, helper-dependent and helper-independent,

3.3 Cosmids, phasmids, phagemids

3.4 Specialist purpose vectors:- M13 based, expression, shuttle, gene inactivation, integrative, RNA probe and RNAi vectors, strong promoter vectors, purification tag vectors, protein solubilisation vectors, secretion vectors

3.5 Artificial chromosomes:- BAC, YAC, PAC

4. Gene probes: development and labeling of DNA and RNA probes

## **UNIT – II**

**(15)**

Basic Cloning Strategies

1. General principles: DNA fragmentation, ligation to vectors, introduction into the host cell, cell based and PCR based strategies

2. Cloning in *Escherichia coli* and other bacteria:

2.1 Construction of genomic libraries – Maniatis' strategy, EMBL 3A vector strategy

2.2 Construction of complementary DNA (cDNA) libraries – Maniatis' hairpin-primed second-strand DNA synthesis, oligo-dC tail method, the Gubler-Hoffman method, direction cDNA cloning, plasmid-linked cDNA synthesis, CAPture method

3. Screening of gene libraries: hybridization, PCR, Immunochemical, Protein-protein interactions, Protein-ligand interaction, functional complementation, gain of function

4. Expression of foreign DNA in transformed bacteria

## **UNIT – III**

**(15)**

Cloning in Eukaryotes

1. Cloning in yeast and fungi:

1.1 Vector systems: YE<sub>p</sub>, YC<sub>p</sub>, YAC, modular expression vector, yeast secretion vector (pGAP)

1.2 Introduction of DNA, selectable markers

1.3 Heterologous protein production – source of DNA, level of heterologous RNA, amount of protein produced, nature of product

2. Cloning in animals:

2.1 Vectors systems: plasmid based vectors - pSV2-dhfr, pRSV-neo, virus based vectors - adenovirus, adeno-associated, baculovirus, herpes virus, retrovirus, Sindbis and Semliki forest disease virus, vaccinia and pox virus, EB virus

2.2 Cloning in mammalian cell-lines: methods of DNA transfection – chemical, physical and biological (viral, bacterial) methods, choice of cell-lines, transient and stable expression

2.3 Transgenesis of whole animals: microinjection of DNA in mice and other animals, Embryo stem cell technology, DNA construct, aberrant expression

3. Cloning in Plants:

3.1 Vectors systems: Ti plasmid of *Agrobacterium tumefaciens* and Ri plasmid of *Ag. Rhizogenes*, viruses – caulimovirus, geminivirus, BMV, TMV, PVX

3.2 Cloning in Plants: *Agrobacterium*- mediated gene transfer, direct DNA transfer, gene targeting, *in planta* transformation

## **UNIT – IV**

**(15)**

Applications of rDNA Technology

1. Production of useful molecules in bacteria, plants and animals

2. Improvement of agronomic traits in plants

3. Study, prevention and cure of diseases

4. Genetically modified foods

## 5. Protein engineering and its applications

### REFERENCE BOOKS

1. Principles of Gene Manipulation and Genomics by S. B. Primrose and R. M. Twyman, Blackwell Publishing, Oxford, UK
2. Molecular Biology and Biotechnology (4<sup>th</sup> Ed) by J. M. Walker and R. Rapley, Panima Publishing Corporation, New Delhi
3. Recombinant DNA by J. D. Watson and others
4. Genetic Engineering by Chakravarty, CRC Publications
5. Genetic Engineering by Sandhya Mitra
6. Molecular Cloning (Volumes 1, 2, 3) by Sambrook and Russell. Cold Spring Harbor Laboratory Press International Edition
7. Principles of Genetics by E. J. Gardner. John Wiley and Sons, New York
8. Maximizing Gene Expression by W. Reznikoff and L. Gold, Butterworths Biotechnology Series
9. Yeast Genetic Engineering by P. J. Barr and others, Butterworths Biotechnology Series

## Paper-XVI (DSE-404): Quality control Microbiology-II 60 Hrs

### UNIT I

(15)

**Pharmaceutical Drug Regulatory Affairs**– Introduction to Regulatory Affairs; Drug Regulatory bodies - United States Food and Drug Administration (USFDA); International Conference on Harmonization of technical Requirement for registration of Pharmaceuticals for Human use (ICH); European Medicines Agency (EMA); Central Drugs Standard Control Organization (CDSCO); Medicines and Healthcare Products Regulatory Agency (MHRA).

### UNIT II

(15)

**Cleanrooms and environmental monitoring** - Introduction; Cleanroom contamination; Cleanroom classification; Isolators; Cleanroom certification; HEPPA and ULPA filters; Cleanroom testing; Microbiological environmental monitoring- Monitoring of air born viable particles, surface monitoring, water monitoring; Aseptic technique; Other cleanroom disciplines; Cleanroom standards,

### UNIT III

(15)

**Bioburden determination** – Introduction; Total microbial count - Traditional counting Methods, Detection of objectionable organisms, Nonsterile products and microbial limits testing; In-process material bioburden assessment; Pre-sterilization bioburden assessment; Alternative methods of bioburden assessment; Microbiological analysis of raw materials and finished products – Microbial count limits for finished products;

**Endotoxin and pyrogen testing** - Introduction; Pyrogenicity; Bacterial endotoxin; Quantifying endotoxin; The *limulus* amoebocyte lysate test - methods , applications , interference; Alternative test methods.

## UNIT IV

(15)

**Quality Management Systems in Pharmaceutical Manufacturing** - Introduction; Pharmaceutical Quality System; Good Manufacturing procedures – Specifications, Batch Manufacturing records, Standard Operating Procedures; Validation- Validation- validation master plan, Qualifications and its types, GMP Inspections; Hazard Analysis and Critical Control Point (HACCP) - Definition, Principles and Guidelines for application of HACCP principles.

**Auditing the microbiology laboratory**- Introduction; Record keeping – Batch Manufacturing Record; Quality audits; Auditors and the audit process; Auditing the microbiology laboratory

## REFERENCES

1. Geoff Hanlon and Norman Hodges - Essential Microbiology for Pharmacy and Pharmaceutical Science, John Wiley & Sons, Ltd.
2. Tim Sandle - Pharmaceutical Microbiology - Essentials for Quality Assurance and Quality Control, Woodhead Publishing publications, Elsevier.
3. Laboratory biosafety manual. – 3rd ed. WHO Library Cataloguing-in-Publication Data ISBN 9241546506.
4. Environmental Monitoring for cleanrooms and Controlled environments by Anne Marie Dixon, Informa Healthcare Newyork, London, ISBN 13;978-0-8247-2359-0.
5. Cleanroom Microbiology for the non-Microbiologists, Second Ed, by Devid M. Carlberg, CRC Press,USA.

## **CCPR – 405: PRACTICAL COURSE -A (120 Hrs) Total:200 Marks**

### **UNIT – I**

1. Chemical analysis of foods: pH, benzoate, sorbate and colour
2. Microbiology of butter and cheese
3. Microbiological Examination of milk: grading of milk - Resazurin test, DMC
4. Platform tests in dairy industry: COB, alcohol precipitation, titratable acidity, quantitative phosphatase test, mastitis test
5. Physical examination of milk: specific gravity and solids non-fat (SNF)
6. Chemical examination of milk: pH, fat, protein, sugar and ash
7. Production of a Lactic starter culture
8. Fermentative production of gluconic acid

### **UNIT - II**

1. Characterization of industrial wastes: pH, Alkalinity, BOD, COD, TOC, DO, total solids (TS), total suspended solids (TSS), total dissolved solids (TDS), total volatile solids (TVS)
2. Treatability test for industrial effluents
3. Development of an activated sludge culture

4. Development of an anaerobic digestion culture and production of bio-gas
5. Preparation of plant tissue culture

#### REFERENCE BOOKS

1. Official Methods of Analysis of the Association of Official analytical Chemists Vols. I and II. Published by Association of Official analytical Chemists, Suite 400, 2200 Wilson Boulevard, Arlington, Virginia 22201, USA
2. Laboratory Methods in Food Microbiology by D. W. Harrigan, Academic Press
3. Handbook of Techniques in Microbiology by A. S. Karwa, M. K. Rai and H. B. Singh Scientific Publishers, Jodhpur
4. Dairy Microbiology by Robinson
5. Outlines of Dairy technology by Sukumar De
6. Standard Methods in Water and Wastewater Analysis by APHA, AWWA and WPCF
7. Analysis of Plants, Irrigation water and Soils by R. B. Somawanshi and others. Mahatma Phule Agricultural University, Rahuri
8. Microbiological aspects of Anaerobic Digestion – Laboratory Manual by D. R. Ranade and R. V. Gadre, MACS Agharkar Research Institute, Pune
9. Pollution Microbiology: A Laboratory Manual by Melvin S. Finstein, Marcel Dekker Inc.
10. Molecular Cloning – A Laboratory Manual, Vol. 1,2,3 by J. Sambrook, E. F. Fritsch and T. Maniatis
11. Molecular Biology and Biotechnology by J. M. Walker and R. Rapley, Panima Publishing Corp. New Delhi
12. Principles and Techniques of Practical Biochemistry by K. Wilson and J. Walker, Cambridge University Press
13. Molecular Biology Laboratory Manual by Denny R. Randall
14. Plant Tissue Culture by H. D. Kumar

#### B: Research Project work

**or**

#### Industrial Training (Minimum-4 Weeks)

	<b>SEC 406: Skill Enhancement Course</b>	<b>30 Hours</b>
Unit-I	<b>1. Industrial Production of Biofertilizers-</b> A) Rhizobium Bio fertilizer Characteristics, Host-Rhizobium interaction, N <sub>2</sub> -fixation in root-nodules, Production, Methods of application: B) Azotobacter Bio-fertilizer-Characteristics,N <sub>2</sub> -fixation process Production, Methods of application, C.Azospirillum Bio-fertilizer-Characteristics,Association with plants Production,Methods of application D. Phosphate Solubilizing Bio-fertilizers- VAM Bio-fertilizer Phosphate solubilizing Bacteria, Mechanism of Phosphate solubilization, Production, Methods of applications,	<b>15</b>
Unit-II	<b>Quality Control in Biofertilizers-</b> 1. FCO Fertilizer Control Order-, FCO-specifications for Biofertilizers	<b>15</b>

	2. Sampling procedure	
	3. Method of analysis	
	4. Standards of bio fertilizers	
	5. Biostability of product bio fertilizer	

### Suggested reading:

1. Bio fertilizers– Arun Sharma.
2. Industrial Microbiology–Agrawal / Parihar
3. Biotechnology–S. S. Purohit.
4. Agriculture Microbiology–G. Rangaswami & D. J. Bagyaraj
5. Text-book of Biotechnology–G. R. Chhatwal.
6. Pharmaceutical Biotechnology–Purohit / Kakrani / Saluja.
7. Practical Microbiology–R. C. Dubey and D. K. Maheshwari
8. Experimental Microbiology–Rakesh J. Patel & Kiran R. Patel. (Vol. I&II)
9. Fertilizer Control Order–1985 amended up to June, 201123. Practical Biochemistry by Plummer.

	<b>GE 407: Quality Management in Pharma Industry</b>	<b>30 Hrs</b>
Unit-I	<b>Quality Assurance and IPR in Pharmaceutical Industry</b> 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 non- clinical testing, animal trials. Records and documents: Records related to products release, Quality review, and Quality audits. Complains and recalls.	15
Unit-II	<b>Quality Control in Pharmaceutical Industry</b> 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.	15

### Suggested readings:

1. Quality control in the Pharmaceutical Industry - Edt. by Murray S.Cooper Vol.2. Academic Press New York.
2. 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.
3. Indian Pharmacopia, USP