

**Anekant Education Society's
Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati**

Autonomous

Course Structure for M.Sc. -II: Microbiology

Semester	Paper Code	Title of Paper	No. of Credits
III	MICRO5301	Immunology	4
	MICRO5302	Molecular Biology I	4
	MICRO5303	Industrial Waste Water Treatment	4
	MICRO5304	Biophysical Techniques	4
	MICRO5305	Practical Course: Practical course based on Immunology, Pharmaceutical Microbiology and Industrial waste water treatment	4
	MICRO5306	Practical Course: Practical course based on Molecular Biology (I and II) and Microbial Technology	4
	CC-23	Certificate Course II	2
	SD-23	Skill Development - I	2
IV	MICRO5401	Pharmaceutical Microbiology	4
	MICRO5402	Molecular Biology II	4
	MICRO5403	Microbial Technology	4
	MICRO5404	Medical Microbiology	4
	MICRO5405	Dissertation I	4
	MICRO5406	Dissertation II	4
	SD-24	Skill Development - II	2

SYLLABUS (CBCS) FOR M.Sc. II Microbiology
(w. e. from June, 2020)
Academic Year 2020-2021

Class	: M. Sc. II (Semester- III)
Paper Code	: MICRO5301
Paper	: I
Title of Paper	: Immunology
Credit	: 4
No. of lectures	: 60

● **Learning Objectives:**

- ✓ To understand overall organization of immune system.
- ✓ To understand tumor immunology.

● **Learning Outcome:**

- Students will be able to describe immunological response and how it is triggered and regulated.
- Students will be able to describe role of immune system.

UNIT 1: Cell surface molecules and receptors (15L)

- Structure and function of: G-protein coupled receptors, Toll-like receptors, Cytokine receptors, T Cell receptor, B Cell Receptor, TCR-CD3 complex.
- Organization of Cytokine receptors and T Cell receptor
- Adhesion molecules in immune activation (adhesion, Selectin, Mucin)
- Signal transduction pathways: JAK/STAT and Ras/MAP Kinase Pathways.

UNIT 2: Regulation of Immune response (15L)

- Negative regulation - Immunological tolerance, Mechanisms of tolerance induction (related experimentation using transgenic animals),
- T cell mediated suppression of immune response.
- Regulation of immune responses by : antigen, antigen-antibody complexes, Network theory and its experimental evidence Cytokine mediated cross regulation of TH subsets (TH1-TH2)
- Immunomodulation: BRMs for therapy
- Regulation of complement system (classical and alternative)

UNIT 3: Experimental Immunology (15L)

- In vitro systems Quantification of cytokines (ELISPOT assay), functional assays for phagocytes and cytokines (cytotoxicity and growth assays)
- In vivo systems – Experimental animals in immunology research (Inbred animal strains, Knockout mice, transgenic animals, Knock in technology), Animal models for autoimmunity and AIDS.

UNIT 4: Tumor Immunology (15L)

- Cellular transformations during neoplastic growth.
- Classification of tumors based on histological, physiological, biochemical and immunological properties, Tumors of lymphoid system (lymphoma, myeloma, Hodgkin's disease).
- Escape mechanisms of tumor from host defense.
- Host immune response to tumor – Effector mechanisms, Immuno-surveillance theory
- Diagnosis of tumors – biochemical and immunological tumor markers
- Approaches in cancer immunotherapy: Immune adjuvant and tumor vaccine therapy.

Text / Reference Books:

- Akihiko Yoshimura, Tetsuji Naka and Masato Kubo, (2007), SOCS proteins, cytokine signaling and immune regulation, *Nature Reviews, Immunology*, 7:454-465 .
- Austyn J. M. and Wood K. J. (1993) *Principles of Molecular and Cellular Immunology*, Oxford University Press,
- Barret James D. (1983) *Text Book of Immunology* 4th edition, C. V. Mosby & Co. London.
- Boyd William C. (1966) *Fundamentals of Immunology*, Interscience Publishers, NY.
- Christopher K. Garcia and Erin J. Adams, (2005), How the T Cell Receptor Sees Antigen A Structural View, *Cell*, Vol. 122: 333– 336, Elsevier Inc.
- David A. Hafler, (2007), Cytokines and interventional immunology, *Nature Reviews, Immunology*, 7: 423
- Gangal Sudha and Sontakke Shubhangi (2013), *Textbook of Basic and Clinical Immunology* Paperback, University Press, India
- Kindt, Osborne, Goldsby, (2006), *Kuby Immunology*, 6th Ed., W. H. Freeman & Co.
- Abbas A. K. and Litchman A. H. (2004), *Basic Immunology, Functions and Disorders of Immune System*, 2nd Ed., Elsevier Inc
- Bhushan Patwardhan, Sham Diwanay and Manish Gautam. (2006). *Botanical Immunomodulators and Chemoprotectants in Cancer Therapy*.
- In Drug discovery and development Volume I: Drug Discovery. Ed. Chorghade Mukund S., (2006), WileyInterscience, John Wiley and Sons Inc. USA. 405-424.
- Michael C Carroll, (2004), The complement system in regulation of adaptive immunity, *Nature Immunology* 10:981-986.
- Roitt I. M. (1988) *Essentials of Immunology*, ELBS, London.
- Roitt M. (1984) *Essentials of Immunology*, P. G. Publishers Pvt. Ltd., New Delhi.
- House Robert V., (1998), *Therapeutic Manipulation of Cytokines*, Biotechnology and Safety Assessment, 2nd Ed., Taylor & Francis, 81-105.
- Masters John R. W., (2000), *Animal Cell Culture A Practical Approach*, 3rd Ed., Oxford University Press.
- Mather Jennie P. and Penelope E. Roberts, (1998), *Introduction to Cell and Tissue Culture Theory and Technique*, Plenum Press, New York.
- Roitt Evan, Brostoff J. Male D. (1993) *Immunology* 6th Ed., Mosby & Co. London.
- Talwar G. P. (1983) *Handbook of Immunology*, Vikas Publishing Pvt. Ltd. New Delhi.
- William E., Md. Paul, (2003), *Fundamental Immunology*, 5th Ed, Lippincott Williams & Wilkins Publishers
- Ann M. Leen, Cliona M. Rooney and Aaron E. Foster, (2007), Improving T Cell Therapy for Cancer, *Ann. Rev. Immunol.* 25:243–65.
- Chatterji C. C. (1992) *Human Physiology* Vol. 1 &2, Medical Allied Agency, Calcutta.
- Guyton A. C. and Hall J. E. (1996) *Text Book of Medical Physiology*, Goel Book Agency, Bangalore.
- Malati T. (2007), Tumor Markers: An Overview, *Indian Journal of Clinical Biochemistry*, 22(2):17-31
- Rev., 435|2:605-611 Bendelac Albert, Paul B. Savage, and Luc Teyton, (2007), The Biology of NKT Cells *Ann. Rev. Immunol.* 25:297–336
- Sham Diwanay, Manish Gautam and Bhushan Patwardhan. (2004). *Cytoprotection and Immunomodulation in Cancer Therapy*. *Current Medicinal Chemistry Anti-Cancer Agents*, 4: 479-490

SYLLABUS (CBCS) FOR M.Sc. II Microbiology
(w. e. from June, 2020)
Academic Year 2020-2021

Class	: M. Sc. II (Semester- III)
Paper Code	: MICRO5302
Paper	: II
Title of Paper	: Molecular Biology I
Credit	: 4
No. of lectures	: 60

● **Learning Objectives:**

- ✓ To understand eukaryotic gene regulation.
- ✓ To understand prokaryotic gene regulation.

● **Learning Outcome:**

- Students will understand principle and techniques of molecular biology.

UNIT 1: Fine Control of Prokaryotic and Eukaryotic transcription (15L)

- Lactose operon: repressor-operator interactions, mechanism of repression, Positive control of lac operon-Mechanism of CAP action, catabolite repression.
- The Arabinose operon: Ara operon repression loop, evidence for repression loop, auto regulation of araC.
- The trp operon:- control of trp operon by attenuation, defeating attenuation.
- Riboswitches
- Sigma factor Switching:- Phage infection- T4,T7 infection in *E. coli*, SPO1 infection in *B. subtilis*.

UNIT 2: RNA processing (15L)

- mRNA processing: splicing, capping, polyadenylation.
- Coordination of mRNA processing.
- rRNA processing
- tRNA processing
- Non coding RNAs and their production
- RNA interference
- SiRNA, micro-RNA role in gene silencing,

UNIT 3: Tools in molecular biology (15L)

Activity gel assay, ChIP,, Designing probe, Detection of DNA binding proteins, DMS foot printing, DNA helicase assay, Epitope tagging, Sequence tagged sites, Filter binding assay, Protein foot printing, Knockout mice, phage display, Expressed sequence tags, Yeast two and three hybrid assay, RFLP, Finding the replicon, DNA finger printing, Measuring transcription rates, Finding RNA sequences that interact with each other.

UNIT 4: Techniques in Molecular biology and diagnostic applications (15L)

- PCR and its modifications, nested PCR, Hot start
- PCR, RT –PCR and Real time PCR (Q –PCR)
- DNA microarray
- Applications of PCR and microarray.
- Molecular diagnostic tools in detection of cancer.

Text / Reference Books:

- Functions and Mechanics of RNA editing, J. M. Goot, Ann. Rev. Gent., 2000, **30**, 419-53.
- http://highered.mcgrawhill.com/sites/0072943696/student_view0/chapter3/animation__dna_replication__quiz_1_.html
- <http://www.johnkyrk.com/DNAreplication.html>
- 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.
- Lewin's Genes XI, (2014) Jones and Bartlett Publishers Inc.
- Mechanism of subcellular mRNA localization, 2002, CSH, **108**, 533-44.
- Micro RNAs in cell proliferation, Cell death and tumorogenesis, B. J. of Cancer, 2006, 94.
- Molecular Biology of the Cell, Bruce Albert et. al. , 6th Edn., Garland Sciences.
- Molecular Biology, Lodish et. al., 7th Edn., W. H. Freeman, 2012
- NC RNAs regulations of disease, Taft et. al., J. of Path, 2010, **220**,126-39
- Recent progress in structure, Biology and tRNA processing and modification. Mol. Cell., **19(2)**, 2005, 157-66
- Weaver R., (2007) *Molecular Biology*, 4th Edition, McGrew Hill Science.
- Concepts of Genetics, W.S. Klug and M.R. Cummings, (2005) Pearson education
- Functions and Mechanics of RNA editing, J. M. Goot, Ann. Rev. Gent, 2000, **30**, 419-53.
- Mechanism of subcellular mRNA localization, 2002, CSH, **108**, 533-44.
- Micro RNAs in cell proliferation, Cell death and tumorogenesis, B. J. of Cancer, 2006, 94.
- Recent progress in structure, Biology and tRNA processing and modification. Mol. Cell., **19(2)**, 2005, 157-66
- <http://onlinelibrary.wiley.com/doi/10.1576/toag.12.1.037.27556/pdf>
- <http://www.annualreviews.org/doi/abs/10.1146/annurevbiochem-052610-091920>
- <http://www.nature.com/nrg/journal/v13/n7/full/nrg3230.html>
- <http://www.nature.com/nrg/journal/v14/n8/full/nrg3535.html>
- <http://www.nature.com/scitable/topicpage/the-role-ofmethylation-in-gene-expression-1070>
- <http://www.ncbi.nlm.nih.gov/pubmed/20920744>
- Recent progress in structure, Biology and tRNA processing and modification. Mol. Cell., **19(2)**, 2005, 157-66
- Micro RNAs in cell proliferation, Cell death and tumorogenesis, B. J. of Cancer, 2006, 94.
- Recent progress in structure, Biology and tRNA processing and modification. Mol. Cell., **19(2)**, 2005, 157-66
- S.B Primrose and R M Twyman 2006 7th edition. Blackwell publishing
- Weaver R., (2007) *Molecular Biology*, 4th Edition, McGrew Hill Science.

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Class : M. Sc. II (Semester- III)
Paper Code : MICRO5303
Paper : III
Title of Paper : Industrial waste water treatment
Credit : 4
No. of lectures : 60

● **Learning Objectives:**

- ✓ To understand the industrial wastewater treatment process.
- ✓ To learn different parameters to study waste water

● **Learning Outcome:**

- Students will understand waste water treatment processes of different industries.

UNIT 1: Principles of Wastewater Treatment (15L)

- The need for Wastewater Treatment
- Measuring Pollution Load of wastewaters
- Methods for estimating parameters used for determining treatment efficacy
- Layout of typical wastewater treatment plants

UNIT 2: Pre-treatment & Primary treatment process (Unit Processes) (15L)

- Flow equalization
- Screening
- Flocculation
- Flotation
- Granular medium filtration

UNIT 3: Secondary and Tertiary Treatment process (Unit Processes) (15L)

- Biological Processes (Aerobic)
- Biological Processes (Anaerobic)
- Biological processes (Combined)
- Sedimentation and clarification
- Disinfection
- Adsorption

Advanced, Combined and Innovative wastewater treatment processes

- Submerged Aerobic Fixed Film reactors (SAFF)
- Membrane bioreactors (MBRs)
- Mixed Bed Bioreactors (MBBRs)

UNIT 4: Current industrial wastewater treatment processes (15L)

- Dairies
- Food processing
- Dyeing industry / Dye-house effluents
- Paper manufacture

Text / Reference Books:

- Biotechnology for Water and Wastewater Treatment. Dr. Satya Prakash. Navyug Publishers & Distributors, New Delhi. 2009.
- Industrial Water Pollution Control. 3rd Edition. W. Wesley Eckenfelder Jr. McGraw Hill. 2000.
- Standard Methods for the Examination of Water & Wastewater. 21st Edition. 2005
APHA.AWWA.WEF
- Wastewater Engineering, Treatment, Disposal and Reuse. 3rd Ed., Metcalf and Eddy (Eds). Tata Mac Graw Hill Publishing Co. Ltd. New Delhi
- Tchobanoglous G. and F. L. Burton. (1991).
- Disposal and Reuse. 3rd Ed., Metcalf and Eddy (Eds). Tata Mac Graw Hill Publishing Co. Ltd. New Delhi
- Biological Wastewater Treatment. Vol. 5. Activated Sludge and Aerobic Biofilm Reactors. Marcos von Sperling. IWA Publishing. London, New York. © 2007 IWA Publishing
- Industrial Wastewater Treatment. A. D. Patwardhan. © Prentice –Hall of India Pvt. Ltd., New Delhi. 2008. ISBN 978-81-203-3350-5.

SYLLABUS (CBCS) FOR M.Sc. II Microbiology
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Class	: M. Sc.II (Semester- III)
Paper Code	: MICRO5304
Paper	: IV
Title of Paper	: Biophysical Techniques
Credit	: 4
No. of lectures	: 60

● **Learning Objectives:**

- ✓ To learn different techniques of biophysics.
- ✓ To learn different techniques of molecular structure determination.

● **Learning Outcome:**

- Students will be able to learn molecular structure determination.

UNIT 1: Mass spectroscopy **(15L)**

Principles of operation, Ionization, Ion fragmentation, Mass Analyzers, GC-MS, MALDI-TOF

UNIT 2: X-ray crystallography **(15L)**

Purification of proteins, Crystallization of proteins.

Instrumentation, acquisition of the diffraction pattern, basic principles of x-ray diffraction, Crystal Structures (Bravais Lattices), Crystal planes and Miller Indices, Fourier Transform and Inverse Fourier, Direct Lattice and Reciprocal lattice, Ewald sphere, Electron density Maps, Phase determination, Phase Refinement, Validation.

UNIT 3: NMR spectroscopy **(15L)**

Basic Principles of NMR, Chemical shift, Intensity, Line width, Relaxation parameters, Spin coupling, Nuclear Overhauser Effect Spectroscopy, Correlation Spectroscopy, Approach to structure determination by 2D-NMR

UNIT 4: Tools of Bioinformatics **(15L)**

General Introduction of Biological Databases, Introduction to Sequences, Sequence alignment, Local and global alignment, pair wise sequence alignment, Multiple sequence Alignment, Dynamic Programming, Homology Modelling, 3-D protein Model. Examples of related tools (FASTA, BLAST, BLAT), databases (GENBANK, PDB, OMIM) and software (RASMOL, Ligand Explorer).

Text / Reference Books:

- Wilson Keith and Walker John (2005) *Principles and Techniques of Biochemistry and Molecular Biology*, 6th Ed. Cambridge University Press, New York.
- Pattabhi, V. and Gautham, N. (2002) *Biophysics*. Kluwer Academic Publishers, New York and Narosa Publishing House, Delhi.
- Rolf Ekman, Jerzy Silberring, Ann Westman-Brinkmalm, Agnieszka Kraj (2009) *Mass spectrometry : instrumentation, interpretation, and applications*, John Wiley & Sons, Inc., Canada.
- Irwin H. Segel (1976) *Biochemical Calculations: How to Solve Mathematical Problems in General Biochemistry*, 2nd Edition. John Wiley & Sons.
- Nölting, B. (2006) *Methods in modern biophysics*. Second Edition. Springer, Germany.
- Cavanagh John *et.al.* (1995) *Proteins NMR Spectroscopy: Principles and Practice*, Academic Press.

- Cotterill, R. M. J. (2002) *Biophysics: An Introduction*. John Wiley & Sons, England.
- Keeler, J. (2002) *Understanding NMR Spectroscopy*. John Wiley & Sons, England.
- Mount, D. W. (2001) *Bioinformatics: sequence and genome analysis*. Cold Spring Harbor Laboratory Press, New York.
- David M Webster (2000) *Protein Structure Prediction-Methods and Protocols*, Methods In Molecular Biology Vol 143 Humana Press.
- Narayanan, P. (2000) *Essentials of Biophysics*. New Age International Publication, New Delhi.

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Class	: M. Sc.II (Semester- III)
Paper Code	: MICRO5305
Paper	: V
Title of Paper	: Practical Course: Practical course based on Immunology, Pharmaceutical Microbiology and Industrial waste water treatment
Credit	: 4
No. of lectures	: 60

● **Learning Objectives:**

- ✓ To enrich students' knowledge and train them in the pure microbial sciences
- ✓ To introduce the concepts of application and research in Microbiology

● **Learning Outcome:**

- Students will learn different CLSI guidelines
- Students will learn different parameters to estimate pollution load

A. Antigen-Antibody Interactions

1. Precipitation reactions of antigen-antibody: Single radial immunediffusion, double immunodifusion, Immunolectrophoresis and rocket immuneelectrophoresis
2. Agglutination techniques: Titer determination of isoantibodies to human blood group antigens

B. Biophysics

Ramchandran plot

C. Detection and isolation of anti-infectives from plant

1. Extraction of bioactive principles from plant and activity fractionation
2. Estimation of its antimicrobial activity using standard guidelines (CLSI)

D. Industrial waste water treatment

1. Estimation of pollution load of a natural sample (e.g. river water / industrial waste water)
2. Setting up a laboratory experiment to assess degradability of synthetic waste water

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Class : M. Sc.II (Semester- III)
Paper Code : MICRO5306
Paper : VI
Title of Paper : Practical Course: Practical course based on Molecular Biology (I and II) and Microbial Technology
Credit : 4
No. of lectures : 60

● **Learning Objectives:**

- ✓ To enrich students' knowledge and train them in the pure microbialsciences
- ✓ To introduce the concepts of application and research inMicrobiology

● **Learning Outcome:**

- Students will learn immobilization testing parameters.
- Students will learn gene annotation.

A. Bioconversion

Bioconversions using immobilized systems (cells / enzyme) Parameter testing

- a. Effect of gel concentration
- b. Effect of cell / enzyme concentration

B. Biosorption

Biosorption of dyes or metals using dead biomass

C. Laboratory scale production

Laboratory scale production and media optimization for exopolysaccharide / bioemulsifier production.

D. Molecular Biology

1. Molecular Characterization of bacterial isolates
2. Gene annotation

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Class	: M. Sc. II (Semester- IV)
Paper Code	: MICRO5401
Paper	: I
Title of Paper	: Pharmaceutical Microbiology
Credit	: 4
No. of lectures	: 60

● **Learning Objectives:**

- ✓ To toxicities of drugs used in medicine.
- ✓ To understand the different methods for development of anti-infective drugs.

● **Learning Outcome:**

- Students will understand drug discovery and development.

UNIT 1: Drug Discovery and Development (15L)

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

A. Drug Discovery:

- I. Conventional Process Bio-prospecting (Medicinal Chemistry) – Extraction and purification principles, Purification and characterization of bioactive molecules from natural sources
- II. Rational Drug Design – Principle (Structure activity relationship-SAR) and Tools (applications of High Through Put Screening, Combinatorial synthesis, Pharmacogenomics)

B. Drug Development

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

UNIT 2: Biopharmaceuticals –Regulations and Sources (15L)

Regulatory authorities and its role: FDA and Pharmacopeia (IP, UK, US)

Drug formulations - Carriers and delivery systems, targeted drug delivery, sustained release

Pharmacokinetic – ADME / Bioavailability studies

E. coli as a source of recombinant, therapeutic proteins

UNIT 3: Development of Anti-infectives: (15L)

Therapeutic ratio, MIC and MBC

Susceptibility Testing:

- A. Use of liquid and solid media
- B. Factors affecting susceptibility testing, CLSI guidelines
- C. Diffusion methods –agar dilution technique, gradient plate techniques, E-test, Kirby Bauer, Stokes method
- D. Susceptibility testing for:
 1. Anti-mycobacterial agents
 2. Anti-fungal agents
 3. Anti-protozoan agents
 4. Anti-viral agents

UNIT 4: Quality Assurance and Validation in Pharmaceutical Industry (15L)

- A. Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in pharmaceutical industry.
- B. Quality assurance and quality management in pharmaceuticals ISO, WHO and US certification. Safety in microbiology laboratory.
- C. Safety profile of drugs:
 - i. Pyrogenicity testing
 - ii. Mutagenicity and Carcinogenicity testing
 - iii. Teratogenicity testing
 - iv. Adverse Drug Reactions
 - v. In vivo and in vitro drug interactions

Text / Reference Books:

- Agarwal S. S. and Paridhavi M., (2007), *Herbal Drug Technology*, Universities Press (India) Pvt. Ltd
- Altreuter D., and D S. Clark, (1999), *Combinatorial Biocatalysis: Taking the Lead From Nature*, Curr. Opin. Biotechnol. **10**, 130.
- Bentley's Textbook of Pharmaceutics, Ed. E. A. Rawlins, 8th Ed.(2002), Bailliere Tindall, London
- Burn J. H. (1957) *Principles of Therapeutics*, Blackwell Scientific Pub. O. Ltd. Oxford.
- Chatwal G. P. (2003) *Bio-pharmaceutics and Pharmacokinetics*, Himalaya Publishing House, Mumbai.
- Paul W. Erhardt, (2006), *Medicinal Chemistry in the New Millennium: A Glance into the Future*, Ed. Chorghade Mukund S. in Drug discovery and development Volume I: Drug Discovery, Wiley-Interscience, John Wiley and Sons Inc. USA, 17-102.
- Committee for the Purpose of Control and Supervision on Experiments on Animals (CPCSEA), www.cpcsea.com
- Dewick Paul M., (2002), *Medicinal natural products: A biosynthetic approach*, 2nd Ed., John Wiley and Sons
- Graly John O. and Pieter H. Joubert, (1997), *Handbook of Phase I / II clinical drug trials*, CRC Press
- Iyengar M. A. (1974) *Pharmacology of Powdered Crude Drugs*, Manipal
- Micheles P. S., Y. L. Khmel'nitsley, J. S. Dordick and D. S. Clark, (1998), *Combinatorial Biocatalysis, A Natural Approach to Drug Discovery*, Trends in Biotechnol. **16**, 197.
- Satoskar R. S. & S. D. Bhandarkar (1991) *Pharmacology and Pharmacotherapeutics*, 12th Ed., Vol. 1 & 2, Popular Prakashan, Mumbai.
- Vyas S. P and Dixit V. R. (2002), *Pharmaceutical Biotechnology*, CBS Publishers and Distributors, New Delhi
- Kokate C. K., Purohit A. P., Gokhale A. B. (2000) *Pharmacology*, 4th Ed., Nirali Prakashan.
- Mannfred A. Holliger, (2008), *Introduction to pharmacology*, 3rd Ed., CRC Press **38**
- Sylvie E. Blondelle, Enrique Pe´rez-Paya, And Richard A. Houghten, (1996), *Synthetic Combinatorial Libraries: Novel Discovery Strategy for Identification of Antimicrobial Agents*, Antimicrobial Agents and Chemotherapy, 1067–1071
- Walsh Gary, (2003), *Biopharmaceutics Biochemistry And Biotechnology*, 2nd Ed., John Wiley & Sons Ltd, England
- Franklin T. J. and Snow G. A., (1975), *Biochemistry of Antimicrobial Action*, Chapman and Hall, London, 1-22 and 160-174
- Gale E. F., Cundliffe E., Reynolds P. E., Richmond M. H. and Waring M. J., (1972), *The molecular basis of antibiotic action*, John Wiley and Sons, London
- Goldstein A., Aronow L., and Kalman S. M. (1969) *Principles of Drug Action, The Basis of Pharmacology*, Harper international edition New York.

- Lorian V., (1986), *Antibiotics in laboratory medicine*, 2nd Ed, Williams & Wilkins Publication
- National Committee for Clinical Laboratory Standards (now Clinical and Laboratory Standards Institute, CLSI). *Methods for dilution antimicrobial susceptibility testing for bacteria that grows aerobically. Approved Standards M7-A4*. Villanova, PA: NCCLS, 1997.
- National Committee for Clinical Laboratory Standards (now Clinical and Laboratory Standards Institute, CLSI). *Performance standards for antimicrobial susceptibility testing; 12th information supplement (M100-S1)*. Villanova, PA; NCCLS: 2002
- MAron Dorothy M. and Bruce N. Ames, (1983), *Revised methods for the Salmonella mutagenicity test*, Mutation Research, 113:173-215
- Osol Arther (1975) *Remington's Pharmaceutical Sciences*, 15th Ed., Mack Pub. Co., Pennsylvania.

SYLLABUS (CBCS) FOR M.Sc. II Microbiology
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Class	: M. Sc. II (Semester- IV)
Paper Code	: MICRO5402
Paper	: II
Title of Paper	: Molecular Biology II
Credit	: 4
No. of lectures	: 60

● **Learning Objectives:**

- ✓ To learn applications of Gene technology.
- ✓ To learn issues related to GMOs

● **Learning Outcome:**

- Students will understand issues related to GMOs and their application.

UNIT 1: Gene technology (15L)

- Gene cloning strategies: preparation of gene, genome libraries, cDNA libraries, PCR cloning and alternatives. Library screening
- Site directed mutagenesis and protein engineering
- Cloning and manipulating large fragments of DNA; YAC BAC HAC
- Gene transfer to host cells.
- Expression vectors

UNIT 2: Applications of recombinant DNA technology – Production of Secondary Metabolites (15L)

Synthesis of commercial products: Amino acids, ascorbic acid, novel antibiotics, peptide antibodies, biopolymers: gum, rubber, polyhydroxyalkanoates. Unconventional microbial systems for production of high quality protein drugs.

UNIT 3: Bioremediation and biomass utilization with the help of GMOs (15L)

Degradation of xenobiotics, engineered degradative pathways.

Utilization of starch and cellulose for fructose, alcohol and silage production

UNIT 4: Genetically modified Microbes, plants and animals (15L)

- Genetically modified organisms- social and ethical issues
- Applications in medicine – prevention, early detection and cure of diseases
- Gene augmentation, gene therapy
- Applications in agriculture – examples of transgenic plants advantages and disadvantages
Producing useful molecules examples

Text / Reference Books:

- R. Glick, J.J. Pasternack, Principles and applications of recombinant DNA, 3rd Ed., ASM press.
- 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.
- Lewin's Genes XI, (2014) Jones and Bartlett Publishers Inc.
- Malom Campbell and L. J. Heyer, Discovering genomics, Proteomics and Bioinformatics, 2nd Ed., Pearson Publication, 2009.
- S.B Primrose and R M Twyman 2006 7th edition. Blackwell publishing
- Walker J.M., Rapley R. (eds.) *Molecular Biology and Biotechnology*, 4th Ed., 2009, Royal Society Press, U.K.

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Class	: M. Sc. II (Semester- IV)
Paper Code	: MICRO5403
Paper	: III
Title of Paper	: Microbial Technology
Credit	: 4
No. of lectures	: 60

● **Learning Objectives:**

- ✓ To understand the different designs of bioreactors
- ✓ To learn different process variables.

● **Learning Outcome:**

- Students will learn downstream process of different fermented products.

UNIT 1: Bioreactor Design **(15L)**

- A. Designing of bioreactors - Design aspects CSTRs: The dimensional ratios of the outer shell, and the operational aspects such as working volume 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.

UNIT 2: Process Variables and Monitoring **(15L)**

A. Process Variables:

- I. Aeration - Theory of oxygen transfer in bubble aeration, Oxygen transfer kinetics (Oxygen Uptake Rate –OUR; Oxygen Transfer Rate OTR; Ccrit), determination of KLa.
- II. Agitation - Functions of agitation. Flow patterns with different types of impellers.
- III. 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

B. Monitoring of process variables:

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

UNIT 3: Microbial Processes **(15L)**

- I. Upstream, Fermentation and Downstream Processing for the following:
- II. Antibiotics (Rifamycin)
- III. Microbial enzymes (Chitinase)
- IV. Exopolysaccharides (Pullulan)
- V. Use of immobilized cells / enzymes to produce protease

UNIT 4: Principles of Validation Process / Method Validation and IPR **(15L)**

- a. The concept of ISO Certification.
- b. Preparation of SOPs
- c. Validation protocols for methods in:
 - i. Quality Control

ii. Process validation

The above should be discussed within WHO Norms. Exercises on preparation of SOPs, operation and validation for analytical methods

Intellectual Property Rights (IPR):

- i. Basic concepts of IPR
- ii. Introduction to forms of IPR – Patents and Designs

Text / Reference Books:

- Bioreactor Design and Product Yield (1992), BIOTOL series, Butterworths Heinemann.
- Doran Pauline (1995) Bioprocess Engineering Principles, Academic Press.
- Lydersen B., N. a. D' Elia and K. M. Nelson (Eds.) (1993) Bioprocess Engineering: Systems, Equipment and Facilities, John Wiley and Sons Inc.
- Ratledge C and Kristiansen B eds. (2001) Basic Biotechnology 2nd Ed. Cambridge Univ. Press. Cambridge
- Operational Modes of Bioreactors, (1992) BIOTOL series, Butterworths Heinemann.
- Shuichi and Aiba. Biochemical Engineering. Academic Press. 1982
- Stanbury and Whittaker. Fermentation technology
- Klegerman, M.E and Groves M.J. (1992) Pharmaceutical Biotechnology: Fundamentals and Essentials. Interpharm Press Ltd. Buffalo Grove IL
- Peppler H. J. and D. Perlman (1970) Microbial Technology Volume 1 and 2, Academic Press New York.
- Ponkhshe S. (1988) Management of Intellectual Property, Bhate and Ponkhshe Prakasham, Pune
- Reed G. Ed. Prescott and Dunn's Industrial Microbiology. 4th Ed., CBS Pub. New Delhi.
- Van Damme E. J. (1984) Biotechnology of Industrial Antibiotics, Marcel Dekker Inc. New York.
- Wiseman A.(1985) Topics in Enzyme and Fermentation - Biotechnology, Vol. 1 and 2, John Wiley and Sons, New York
- Supplementary Training Modules on Good Manufacturing Practice. Validation-WHO Technical Report Series, No.937, 2006, Annex 4.
- The FDA's draft process validation Guidance-A perspective from industry. By Naula Calnan, Alice Redmond and Stan O' Neill. Process Validation Guidance

SYLLABUS (CBCS) FOR M.Sc. II Microbiology
(w. e. from June, 2020)
Academic Year 2020-2021

Class	: M. Sc. II (Semester- IV)
Paper Code	: MICRO5404
Paper	: IV
Title of Paper	: Medical Microbiology
Credit	: 4
No. of lectures	: 60

● **Learning Objectives:**

- ✓ To understand mechanism of emerging infectious diseases
- ✓ To understand mechanism of anti infectives.

● **Learning Outcome:**

- Students will able to learn multidrug resistance in bacterial pathogens.

UNIT 1 & 2: Determinants of Microbial Pathogenicity (30L)

- a. Adhesion and Colonization
- b. Invasion
- c. Evasion
- d. Toxigenesis (mode of action and *in vitro* and *in vivo* assay systems for diphtheria, cholera, tetanus toxins and endotoxins of Gram negative bacteria)
- e. Bacterial resistance to host defenses: phagocytosis, nonspecific and specific humoral factors
- f. Molecular basis of bacterial pathogenicity – cytoskeletal modulation of host cell, virulence genes and pathogenicity islands

UNIT 3: Clinical Microbiology (15L)

Epidemiological and investigational approaches for emerging infectious diseases:

- A. Viral diseases:
SARS (severe acute respiratory syndrome), Avian and Swine influenza, COVID-19
- B. Diseases by multi-drug resistant bacterial pathogens:
Mechanisms of development of drug resistance
Vancomycin resistant Enterococci (VRE),
Methicillin resistant *Staphylococcus aureus* (MRSA),
Vancomycin resistant *Staphylococcus aureus* (VRSA),
Extended Spectrum Beta Lactamase (ESBL) producers

UNIT 4: Discovery of anti-infectives (15L)

- A. Drug targets in bacteria with examples of established drugs: Cell wall biosynthesis, Cell membrane function, Proteins synthesis and Nucleic acid synthesis and metabolism
- B. Methods to quantify growth / inhibition and metabolic changes in microbial population on exposure to anti-infectives, for evaluation of antiinfective activity and developing insight in its' mode of action:
 1. Direct counts (Counting chambers, calibrated smears, proportionate counts),
 2. Turbidometry and nephelometry,
 3. Electrical Resistance, Electrical impedance,
 4. Microcalorimetry,
 5. Flow cytometry and
 6. Radiometric methods
 7. Radiolabelling techniques

C. Laboratory methods to assess activity of antimicrobial combinations (antagonism, Synergism, and additive effect)

- **Text / Reference Books:**

- Babych E. M., Ryzhkova T. A., Kalinichenko S. V. and Sklyar N. I., (2008), *General Characteristic of the methods for detection of diphtheria toxin*, Annals of Mechnikov Institute, 19-21 (www.imiamn.org/journal.htm)
- Bhavsar Amit P., Julian A. Guttman and B. Brett Finlay, (2007), *Manipulation of host-cell pathways by bacterial pathogens*, Nature Rev **449/18**:827-834
- Brubaker R. R., (1985), *Mechanisms of Bacterial Virulence*, Ann. Rev. Microbiol. 39:21-50
- Carpenter Philip L., (1975), *Saunders International Edition - Immunology and Serology*, W. B. Saunders and Co., London
- David N. Fredricks and David A. Relman, (1996), *Sequence-Based Identification of Microbial Pathogens: a Reconsideration of Koch's Postulates*, Clinical Microbiology Reviews, 18–33
- Eduardo A. Groisman and Howard Ochman, (1994), *How to become a pathogen*, Trends in Microbiology, **2(8)**:289-294
- Hughes Eric A. and Jorge E. Galan, (2002), *Immune Response to Salmonella: Location, Location, Location?*, Immunity, **16**: 325–328
- Mark J. Pallen1 & Brendan W. Wren, (2007), *Bacterial pathogenomics*, Nature Rev. **449/18**: 835-842
- Schlessinger David, Editor, *Biochemical Genetics of Pathogenicity*, in Microbiology – 1979, American Society for Microbiology, Washington D. C., 79 - 230
- Schlessinger David, Editor, *Mechanism of Microbial Virulence*, in Microbiology – 1979, American Society for Microbiology, Washington D. C., 79-230
- Unsworth K. E. and David W. Holden, (2000), *Identification and analysis of bacterial virulence genes in vivo*, Phil. Trans. R. Soc. London B. **355**, 613-622
- Franklin T. J. and Snow G. A., (1975), *Biochemistry of Antimicrobial Action*, Chapman and Hall, London, 1-22 and 160-174
- Kavanagh Frederick, (1963), *Analytical Microbiology Volume I and II*, Academic Press, London
- Lorian V., (1986), *Antibiotics in laboratory medicine*, 2nd Ed, Williams & Wilkins Publication
- Sylvie E. Blondelle, Enrique Pe Rez-Paya, And Richard A. Houghten, (1996), *Synthetic Combinatorial Libraries: Novel Discovery Strategy for Identification of Antimicrobial Agents*, Antimicrobial Agents and Chemotherapy, 1067–1071
- Vyas S. P and Dixit V. R. (2002), *Pharmaceutical Biotechnology*, CBS Publishers and Distributors, New Delhi

SYLLABUS (CBCS) FOR M.Sc. II Microbiology
(w. e. from June, 2020)
Academic Year 2020-2021

Class : M. Sc. II (Semester- IV)
 Paper Code : MICRO5405
 Paper : V
 Title of Paper : Dissertation I
 Credit : 4
 No. of lectures : 60

● **Learning Objectives:**

- ✓ To understand the process of scientific research.

● **Learning Outcome:**

- Students will able to learn basics of research process.

1. A dissertation can be carried out by a single student or by group of students where the group should not contain more than four students. The dissertation report will be prepared as per the thesis format. Submission of the dissertation report will be at least three days before the date of examination. One copy of the report will be preserved in the department. If there is more than one student carrying out a single dissertation, a single report can be submitted and these students will be assessed based on single oral presentation. In such case, presentation should be carried out by all the students carrying out the same work; dividing the presentation equally among them.
2. At the time of presentation, the external and internal examiners appointed by the university will be present; the dissertation guide may or may not be present.
3. Presentation should be carried out to an audience comprising of examiners appointed by the university, departmental teaching staff and the postgraduate students of the department. Oral presentation can be carried out using posters, blackboard, transparencies, model or LCD projector. The allotted time for each oral presentation (one project) should be 10 to 12 minutes, followed by question-answer session of 5 to 8 minutes. The audience can participate in this session.
4. The assessment of the dissertation I is for total of 100 marks, out of which the end-semester - will be for 60 marks and the in-semester assessment will be for 40 marks.
5. The assessment of in-semester examination will be carried out by the guide who has supervised the work of the candidate(s) throughout the semester. The assessment will be carried out on the basis of the points, as per the accompanied format. Head of the department should communicate this point wise assessment system to the dissertation supervisor (Guide), well in advance. Guide will give appropriate marks, point-wise and submit it in a sealed envelope to the Head of the respective department, three days prior to examination and project presentation. On the day of examination, Head of the department will hand over these unopened envelopes to the examiners.

Points for Evaluation	Max. Marks	Evaluation
Intellectual potential – Understanding of the research problem by the student	4	
Research aptitude –		
1. Depth of literature survey for the proposed work.	4	
2. Inputs of student in development of plans and protocols for the experimentation	8	
3. Ability to analyze data and formulate a solution	4	
4. Analytical and reasoning abilities of the student for interpretation of data, inputs in discussion	6	

Motivation – punctuality, meeting dead-lines and seriousness	2	
Ability to work with others	2	
Maturity of scientific thoughts	2	
Communication skill – oral and written	8	
Total	40	

6. Assessment of end-semester examination will be carried out (i.e. oral presentation) for individual student at the time of examination jointly by internal and external examiners. The assessment will be carried out on the basis of the points as per the accompanied format.

Points for Evaluation	Max. Marks	Evaluation
Proficiency of presentation skills – use of audio-visual aids, preparation of graphs, charts, models, etc., use of scientific language	24	
Quality of the work, results and interpretation, outcome of the study and possible future plans, publication potential of the work	12	
Submission of progress reports, the dissertation report preparation (scientific writing) and its contents	18	
Abilities of satisfactory responses to the queries from the audience	6	
Total	60	

7. Students should be made aware of the assessment parameters, on which they will be assessed at the end of the fourth semester.
8. The external and internal examiners by mutual agreement will appropriately settle the marks given by the guide (reconsider, if necessary) and marks of oral presentation.

SYLLABUS (CBCS) FOR M.Sc. II Microbiology
(w. e. from June, 2020)
Academic Year 2020-2021

Class : M. Sc. II (Semester- IV)
 Paper Code : MICRO5406
 Paper : VI
 Title of Paper : Dissertation II
 Credit : 4
 No. of lectures : 60

● **Learning Objectives:**

- ✓ To understand the process of scientific research.

● **Learning Outcome:**

- Students will able to learn basics of research process.

1. A dissertation can be carried out by a single student or by group of students where the group should not contain more than four students. The dissertation report will be prepared as per the thesis format. Submission of the dissertation report will be at least three days before the date of examination. One copy of the report will be preserved in the department. If there is more than one student carrying out a single dissertation, a single report can be submitted and these students will be assessed based on single oral presentation. In such case, presentation should be carried out by all the students carrying out the same work; dividing the presentation equally among them.
2. At the time of presentation, the external and internal examiners appointed by the university will be present; the dissertation guide may or may not be present.
3. Presentation should be carried out to an audience comprising of examiners appointed by the university, departmental teaching staff and the postgraduate students of the department. Oral presentation can be carried out using posters, blackboard, transparencies, model or LCD projector. The allotted time for each oral presentation (one project) should be 10 to 12 minutes, followed by question-answer session of 5 to 8 minutes. The audience can participate in this session.
4. The assessment of the dissertation II is for total of 100 marks, out of which the end-semester - will be for 60 marks and the in-semester assessment will be for 40 marks.
5. The assessment of in-semester examination will be carried out by the guide who has supervised the work of the candidate(s) throughout the semester. The assessment will be carried out on the basis of the points, as per the accompanied format. Head of the department should communicate this point wise assessment system to the dissertation supervisor (Guide), well in advance. Guide will give appropriate marks, point-wise and submit it in a sealed envelope to the Head of the respective department, three days prior to examination and project presentation. On the day of examination, Head of the department will hand over these unopened envelopes to the examiners.

Points for Evaluation	Max. Marks	Evaluation
Intellectual potential – Understanding of the research problem by the student	4	
Research aptitude –		
1. Depth of literature survey for the proposed work.	4	
2. Inputs of student in development of plans and protocols for the experimentation	8	
3. Ability to analyze data and formulate a solution	4	
4. Analytical and reasoning abilities of the student for interpretation of data, inputs in discussion	6	

Motivation – punctuality, meeting dead-lines and seriousness	2	
Ability to work with others	2	
Maturity of scientific thoughts	2	
Communication skill – oral and written	8	
Total	40	

6. Assessment of end-semester examination will be carried out (i.e. oral presentation) for individual student at the time of examination jointly by internal and external examiners. The assessment will be carried out on the basis of the points as per the accompanied format.

Points for Evaluation	Max. Marks	Evaluation
Proficiency of presentation skills – use of audio-visual aids, preparation of graphs, charts, models, etc., use of scientific language	24	
Quality of the work, results and interpretation, outcome of the study and possible future plans, publication potential of the work	12	
Submission of progress reports, the dissertation report preparation (scientific writing) and its contents	18	
Abilities of satisfactory responses to the queries from the audience	6	
Total	60	

7. Students should be made aware of the assessment parameters, on which they will be assessed at the end of the fourth semester.
8. The external and internal examiners by mutual agreement will appropriately settle the marks given by the guide (reconsider, if necessary) and marks of oral presentation.