



UNIVERSITY OF CALICUT

Abstract

MSc programme in Microbiology-University Teaching Department-under Choice based Credit Semester System (PG)-Revised Syllabus-approved -implemented with effect from 2013 admissions - Orders issued

UNIVERSITY OF CALICUT (G & A - IV - J)

U.O.No. 6632/2013/CU

Dated, Calicut University.P.O, 12.12.2013

*Read:-*1. U.O.No.GA IV/J1/1373/08 dated 01.07.2008.

2. Item No:1 of the minutes of BOS in Microbiology Dated 27.12.2013
3. The remarks of the Dean, Faculty of Science Dtd 03.12.13
4. Order of the Vice Chancellor in the file no:4521/GA/IV-J1/2013/CU on 8.12.13

ORDER

The Choice based Credit Semester System was implemented in all Regular PG programmes in University Teaching Departments of the University with effect from 2008 admissions, vide paper read as (1) above. The Modified Syllabus of MSc programme in Microbiology under CCSS (PG) in the University Teaching Department was implemented with effect from 2010 admissions.

The Board of Studies in Microbiology, vide paper read as (2), resolved to approve the Revised Syllabus of MSc programme in Microbiology under CCSS (PG) in the University Teaching Department with effect from 2013-14 admissions.

The Dean Faculty of Science has recommended to approve item No:1 of the the minutes and the Syllabus as per paper read 3rd above.

The Vice Chancellor in view of exigency exercising the powers of Academic Council has approved Item No:1 of the minutes of the meeting of the Board of Studies in Microbiology and also approved to implement the Syllabus subject to the ratification of the Academic Council as per reference cited 4th.

Sanction has, therefore, been accorded for implementing the Revised Syllabus of MSc programme in Microbiology under CCSS (PG) in the University Teaching Department with effect from 2013-14 admissions.

Orders are issued accordingly.

(The Syllabus is available in the Official website of the University:universityofcalicut.info)

Muhammed S
Deputy Registrar

To

Forwarded / By Order

Section Officer



UNIVERSITY OF CALICUT

SCHEME AND SYLLABUS FOR M. Sc. MICROBIOLOGY (CCSS)

COURSE OFFERED BY

DEPARTMENT OF LIFE SCIENCES

2013 Admission onwards

Regulations, Scheme and Syllabus for M. Sc degree course in Microbiology

Eligibility: A candidate seeking admission to M. Sc. Microbiology must have B. Sc in Microbiology

Admission: 50% of marks (or corresponding CGPA) obtained in B. Sc Microbiology

Curriculum: Course of study consists of four semesters in two consecutive academic years.

PER WEEK WORK LOAD

Semester	Theory		Practical		Library/ Assignment/ Tutorial (Hours)	Project	Total		
	Credit	Hours (Creditx1)	Credit	Hours (Creditx3)			Credits	Hours	Marks
I	4x4=16	16	2x1=2	6	8	-	18	30	500
II	3x4=12	12	3x2=6	18	-	-	18	30	600
III	4x4=16 (2EL)	16	2x2=4	12	2	-	20	30	600
IV	2x4=8 (2 EL)	8	-	-	8	8	16	24	300
Total	52	52	12	36	18	8	72	114	2000

No	Papers	Hr /week	Credit	Exams	Marks			Total
					Total	Ext [▲]	Int ^{▲▲}	
Semester I			18					
1.	MBG 1C01. Microbial Physiology and Microbial Genetics	4	4	3	100	80	20	500
2.	MBG 1C02. Microbial Metabolism	4	4	3	100	80	20	
3.	MBG 1C03. Environmental Microbiology	4	4	3	100	80	20	
4.	MBG 1C04. Immunology	4	4	3	100	80	20	
5.	MBG 1C05. Practical I– (Microbial Physiology, Microbial Genetics & Microbial Metabolism)	6	2	5x2	100	80	20	
Semester II			18					
6.	MBG 2C06. Industrial Microbiology	4	4	3	100	80	20	600
7.	MBG 2C07. Medical Microbiology	4	4	3	100	80	20	
8.	MBG 2C08. Biostatistics and Bioinformatics	4	4	3	100	80	20	
9.	MBG 2C09. Practical II (Environmental Microbiology & Industrial Microbiology)	6	2	5x2	100	80	20	
10.	MBG 2C10. Practical III (Medical Microbiology and Immunology)	6	2	5x2	100	80	20	
11.	MBG 2C11. Practical IV (Bioinformatics)	6	2	5x2	100	80	20	
Semester III Elective papers (EL) any two			20					
12.	MBG 3C12. Food and Agricultural Microbiology	4	4	3	100	80	20	600
13.	MBG 3C13. Molecular biology and RDNA Technology	4	4	3	100	80	20	
14.	MBG 3C14. Practical V (Food and Agricultural Microbiology)	6	2	5x2	100	80	20	
15.	MBG 3C15. Practical VI (Molecular biology and RDNA Technology)	6	2	5x2	100	80	20	
16.	MBG 3E01. Bioinstrumentation	4	4	3	100	80	20	
17.	MBG 3E02. Epidemiology and Public health	4	4	3	100	80	20	
18.	MBG 3E03. Biosafety, Bioethics and Intellectual Property Rights	4	4	3	100	80	20	
19.	MBG 3E04. Microbial Biotechnology	4	4	3	100	80	20	
Semester IV Elective papers (EL) any two			16					
20.	MBG 4C16. Dissertation and Viva-voce	-	8	5	100	100	-	300
21.	MBG 4E05. Antibiotic action and resistance.	4	4	3	100	80	20	
22.	MBG 4E06. Microbial bioremediation technology	4	4	3	100	80	20	
23.	MBG 4E07. Modern Trends in Diagnostic Microbiology and nanobiotechnology	4	4	3	100	80	20	
24.	MBG 4E08. Microbial Pest control	4	4	3	100	80	20	
Total			72		2000	1620	380	2000

▲ External Examination.

Practical examination - 80 Marks (Experiment –50, Viva -20 and Record -10) should be conducted by one external and one internal examiner.

* Dissertation –100 Marks (submitted work-75 marks, Defense – 25 marks.)

▲▲ Internal Assessment.

Theory- 20 Marks (Seminar –5, Assignment –5, Written test – 6, and Attendance – 4)

Practicals- 20 Marks (Continuous assessment -16 and attendance-4).

SEMESTER I

Core Papers

01. MBG 1C01. Microbial Physiology and Microbial Genetics
02. MBG 1C02. Microbial Enzymes and Secondary Metabolism
03. MBG 1C03. Environmental Microbiology
04. MBG 1C04. Immunology
05. MBG 1C05. Practical I (Microbial Physiology, Genetics & Metabolism)

MBG 1C01. Microbial Physiology and Microbial Genetics

1. Common nutrient requirements; carbon, hydrogen, oxygen, electrons, nitrogen, phosphorus, sulfur and growth factors. Nutritional types of microorganisms. Substrate uptake and entry to the cell; chemotaxis, utilization of low and high molecular weight substrates, mechanism of nutrient uptake and transport, specific transport systems.
2. Main energy pathways; fermentation, respiration, pentose phosphate cycle. Photosynthesis. Fixation of CO₂ – Calvin cycle, C3-C4 pathway, Chemolithotrophy. Energy storage; carbohydrate, lipid, polyphosphate and sulfur reserves. Spores, sporulation and associated production of usefuls. Structural and physiological features of archea.
3. Growth curve, measurement of microbial growth, continuous and batch culture of microorganisms, microbial growth in natural environments, factors affecting microbial growth; nutrition, oxygen, carbon dioxide etc. Extremophiles and microbial stress responses. Microbial cell quantifying methods; microscopic, physical and chemical methods. Culture preservation strategies. Physical and chemical control of microbial growth.
4. Transfer of genetic information in prokaryotes, plasmids, plasmid replication, conjugation, f factor, transformation, transduction, recombination. Insertion sequences and transposable elements; conjugative transposition, integrons.
5. Mutagenesis; spontaneous mutations, the nature of mutational events, suppressor mutations, adaptive mutations, DNA Repair systems; photoreactivation, nucleotide excision repair, transcription-coupled repair, methyl-directed mismatch repair, very short-patch mismatch repair, DNA glycosylases and base excision repair, adaptive response to methylating and ethylating agents, postreplication daughter strand gap repair, SOS-Inducible repair.

References

1. Albert G. Moat., John W. Foster, Michael P. Spector. *Microbial Physiology*. 4th Edn. Wiley-Liss, Inc., New York. 2002
2. Ian W Dawes and Ian W Sutherland. *Microbial physiology* 2nd Edn. Basic microbiology series Vol 4. Blackwell Science.1992.
3. Joanne Willey & Linda Sherwood & Chris Woolverton. *Prescott's Principles of Microbiology*. McGraw-Hill Higher Education. 2008.
4. Eugene W. Nester & Martha T. Nester & Denise G. Anderson & C. Evans Roberts. *Microbiology: A Human Perspective* Sixth Edition. Mcgraw-Hill College. 2000

MBG 1C02. Microbial Enzymes and Secondary Metabolism

1. Applications of Microbial enzymes in food processing; Bacterial proteinases, Amylases Amyloglucosidases, Glucose Oxidases, Glucose dehydrogenases, glucose isomerases, beta galactosidases, Invertases, Pectic enzymes, Cellulases, Enzymic bioconversions e.g. starch and sugar conversion processes; High-Fructose Corn Syrup; Inter-esterified fat; Hydrolyzed protein etc. and their downstream processing; baking by amylases, deoxygenation and desugaring by glucoseroxidase, beer mashing and chill proofing; cheese making by proteases and various other enzyme catalytic actions in food processing. Applications of Microbes in food process operations and production: Fermented foods and beverages; Food ingredients and additives prepared by fermentation and their purification; fermentation as a method of preparing and preserving foods; Microbes and their use in pickling, producing colours and flavours, alcoholic beverages and other products; Process wastes-whey, molasses, starch substrates and other food wastes for bio conversion to useful, Production of Bio ethanol, Bio hydrogen and bio pesticides
2. Microbial enzymes in Pharmaceuticals; Enzymes associated with the production of chiral intermediates for anticancer drugs, antiviral agents, β -receptoragonists, antihypertensive drugs, melatonin receptor agonists, anti cholesterol drugs, and anti-Alzheimer's drugs.
3. Microbial secondary metabolism; introduction to secondary metabolism -general aspects of secondary metabolism, bacterial antibiotics, types, synthesis and regulation, screening of novel receptor-active compounds of microbial origin, microbial siderophores, peptide antibiotics, lantibiotics, glycopeptide antibiotics, aminoglycosides and sugar components in other secondary metabolites, cyclosporins. Bacterial toxins - chemistry, properties and mechanism of toxigenicity. Fungal toxins: - aflatoxins and ochratoxins- toxic effects and Mechanism of toxigenicity. Energy production in anaerobic microbes; Biochemistry of methanogenesis. Biochemistry of bioluminescence; Bioluminescent bacteria, biochemistry of rancidity development and microbial lipolysis; chemical nature and ultra structure of storage granules in bacterial cell; PHB- synthesis; volutine synthesis; alginates, their structure and functions. Microbial metabolism of xenobiotics. Stages,& pathways, co-metabolism and steroid transformations.

References :

1. Michael Shuler and Fikret Kargi, *Bioprocess Engineering: Basic Concepts*, 2nd Edition, Prentice Hall, Englewood Cliffs, NJ, 2002.
2. Stanbury RF and Whitaker A., *Principles of Fermentation Technology*, Pergamon press, Oxford, 1997.
3. Baily JE and Ollis DF., *Biochemical Engineering fundamentals*, 2nd Edition, McGraw-Hill Book Co., New York, 1986.
4. Pauline Doran, *Bioprocess engineering principles*, 1 Edition, Academic Press, 1995.
5. Colin Ratledge, Bjorn Kristiansen, *Basic Biotechnology*, 2nd Edition, Cambridge. University Press, 2001.
6. Roger Harrison et al., *Bioseparations Science and Engineering*, Oxford University Press, 2003.
7. Jackson AT., *Bioprocess Engineering in Biotechnology*, Prentice Hall, Englewood Cliffs, 1991.
8. Aiba S, Humphrey AE and Millis NF, *Biochemical Engineering*, 2nd Edition, University of Tokyo press, Tokyo, 1973
9. A H Rose. *Economic microbiology* Vol 5. ACADEMICPRESS. 1980
10. Horst Kleinkauf. *Biotechnology Second Edition Volume 7. Products of Secondary Metabolism*. In *Biotechnology: A Multi-Volume Comprehensive Treatise; 2nd Completely Rev. Ed.* Editors H.-J. Rehm and G. Reed., A. Piehler and P. Stadler. Wiley-VCH.1999
11. *Enzyme and Microbial Technology* 31 (2002) 804–826
12. *Microbial/enzymatic synthesis of chiral intermediates for pharmaceuticals*, Ramesh N. Patel* Process Research & Development, Bristol-Myers Squibb Pharmaceutical Research Institute, New Brunswick, NJ 08903, USA.

MBG 1C03. Environmental Microbiology

1. Soil microflora, microbial interactions -competition, succession, symbiosis, parasitism, synergism and antagonism. Geocycles of C, N, S, P. iron and sulphur oxidation. N₂ fixation. Mycorrhiza, rhizosphere and phylloplane microflora. Effects of Genetically Modified Plants on Soil Microorganisms.
2. Air microbiology: Source of microbes and their quantitation techniques. Factors affecting the extent and type of air microflora. Early warning of animal, human and plant diseases by air monitoring. Brief account of air born transmission of microbes – viruses, bacteria and fungi –their preventive measures.
3. Water and wastewater; physical parameters, chemical parameters, biological characteristics, disposal of wastewater, treatment of wastewater, wastewater biology and indicator organisms, secondary treatment, anaerobic treatment, effluent disposal, sludge treatment and BOD concepts. Bacteriological analysis of drinking water. New molecular methods for detection of waterborne pathogens.

4. Autoaggregation of microorganisms: flocs and biofilms, development of biofilms, role of organisms in flocs and biofilms. Monitoring of environmental processes with biosensors and biological indicators, treatment of tannery and slaughter house waste. Solid waste management and land filling. Biodeterioration; paper, leather, wood, textiles etc., metal corrosion- mode of deterioration- organisms involved – its disadvantages – mode of prevention. Environmental impact of GMOs.

References

1. Hans-Jürgen Rehm & Gerald Reed & Josef Winter. *Biotechnology, 2E, Vol.11A, Environmental Processes* I. VCH. 1999.
2. Ralph Mitchell & Ji-Dong Gu. *Environmental Microbiology*. Wiley-Blackwell. 2009
3. Eugene L. Madsen . *Environmental Microbiology: From Genomes to Biogeochemistry*. Wiley-Blackwell. 2008.
4. Myung-Bo Kim. *Progress in Environmental Microbiology*. Nova Biomedical Books. 2008

MBG 1C04. Immunology

1. Specific immune response. Humoral and cell mediated immune system. Antigens and Immunogens, Immunoglobulin structure & classes. Isotypes, allotypes and idiotypes. Antigen-antibody reactions and their applications in immunodiagnosis. Monoclonal antibodies and hybridoma technology. Complement system, Immunological tolerance-central and peripheral.
2. Cells involved in immune system-myeloid and lymphoid lineage. Maturation and development of B cell and T cell. Structure and function of B cell receptors (Ig) and T cell receptors (TcR) for antigens, MHC-class I and MHC-class II molecules. Other surface molecules -CD4 &CD8, co-receptor, costimulatory, adhesion molecules etc. Sub population of T cell and their functions, homing and trafficking of lymphocytes - related receptors.
3. Organisation of genes for B cell and T cell antigen receptors and mechanism for generating diversity of antibodies and T-cell receptors. Genetic organisation of MHC complex (HLA) and peptide loading and expression of MHC-I and MHC-II molecules.
4. B cell and T cell activation by antigen. Role of various antigen presenting cells and the processing and presentation of extra cellular and intracellular antigens. Priming of naive CD4+T cell and cellular mechanism involved in their activation. Major cytokines (TNF, IFN, IL-1, IL-2, IL-4, IL-6, IL-10,IL-17 etc) and their role in immune regulation. Cell

mediated cytotoxicity- activation of CD8+ cytotoxic T cell and killing of target cells. B cell activation and cellular mechanisms involved in antibody production, T-B cell co-operation in antibody production, B cell activation in the absence of T cell help.

5. Autoimmune diseases- mechanism of autoimmunity, brief account of common autoimmune diseases, Hypersensitivity 1-IV reactions- comparative account with examples, Transplantation immunology-graft rejection and GVH reaction. HLA matching, Tumor antigens, immune response to tumors and immune therapy to tumors, Immune deficiency diseases.

References

1. Eli Benjamini, Geoffrey Sunshine, Sydney Leskowitz. *Immunology a short course*. Wiley Liss Publications.
2. Delves PJ, Martin SJ, Burton DR, Roitt IM; *Roitt's Essential Immunology* 11th edition. Blackwell Publishing/Oxford Univ. Press; 2006.e
3. Kindt TJ, Goldsby RA, Osborne BA, Kuby J: *Kuby Immunology* 6th edition. New York. WH Freeman; 2006.
4. Janeway CA, Travers P, Walport M, Shlomchik MJ: *Immunobiology: The immune system in health and disease* 6th edition. New York. Garland Science Publishing; 2005.
5. Levinson W, Jawetz E: *Medical Microbiology and Immunology*. Lange publication; 2001.
6. Helen Chapel, Mansel Haeney, Siraj Misbah, Neil Snowden. *Essentials of Clinical Immunology*, 5th Edition. Wiley-Blackwell. 2006
7. William E. Paul. *Fundamental immunology*. Seventh Edition 2012
8. C.K. Jayaram Paniker, R. Ananthanarayan. *Ananthanarayan and Paniker's Textbook of Microbiology* Universities Press (India) Pvt. Ltd., Orient Longman Limited. 2009.

MBG 1C05. Practical I (Microbial Physiology and Microbial Genetics, Microbial Metabolism)

1. Cell quantitation methods- Breeds count, CFU, turbidimetry and PCV
2. Effect of pH, temp, oxygen and salinity on bacterial growth.
3. Bacterial growth curve under aerobic conditions.
4. Factors affecting enzyme activity: temperature, substrate concentration and pH using any stable enzyme and Kinetics of enzyme activity.
5. Anaerobic culturing by liquid paraffin overlay and pyrogallol.
6. Anaerobic enrichment of cellulose digesters.
7. Starvation induced sporulation of bacteria.
8. Demonstration of Microbial Bioluminescence.
9. Demonstration of microbial enzyme activities –amylase, cellulase, pectinase etc.,
10. UV induced mutagenesis.
11. Demonstration of mutation in bacteria.
12. Isolation of antibiotic resistant bacterial population by gradient plate method.
13. Isolation of streptomycin resistant mutants by replica plating technique.
14. Demonstration of genetic recombination in bacteria by conjugation.
15. UV induced auxotrophic mutant production and their isolation
16. Preparation buffers.
17. Protein Estimation using Lowry's method
18. Assay of trypsin
19. Estimation of ascorbic acid in plant matter
20. Citric acid estimation
21. SDS PAGE using protein Standards
22. Gel filtration chromatography
23. Dialysis of proteins
24. Paper chromatography
25. TLC
26. Column separation of plant pigments

SEMESTER II

Core Papers

1. MBG 2C06. Industrial Microbiology
2. MBG 2C07. Medical Microbiology
3. MBG 2C08. Biostatistics and Bioinformatics
4. MBG 2C09. Practical II (Environmental and Industrial Microbiology)
5. MBG 2C10. Practical III (Medical microbiology and Immunology)
6. MBG 2C11. Practical IV (Bioinformatics)

MBG 2C06. Industrial Microbiology

1. Isolation and screening of industrially important microbes. Strain selection and improvement. Bioprocesses- concepts and design. Continuous and batch fermentations. Types of bioreactors. Bioreactor design and control. Submerged systems, Airlift reactor, CSTR, Algae bioreactor, Photobioreactor, Membrane bioreactor.
2. Kinetics of fermentation process. Transport phenomena in bioprocess such as mass transport coefficients for gases and liquids and oxygen transfer coefficients, heat transfer.
3. Industrial media and the nutrition of industrial organisms; basic nutrient requirements, criteria for the choice of raw materials, potential sources of components, use of plant waste materials and other natural resources. Sterilization systems.
4. Concepts of inoculum development. Monitoring and control of variables such as temperature, agitation, pressure and pH. Down stream processing – filtration, centrifugation, precipitation, salting out, crystallization and biphasic separation.
5. Industrial microbiological products as primary and secondary metabolites, regulation of overproduction of primary and secondary metabolites, bypassing of regulatory mechanisms for the over-production of primary and secondary metabolites.
6. Antibiotics: Screening of soil for antibiotic producers, Isolation and use of mutants. Production of antibiotics in bioreactors – penicillin, cephalosporins, aminoglycosides, and macrolides.
7. Production of organic acids- citric acid, lactic acid and industrial alcohol. Industrial fermentation of wine and beer. Production of amino acids by fermentation- semi-fermentation, enzymatic process, direct fermentation. Production of amino acids by mutants and metabolically engineered organisms. Production of ergot alkaloids. Commercial microbial enzymes. Acetone - butanol fermentation. Importance and production of single cell protein (SCP).

References

1. Michael J. Waites & Neil L. Morgan & John S. Rockey & Gary Higton. *Industrial Microbiology: An Introduction*. Wiley-Blackwell.2006
2. Nduka Okafor. *Modern Industrial Microbiology and Biotechnology*. Science Pub Inc 2007
3. Rajiv Dutta. *Fundamentals of Biochemical Engineering*. Ane Books India. 2008
4. Wulf Crueger, Anneliese Crueger. *Text book of Biotechnology*. Sinauer Associates Inc; 2 Sub edn. 1990

5. Richard H. Baltz, Julian E. Davies, Arnold L. Demain. *Manual of Industrial microbiology and biotechnology*. Amer Society for Microbiology; 3 edn. 2010
6. G. Reed. *Prescott & Dunn's Industrial Microbiology*. CBS Publishers & Distributors. 2004
7. Peter Stanbury & Allan Whitaker & Stephen K. Hall. *Principles of Fermentation technology*. Oxford, U.K. : Pergamon, 1995.
8. Reham and G. Reed. *Biotechnology (A multi-volume comprehensive treatise)*. Second Editon. VCH publishing house mbH. 2003.
9. Murray and Moo-Young. *Comprehensive biotechnology*. 2nd edn. Elsevier B.V. 2011.

MBG 2C07. Medical Microbiology

1. Epidemiology, pathogenicity and treatment of diseases caused by *H. influenzae*, *C.diphtheriae*, *Pseudomonas*, *Bacillus anthracis*, Epstein Barr virus, *Candida albicans*, *Cryptococcus neoformans*, *Histoplasma capsulatum*, *Giarida lambia*, *Trypanosoma*, *Toxoplasma*.
2. Factors that contribute to the emergence and re-emergence of infectious diseases - impact of urbanization, international travel and trade, role of global warming...etc. Mechanism of emergence of new pathogens - microbial change and adaptation, horizontal gene transfer (HGT), pathogenicity islands, role of integrons.
3. Newly emerging and re-emerging diseases: Respiratory-SARS, Avian flu, MDR-*M. tuberculosis*; Diarrheal diseases - by *V. cholerae* 0:139, Enterohemorrhagic E.coli (EHEC); Vector borne diseases - Dengue hemorrhagic fever, Chikungunya. Other diseases -Lyme disease, Japanese encephalitis, Hand, foot, mouth disease, Ebola, AIDS, Malaria. Diseases caused by *Helicobacter pylori*, Prions, Chlamydia pneumoniae, Opportunistic fungal pathogens.
4. Microbial warfare. Microbial agents with bioterrorism potential - B. Antracis, *Yersnia pestis*, *Cl. Botulinum* and Variola.

References

1. C.K. Jayaram Paniker, R. Ananthanarayan. *Ananthanarayan and Paniker's Textbook of Microbiology*. Universities Press (India) Pvt. Ltd., Orient Longman Limited. 2009
2. Thomas Jones Mackie, J. G. Collee, James Elvins McCartney. *Medical Microbiology*. Churchill Livingstone, 1989
3. Betty A. Forbes, Daniel F. Sahm, Alice S. Weissfeld. *Bailey & Scott's Diagnostic Microbiology, 12e* 2007
4. Stephen D. Allen, William M. Janda, Paul C. Schreckenberger, Washington C. Winn Elmer W. Koneman. *Diagnostic Microbiology* 5th Edn.. Lippincott Williams and Wilkins. 1998

5. Ellen JO Baron and Patrick R Murray. *Manual of clinical microbiology-9th Edition. Volume -1*. ASM Press. 2007
6. Stephen Gillespie & Peter M. Hawkey. *Principles and Practice of Clinical Bacteriology*. Wiley. 2005

MBG 2C08. Biostatistics and Bioinformatics

1. Biostatistics: Methods for collecting data, tabulation and representation of data, sampling and sample design, types of classification, tabulation, diagrammatic representation line diagram, bar diagram, pie diagram, histogram, frequency polygon, frequency curves and cumulative frequency curves. Measures of central tendency: mean, median, mode, range, mean deviation and standard error. Correlation analysis and regression analysis, probability analysis of variables. Tests of significance: t- test, Chi square test and goodness of fit; Analysis of variance: one way classification and two way classification.
2. Introduction to bioinformatics: definition and history of bioinformatics, internet and bioinformatics, introduction to data mining, applications of data mining to bioinformatics problems.
3. Introduction to biological databases, classification of biological databases, Genbank, Protein Data Bank, Swiss-prot etc. Biological data formats, data retrieval - Entrez and SRS. ExPASSY,
4. Introduction to Sequence alignment, Local and Global alignment concepts Multiple sequence alignment –Progressive alignment. Database searches for homologous sequences –Fasta and Blast versions. Bioinformatics Softwares: Clustal, RasMol, Oligo, Molscrip, Treeview, Alscript, Genetic Analysis Software, Phylip. Evolutionary analysis: distances - clustering methods – rooted and unrooted tree representation.
5. Fragment assembly-Genome sequence assembly. Gene finding method, Gene prediction - Analysis and prediction of regulatory regions. Structure prediction and protein modelling.

References

1. Andreqas D. Baxevanis, B. F. Francis Ouellette. *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins*. John Wiley and Sons, New York (1998).
2. Jonathan Pevsner. *Bioinformatics and functional genomics*. 2edn, John Wiley & Sons, Inc. 2009
3. Bryan Bergeron. *Bioinformatics computing*. Prentice Hall PTR. 2002
4. David W. Mount. *Bioinformatics - sequence and genome analysis*. Cold Spring Harbor Laboratory Press; 2nd edition. 2004
5. Arthur M Lesk. *Introduction to Bioinformatics*. Oxford University Press. 2002
6. Jerrold H. Zar. *Biostatistical Analysis*. 5th Edn. 2009

MBG 2C09. Practical II (Environmental Microbiology & Industrial Microbiology)

1. Study of air microflora by plate exposure and liquid entrapment.
2. Water portability testing using indicator organisms.
3. Use of biofilms in sewage treatment.
4. Determination of dissolved oxygen (DO)
5. Determination of chemical oxygen demand (COD)
6. Demonsration of microbial succession
7. Isolation of antibiotic producers from soil
8. Isolation of extracellular enzyme producers - cellulase, protease, lipase and phosphatase
9. Solid state fermentation
10. Isolation of Aflatoxin producing organism
11. Isolation and characterization of bacterial pigment
12. Detection, isolation and characterization of PHB granules in bacteria
13. Alcohol fermentation
14. Production of wine from grapes
15. Citric acid production.
16. Production of penicillin
17. Lipase production test
18. Detection of siderophore production by *Azospirillum* and *Pseudomonas*
19. Enzyme/cell immobilization
20. Cell disruption techniques
21. Downstream processing - Salting out
22. Laboratory scale production of exopolysaccharide (Pullulan gum)
23. Laboratory scale production microbial emulsifiers
24. Media optimization using RSM
25. Determination of BOD of water

MBG 2C10. Practical IV (Medical microbiology and Immunology)

1. To study cultural characteristics of pathogenic bacteria on following selective/differential media:TCBS agar; Hektoen Enteric agar; XLD agar; Endo agar; Salmonella -Shigella agar; Deoxycholate citrate agar.

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2. Antimicrobial sensitivity tests - Kirby-Bauer Method, Stoke's Method, Agar Dilution Method, Broth Dilution Method, E-Test
 3. Estimation of antimicrobial activity using standard guidelines (NCCLS/CLSA)
 4. Detection of beta lactamase production
 5. Detection of antifungal activity
 6. Identification of the common bacterial pathogens using biochemical tests.
 7. Normal microflora of skin, oral cavity and throat.
 8. ELISA
 9. Precipitation reactions of antigen-antibody; Ouchterlony double immunodiffusion, immunoelectrophoresis, VDRL
 10. Agglutination techniques: Latex Agglutination, WIDAL
 11. Blood group determination
 12. Blood cell count – TC and DC
 13. ESR determination
 14. Preparation of primary cell line

MBG 2C11. Practical IV (Bioinformatics)

1. Data retrieval from Swiss-Prot, GenBank and PDB
2. Similarity search – BLAST
3. Multiple Sequence Alignment - CLUSTAL W
4. Gene structure and function prediction (using GenScan, GeneMark)
5. Protein sequence analysis (ExPASy proteomics tools)
6. Molecular phylogeny (PHYLIP)
7. Secondary Structure Prediction of Protein
8. Protein/Nucleotide Sequence Analysis using EMBOSS
9. Molecular Visualisation tools
10. Homology modeling using SPDBV
11. Model structure refinement using SPDBV
12. Model validation using What Check and Pro Check
13. Docking using AUTODOCK/ HEX

SEMESTER III

Core Papers

1. MBG 3C12. Food and Agricultural Microbiology
2. MBG 3C13 Molecular Biology and RDNA technology
3. MBG 3C14. Practical V (Food and Agricultural Microbiology)
4. MBG 3C15. Practical VI (Molecular Biology and RDNA technology)

Elective Papers (Any Two)

1. MBG 3E01. Bioinstrumentation
2. MBG 3E02. Epidemiology and Public Health
3. MBG 3E03. Biosafety, Bioethics and Intellectual Property Rights
4. MBG 3E04. Microbial Biotechnology

MBG 3C12. Food and Agricultural Microbiology

1. Microorganisms important in food microbiology and their source. Factors affecting microbial growth in food – intrinsic and extrinsic factors, Spoilage of meat fish, milk, vegetables, fruits and stored grains. Spoilage at low temperature.
2. Principles of food preservation. Food preservation by physical and chemical means: irradiation, drying, heat processing, chilling, freezing, high pressure and food preservatives. Class I and class II preservatives. Effect of self generated preservatives like organic acids. Modern techniques like high electronic field pulses, oscillating magnetic fields – pulses, intense light pulses and ultra high hydrostatic pressure.
3. Fermented dairy products- microbiology of yoghurt and cheese production. Fermented meat and vegetable products. Microbiology of malt beverages, wine and distilled liquors. Vinegar production. Idli, soyasauce and Indian pickle fermentations. Yeast role in bread making. Use of probiotics.
4. Food poisoning, intoxications like botulism and aflatoxins. Infections like *Salmonella*, *Staphylococcus*, *Listeria* etc. Foodborne Viruses, Spongiform Encephalopathies.
5. Methods for the microbiological examination of foods; conventional and rapid detection methods. Controlling the microbiological quality of foods; codes for GMP. HACCP and FSO Systems for food safety. Food control agencies and their regulations.
6. Microbial interactions between plants rhizosphere -phyllosphere - mycorrhizae - symbiotic association in root nodules. Fixation of molecular nitrogen. Ti plasmid and its importance. Biofertilizers: VAM, *Rhizobium*, *Phosphobacteria* *Frankia*, *Azospirillum*, *Azotobacter* cyanobacteria. Microbial inoculants.
7. Factors predisposing plants to microbial infections. Mycoplasma and coconut wilt. Brief account of plant diseases caused by microbes. Plant –pathogen interactions, plant defences, endophytic microbes. Plant disease control strategies. Biological insect control using microbial insecticides - *Bacillus thuringensis*, *Bacillus sphericus*, *Bacillus popilliae* against insects and *Pasteuria penetrans* against nematodes. Viruses – baculovirus – NPV, CPV, nematodes like *Neoaplectana carpocapsae*. Fungi – *Entomophthora muscae* and *Beauveria bassiana*. Advantages and disadvantages of biopesticides, qualities of an ideal microbial pesticide. Factors affecting its efficiency. Mass production of bacterial, viral and fungal pesticides. Bioassays, quality control.

References

1. James M. Jay & Martin J. Loessner & David A. Golden. Modern Food Microbiology Seventh Edition. Springer. 2005
2. Bibek Ray & Arun K. Bhunia. Fundamental Food Microbiology. CRC Press. 1996
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6. G. Rangaswami, D. J. Bagyaraj, D.G. Bagyaraj. Agricultural Microbiology 2nd Edn. PHI Learning Pvt. Ltd. 2004
7. Sushil Khetan. Microbial Pest Control. CRC Press. 2001
8. Nicolas Talbot. Plant-Pathogen Interactions. 2004
9. Amos Navon & K. R. S. Ascher. Bioassays of Entomopathogenic Microbes and Nematodes. CABI. 2000

MBG 3C13 Molecular Biology and RDNA technology

1. Organization of Microbial and Eukaryotic Genomes. C-value paradox, Pseudogenes, Gene families, Gene clusters, Super-families. Watson & Crick model of DNA, DNA replication in prokaryotes & eukaryotes, reverse transcription. DNA damage & repair, DNA recombination, transposons.
2. Transcription: Transcription machinery of prokaryotes, various transcription enzymes and cofactors, initiation, elongation and termination, sigma factors, Transcription machinery of eukaryotes, various forms of RNA polymerase and cofactors, initiation, elongation and termination, promoters, enhancers, silencers, activators, effect of chromatin structure, regulation of transcription. Post-transcriptional processes: RNA processing, splicing, capping and polyadenylation, rRNA and tRNA processing, RNA Editing; RNAi and miRNAs, Antisense RNA, Post-transcriptional gene regulation. Operon concept,- Lac & Trp operons.
3. Translation: The genetic code, Mechanisms of translation in prokaryotes and eukaryotes, in vitro translation systems, Regulation of translation, RNA instability, inhibitors of translation, stringent response in bacteria. Post-translational processing: Protein modification, folding, chaperones, transportation; The Signal Hypothesis, protein degradation.

4. Polymerase Chain Reaction: Concept of PCR and various thermophilic enzymes used in PCR. Designing primers. Cloning PCR products. Variants of PCR, Ligation Chain Reaction, Overlap PCR, Rolling Circle Amplification Technology. Molecular markers in genome analysis: RFLP, RAPD, AFLP analysis. Probes- radiolabelled DNA/RNA probes, synthetic oligonucleotide probes.
5. Restriction endonucleases, Cloning vectors, cutting & joining DNA molecules, linkers, adaptors & homopolymer tailing. DNA libraries-genomic & cDNA libraries, Cloning strategies, Expression strategies, Screening strategies. DNA sequencing, nucleic acid microarrays, site directed mutagenesis & protein engineering, DNA introduction methods.
6. Pharmaceutical products of DNA technology: Human protein replacements – insulin, hGH and Factor VIII. Human therapies – TPA, interferon, antisense molecules. Vaccines – Hepatitis B, AIDS, and DNA vaccines. Transgenics and animal cloning: Creating transgenic animals and plants.

References

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2. Fred M. Ausubel; Roger Brent; Robert E. Kingston; David D. Moore; John A. Smith; Kevin Struhl. Current Protocols in Molecular Biology Edited by: John Wiley and Sons, Inc. 2007
3. I. Edward Alcamo. DNA Technology: The Awesome Skill. 2nd edn; Hardcourt Academic Press; 2001.
4. Benjamin Lewin, Gene IX. Jones and Bartlett Publishers, Sudbury, Massachusetts, 2007.
5. David P. Clarke. Molecular Biology 1st edn; Elsevier Academic Press; 2005.
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8. J.D. Watson, T.A. Baker, S.P. Bell, A. Gann, M. Levin, R. Losick. Molecular Biology of the Gene. 6thedn, Benjamin Cummings, San Francisco, USA, 2007.
9. Joseph Sambrook & David Russell. Molecular Cloning: A laboratory manual 3rd edn; CSHL press; 2001.
10. Desmond S. T. Nicholl. An Introduction to Genetic Engineering 3rd Edn. Cambridge University Press. 2008

11. Louis-Marie Houdebine. Animal Transgenesis and Cloning. John Wiley & Sons, Inc. 2003
12. Christopher Howe. Gene Cloning and Manipulation 2nd Edn. Cambridge University Press. 2007
13. S.B. Primrose and R.M. Twyman. Principles of Gene Manipulation and Genomics. 7th Edn. Blackwell Publishing. 2006
14. HJ Reham and G. Reed Biotechnology (A multi-volume comprehensive treatise). Second Edition. Vol 2. Genetic fundamentals and genetic engineering. VCH publishing house mbH. 1993.
15. Gary Walsh. Pharmaceutical Biotechnology Concepts and Applications. John Wiley & Sons Ltd. 2007
16. K. Sambamurthy and Ashutosh Kar. Pharmaceutical Biotechnology. New Age International Pvt Ltd Publishers. 2006

MBG 3C14. Practical V (Food and Agricultural Microbiology)

1. Study of microflora in idli, soya-sauce, chilli sauce, palm toddy
2. Aerobic mesophilic count of fish samples.
3. Direct microscopic count of milk.
4. Methylene blue reductase test
5. Isolation of constituent flora of fermented milk.
6. Isolation of rhizobium.
7. Isolation of azotobacter.
8. Isolation of phosphate solubilizing organisms
9. Testing of nodulation ability by rhizobia
10. Preparation of bioinoculants – phosphate solubilizers and N₂ fixers -and cell count determination on time scale
11. Study of probiotic properties of Lactobacilli (Cholesterol Reduction and Bile Salt Hydrolase Activity)
12. Cultivation of Psychrotrophic Microorganisms

References

1. John F. T. Spencer & Alicia L. Ragout de Spencer. Food Microbiology Protocols. Humana Press. 2001
2. Diane Roberts (ph. D.) & Diane Roberts & Melody Greenwood. Practical Food Microbiology. Wiley. 2003

MBG 3C15. Practical VI (Molecular Biology and RDNA technology)

1. Study of mitotic stages using onion root tip
2. Karyotype preparation
3. Isolation of DNA and RNA
4. Estimation of DNA and RNA
5. Hyperchromic shift of DNA
6. Induction of Beta galactosidase gene in *E. coli*
7. Expression of cloned gene in *E. coli*
8. Agarose electrophoresis of RE digest of DNA
9. Western Blot
10. Plasmid DNA extraction and agarose gel electrophoresis. Determination of molecular weight of plasmid DNA.
11. PCR amplification of desired gene
12. Restriction digestion and ligation of DNA, Endonuclease mapping of DNA
13. Preparation of competent cells and transformation of plasmid DNA in *E. coli*.

MBG 3E01. Bioinstrumentation

1. Absorption and Transmittance, Lambert-Beer's law, Colorimetry, Single beam and double beam spectrophotometers, Calibration and standardization, Centrifugation - Principles, types, applications. Ultracentrifugation. Dialysis, Ultrafiltration.
2. Chromatographic techniques- TLC, Paper, Gas, Column, Ion exchange, HPLC, GC-MS, Affinity chromatography. Gel electrophoresis- Principles and instrumentation, Isoelectric focusing, Two dimensional gel electrophoresis, Pulse field gel electrophoresis, Gel documentation.
3. X-ray diffraction and molecular structure, Mass spectrometry, Ionization and fragmentation, Basics of LC/MS, Tandem mass spectrometry, MALDI-TOF, Nuclear magnetic resonance spectrometry.
4. Nucleic acid amplification methods, PCR-Types- Nested PCR, Real time PCR; RFLP; RAPD and AFLP analysis; Blotting techniques, Protein and nucleic acid sequencing; Nucleic acid microarrays.
5. Phase contrast and confocal microscopy, Principles of SEM & TEM, Fluorescence microscopy, Atomic force microscopy. EIA, ELISA, Immunofluorescence, RIA,

Chemiluminescence, Blotting Technique (Western, Southern, Northern), Flow cytometric assays.

References

1. Vasantha patabhi and N. Gautham. Biophysics. Kluwer academic publishers. 2002
2. Bengt Nölting. Methods in modern biophysics. 2nd edn. springer-verlag berlin heidelberg. 2006
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4. Thomas Jue. Biomedical applications of biophysics. Vol 3. Humana press. 2010
5. Rodney F. Boyer. Modern experimental biochemistry. 3rd edn. 2000
6. Keith Wilson and John Walker. Principles and techniques of biochemistry and molecular biology 7th edn. Cambridge university press. 2010

MBG 3E02. Epidemiology and Public Health

1. Health- definition-Determinants & Indicators of health - Health promotion-Health education in health promotion
2. Epidemiology definition- Define rate, ratio, proportion (measures of disease frequency) - Measures of Morbidity-Prevalence & Incidence-Mortality Measures -Common measures of fertility Classification of epidemiologic methods (with help of flow chart/line diagram)-Descriptive epidemiology – Steps in descriptive studies-Use of epidemic curve-Different types of disease fluctuations-student -Role of spot maps-Uses of descriptive studies-Types of analytical studies Differences between Case control study & Cohort study-Concept of Absolute risk-Relative risk –Attributable risk –Odd's Ratio-Experimental epidemiology-Design of a Randomised controlled trial-Blinding-Randomisation – Phases in clinical trials-Steps in Research
3. Define the term surveillance of disease- Uses-Enlist the basic steps in surveillance-essential qualities of well-conducted surveillance system.
4. Epidemic; Steps in an outbreak investigation, Collection of samples in outbreaks.
5. Environment; Common environmental health problems, Emerging and reemerging diseases of public health importance. Infection control measures in health.

References

1. Centers for disease control and prevention. *Principles of epidemiology in public health practice*. An introduction to applied epidemiology and biostatistics. 3rd edn. U.s. Department of health and human services.

2. K.park - *Park's textbook of preventive and social medicine*. Banarsidas bhanot publishers. 20th edn (2009).
3. Richard Farmer. Ross Lawrenson. *Lecture Notes on Epidemiology and Public Health Medicine*. 5th Edn. (2004)
4. Susan Carr, Nigel Unwin and Tanja Pless-Mulloli. *An Introduction to Public Health and Epidemiology* Second Edition. Open University Press, McGraw-Hill Education (2007)
5. R. Beaglehole., R. Bonita., T. Kjellstrom. *Basic epidemiology*. WHO (1993)
6. Ross c. Brownson., diana b. Petitti. *Applied epidemiology. Theory to practice*. (eds) Oxford university press (1998)
7. Alexander Krämer & Mirjam Kretzschmar & Klaus Krickeberg. *Modern Infectious Disease. Epidemiology: Concepts, Methods, Mathematical Models, and Public Health*. Springer. 2009

MBG 3E03. Biosafety, Bioethics and Intellectual Property Rights

1. Definition of bioethics. The principles of bioethics: autonomy, human rights, beneficence, privacy, justice, equity etc. Applications of bioethics. Bioethics in laboratory. Experiments on animals. ELSI of Human genome project. Ethical issues of Prenatal diagnosis and genetic manipulations. Genetic studies on ethnic races. Reproductive Cloning, Therapeutic Cloning and Experiments with Human Cells, Genetic Testing and Concerns about Eugenics, GM Foods and the Rise of Environmental Movements Owning Genes, Genomes, and Living Beings.
2. Biosafety guidelines and regulations, Risk assessment, Laboratory safety, Controlling the exposure to hazardous substances. Release of GMOs to environment. Biotechnology and food safety: The GM-food debate and biosafety assessment procedures for biotech foods & related products, including transgenic food crops. Ecological safety assessment of recombinant organisms and transgenic crops.
3. *Intellectual Property Rights*: Copyrights, Trade Mark, Design Rights, Geographical indications and Traditional Knowledge. Patent Application procedure, Drafting of a Patent Specification. Objectives, Rights, Assignments of patents and Defences in case of Infringement.
4. Protection of biotechnological inventions. patentable subjects and protection in biotechnology. Strasbourg convention and UPOV convention. Plant variety protection in India. Experimental Use Exemption. The patentability of microorganisms, transfer of technology. Patentability of vectors. Patented research tools - Recombinant DNA, PCR, Taq Polymerase, Protein and DNA Sequencing Instruments.

References

1. Ben Mepham. *Bioethics: An Introduction for the Biosciences*. 2nd Edn. Oxford university Press. 2008
2. Sathish M.K. *Bioethics and Biosafety*. International Publishing house Ltd. New Delhi, 2011.
3. Alexander Poltorak and Paul Lerner. *ESSENTIALS of Intellectual Property*. JOHN WILEY & SONS, INC.2002.
4. Stephen G. Post. *Encyclopedia Of Bioethics*. 3rd Edn. Macmillan Reference USA. 2004
5. Darryl R.J Macer. *Biotechnology - A comprehensive treatise (Vol. 12). Legal economic and ethical dimensions* VCH. Eds, H-J. REHM and G. REED.
6. Sree Krishna. V. *Bioethics and Biosafety in Biotechnology*. New Age International.2007

MBG 3E04. Microbial Biotechnology

1. Hybridoma technology for monoclonal antibodies, recombinant vaccines, Vaccine farming, Gene Therapy.
2. Immobilization: Immobilization of cells and enzymes. Methods of immobilization – adsorption, covalent linking, entrapment, encapsulation. Microcarriers and holofibers. Advantages and disadvantages of immobilized systems. Emerging microbiological methods for water quality analysis - Fast Detections using Chromogenic Substances, Application of Monoclonal and Polyclonal Antibodies, IMS/culture and other Rapid Culture-Based Methods, PCR, FISH,
3. Biosensors/enzyme electrodes: Generalized biosensor, Electrochemical sensors, Application of biosensors. Electrochemical and microbial electrodes. Biosensor variants. ATPase based cell quantitation and Lumac system. Biochips. Microbial leaching mechanisms : biohydrometallurgy – biomining, bioleaching. Microbial enhanced oil recovery. Environmental applications of microbial technology- Designer organisms and enzyme engineering for enhanced biodegradation, evolutionary and genomic approaches, process engineering for improved biodegradation.
4. Microbial Insecticides, Commercial Products by Recombinant Microbes, Plant and animal Transgenesis. Environmental impact of genetic engineering – problems of GM foods and crops, Bti. Toxin resistance of insects - cotton bollworm, tobacco budworm, use of multiple alleles of Bti toxin genes. Environmental release and monitoring of genetically modified/engineered organisms. Milk flavor manipulation through rumen microflora, mitigating greenhouse gas emission from dairying using biotechnology.

5. Biofuels: enzymes for clean energy production – bioethanol and biofuel cells. Microbes as a health food - Spirulina and its production methods. Probiotics - use of *Lactobacilli* and *Bifidobacterium* - therapeutic and nutritional value.

References

1. Uma Shankar Singh and Kiran Kapoor. *Microbial Biotechnology*. Oxford book company, Jaipur, India. 2010.
2. K. Sambamurthy and Asuthosh Kar. *Pharmaceutical biotechnology*. New Age International (P) Ltd. Publishers. 2006.
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4. Alexander N. Glazer and Hiroshi Nikaido. *Microbial biotechnology fundamentals of applied microbiology, second edition*. Cambridge University Press. 2007.
5. Murray and Moo-Young. *Comprehensive biotechnology 2nd edn*. Elsevier B.V. 2011.
6. Wulf Crueger and Anneliese Crueger. *Biotechnology: A Textbook of Industrial Microbiology*. Sinauer Associates Inc; 2 Sub edition. 1990
7. Richard H. Baltz, Julian E. Davies and Arnold L. Demain. *Manual of Industrial Microbiology and Biotechnology*. Amer Society for Microbiology; 3 edition. 2010
8. Gabrielle J Persley. *Biotechnology and Integrated Pest Management* (Biotechnology in Agriculture Series). CABI; First edition. 1996
9. P F STANBURY, S. Hall and A. Whitaker. *Principles of Fermentation Technology*, Second Edition. Butterworth-Heinemann; 2 edition. 1999 Fundamentals of biotechnology – Ed. Paul Prave *et al.*,
10. B.D. Singh. *Biotechnology*. 4th Edn. Kalyani, 2010
11. Gloria Sanchez and Elizabeth Hernandez. *Environmental Biotechnology and Cleaner Bioprocesses*. CRC Press; 1 edition. 1999

SEMESTER IV

Core Papers

1. MBG 4C16. Dissertation and Viva-voce

Elective Papers (Any Two)

1. MBG 4E05. Antibiotic action and resistance.
2. MBG 4E06. Microbial bioremediation technology
3. MBG 4E07. Modern Trends in Diagnostic Microbiology and nanobiotechnology
4. MBG 4E08. Microbial Pest control

MBG 4E05. Antibiotic action and resistance

1. Target sites in bacteria for antibiotic action.
2. Action mechanism and activity spectrum of major antibiotic classes - Aminoglycosides, Cephalosporins, Macrolides, Penicillins, Quinolones, Tetracyclines and Glycopeptides.
3. Antibiotic resistance: Significance of the problem and increase of incidence. Molecular genetics of antibiotic resistance in bacteria- role of plasmids, transposable genetic elements, DNA integration elements. Mechanism of antibiotic resistance- enzymatic destruction and modification, decreased permeability, promotion of antibiotic efflux, alteration and protection of target sites, bind-up antibiotics etc.
4. Multidrug resistance mechanism among bacteria. Multi drug resistant TB, Malaria, MRSA. Resistance to antiretroviral drugs.
5. New strategies for the discovery of novel antibiotics; New looks at targets, new molecules.

Reference

1. Christopher Walsh. *Antibiotics: Actions, Origins, Resistance*. Amer Society for Microbiology; 1 ed. 2003
2. Aníbal de J. Sosa & Denis K. Byarugaba & Carlos F. Amábile-Cuevas & Po-Ren Hsueh & Samuel Kariuki & Iruka N. Okeke. *Antimicrobial Resistance in Developing Countries*. Springer. 2009
3. Richard G. Wax & Kim Lewis & Abigail A. Salyers & Harry Taber. *Bacterial Resistance to Antimicrobials*. CRC Press. 2008
4. David M. Shlaes. *Antibiotics: The Perfect Storm*. Springer. 2010

MBG 4E06. Microbial bioremediation technology

1. Introduction to recalcitrant compounds. Biological remediation of Soil: An overview of Global market and available technologies, Biosurfactants in Bioremediation, Soluble Di-iron Monooxygenases with Bioremediation Applications.
2. Engineering of bioremediation processes-strategies for bioremediation of polluted soil, explosives-contaminated soil, petroleum contaminants, PCB, PAHs. Bioremediation of BTEX Hydrocarbons. Bioremediation of oil spills.
3. Advances in phytoremediation and rhizoremediation. Heavy metal phytoremediation: microbial indicators of soil health for the assessment of remediation efficiency. Industrial wastewater sources and treatment strategies.

4. Transformations of toxic metals and metalloids, biomining microorganisms and applications in biotechnology and bioremediation.
5. Bioreporter technology for monitoring soil bioremediation. Molecular tools for monitoring and validating bioremediation. Genetic engineering of bacteria and their potential for bioremediation. commercial use of GMOs in bioremediation and phytoremediation

References

1. Ajay Singh • Ramesh C. Kuhad., Owen P. Ward. *Advances in Applied Bioremediation*. Springer-Verlag Berlin Heidelberg 2009
2. Jeffrey W. Talley. *Bioremediation of recalcitrant compounds*. Taylor & Francis group, LLC. 2005
3. John M. Walker. *Bioremediation Protocols*. Humana Press Totowa, New Jersey. 1997
4. Rosa Margesin Franz Schinner (Eds.). *Manual for Soil Analysis – Monitoring and Assessing Soil Bioremediation*. Springer-Verlag Berlin Heidelberg. 2005
5. Hans-Joachim Jördening., Josef Winter. *Environmental Biotechnology*. WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim. 2005
6. Ronald M. Atlas, Richard Bartha. *Microbial Ecology: Fundamentals and Applications* (4th Edition). Benjamin Cummings. 1997

MBG 4E07. Modern Trends in Diagnostic Microbiology and Nanobiotechnology

1. Conventional and Rapid methods for identification of bacteria and fungi: Biochemical profile based microbial identification systems.
2. Probe-based microbial detection and identification. southern and northern blotting, nucleic acid hybridization techniques, FISH. Probes and probing, RFLP, Pulsed-Field Gel electrophoresis. DNA amplification methods, PCR, Variations of PCR, Mutation detection. Diagnostic sequencing. Non PCR mediated target amplification techniques. Microarray-based Microbial identification and characterization. Genotyping of bacteria by using variable number tandem repeats. Molecular diagnoses of HIV and Hepatitis C Virus.
3. Rapid antigen tests: agglutination, immunofluorescence, EIA, Chemiluminicent methods and other rapid formats, Advanced antibody detection – ELISA, immunoblotting, RIA, CLIA, ECL and florescent immuno assays. Flow cytometric assays.

4. Nanoparticles, nanoparticles for molecular diagnostics - nanoparticles as biolabels, paramagnetic and superparamagnetic nanoparticles, role of nanobiotechnology in discovery of biomarkers, nanobiotechnology and cytogenetics,
5. Pharmaceutical applications of nanobiotechnology - drug discovery and development, nanobiotechnology-based drug delivery. Role of nanobiotechnology in biological therapies, - cell therapy, gene therapy, vaccines, antisense therapy, RNA interference etc. nanobiotechnology for the development of personalized medicine, safety issues of nanoparticles.

References

12. Murray and Moo-Young. *Comprehensive biotechnology* 2nd edn. Elsevier B.V. 2011.
13. Betty A. Forbes, Daniel F. Sahm, Alice S. Weissfeld. *Bailey & Scott's Diagnostic Microbiology*, 12e. Mosby. 2007 Diagnostic Microbiology-V- Edition. Elmer .Keneman, Stephen D. Allen, William M. Janda.
14. Ellen JO Baron and Patrick R Murray. *Manual of clinical microbiology-9th Edition. Volume -1*. ASM Press. 2007
15. David H. Persing. *Molecular Microbiology: Diagnostic Principles and Practice*, Second Edition. ASM Press; 2 edition. 2011
16. Yi-Wei Tang., Charles W. Stratton. *Advanced Techniques in Diagnostic Microbiology*. Springer(2006)

MBG 4E08. Microbial Pest control

1. Bacterial Insecticide: *Bacillus thuringiensis*, -Production of *Bt*, *Bt* Crystal proteins and genes, insecticidal activity, mode of action, persistence, safety and ecotoxicology of *Bt*. Bacterial insecticides for crop and forest protection and insect vector control - *Bacillus thuringiensis* subsp. *Kurstaki*, *Bacillus thuringiensis* subsp. *Israelensis*, and *Bacillus sphaericus*. Genetically modified *Bt* strains and *Bt* transgenic plants.
2. Formulation of bacterial insecticides- characteristics of microbial insecticide formulations, commonly used formulations of *Bt*, improved *Bt* formulations, target-specific tailor-made formulations of bacterial larvicides, efficient effective delivery at low dose. Insect resistance to *Bt* toxins
3. Natural and recombinant viral insecticides, biofungicides, bioherbicides, and mycoinsecticides, integrated use and commercialization of biopesticides with synthetic chemical pesticides

References

1. Jack E. Rechcigl and Nancy A. Rechcigl. Biological and Biotechnological Control of Insect Pests. CRC Press LLC. 1998
2. Sushil K Khetan. Microbial pest control. Marcel Dekker, Inc. 2001