

**Deccan Education Society's
FERGUSSON COLLEGE (AUTONOMOUS),
PUNE**

Syllabus
for

M. Sc. (Microbiology) Part II
(Semester-III and Semester-IV)
[Pattern 2019]

from Academic Year
2020-21

Program Structure of M.Sc. (Microbiology) Part-II

Particulars	Paper	Paper code	Title of Paper	Type of Paper	No. of Credits
M.Sc. Semester- III	Paper- 1	MIC5301	Biostatistics	Special-1	4
	Paper - 2	MIC5302	Bioprocess development	Special-2	4
	Paper - 3	MIC5303	Practical course based on Biostatistics, Microbial Ecology and Applied Molecular Biology	P-Special-1	4
	Paper -4	MIC5304	Practical course based on Bioprocess development, Food technology and Pharmaceutical Microbiology	P-Special-2	4
	Paper -5	MIC5305	D: Microbial Ecology and Environmental Microbiology	Elective-3	4
		MIC5306	G: Applied Molecular Biology		
		MIC5307	M: MOOCS		
	Paper -6	MIC5308	D: Pharmaceutical Microbiology	Elective-4	4
		MIC5309	G: Food Technology		
		MIC5310	M: MOOCS		
M. Sc. Semester- IV	Paper -1	MIC5401	Project work and Dissertation-1	P-Special-3	4*
	Paper - 2	MIC5402	Project work and Dissertation-2	P-Special-4	4*

Guidelines for MIC 5401 and MIC 5402 [8 credits]

Microbiology Project (8 Credits)

- Students can select project in outside research institutes or can-do projects in the department itself.
- The total project work is of 200 marks and divided as 50 percent internal and 50 percent external assessment.
- It is expected to spend 5-6 hours per credit ie. For 8 credit course 40-48 hours per week. Therefore, a student working on project in department or in institute is expected to spend 40-48 hours on project work.
- Weekly reporting of the progress of the work should be done to the Faculty mentor of the department for student working outside the department. In house students are expected to report every day to their project guide.
- 100 internal plus 100 externals = 200 marks evaluation.
- The external examiner assesses the student for 50 marks based on his/her dissertation report and presentation skills. The internal examiner will assess for 50 marks for the same components. The project guide will examine the student for 100 marks during the entire semester. During this assessment student will present his or her work twice, the literature survey will be evaluated, student writes the review article on the topic related to their project work, their attendance and working in the laboratory is also considered for their evaluation for 100 marks.

MIC5301: Biostatistics [Credits – 4]**Course Outcomes**

After learning this course student will be able to

CO1: Procure samples in a way most appropriate for carrying out his/ her desired experiment. He/ she will also be able to organize and represent the data obtained in the experiment in a suitable way.

CO2: Apply the measures of central tendency as well as those of dispersion to his/ her data. He/ she will also be able to calculate the probability of obtaining the expected results in his/ her experiments.

CO3: Formulate a hypothesis for his/ her experiment as well as test it using appropriate tests.

CO4: Design his/ her experiments based on the different principles that he/ she will learn in this course.

Unit I	<p>Introductory Biostatistics, Data Representation and Interpretation</p> <p>A. Importance of statistics in Biology, Samples and Population</p> <p>B. Types of data, Random sampling methods and sampling errors, Scales and Variables, Accuracy and precision, Collection and organization of data, tabulation, diagrammatic representation (Simple bar diagram, percentage bar diagram, multiple bar diagram, sub-divided bar diagram and pie diagram, pictogram). Graphical representation (Histogram, frequency polygon and ogive curves survival curves),</p> <p>References:</p> <ol style="list-style-type: none"> 1. Goon, Gupta and Dasgupta Fundamentals of Statistics, World Press Kolkata 2. Gupta S. P. Statistical methods, Sultan Chand & Sons Publisher, New Delhi 3. Irfan Ali Khan and Atiya Khanum, Fundamentals of Biostatistics. 3rd Ed. Ukaaz, Publications, Hyderabad
Unit II	<p>Descriptive Statistics and Probability</p> <p>A. Measures of central tendency—Mean(arithmetic, geometric, harmonic) median , mode, quartiles, percentiles</p> <p>B. Measures of dispersion—Mean deviation Standard deviation and Variance;</p> <p>C. Measures of skewness;</p> <p>D. Regression and correlation</p> <p>E. Concept of Probability – classical definition, discrete and continuous random variable, notion of density/ mass function</p> <p>F. Probability distribution – Normal (x-scale and z-scale), Binomial and Poisson distributions.</p> <p>References:</p> <ol style="list-style-type: none"> 1. Gupta S.P. Statistical methods, Sultanchand & Sons Publisher, New Delhi 2. Irfan Ali Khan and Atiya Khanum, Fundamentals of Biostatistics. 3rd Ed. Ukaaz, Publications, Hyderabad 3. Bernard Rosner Fundamentals of Biostatistics, 5th Ed. Duxbury
Unit III	<p>Testing of Hypothesis - I</p> <p>A. The concepts of null hypothesis, alternative hypothesis, significance level, type I and type II errors, p-value, one tailed and two tailed tests</p> <p>B. Distribution of sample means, standard error and confidence interval, Degrees of freedom</p> <p>C. Equality of two population means - t-tests and z - test, z proportions, paired t test</p>

	<p>D. Non Parametric Tests – Median Test, Mann Whitney U Test, Wilcoxon Signed Rank Test</p> <p>E. χ^2(chi square)test –test for goodness of fit, independence</p> <p>References:</p> <ol style="list-style-type: none"> 1. Irfan Ali Khan and Atiya Khanum, Fundamentals of Biostatistics. 3rdEd. Ukaaz, Publications, Hyderabad 2. Gupta S.P. Statistical methods, Sultan Chand & Sons Publisher, New Delhi 3. Norman T.J. Bailey Statistical methods in biology, 3rdEd. Cambridge University Press
Unit IV	<p>Testing of Hypothesis – II</p> <ol style="list-style-type: none"> A. Concept of Design of Experiments B. Principles of Design – Replication, Randomization, Local Control (Blocking) C. Concept of ANOVA for comparison of three or more samples (one way and two way) D. Factorial Designs, analyzing 2² and 2³ designs using Yates table E. Plackett Burman Design <p>References:</p> <ol style="list-style-type: none"> 1. Goon, Gupta and Dasgupta Fundamentals of Statistics, World Press Kolkata 2. Gupta S.P. Statistical methods, Sultan Chand & Sons Publisher, New Delhi 3. Irfan Ali Khan and Atiya Khanum, Fundamentals of Biostatistics. 3rdEd. Ukaaz, Publications, Hyderabad

MIC5302: Bioprocess Development [Credits – 4]

Course Outcomes

After learning this course student will be able to

CO 1: Understand the configuration of bioreactor, various parts of the bioreactor, their structure, functions and applications. To understand different types of bioreactors used in industries and types of fermentations like continuous, batch and fed batch type.

CO2: Understand the theory of aeration, oxygen transfer, oxygen uptake rate in the fermentation medium and their effects on running the successful fermentation. The study of broth rheology, how it affects the rate of agitation, increase in power requirement, study of Reynold's number, aeration number, power number and solve the numerical based on it. To understand the concept of Newtonian and non-Newtonian fluids and different types of sensors used to monitor the process variables in a particular fermentation.

CO3: Understand the difference between primary metabolites and secondary metabolites, how these are associated with growth or not associated with growth of producer organisms. To study the growth kinetics of the producer strain and how the morphology of the producer organism, like fungus, alters the fermentation parameters and yield coefficient and efficiency of the process

CO4: Understand the upstream, fermentation proper and downstream processing of several novel fermentation products like antibiotics, Teixobactin, Exopolysaccharides like pullulan, recombinant enzyme like streptokinase and recombinant vaccine like hepatitis B.

Unit I	<p>Bioreactor design and operation</p> <ol style="list-style-type: none"> A. Designing of bioreactors <ol style="list-style-type: none"> i. Design aspects STRs: ii. The dimensional ratios of the outer shell iii. Operational aspects such as working volume, iv. Baffles and impellers. B. The configuration (placement) of impellers in a vessel and the different types of impellers (types of turbines and propellers, and their combinations) C. Immobilized cell reactors and air-lift reactors – Design and operation. D. Batch, Fed-batch and Continuous operation: Applications, advantages and limitations of each type <p>References</p> <ol style="list-style-type: none"> 1. Doran Pauline (1995) Bioprocess Engineering Principles, Academic Press. 2. Lydersen B., N. a. D' Elia and K. M. Nelson (Eds.) (1993) Bioprocess Engineering: Systems, Equipment and Facilities, John Wiley and Sons Inc. 3. Ratledge C and Kristiansen B eds. (2001) Basic Biotechnology 2ndEd. Cambridge Univ. Press.
Unit II	<p>Process Variables</p> <ol style="list-style-type: none"> A. Aeration - Theory of oxygen transfer in bubble aeration, Oxygen transfer kinetics (Oxygen Uptake Rate –OUR; Oxygen Transfer Rate OTR; Ccrit), determination of KLa. B. Agitation - Functions of agitation. Flow patterns with different types of impellers. C. Fermentation broth rheology and power requirements for agitation – Concept of Newtonian and non-Newtonian fluids, effect of broth rheology on heat, nutrient and oxygen transfer, Reynold's number, Power number, Aeration number: working out examples

	<p>D. Use of various types of sensors and biosensors for monitoring environmental parameters (pressure, pH, temperature, DO and DCO₂), Basic principles of operation, types of biosensors.</p> <p>References</p> <ol style="list-style-type: none"> 1. Lydersen B., N. a. D' Elia and K. M. Nelson (Eds.) (1993), Bioprocess Engineering: Systems, Equipment and Facilities, John Wiley and Sons Inc. 2. Operational Modes of Bioreactors, (1992) BIOTOL series, Butterworths Heinemann. 3. Shuichi and Aiba. Biochemical Engineering. Academic Press. 1982 <p>Stanbury and Whittaker. Fermentation technology</p>
Unit III	<p>Microbial Growth characteristics and product formation</p> <ol style="list-style-type: none"> A. Concept of primary (growth associated) and secondary (growth non-associated) metabolites and their control, B. Kinetics of growth and product formation (growth rate, yield coefficient, efficiency etc.) C. Effect of type of growth on fermentation: The type of growth (mycelial pellet form, mycelial filamentous form, free cell, cells producing exopolysaccharides) affects mass transfer of nutrients, oxygen and heat; as also cell proliferation can be affected by shearing of cells. At least one example of each type may be explained to show these effects in any suitable fermentation. <p>References</p> <ol style="list-style-type: none"> 1. DubasiGovardhana Rao, Rao 2010 Introduction to Biochemical Engineering Tata Mcgraw- Hill Education 2. Peter F. Stanbury. Principles Of Fermentation Technology, 2E,Elsevier (A Division of Reed Elsevier India Pvt. Limited), 2009, Vijai Kumar Gupta, Monika Schmoll, Minna Maki, Maria Tuohy, Marcio Antonio Mazutt editors Applications of Microbial Engineering. CRC Press 2013
Unit IV	<p>Microbial Processes</p> <p>Upstream, fermentation and downstream processing for</p> <ol style="list-style-type: none"> A. Antibiotics (Teixobactin) B. Recombinant enzymes (Streptokinase) C. Exopolysaccharide (Pullulan) D. Recombinant Vaccine (Hepatitis B) <p>References</p> <ol style="list-style-type: none"> 1. C.S.K. Mishra, Ed., Pascale Champagne Associate editor, Biotechnology applications. I.K. International Pvt. Ltd. 2009 Sudhir U. Meshram, Gangadhar B Shinde, Applied biotechnology. I.K. International Pvt. Ltd. 2009

MIC5303: Practical Course Based on Biostatistics, Microbial Ecology and Applied Molecular Biology [Credits – 4]

Course Outcomes	
After learning this course student will be able to	
CO1: Organize and represent the data obtained in his/ her experiments in a suitable graphical manner. He/ she will also be able to use computer applications to analyse the obtained data.	
CO2: Introduced to the programming software R / PAST. He/ she will also be able to calculate the probability of obtaining the expected results in his/ her experiments.	
CO3: Understand plant-microbe interaction with respect to root nodules of leguminous plants and the associated nitrogen fixing bacteria.	
CO4: Understand the effect of various elements and metals at varying pH values and parameters of such environmental stress on microbes	
CO5: Understand the process of plasmid curing using various agents and to understand the amplification and manipulation of DNA samples	
Unit I	Biostatistics I <ol style="list-style-type: none"> A. Computer applications: using datasheets, sorting data with different parameters B. Plotting graph, bar charts, line graphs, pie charts, adding error bars C. Statistical analysis of data – students t test, ANOVA, Chi square test, F test using computer softwares (Eg Microsoft Excel) References: <ol style="list-style-type: none"> 1. Irfan Ali Khan and Atiya Khanum, Fundamentals of Biostatistics. 3rdEd. Ukaaz, Publications, Hyderabad 2. Wardlaw A.C. (1985) Practical Statistics for Experimental Biologists. John Wiley and Sons
Unit II	Biostatistics II <ol style="list-style-type: none"> A. Introduction to programming software R or PAST B. Correlation and linear regression analysis C. Fitting of distributions – Binomial , Poisson and Normal distributions References: <ol style="list-style-type: none"> 1. Irfan Ali Khan and Atiya Khanum, Fundamentals of Biostatistics. 3rdEd. Ukaaz, Publications, Hyderabad 2. Wardlaw A.C. (1985) Practical Statistics for Experimental Biologists. John Wiley and Sons
Unit III	Microbial Ecology I <ol style="list-style-type: none"> A. Host microbe interaction: in situ observation of root nodules B. Consortium preparation from natural samples OR Applied Molecular Biology I <ol style="list-style-type: none"> A. Determination of sub-lethal concentration of different plasmid curing agents B. Plasmid curing References: <ol style="list-style-type: none"> 1. Purdom Daniel and Arthur T. Trese (1995) Morphological and Molecular Characteristics of Host-Conditioned Ineffective Root Nodules in Cowpea. 109: 239-244 2. Patowary K. (2016) Development of an Efficient Bacterial Consortium for the Potential Remediation of Hydrocarbons from Contaminated Sites. Frontiers in Microbiology, 1092 (7)

Unit IV	Microbial Ecology II A. Effect of stress on microbial ecosystem: effect of different concentrations of phosphates, nitrates, chlorides and heavy metals at different values of pH B. calculation of dominance and diversity of microbial ecosystems upon exposure to stress OR Applied Molecular Biology II A. Polymerase chain reaction B. Restriction digestion of DNA Ligation of DNA References: 1. K. Wilson and J. Walker, 'Principles and techniques of biochemistry and Molecular Biology', (2005), 7 th Edition, Cambridge university Press 2. Sambrook and Russel, 'Molecular cloning: A laboratory manual', Volume 1, 2 and 3 (2001), 3 rd Edition, Cold spring harbor laboratory press, New York. 3. D. Scott Witherow, H. Miller and Sue Carson, 'Molecular biology Techniques: A classroom laboratory manual', 3 rd edition, Elsevier
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MIC5304: Practical Course Based on Bioprocess Development, Food Technology or Pharmaceutical Microbiology [Credits – 4]

<p>Course Outcomes After learning this course student will be able to CO1: Understand the principle, technique applications of checking the synergistic and antagonistic action of drugs. CO2: Understand the principle, technique, and applications and of the microbial limit test in pharma industry CO3: Understand different techniques like direct inoculation and membrane filtration for sterility testing of the pharmacological products CO4: Understand the principle, technique, and the applications of LAL test. To determine food composition and adulteration in food. CO5: Learn to immobilize the yeast cells and find the activity of invertase in it to change the gel and cell concentration and how it affects the activity of enzyme. CO6: Isolate the pigment producing organisms from natural ecosystem and characterize these pigments. The organisms are <i>Serratia marcescens</i> and <i>Aspergillus fumigatus</i> CO7: Isolate xylanase or lipase producing bacteria and study the production of enzyme in shake flask. Different parameters like pH, Temperature, agitation and aeration on yield of enzymes. To manufacture wine from grapes and cultivation of Spirulina as single cell protein</p>	
Unit I	<p>A. Study of immobilization of yeast cells by sodium alginate method. B. Effect of immobilization on enzyme activity C. Effect of change in concentration of calcium chloride D. Effect of change in concentration of sodium alginate . E. Effect of change in cell concentration on enzyme activity.</p> <p>Reference 1. Immobilization of enzymes by sodium alginate method.M.Kierstan, C.Bruke-Biotechnology and Bioengineering,1977- willy online library.</p>
Unit II	<p>A. Isolation of pigment producing organisms B. Isolation of the pigment produced by <i>Serratia marcescens</i> C. Isolation of melanin produced by <i>Aspergillus fumigatus</i> D. Characterization of the pigments</p> <p>References 1. Studies on pigmentation of <i>Serratia marcescens</i>:RPWilliams,JAGreen,J.Bact 1956.</p>
Unit III	<p>A. Isolation of xylanase or lipase producing bacteria. B. Production of enzymes in shake flask. C. Effect of different fermentation parameters like Temperature,pH, agitation,aeration on yield and activity of enzyme. D. Production of wine from grapes by fermentation. Study of single cell protein.</p>
Unit IV	<p>Pharmaceutical Microbiology A. Checking synergistic and antagonistic action of drugs B. Microbial limit test C. Sterility testing by direct inoculation and membrane filtration D. LAL test</p> <p>References</p>

1. Synergistic and antagonistic action of antibiotic, Microbiological Assays: by Kavenagh et al
2. LAL test an alternative method for detection of bacterial endotoxins: R.Blechova,D.Pivodova Acta veterinaria Brno,2001-actavet.vfu.cz

OR

- A. Food technology
- B. Determination of Ca, Iron, Phosphorus and Ash content of food.
- C. Determination of acid value and saponification value of fats.
- D. Determination of vit. C by DNPH method.
- E. Food adulteration testing.
- F. Estimation of fat content of milk/meat.
- G. Estimation of moisture content of food.

Reference

Recent developments in food characterization and adulteration detection:C.Cordella,I Moussa, Agriculture and food microbiology 2002, ACS publication

MIC5305D: Microbial Ecology and Environmental Microbiology [Credits – 4]

Course Outcomes	
After learning this course student will be able to	
CO1: Understand how the environment interacts with the macro and microorganisms and the interactions amongst themselves	
CO2: Understand the mechanisms of quantitating ecological aspects, study the laws defining adaptability to environmental conditions and the effect of microbial interactions on the different pollutants	
CO3: Understand the methods to assess microbial community changes and learn about the environment impact assessment tools	
CO4: Understand the interaction between animals and their systems with the microbes as well as the plant interactions with microbes	
Unit I	<p>Interactions between environment and biota</p> <p>A. Autecology and synecology of Macro and microorganisms: definitions, terminology, concepts</p> <p>B. Concept of habitat and ecological niches: niche width and overlap; fundamental and realized niche</p> <p>C. Community: Structure, composition and stratification. Development of microbial community</p> <p>D. Ecological succession: types and mechanisms of succession and concept of climax</p> <p>E. Species interactions: plant microbe interaction and animal microbe interaction, mutualism, commensalism, competition, predation, trophic interaction</p> <p>References:</p> <ol style="list-style-type: none"> 1. Dash, M.C. (1993). Fundamentals of Ecology. Tata McGraw Hill Publishing Hill Co. Ltd., New Delhi 2 2. Macan, T. T. (1974). Freshwater Ecology. Longman Group Ltd., London 3. Meadows, P. S. and Campbell. (1978). An introduction to Marine Science. Blackie and Sons Ltd., Glasgow
Unit II	<p>Applied Ecology</p> <p>A. Quantitative ecology: Sample collection, Sample processing, Detection of microbial populations, Determination of microbial numbers, Detecting nonculturable bacteria, Determination of microbial biomass, Measurement of microbial metabolism</p> <p>B. Adaptation to environmental conditions: Abiotic limitations to Microbial growth; Liebig's law of the minimum and Shelford's law of tolerance, Environmental determinants.</p> <p>C. Microbial interactions with Xenobiotic and inorganic pollutants: Persistence and biomagnification of xenobiotic molecules, Microbial interactions with inorganic pollutants, Biochemistry and Genetics of 2,4-D biodegradation</p> <p>References:</p> <ol style="list-style-type: none"> 1. Richards, B. N. (1987). Microbiology of Terrestrial Ecosystems. Longman Scientific and Technical, N.Y. 2. Madigan et al. (2011). Brock Biology of Microorganisms, 13th ed. Pearson <p>Falkowski et al (2008). The microbial engines that drive Earth's biogeochemical cycles</p>
Unit III	<p>Environment impact assessment and tools</p> <p>A. Methods for investigating microbial community changes- Microscopy, SIP, NanoSIMS, FISH probes</p> <p>B. Environment Impact Assessment:</p>

	<ul style="list-style-type: none"> i. Introduction: What is EIA and its need ii. Types of Impacts and their attributes. Determining the most significant impacts iii. Phase I studies: Initial inquiries iv. Phase II studies: Full EIA study v. Arriving at the findings (identify, predict and judge) <p>C. Genetically Modified Organisms</p> <p>References:</p> <ol style="list-style-type: none"> 1. Gurdeep Rastogi and Rajesh K. Sani (2011), Molecular Techniques to Assess Microbial Community Structure, Function, and Dynamics in the Environment, <i>Microbes and Microbial Technology: Agricultural and Environmental Applications</i>, 10(2):29-57 2. Wagner <i>et al.</i> (2003), Fluorescence in situ hybridisation for the identification and characterisation of prokaryotes, <i>Current Opinion in Microbiology</i>, 6:302–309 3. Yin Chen and J. Colin Murrell (2010), When metagenomics meets stable-isotope probing: progress and perspectives, <i>Trends in Microbiology</i>, 18 (4):157-163 4. Musat <i>et al.</i> (2016), Tracking microbial interactions with NanoSIMS, <i>Current Opinion in Biotechnology</i>, 41: 114-121 5. Holger Daims and Michael Wagner (2007), Quantification of uncultured microorganisms by fluorescence microscopy and digital image analysis, <i>Applied Microbiology and Biotechnology</i>, 75(2):237-48 6. John Glasson and Riki Therivel (2005), <i>Introduction to Environmental Impact Assessment</i>, Oxford, 3rd Ed. 7. A. K. Shrivastava (2007), <i>Environmental Impact Assessment</i>, APH Publishing, 1-163 Lei Han (2004), <i>GMM Development and Applications</i>, <i>The GMO Handbook: Genetically Modified Animals, Microbes, and Plants in Biotechnology</i>, 29-51
Unit IV	<p>Host- microbe interaction</p> <p>A. Animal- microbe interaction:</p> <ul style="list-style-type: none"> i. Gastrointestinal System ii. Skin iii. Upper respiratory tract iv. Genital tract v. Gut (termite) vi. Rumen <p>B. Plant- microbe interaction:</p> <ul style="list-style-type: none"> i. Root symbionts ii. <i>Agrobacterium</i> iii. Phytopathogenic organisms iv. mycorrhizal fungi v. nitrogen-fixing bacteria vi. Plant-Growth-Promoting Rhizobacteria(PGPR) <p>References:</p> <ol style="list-style-type: none"> 1. Pandeya <i>et al.</i> (2012), Host-microbial interaction in the mammalian intestine and their metabolic role inside, <i>Biomedical Research</i>, 23 (1): 9-21 2. Nina N. Schommer and Richard L. Gallo (2013), Structure and function of the human skin microbiome, <i>Trends in Microbiology</i>, 21(12): 660–668 3. Martin Clémence <i>et al.</i>(2014), Host–microbe interactions in distal airways: relevance to chronic airway diseases, <i>Chronic Airway Diseases</i>, 24: 78–91 4. Ma Bing <i>et al.</i> (2012), The vaginal microbiome: rethinking health and diseases, <i>Annual Reviews in Microbiology</i>, 66: 371–389

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| | <ol style="list-style-type: none">5. Krishnan Muthukalingan <i>et al.</i> (2014), Insect gut microbiome - An unexploited reserve for biotechnological application, Asian Pacific Journal of Tropical Biomedicine, 4: S16-S216. Henderson Gemma <i>et al.</i> (2015), Rumen microbial community composition varies with diet and host, but a core microbiome is found across a wide geographical range, Scientific Reports, 57. Sandy Primrose, Richard Twyman, Bob Old (2001), Principles of Gene Manipulation, Blackwell Science Ltd., 6th Edition8. Vejan Pravin <i>et al.</i> (2016), Role of Plant Growth Promoting Rhizobacteria in Agricultural Sustainability—A Review, Molecules, 219. N.S. Subbarao (1999), Soil Microbiology, Science Publishers Technology & Engineering, 4th Edition |
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MIC 5306: G Applied Molecular Biology [Credits – 4]**Course Outcomes**

After learning this course student will be able to

CO1: Understand the detailed strategies of gene cloning and manipulation of DNA, to clone the large fragments of DNA, to produce the proteins on a commercial scale having therapeutic applications and also to apply this knowledge in treatment of genetic diseases

CO2: Understand the application of gene manipulation techniques to genetically alter the plants and animals and obtain important products

CO3: Understand the sequencing and mapping of genome and methods to develop and use the huge data base of information

CO4: Understand the principles and applications of different techniques used in molecular biology and to study the molecular methods used in diagnosis of infectious and non-infectious diseases.

Unit I**Gene technology**

- A. Gene cloning strategies: preparation of gene, genome libraries, cDNA libraries, Library screening
- B. Site directed mutagenesis and protein engineering,
- C. Cloning and manipulating large fragments of DNA ; YAC BAC HAC 4. Transfer of modified genes to host cells; example of insulin gene, factor VIII gene
- D. Expression vectors; lac Z construct
- E. Ti plasmids and its applications
- F. Gene augmentation, Gene therapy

References:

1. James D. Watson, Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Loswick (2004) Molecular Biology of the Gene, 5th Edition, Pearson Education, Inc. and Dorling Kindersley Publishing, Inc.
2. Lewin's Genes XI, (2014) Jones and Bartlett Publishers Inc.
3. S.B Primrose and R M Twyman 2006 7th edition. Blackwell publishing Discovering genomics, Proteomics and Bioinformatics, Malom Campbell and L. J. Heyer 2nd Edn., Pearson Publication, 2009.
4. Walker J.M., Rapley R. (eds.) Molecular Biology and Biotechnology, 4th Ed., 2009, Royal Society Press, U.K.
5. B. R. Glick, J.J.Pasterneck, Principles and applications of recombinant DNA, 3rd Edn., ASM press.
6. Weaver R., (2007) Molecular Biology, 4th Edition, McGraw Hill Science
W.S. Klug and M.R. Cummings, Concepts of Genetics (2005) Pearson education

Unit II**Transgenic plants and animals**

- A. Genetically modified organisms- social and ethical issues
- B. Transgenic animals and their applications in medicine – prevention, early detection and cure of diseases
- C. Transgenic plants: and their applications in agriculture
- D. Examples of transgenic plants and animals: advantages and disadvantages
- E. Producing useful molecules with examples

References:

1. S.B Primrose and R M Twyman 2006 7th edition. Blackwell publishing
2. Malom Campbell and L. J. Heyer Discovering genomics, Proteomics and Bioinformatics 2nd Edn., Pearson Publication, 2009.
3. Walker J.M., Rapley R. (eds.) Molecular Biology and Biotechnology, 4th Ed., 2009, Royal Society Press, U.K.

	<p>4. Principles and applications of recombinant DNA, B. R. Glick, J.J.Pasterneck, 3rd Edn., ASM press</p>
Unit III	<p>Genome projects</p> <p>A. Concept and meaning of genome projects and their applications. B. Introduction to Genome projects of <i>E. coli</i>, Yeast, Plasmodium, Fruit fly, Mouse, Drosophila and Rice and comparative genomics C. Gene annotation D. Human Genome project and its applications</p> <p>References:</p> <p>1. S.B Primrose and R M Twyman 2006 7th edition. Blackwell publishing Discovering genomics, Proteomics and Bioinformatics, Malom Campbell and L. J. Heyer 2nd Edn., Pearson Publication, 2009. 2. Walker J.M., Rapley R. (eds.) Molecular Biology and Biotechnology, 4th Ed., 2009, Royal Society Press, U.K. Principles and applications of recombinant DNA, B. R. Glick, J.J.Pasterneck, 3rd Edn., ASM press</p>
Unit IV	<p>Techniques in Molecular biology and diagnostic applications</p> <p>A. PCR and its modifications, nested PCR, Hot start PCR, Reverse transcriptase based PCR (RT –PCR) and Real time PCR (Q –PCR) B. DNA microarray and its applications C. Molecular diagnostic tools in detection of diseases D. Gene editing tool: CRISPR-Cas-9 E. ChIP F. RFLP G. Designing and detection of probe H. Knockout mice I. Phage expression system J. Yeast two and three hybrid assay K. Measuring transcription rates</p> <p>References:</p> <p>1. S.B Primrose and R M Twyman (2006) 7th edition. Blackwell publishing 2. James D. Watson, Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Loswick (2004) Molecular Biology of the Gene, 5th Edition, Pearson Education, Inc. and Dorling Kindersley Publishing, Inc. 3. Walker J.M., Rapley R. (eds.) Molecular Biology and Biotechnology, 4th Ed., 2009, Royal Society Press, U.K. 4. Principles and applications of recombinant DNA, B. R. Glick, J.J.Pasterneck, 3rd Edn., ASM press. 5. Malom Campbell and L. J. Heyer, Discovering genomics, proteomics and bioinformatics (2009), 2nd Edition., Pearson publication</p>

MIC5308 D: Pharmaceutical Microbiology [Credits – 4]**Course Outcomes**

After learning this course student will be able to

CO1: Understand the contributions of different scientists in drug discovery, concepts of lead compounds, candidate drug, differences between conventional and rational drug discovery process, and tools useful for rational drug design like HTS, combinatorial chemistry and proteomics.

CO2: Understand the steps in the drug development process, preclinical and clinical testing of the drugs, ADME and bioavailability studies of drugs and role of FDA in drug development process

CO3: Understand different methods to determine the antimicrobial activity, evaluate and mechanisms determination of the drugs and methods to determine the synergistic and antagonistic activity of drugs

CO4: Understand role of ISO, WHO and US certification, different pharmacopeia, role of quality assurance in drug development, different carriers, and formulations useful in drug development and different drug delivery systems

Unit I**A. Introduction to Drug Discovery**

- h. Contributions and postulates of Paul Ehrlich
- ii. Significance of terms - Lead compound, Lead optimization
Candidate selection

B. Drug Discovery:**i. Conventional Process Bio-prospecting (Medicinal Chemistry) –**

- a. Extraction and purification principles,
- b. Purification and characterization of bioactive molecules from natural sources

C. Rational Drug Design –

Principle (Structure activity relationship -SAR) and Tools (applications of High Through Put Screening, Combinatorial synthesis, Pharmaco-genomics)

References:

1. Agarwal S. S. and Paridhavi M. (2007), Herbal Drug Technology, Universities Press (India) Pvt. Ltd
2. Altreuter D., and D S. Clark, (1999), Combinatorial Biocatalysis: Taking the Lead From Nature, Curr. Opin. Biotechnol. **10**, 130.
3. Burn J. H. (1957) *Principles of Therapeutics*, Blackwell Scientific Pub. O. Ltd. Oxford.
4. Chatwal G. P. (2003), Bio-pharmaceutics and Pharmacokinetics, Himalaya Publishing House, Mumbai.
5. Paul W. Erhardt, (2006), Medicinal Chemistry in the New Millennium: A Glance into the Future, Ed.
6. Chorghade Mukund S. Drug discovery and development. Volume I: Drug Discovery, Wiley-Interscience, John Wiley and Sons Inc. USA, 17-102.
7. Dewick Paul M., (2002), *Medicinal natural products: A biosynthetic approach*, 2nd Ed., John Wiley and Sons.
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Unit II**Drug Development**

- A. Preclinical development: Toxicity testing – acute, sub-acute and chronic toxicity
- B. Clinical development: Clinical trials – (Aims, Objectives, Conduct): I, II, III and IV

	<p>C. Drug development: ADME and Bioavailability studies D. Adverse Drug Reactions E. Role of FDA in drug development (INDA, NDA)</p> <p>References:</p> <ol style="list-style-type: none"> 1. Chorghade Mukund S. Drug discovery and development Volume I: Drug Discovery, Wiley Interscience, John Wiley and Sons Inc. USA, 17-102. 2. Burn J. H. (1957) Principles of Therapeutics, Blackwell Scientific Pub. O. Ltd. Oxford. Graly 3. John O. and Pieter H. Joubert, (1997), Handbook of Phase I / II clinical drug trials, CRC Press 4. Vyas S. P and Dixit V. R. (2002), Pharmaceutical Biotechnology, CBS Publishers and Distributors, New Delhi 5. Chatwal G. P. (2003) Biopharmaceutics and Pharmacokinetics, Himalaya Publishing House, Mumbai
Unit III	<p>Discovery of anti-infectives</p> <p>A. Evaluation and mechanism determination of anti-infectives using biochemical and microbiological techniques.</p> <ol style="list-style-type: none"> i. Direct counts (Counting chambers, calibrated smears, proportionate counts), ii. Turbidometry iii. Nephelometry, iv. Electrical Resistance v. Electrical impedance vi. Microcalorimetry vii. Flow cytometry viii. Radiometric methods ix. Radiolabelling techniques <p>B. Laboratory methods to assess activity of antimicrobial combinations</p> <ol style="list-style-type: none"> i. Antagonism ii. Synergism <p>References:</p> <ol style="list-style-type: none"> 1. Lorian V., (1986), <i>Antibiotics in laboratory medicine</i>, 2nd Ed, Williams & Wilkins Publication 2. Vyas S. P and Dixit V. R. (2002), <i>Pharmaceutical Biotechnology</i>, CBS Publishers and Distributors <p>Franklin T. J. and Snow G. A., (1975), <i>Biochemistry of Antimicrobial action</i>, Chapman and Hall, London.</p>
Unit IV	<p>Quality Assurance and Validation in Pharmaceutical Industry</p> <ol style="list-style-type: none"> A. Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in pharmaceutical Industry B. Quality assurance and quality management in pharmaceuticals C. ISO, WHO and US certification D. Safety in microbiology laboratory E. Biopharmaceuticals –Regulations and Sources: Regulatory authorities and its role: FDA and Pharmacopeia (IP, UK, US) F. Drug formulations - Carriers and delivery systems, targeted drug delivery, sustained release <p>References:</p>

	<ol style="list-style-type: none">1. Agarwal S. S. and Paridhavi M., (2007), Herbal Drug Technology, Universities Press (India) Pvt. Ltd2. Franklin T. J. and Snow G. A., (1975), Biochemistry of Antimicrobial action, Chapman and Hall, London.3. Vyas S. P and Dixit V. R. (2002), Pharmaceutical Biotechnology, CBS Publishers and Distributors4. Satoskar R.S. and S.D.Bhandarkar(1991),Pharmacology and Pharmacotherapeutics,12th ed.Vol.1and 2,Popular prakashan, Mumbai.
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MIC 5309 G: Food Technology [Credits – 4]

Course Outcomes

After learning this course student will be able to

CO1: Understand the processes of food analysis, data evaluation, safety and security.

CO2: Study the concept, importance, properties, classification, scope of food as nutraceuticals.

CO3: Understand how nutraceuticals rich supplements play important role in treatment of various disorders of body with some examples.

CO4: Study roles certain government bodies to maintain food standards and quality of food.

Unit I	<p>FOOD PRODUCTS TECHNOLOGY</p> <p>1. Principles of Food Analysis: Types of samples analysed, steps in analysis, choice of methods; sampling procedures, considerations and sample preparation; Evaluation of analytical data – accuracy and precision, sources of errors, specificity, sensitivity and detection limits, regression analysis, reporting results. Analysis of chemical constituents, their characterization and significance- moisture, ash, minerals, lipids, fat, proteins, fibre, titratable acidity, starch, reducing sugars.</p> <p>2. Introduction to food safety and security: Hygienic design of food plants and equipments, Food Contaminants (Microbial, Chemical, Physical), Food Adulteration (Common adulterants), Food Additives (functional role, safety issues)</p> <p>References:</p> <p>1) Food and Packaging Interactions by Risch.S.H. Publisher American chemical society, Washington (1991).</p> <p>2) Rathore,N.S.<i>et al.</i> 2008.Fundamentals of Dairy Technology- Theory & Practices. Himanshu Publ.</p> <p>3) AOAC International.2003. Official methods of analysis of AOAC International. 17th Ed. Gaithersburg, MD, USA, Association of Analytical Communities.</p> <p>4) The food safety information handbook by Cynthia A. Robert, 2009.</p>
Unit II	<p>NUTRACEUTICALS</p> <p>1. Introduction to Nutraceuticals as Science Historical perspective, classification, scope & future prospects. Applied aspects of the Nutraceutical Science. Sources of Nutraceuticals. Relation of Nutraceutical Science with other Sciences: Medicine, Human physiology, genetics, food technology, chemistry and nutrition.</p> <p>2. Study of various Nutraceuticals Properties, structure and functions of Glucosamine, Octacosanol, Lycopene, Carnitine, Melatonin. Use of proanthocyanidins, flaxseed oil as Nutraceuticals.</p> <p>3. Microbial Nutraceuticals Concept of prebiotics and probiotics - principle, mechanism, production and technology involved, applications - examples of bacteria used as probiotics, use of prebiotics in maintaining the useful microflora - extraction from plant sources.</p> <p>References:</p> <p>1) Post harvest biotechnology of vegetables, SalunkheD.K.Handbook of fruits science and tech. Salunkhe D.K. and Kadam S.S.</p> <p>2) Food and Packaging Interactions by Risch.S.H. Publisher American chemical society, Washington (1991).</p> <p>3) Cereal Processing and Technology, Gavin Owens</p>

	4) Rathore, N.S. <i>et al.</i> 2008. Fundamentals of Dairy Technology- Theory & Practices. Himanshu Publ.
Unit III	<p>Food as remedies Nutraceuticals bridging the gap between food and drug, Nutraceuticals in treatment for cognitive decline, Nutraceutical remedies for common disorders like Arthritis, Bronchitis, circulatory problems, hypoglycemia, Nephrological disorders, Liver disorders, Osteoporosis, Psoriasis and Ulcers etc. Brief idea about some Nutraceutical rich supplements e.g. Bee pollen, Caffeine, Green tea, Lecithin, Mushroom extract, Chlorophyll, Kelp and Spirulina etc.</p> <p>References:</p> <ol style="list-style-type: none"> 1) Post harvest biotechnology of vegetables, Salunkhe D.K. Handbook of fruits science and tech. Salunkhe D.K. and Kadam S.S. 2) Food and Packaging Interactions by Risch.S.H. Publisher American chemical society, Washington (1991). 3) Rathore, N.S. <i>et al.</i> 2008. Fundamentals of Dairy Technology- Theory & Practices. Himanshu Publ. 4) AOAC International. 2003. Official methods of analysis of AOAC International. 17th Ed. Gaithersburg, MD, USA, Association of Analytical Communities. 5) Linden G. 1996. Analytical Techniques for Foods and Agricultural Products.
Unit IV	<p>Food standards and quality maintenance: FPO, PFA, Agmark, ISI, HACCP, food plant sanitation and cleaning in place (CIP), FAO in India, Technical Cooperation programmes, Bio-security in Food and Agriculture</p> <p>Hurdle technology: Principles and applications, Hurdle effect in fermented foods, shelf stable products, intermediate moisture foods, application of hurdle technology.</p> <p>References:</p> <ol style="list-style-type: none"> 1) Food and Packaging Interactions by Risch.S.H. Publisher American chemical society, Washington (1991). 2) Rathore, N.S. <i>et al.</i> 2008. Fundamentals of Dairy Technology- Theory & Practices. Himanshu Publ. 3) The food safety information handbook by Cynthia A. Robert, 2009.

