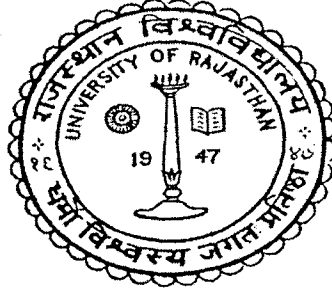


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University of Rajasthan


Jaipur

Syllabus

M.Sc. Microbiology

2015-2016 (I & II Semester)

2016-2017(III& IV Semester)


Asstt. Registrar (Acad-I)
University of Rajasthan
JAIPUR

MAX MARKS 100, PASS MARKS 36, THEORY PAPER DURATION 3 HRS.
PRACTICAL 4 HRS, 6 CREDITS FOR EACH PAPER

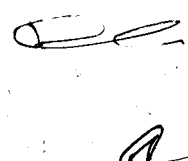

Appendix-I

First Semester

Paper		Marks	Total
GM 101	Techniques in Microbiology	100	
GM 102	General Microbiology and Bacteriology	100	
GM 103	Virology	100	
GM 104	Phycology and Mycology	100	
Practical –I	Based on theory paper GM 101-102	100	
Practical –II	Based on theory papers GM 103-104	100	600

Second Semester

Paper		Marks	Total
GM 201	Microbial Growth , Nutrition & Metabolism	100	
GM 202	Molecular Biology	100	
GM 203	Microbial Biochemistry	100	
GM 204	Biostatistics and Bioinformatics	100	
Practical –III	Based on theory paper GM 201-202	100	
Practical –IV	Based on theory papers GM 203-204	100	600



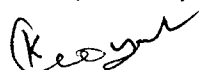
Appendix -II

Third Semester

Paper		Marks	Total
GM 301	Medical Microbiology	100	
GM 302	Immunology and Clinical Microbiology	100	
GM 303	Agricultural Microbiology	100	
GM 304	Industrial Microbiology	100	
Practical –V	Based on theory paper GM 301-302	100	
Practical –VI	Based on theory papers GM 303-304	100	600

Fourth Semester

Paper		Marks	Total
GM 401	Environmental Microbiology	100	
GM 402	Food and Dairy Microbiology	100	
GM 403	Microbial Genetics	100	
GM 404	Genetic Engineering	100	
Practical -VII	Based on theory paper GM 401-402	75	
Practical -VIII	Based on theory papers GM 403-404	75	
Project work/Dissertation (Submission & Presentation)		50	600
Total Marks		(600 x4)	2400



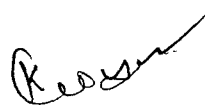
SCHEME OF EXAMINATION MICROBIOLOGY (2015-2016 & 2016-2017)

- As per discussion of academic council, the student will require to earn 120 credits for PG course out of total 144 credits.
- In theory, 15 hrs of teaching is equal to one credit.
- In practicals, 45 hrs of laboratory works is equal to 2 credits.
- Each Semester of PG course shall have 36 credits.
- Each Semester will have continuous assessment which will include internal assessment in theory and practical by internal examination /seminar/oral examination- Viva voce etc. and the maximum marks will be 30.
- Each theory paper shall carry 100 marks. It will be of 3 (three) hrs duration.
- Part A of question paper shall contain 10 (Ten) very short answer type questions covering the entire syllabus. Each question will carry 2 (two) marks i.e. part A will be of total 20 marks.
- In part B, there will be 4 questions, one per unit with internal choice. Each question will carry 20 marks i.e. total of 80 marks.
- Each practical examination will be of 4 hrs duration and will involve laboratory experiments / exercises and Viva –voce examination.

SCHEME OF PRACTICAL EXAMINATION

For first, second and third Semesters, the scheme of practical examination is as follows:

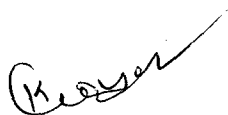
MM: 100	Duration 4 hrs
1. Major Experiment	15 Marks
2. Major Experiment	15 Marks
3. Minor Experiment	10 Marks
4. Minor Experiment	10 Marks
5. Spotting	24 Marks
6. Seminar	06 Marks
7. Record	10 Marks
8. Viva- voce	10 Marks
Total	100 Marks

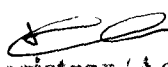


For IV Semester, the scheme of practical examination is as follows:

MM: 100	Duration 4 hrs
1. Major Experiment	10 Marks
2. Major Experiment	10 Marks
3. Minor Experiment	6 Marks
4. Minor Experiment	5 Marks
5. Spotting	24 Marks
6. Record	10 Marks
7. Viva- voce	10 Marks
Total	75 Marks

Project work/Dissertation 50 Marks
(Submission & Presentation)




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Syllabus M.Sc. Microbiology

MBC 101: Techniques in Microbiology

Unit –I

Microscopy & staining techniques: Basic principles for the examination of microbes by light , dark field , phase contrast, confocal , fluorescent and electron (transmission and scanning) microscopy; Micrometry, Specimen preparation and basic principles of simple, Gram, negative, capsule, endospore, flagella, acid- fast and flurochrome staining.

Unit-II

Basic principles and methods of sterilization: Control of microorganisms by physical methods: heat, filtration and radiation; Chemical methods: Phenolics, alcohols, halogens, heavy metals, quaternary ammonium compounds, aldehydes and sterilizing gases; Evaluation of antimicrobial agent effectiveness; Principle and function of Laminar air flow hood (LAF).

Unit-III


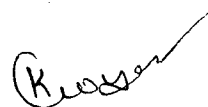
Basic principles, procedure and applications of various techniques: X-ray diffraction, autoradiography, UV-vis spectrophotometry, colorimetry, flame photometry and atomic absorption spectrophotometry.

Unit-IV

Chromatography (paper, thin layer, column), gel permeation chromatography, ion-exchange and affinity chromatography, GLC, HPLC, electrophoresis for protein and DNA, iso –electric focusing and 2D gel electrophoresis, centrifugation, ultracentrifugation, dialysis, ultrafiltration and lyophilization.

Practicals:


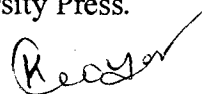
1. Laboratory rules and requirement, Bio safety equipments.
2. Microscopy (a) Dissecting, compound & phase contrast.
(b) Micrometry.
3. Simple staining.
4. Negative staining.
5. Differential staining –Gram staining & Acid –Fast staining.
6. Sterilization.
7. Spectrophotometry / Colorimetry- Absorption maxima.
8. Paper chromatography.
9. Thin layer chromatography.
10. Column chromatography, GLC and HPLC.



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Books Recommended:

1. Atlas R.M., 1997, Principles of Microbiology, 2nd Edition, McGraw Hill Publications.
2. Balows A., Truper H.G., Dworkin M., Harder K. and Schleifer K-H., 1991, The Prokaryotes, Springer Verlag, New York.
3. Berg J.M., Tymoczko J.L. and Stryer L., 2006, Biochemistry, 6th Edition, W.H. Freeman and Company, New York.
4. Berg J.M., Tymoczko J.L., Gatto Jr. G.J. and Stryer L. 2015, Biochemistry, 8th Edition, Macmillan Education.
5. Berg J.M., Tymoczko J.L., and Stryer L. 2012, Biochemistry, 7th Edition, W.H. Freeman, New York.
6. Gunsales I.C. and Stainer R.Y., The Bacteria, Volumes I-V, Academic Press.
7. Nelson D. and Cox M.M., 2008, Lehninger Principles of Biochemistry, 5th Edition, W.H. Freeman and Company, New York.
8. Nelson D.L. and Cox M.M., 2013, Lehninger Principles of Biochemistry, 6th Edition, W.H. Freeman, New York.
9. Potter G.W.H. and Potter G.W., 1995, Analysis of Biological Molecule: An Introduction to Principles, Instrumentation and Techniques, Kluwer Academic Publishers.
10. Prescott L.M., Harley J.P. and Klein D. A., 2007, Microbiology, 7th Edition, McGraw Hill.
11. Rietdorf J., 2010, Microscopy Techniques, Springer Berlin.
12. Stainer R.Y., Ingraham J., Wheelis M., and Painter P., 1987, General Microbiology, 5th revised Edition, Palgrave Macmillan
13. Talaro K.P. and Talaro A., 2006, Foundations in Microbiology, McGraw Hill Publications.
14. Wilson K. and Walker J., 2000, Techniques of Principles Biochemistry, 5th Edition, Cambridge University Press.
15. Wilson K. and Walker J., 2010, Principles and Techniques of Biochemistry and Molecular Biology, 7th Edition, Cambridge University Press.



Asstt. Registrar (Acad-I)
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MBC 102: General Microbiology & Bacteriology

Unit –I

Discovery of microbial world : History of microbiology and contributions of Anton Von Leeuwenhoek, Joseph Lister, Paul Ehrlich, Edward Jenner, Louis Pasteur, Robert Koch, Martinus Beijerinck, Sergei Winogradsky, Alexander Fleming, Selman Waksman; Spontaneous generation controversy; Current thoughts on microbial evolution including the origin of life; Scope and relevance of microbiology.

Unit –II

Morphology and ultrastructure of bacteria: Size , shape and arrangement of bacteria, structure and chemical composition of cell wall of Gram positive and Gram negative bacteria and archae; Structure , composition and function of cell membrane, capsule, flagella, pili, gas vesicles, cytoplasmic matrix reserve food materials, nucleoid, plasmids; Bacterial life cycles, nutrition , respiration & reproduction; Economic importance of bacteria.

Unit –III


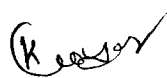
Microbial diversity: Classification of microorganisms; General methods of classifying bacteria; Bacterial nomenclature; Modern trends of bacterial taxonomy; Bergey's system of bacterial classification; Numerical and molecular taxonomy; 16S rDNA sequencing; General characteristics and classification of Archaeobacteria and Cyanobacteria ; Occurrence, structure, reproduction and economic importance of Cyanobacteria.

Unit-IV

Culture characteristics: Types of culture media, preparation of medium and methods of pure cultures (Pour plate method, streak plate method & spread plate method); Cultivation of bacteria: Aerobic & anaerobic; Preservation of culture: Short term & long term.

Practicals:

1. Identification of Cyanobacteria.
2. Media preparation: Liquid and solid.
3. Use of indicator media.
4. Aerobic / Anaerobic cultivation.
5. Streak plate technique.
6. Pour plate technique.
7. Spread plate technique.
8. Study of microorganism morphology: Hanging drop method and wet mount.
9. Preservation of cultures.
10. Use of selective and differential medium

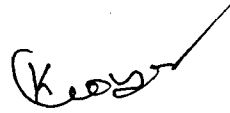


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Books Recommended:

1. Aneja K.R., Jain P. and Aneja R., 2008, A Text Book of Basic and Applied Microbiology, New Age Int. Publications, New Delhi.
2. Atlas R.M., 1995, Principles of Microbiology, Mosby Publishers, St. Louis.
3. Balows A., Truper H. G., Dworkin M., Harder W. and Schleifer K-H., 1992, The Prokaryotes. A Handbook on the Biology of Bacteria: Ecophysiology, Isolation, Identification, Applications, Volumes I-IV, Springer-Verlag, New York.
4. Berg J.M., Tymoczko J.L. and Stryer L., 2006, Biochemistry, 6th Edition, W.H. Freeman and Company, New York.
5. Berg J.M., Tymoczko J.L., Gatto Jr. G.J. and Stryer L. 2015, Biochemistry, 8th Edition, Macmillan Education.
6. Black J.G., 2012, Microbiology: Principles and Exploration, 8th Edition, John Wiley & Sons. USA
7. Holt J.G, and Krieg N.R., 1984-1989, Bergey's Manual of Systematic Bacteriology, 1st Edition, (Volumes 1-4), Williams and Wilkins Co Springer, Baltimore.
8. Holt J.G., and Krieg N.R., Sneath P.H.A., Staley J.T. and Williams J.T., 1994, Bergey's Manual Determinative Bacteriology, 9th Edition, Williams and Wilkins Co., Springer, Baltimore.
9. Logan, A. and Logan N.A., 1994, Bacterial Systematics, Wiley-Blackwell.
10. Madigan M.T., Martinko J.M., Binder K. and Buckley D., 2011, Brock Biology of Microorganisms, 13th Edition, Pearson Education, USA.
11. Nelson D. and Cox M.M., 2008, Lehninger Principles of Biochemistry, 5th Edition, W.H. Freeman and Company, New York.
12. Nelson D.L. and Cox M.M., 2013, Lehninger Principles of Biochemistry, 6th Edition, W.H. Freeman, New York.
13. Prescott L.M., Harley J.P. and Klein D.A., 2007, Microbiology, 7th Edition, McGraw Hill Publishers.
14. Talaro K.P. and Chess B., 2014, Foundation in Microbiology, 9th Edition, McGraw Hill Higher Education.
15. Talaro K.P. and Talaro A., 2006, Foundations in Microbiology, 6th Edition, McGraw Hill Publisher.
16. Talaro K.P., 2008, Foundations Microbiology, Basic Principles, McGraw-Hill Co., Inc.

17. Tortora G.J. Funke B.R., and Case C.L., 2013, Microbiology: An Introduction, 11th Edition, International Edition, Pearson, Boston.
18. Tortora G.J., Funke B.R. and Case C.L., 2010, Microbiology: An Introduction, 10th Edition, CA Pearson Benjamin cummings, San Francisco.
19. Willey J.M., Sherwood L. and Woolverton C., 2013, Prescott's Microbiology, 9th revised Edition, McGraw Hill Higher Education, New York.
20. Wilson K. and Walker J., 2008, Principles and Technique of Biochemistry and Molecular Biology, 6th Edition, Cambridge University Press.
21. Woese C.R., 1981, Archeabacteria, Scientific American, 244:98-122.
22. Woese C. R., 1987, Bacterial Evolution, Microbiological Reviews, 51: 221-271.
23. Woese C.R., Kandler O. and Wheelis M.L., 1990, Towards a Natural System of Organisms: Proposal for the Domains Archea, Bacteria and Eucarya, Proc. Natl. Acad. Sci., 87: 4576- 4570.



MBC 103: Virology

Unit-I

General virology: Brief outline on discovery of viruses, nomenclature & classification of viruses; Distinctive properties of viruses, morphology & ultra structure; Capsids & their arrangements; Type of envelopes and their composition; Viral genomes: Types and structures, replication of viruses; Viron, viroids & prions.

Unit-II

Bacteriophages: Classification; morphological groups; virulent dsDNA phages (T-4 phage), one step growth curve, ssDNA phage (Φ X174); bacteriophage typing; Lytic cycle, Lysogenic cycle; Cyanophages: Morphology and growth cycle; Mycophages: Types of mycophages; Taxonomic affinity.

Unit-III

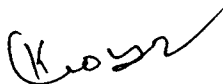
General characters of major plant viruses: Tobacco mosaic virus group (TMV); Tymovirus group (circular mosaic virus); Tomato spotted wilt virus; Cauliflower mosaic virus; Effects of these viruses on plants; General characters of major human and animal viruses: Adenovirus, Poxvirus, Picornavirus, Retrovirus & Reoviruses.

Unit-IV

Cultivation of viruses: Growth of viruses in embryonated egg, experimental animals and cell cultures, primary and secondary cell lines, suspension cell cultures and monolayer cell cultures; Assay of viruses: Physical and chemicals methods of assay (protein, nucleic acid, radioactivity tracers, electron microscopy etc); Infectivity assay of plant & animal viruses, plaque method, pock counting and end point method.

Practicals:

1. Viral plaques assay.
2. Study of plant virus-TMV.
3. Study of plant virus-CaMV.
4. Study of animal viruses.
5. Study of retroviruses.
6. Growth of viruses in embryonated eggs.
7. One step growth curve of (Φ X174) virus.
8. Animal cell culture media.
9. Cultivation and maintenance of animal cell lines.
10. Use of suspension /monolayer cell cultures for viral cultivation.



Books Recommended:

1. Cann A.J., 1997, Principles of Molecular Virology, 2nd Edition, Academic Press, California.
2. Cann A.J., 2001, Principles of Molecular Virology, 3rd Edition, Elsevier Academic Press.
3. Carter J. and Saunders V., 2007, Virology: Principles and Applications, 1st Edition, John Wiley & Sons.
4. Carter J., and Saunders V., 2013, Virology: Principles and Applications, 2nd Edition, Wiley.
5. Conrat H.F., Kimball P.C. and Levy J.A., 1988, Virology, 2nd Edition, Prentice Hall, Englewood Cliff, New Jersey
6. Dimmock N., Easuton A. and Leppard K., 2005, Introduction to Modern Virology, 5th Edition, Blackwell Publishing.
7. Dimmock N.J. and Primrose S. B., 1994, Introduction to Modern Virology, 4th Edition, Blackwell Scientific Publications, Oxford.
8. Flint S.J., Enquist L.W., Krung R. Racaniello V.R. and Skalka A.M., 2004, Principles of Virology, ASM Press.
9. Flint S.J., Enquist L.W., Racaniello V.R., and Skalka A.M., 2008, Principles of Virology, 3rd Edition (2Volume set), ASM Press.
10. Granoff A. and Webster R.G., 1999, Encyclopedia of Virology, Volume I, II and III, Academic Press, San Diego
11. Hull R., 2002, Plant Virology, 4th Edition, Academic Press.
12. Knipe D.M. and Howley P.M., 2006, Fields Virology, 6th Edition, Wolters Kluwer/Lippincott- Williams.
13. Luria S.E., 1978, General Virology, 3rd Edition, John Wiley and Sons, New York.
14. Norkin L., 2009, Virology: Molecular Biology and Pathogenesis, Ist Edition, ASM Press.
15. Parker M.T., Collier L.H., 1990, Topley and Wilson's Principles of Bacteriology, Virology and Immunity, 8th Edition, Hodder Arnold.
16. Reddy S.R. and Reddy S. M., 2007, Essentials of Virology Scientific Publishers Journals Deptt., India.
17. Straus J.H. and Straus E.S., 1998, Evolution of RNA Viruses Am. Rev. Microbiol., 42; 627-83.

18. Wanger E.K., Hewiett M., Bloom D. and Camerini D., 2007, Basic Virology, 3rd Edition, Blackwell Publishing.

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MBC 104: Phycology & Mycology

Unit-I

General characters and classification of algae; Important features, asexual and sexual reproduction in representative genera of Chlorophyceae (*Chlamydomonas*, *Spirogyra* & *Dianoflagellates*) Pheophyceae (*Ectocarpus* & *Sargassum*), Bacillariophyceae (Diatoms), Rhodophyceae (*Polysiphonia*) and Cyanophyceae (*Spirulina* & *Anabaena*).

Unit-II

General characters and classification of fungi; Mastigomycotina (*Albugo* & *Phytophthora*), Zygomycotina (*Rhizopus*), Ascomycotina (*Saccharomyces* & *Neurospora*), Basidiomycotina (*Puccinia* & *Agaricus*) and Deuteromycotina (*Cercospora* & *Colletotrichum*).

Unit-III

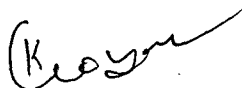
Economic importance of algae: Algae as pollution indicators, eutrophication agent and role in bioremediation, algae in global warming and environmental sustainability, cyanobacteria and selected microalgae in agriculture-biofertilizer and algalization.

Unit-IV

Lichens: Structure, relationships, reproduction of ascolichens, basidiolichens & deuterolichens; Mycorrhiza: ecto-, endo, ectendo- VAM; Fungi as insect symbionts & biocontrol agent, fungi attack on other microorganisms; Economic importance of fungi.

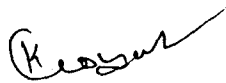
Practicals:

1. Fungi cultivation methods.
2. Study of mycorrhizae.
3. Study of lichens.
4. Study of representative algae (as listed in syllabus).
5. Identification of fungi from food samples.
6. Study of representative fungi (as listed in syllabus).
7. Study of specific fungi from crops.
8. Characterization and identification of yeast.
9. Spore print of mushrooms.
10. Use of algae for biofuel production.



Books Recommended:

1. Atlas R.M., 1997, Principles of Microbiology, 2nd Edition, McGraw Hill.
2. Barsanti L. and Gualtieri P., 2006, Algae: Anatomy, Biochemistry and Biotechnology, Taylor and Francis Group, LLC.
3. Chatterjee K.O., 1999, Parasitology, Calcutta Publication.
4. Lee R.E., 1999, Phycology, 3rd Edition, Cambridge University Press, Cambridge.
5. Nester E.W., Anderson O.G. and Nester M.T., 2006, Microbiology: A Human Perspective, McGraw Hill Publishers.
6. Pommerville J.C., 2009, Alcamo's Fundamental of Microbiology, Jones and Bartlett Publishers.
7. Prescott L.M., Harley J.P. and Klein D.A., 1996, Microbiology, 1st Edition, Wm C. Brown Publishers.
8. Prescott, L.M., Harley J.P. and Klein D.A., 2007, Microbiology, 7th Edition, McGraw Hill Publishers.
9. Talaro, K.P. and Talaro A., 2006, Foundations in Microbiology, McGraw Hill Publishers.
10. Willey J., Sherwood L. and Woolverton C., 2008, Prescott Harley/Klein's Microbiology, 7th Edition, McGraw Hill-Dubuque.
11. Willey J.M., Sherwood L. And Woolverton C., 2013, Prescott's Microbiology, 9th revised Edition, McGraw Hill Higher Education, New York.



MBC 201: Microbial Growth, Nutrition and Metabolism

Unit –I

Microbial nutrition & growth: Nutritional categories of microorganisms; Nutritional requirements; Measurement of microbial growth, direct & indirect measurement of microbial growth; Influence of environmental factors on microbial growth.

Unit-II

Nitrogen fixation in symbiotic and free living system; Oxygen and hydrogen regulation of nitrogen fixation; nitrification, denitrification and ammonifying bacteria; Pathway of nitrate assimilation in photosynthetic and non photosynthetic systems; Transamination and deamination reaction; Synthesis of essential & non essential amino acids; Synthesis of peptidoglycans & polyamines.

Unit-III

History of photosynthetic prokaryotes; Classification of photosynthetic bacteria (purple bacteria, purple sulphur bacteria, green bacteria & purple non sulphur bacteria); polysynthetic pigments (chlorophyll, bacteriochlorophyll, carotenoids & phycobilliproteins); Mechanism of photosynthesis in oxygenic & non-oxygenic bacteria; Photorespiration; Calvin cycle; Chemolithotrophs.

Unit –IV

Respiratory metabolism: Glycolytic pathway of carbohydrates breakdown, glycolysis, (Embden Meyerhoff pathway), Kreb's cycle and Entner – Duoderoff pathway, phosphoketolase pathway, pentose phosphate pathway, oxidative and substrate level phosphorylation, gluconeogenesis, glycogen metabolism, glyoxylate cycle, fermentation of carbohydrates and homo- & hetero-lactic fermentation.

Practicals:

1. Physiological differentiation of microorganisms of TSIA differential media.
2. Study of nitrification.
3. Isolation and identification of symbiotic nitrogen fixer (Rhizobium) from root nodules.
4. Isolation and Identification of free living nitrogen fixer from soil.
5. Study of ammonification.
6. Fermentation of carbohydrates.
7. Study of chemolithotrophs.
8. Litmus milk-homo-fermentation/ hetero-fermentation.
9. Effect of temperature and pH on bacterial growth.
10. Determination of microbial growth.

Books Recommended:

1. Atlas R.M., 1997, Principles of Microbiology, 2nd Edition, McGraw Hill Publications.
2. Berg J.M., Tymoczko J.L. and Stryer I., 2006, Biochemistry, 6th Edition, W.H. Freeman and Company, New York.
3. Berg J.M., Tymoczko J.L. and Stryer L., 2012, Biochemistry, 7th Edition, W.H. Freeman Publishers, New York.
4. Berg J.M., Tymoczko J.L., Gatto Jr. G.J. and Stryer L. 2015, Biochemistry, 8th Edition, Macmillan Education.
5. Black J.G. 2012 Microbiology: Principles and Exploration, 8th Edition, John Willy & Sons .USA.
6. Madigan M.T., Martinko J.M., Binder K. And Buckley D., 2011, Brock Biology of Microorganisms, 13th Edition, Pearson Education, USA.
7. Nelson D. L. and Cox M. M., 2008, Lehninger's Principles of Biochemistry, 5th Edition, W. H. Freeman & Co., NY.
8. Nelson D.L. and Cox M.M., 2013, Lehninger Principles of Biochemistry, 6th Edition, W.H. Freeman & Co., NY
9. Potter G.W.H and Potter G.W., 1995, Analysis of Biological Molecules: An Introduction to Principles, Instrumentation and Technique, Kluwer Academic Publications.
10. Prescott L.M., Harley J.P. and Klein D.A., 2007, Microbiology, 7th Edition, McGraw Hill.
11. Stryer L., 2001, Biochemistry, 5th Edition, W.H. Freeman.
12. Talaro K.P. and Chess B., 2014, Foundations in Microbiology, 9th Edition, McGraw Hill.
13. Talaro K.P., 2008, Foundation in Microbiology, Basic Principles, McGraw Hill Co., Inc.
14. Talaro, K.P. and Talaro A., 2006, Foundations in Microbiology, McGraw Hill Publications.
15. Tortora G.J.Funke B.R., Case C.L., 2013, Microbiology: An Introduction, 11th Edition, International Edition, Pearson, Boston.
16. Voet D., Voet J.G. and Pratt C.W., 2013, Principles of Biochemistry, 4th Edition, John Wiley & Sons, Inc., New York.

17. Willey J., Sherwood L. and Woolverton C., 2007, Prescott V Harley/Klein's Microbiology, McGraw Hill Publications.
18. Willey J.M., Shirwood L. and Woolverton C., 2013, Prescott's Microbiology, 9th revised Edition, McGraw Hill Higher Education, New York.

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MBC 202: Molecular Biology

Unit –I

Nucleic acids: DNA structure; Chargaff's rule; Types of DNA; Reannealing and hybridization; DNA replication in prokaryotes and eukaryotes: Polymerases, replication origin, initiation, elongation and termination; Synthesis of telomeric DNA; topological properties: linking number, superhelicity, mechanism of topoisomerases; Drugs & inhibitors of DNA synthesis.

Unit –II

Transcription: Prokaryotes - polymerase, promoter, initiation, elongation and termination; Eukaryotes- promoters, initiation, elongation, termination and post translational modification of mRNA [capping & polyadenylation, Splicing: L & Y splicing (Group I and II introns) hRNA using spliceosome/snurposome]; Ribozymes; Inhibitors of transcription.

Unit –III

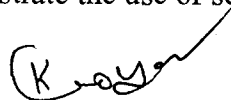
Types of RNA: Structural features (mRNA, rRNA, tRNA); Genetic code: Degeneracy of the code, three rules governing the code; Protein synthesis in prokaryotes and eukaryotes: initiation, elongation and termination; Protein synthesis on membrane bound ribosomes: signal hypothesis, post translation modification in ER and Golgi complex; Drugs & inhibitors of protein synthesis.

Unit –IV

Regulation of gene expression: Operon concept, negative & positive regulation, inducers, corepressors and catabolite repression; Negative regulation-Lac operon; Positive regulation-Ara operon; Regulation by attenuation –trp operon; Anti termination –N protein and nut sites in lambda.

Practicals:

1. Preparation of buffers.
2. DNA isolation from different cell types-microbes and eukaryotic cell.
3. Check for purity of isolated DNA sample.
4. Quantification of DNA using spectrophotometer.
5. DNA denaturation and determination of T_m and G+C content.
6. Perform Agarose gel electrophoresis of DNA.
7. Viable count of *E. coli*, use of minimal and LB Plates.
8. Total RNA isolation from bacterial cells.
9. Use of genetically different marked strains to demonstrate the use of selective minimal plates and scoring of phenotypic markers.
10. Exercise on gene expression.



Books Recommended:

1. Alberts B., Bray D., Hopkin K., Johnson A.D., Lewis J., Raff M., Roberts K., and Wolter P., 2013, Essential Cell Biology, 4th Edition, Garland Science.
2. Bale J.W., 1994, Molecular Genetics of Bacteria, John Wiley & Sons.
3. Clarke D.P., 2005, Molecular Biology, 1st Edition, Elsevier Academic Press.
4. Friedberg C., Walker G.C. and Wolfman S., 1995, DNA Repair and Mutagenesis, ASM Publications.
5. Friefelder D., 1995, Molecular Biology, 2nd Edition, Narosa Publishing House.
6. Gardner E.J., Simmons M.J. and Snustad D.P., 1991, Principles of Genetics, 8th Edition, John Wiley & Sons Inc.
7. Karp G., 2010, Cell and Molecular Biology – Concepts and Experiments, 5th Edition, John Wiley & Sons, New York.
8. Larry S. and Wendy, 1997, Molecular Genetics of Bacteria, ASM Publications,
9. Lewin B., 2000, Gene VII, Oxford University Press.
10. Lewin B., 2004, Genes VIII, International Edition, Pearson Prentice Hall.
11. Lodish H., Berk A., Kaiser C.A., Krieger M., Bretscher A., Pioegh H., Amen A., and Scott M.P., 2012, Molecular Cell Biology, 7th Edition, W.H. Freeman & Co.
12. Maloy, S., Cronan J., and Freifelder D., 1994, Microbial Genetics, 2nd Edition, Jones & Bartlett Publishers, Inc.
13. Pierce B.A., Genetics- A Conceptual Approach, 2nd Edition, W. H. Freeman & Co. New York.
14. Sambrook J. and Russell D., 2001, Molecular Cloning: A Laboratory Manual, 3rd Edition, Cold Spring Harbor Laboratory Press, New York.
15. Streip and Yashbin, 1991, Modern Microbial Genetics, Niley Ltd.
16. Watson J.D., 2007, Molecular Biology of the Gene, 6th Edition, Cold Spring Harbor Laboratory Press. New York.
17. Watson J.D., Baker T.A., Bell S.P., Gana A., Levine M. and Losick R., 2013, Molecular Biology of the Gene, 7th Edition, Cold Spring Harbor Laboratory Press, New York.

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MBC203: Microbial Biochemistry

Unit-I

Chemical properties of water: ionization and acid base chemistry; Carbohydrates-classification; Configuration and conformation of: monosaccharides, disaccharides polysaccharides (structural-cellulose, peptidoglycan, storage-glycogen) and glycoproteins; Lipids: General characters and classification, biosynthesis of saturated and unsaturated fatty acids; Structure and functions of triglycerides, phospholipids, glycolipids and steroids.

Unit -II

Structure of amino acids; Classification of essential amino acids based on polarity; Proteins: structure – secondary tertiary, quaternary & protein folding and stability; Properties of proteins: Acid - base & solubility; Ramchandran plot; Methods of purification: General approach; Protein solubility chromatography, electrophoresis & ultracentrifugation; Sequencing of proteins: Preliminary steps, polypeptide cleavage, Edman degradation & reconstruction of protein sequence.

Unit -III

Laws of thermodynamics: First and second law, concept of free energy, oxidation reduction reactions; Enzymes: Classification and nomenclature, mechanism of enzyme action, enzyme inhibition, allostery, cofactors, coenzymes and prosthetic groups; Enzyme kinetics: Derivation of Michaelis - Menton equation and its significance, Lineweaver-Burke plot & Haldane-Briggs relationship.

Unit-IV

Chemical analysis of microbial cells for- carbohydrates, amino acids, proteins, lipids and nucleic acids; Structure and classification of secondary metabolites: Antibiotics (penicillin, streptomycin etc), alkaloids (Ergot toxins), flavanoids, vitamins and bacterial toxins.

Practicals:

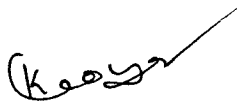
1. Qualitative tests for lipids, carbohydrates and proteins.
2. Calibration of standard curve.
3. Quantitative estimation of proteins.
4. Quantitative estimation of blood glucose & glycogen.
5. Quantitative estimation of lipids & cholesterol.
6. Quantitative estimation of DNA & RNA.
7. Quantitative estimation of any enzyme.
8. Quantitative estimation of polyphenol & carotenoids.
9. Quantitative estimation of secondary metabolites- flavanoids.
10. Quantitative estimation of vitamins.



Books Recommended:

1. Alexander R.R. and Griffith J.M., 1993, Basic Biochemistry Methods, 2nd Edition, John Wiley & Sons, Inc. New York.
2. Atlas R.M., 1997, Principles of Microbiology, 11th Edition, McGraw Hills.
3. Berg J.M., Tymoczko J.L. and Stryer L., 2007, Biochemistry, 6th Edition, W.H. Freeman and Co. New York.
4. Berg J.M., Tymoczko J.L., Gatto Jr. G.J. and Stryer L. 2015, Biochemistry, 8th Edition, Macmillan Education.
5. Bery J.M., Tymoczko J.I., Stryer L. and Gatto Jr. G.L., 2011, Biochemistry, 7th Edition, W.H. Freeman, New York.
6. Cohen, G.N. 2011, Microbial Biochemistry, 2nd Edition, Springer.
7. Conn E.E. and Stumpf P.K., 2006, Outlines of Biochemistry, 5th Edition, John Wiley & Sons, Inc. New York.
8. Moat A.G. and Foster J.W., 2002, Microbial Physiology, 3rd Edition, John Wiley and Sons, Inc. New York.
9. Nelson D.L. and Cox M.M., 2008, Lehninger Principles of Biochemistry, 5th Edition, W.H. Freeman and Co. New York.
10. Nelson D.L. and Cox M.M., 2013, Lehninger Principles of Biochemistry 6th Edition, W.H. Freeman, New York.
11. Plummer D., 1988, An Introduction to Practical Biochemistry, 3rd Edition, Tata McGraw-Hills.
12. Potter G.H.W. and Potter G.W., 1995, Analysis of Biochemical Molecules: An Introduction to Principles, Instrumentation and Techniques, Kluwer Academics Publisher.
13. Stryer L., 2001, Biochemistry, 5th Edition, WH Freeman.
14. Talaro K.P. and Talaro A., 2006, Foundation in Biochemistry, 6th Edition, Tata McGraw Hills.
15. Voet D. and Voet J.G., 1995, Biochemistry, 4th Edition, John Wiley and Sons Inc.
16. Voet D., Voet J.G. and Pratt C.W., 2013, Principles of Biochemistry, 4th Edition, John Wiley & Sons, Inc., New York.
17. White D., 2000, The Physiology and Biochemistry of Prokaryotes, 2nd Edition, Oxford University Press.
18. Willey J., Sherwood L. and Woolverton C., 2008, Prescott Harley/Klein's Microbiology, McGraw-Hills-Dubuque.

19. Wilson K. and Walker J., 2000, Principles and Techniques of Practical Biochemistry, 5th Edition, University Cambridge Press.
20. Wilson K. and Walker J., 2010, Principles and Techniques of Practical Biochemistry and Molecular Biology, 7th Edition, University Cambridge Press.
21. Zubay G.L., 2008, Biochemistry, 4th Edition, Addison-Wesley Educational Publishers Inc.



MBC 204: Biostatistics and Bioinformatics

Unit-I

Definition and applications of biostatistics; Frequency distribution; Presentation of data; Measures of central tendency (mean, median and mode); Measures of dispersion: Mean deviation and standard deviation, standard error; Correlation and regression: Scatter diagram, coefficient of correlation, rank correlation, equations and lines of regression.

Unit-II

Testing of hypothesis: Null & alternative hypothesis, levels of significance, errors in hypothesis testing; critical region; Students t- test (unpaired & paired test); Chi- square test and F test for population variance; ANOVA (one way & two way).

Unit-III

Probability: Basic concepts related to probability theory, Classical, Posteriori personalitic & Axiomatic probability, Theorems of Probability. Probability distributions; Properties of Binomial, Poisson, Normal and skewed distribution and their applications in biology.



Unit-IV

Overview of computer systems: Types of computers ; Components of computer; Generation of computers; Number system; Basics for operation system; (MS-DOS, WINDOWS, Unix & Linux); Introduction to software; Applications of MS office (MS-WORD, Power Point, MS Excel & Photoshop); Types of networking (LAN, WAN, MAN & VPN), Applications of networking, Downloading files with anonymous FTP, Web browsing & Search engines.

Introduction of Bioinformatics: Biological databases (nucleic acid & protein sequence database); Sequence alignment (BLAST, FASTA & PSI-BLAST); Important bioinformatics websites (NCBI, FBI, DDBJ etc.); Introduction to genomics & proteomics.

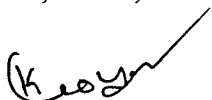
Practicals:

1. Graphical representation of data: Bar diagram, histogram, frequency polygon, frequency curve and ogives or cumulative frequency curve and pie diagram.
2. Measure of central tendency, Mean deviation, standard deviation and standard error (Individual, discrete and continuous series)
3. Plotting of scatter diagram and regression lines. Calculation of correlation coefficient, regression equation and regression analysis.
4. Test of significance by student's t- test, chi-square test, one way and two way ANOVA.
5. Conversion of decimal into binary, octal and hexadecimal number system.
6. On line searching of biological literature related to bioinformatics.
7. Scoring schemes and methods of sequence alignment.
8. Use of MS Word.
9. Statistical calculations using MS Excel /SPS software.
10. Preparation of graphs using computers.


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Books Recommended:

1. Bailey N.T.J., 2000, Statistical Methods in Biology, English University Press.
2. Bansi L., 1968, Mathematics of Probability of Statistics, S.Chand & Co., Delhi.
3. Baxevanis A.D. and Ouellette, 2005, Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd Edition, John Wiley and Son Inc.
4. Campbell R.C., 1974, Statistics for Biologist, Cambridge University Press.
5. Gralla P., 2006, How the Internet Works, 8th Edition, Que Publishing.
6. Kenny J.F. and Keeping E.S., 1964, Mathematics of Statistics Part I & II, Affiliated East-West Press Ltd, New Delhi.
7. Krane D.E., 2005, Fundamental Concept of Bioinformatics, Dorling Kindersley Pvt. Ltd.
8. Lesk A.M., 2013, Introduction to Bioinformatics, 4th Edition, Oxford University Press Oxford.
9. Mount D.W., 2002, Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press, New York.
10. Mount D.W., 2004, Bioinformatics Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press, New York.
11. Sinha P.K., 2004, Fundamentals of Computers, BPB Publications, New Delhi.
12. Snedecor G.W. and Cochran W.G., 1968, Statistical Methods, Oxford & IBH, Delhi.
13. Tramontano A., 2007, Introduction to Bioinformatics, Chapman & Hall / CRC.
14. White R., 2004, How Computer Works, 7th Edition, Que Publishing.
15. White R., 2007, How Computers Work, 9th Edition, Que Publishing.
16. White R., 2014, How Computers Work: The Evolution of Technology, 10th Edition, Que Publishing.
17. Zvelebil M. and Baum, 2008, Understanding Bioinformatics, Chapman & Hall/CRC.



MBC 301: Medical Microbiology

Unit: 1

Historical development in medical microbiology; Normal flora of human body, pathogenicity, progress of diseases, transmission of diseases, types of diseases, establishment of diseases and nosocomial infections.

Unit: II

Occurrence, pathogenesis, symptoms, diagnosis, prevention and treatment of the bacterial airborne diseases (tuberculosis, diphtheria, meningococcal meningitis, pneumococcal pneumonia & whooping cough); food and water borne disease (botulism, clostridial food poisoning, typhoid fever & cholera); soil borne diseases (tetanus); sexually transmitted diseases (gonorrhoea, syphilis, leprosy & urinary tract infection) ; Bacterial vaccines.

Unit III

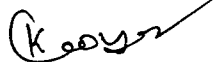
Occurrence, pathogens, symptoms, preventions, diagnosis and treatment of viral diseases (influenza, mumps, measles, small pox, rabies, polio, hepatitis, chickenguniya, swine flu & bird flu); Viral cancers; Viral vaccines; Antiviral agents; Fungal diseases (superficial mycoses, subcutaneous mycoses, systemic mycoses & opportunistic mycoses) ; Antifungal agents.

Unit IV

Occurrence, pathogenesis, symptoms, diagnosis, prevention and treatment of protozoan diseases (amoebiasis, giardiasis, trypanosomiasis, trichomoniasis, leishmaniasis & malaria); helminthes diseases (liver fluke diseases, beef and pork tapeworm diseases, pinworm, disease, roundworm disease, hook worm disease & filariasis).

Practicals:

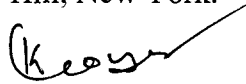
1. Identification of pathogens in various samples using different stains.
2. Collection of samples and containers used for collecting samples.
3. Isolation of pathogens from clinical samples pus, blood and urine.
4. Conventional and rapid methods of isolation and identification of pathogens.
5. Normal flora of skin.
6. Pathogenic bacteria: *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa* & *Vibrio cholera*.
7. Pathogenic fungi: *Candida albicans*.
8. Parasites: *Entamoeba histolytica*, *Giardia lamblia*, *Plasmodium*, *Trypanosoma leishmania sp.*, *Trichomonas vaginalis* & *Taenia solium*.
9. Drug susceptibility testing.
10. Models / Diagrams showing structure of various pathogenic viruses.



Books Recommended:

1. Atlas R.M., 1997, Principles of Microbiology, 11th Edition, McGraw Hills.
2. Black J.G. 2012, Microbiology: Principles and Exploration 8th Edition, John Wiley & Sons .USA.
3. Brooks G.F., Butel J.S., Morse S.A., Melnick J.L., Jawetz E., Adelberg E.A., 2004, Jawetz, Melnick, and Adelberg's Medical Microbiology, 23rd Edition, Lange Publications.
4. Greenwood D., 2007, Medical Microbiology, 41/1 Edition, I.K. International.
5. Hacker J. and Dorbindt U., 2006, Pathogenomics: Genome Analysis of Pathogenic Microbes, Wiley-VCH, Verlag Gmbh & Co.
6. Harvey R.A., Champe P.C. and Fisher B.O., 2007, Lippincott's Illustrated Reviews: Microbiology, Lippincott Williams and Wilkins, New Delhi /New York.
7. Madigan M.T., Martinko J.M., Binder K. And Buckley D., 2011, Brock Biology of Microorganisms, 13th Edition, Pearson Education, USA.
8. Murray P.A., Ptaller M.A., Tenover F.E. and Tenover A.H., 2007, Clinical Microbiology, ASM Press.
9. Nelson D.L. and Cox M.M., 2013, Lehninger Principles of Biochemistry, 6th Edition, W.H. Freeman & Co., NY.
10. Nelson K.E., Williams C.M. and Graham N.M.H., 2001, Infectious Disease Epidemiology: Theory and Practice, Aspen Publications.
11. Nester E.W., Anderson D.G. and Nester M.T., 2006, Microbiology: A Human Perspective, McGraw Hills.
12. Salyers A.A. and Whitt D.D., 2002, Bacterial Pathogenesis: A Molecular Approach, American Society for Microbiology Press, Washington DC, USA.
13. Talaro K.P., 2008 Foundations Microbiology, Basic Principles, McGraw-Hill Co., Inc.
14. Talaro P.K. and Talaro A., 2006, Foundations in Microbiology, 6th Edition, McGraw Hills.
15. Talaro K.P. and Chess B., 2014, Foundation in Microbiology, 9th Edition, McGraw Hill.
16. Tortora G.J., Funke B.R. and Case C.L., 2004, Microbiology: An Introduction, 8th Edition, CA Pearson Education Pvt. Ltd. Singapore.

17. Tortora G.J., Funke B.R. and Case C.L., 2013, Microbiology: An Introduction, 11th Edition, International Edition, Pearson, Boston.
18. Wiley J., Sherwood L. and Woolverton C., 2007, Prescott Harley/Klein's Microbiology, McGraw Hills, Yew York.
19. Willey J.M., Shirwood L. And Woolverton C., 2013, Prescott's Microbiology, 9th revised Edition, McGraw Hill, New York.



MBC 302: Immunology and Clinical Microbiology

Unit I

Immune system: Innate immunity, adaptive immunity, natural and artificial immunity; Cells of immune system : Lymphocytes, lineage subsets of lymphocytes; Myeloid lineage- Phagocytes, neutrophils, macrophages, mast cells, basophils & eosinophils; Lymphoid tissues and organs-primary (Thymus & Bone marrow) & secondary (Spleen, Lymph nodes & Mucosa-associated lymphoid tissues).

Unit II

Antigens: Types-haptens, super antigens and cluster of differentiation molecules(CDs); determinants –linear, conformational and neo-antigenic determinants; Immunoglobulin: structure and types; catalytic antibodies; Humoral and cell mediated immune response; Major Histocompatibility Complex(MHC) molecules and genes- structure of class I & II molecules, organisation of class I & II molecules, peptide binding of MHC molecules ; Complement activation: classical, alternative and lectin pathway, regulation of the complement system; Cytokines: General properties & regulation of immune response.

Unit III

Vaccines and Immunization: Types of vaccines (DNA, recombinant vector, synthetic peptide and Multivalent peptide) and their characteristics; National immunisation schedules, Hypersensitivity- Gell and Coombs classification, Type I,II , III & IV hypersensitivity; Autoimmune diseases-Classification of autoimmune diseases, Mechanism of autoimmunisation; Transplantation –Types of grafts, types of graft rejection, HLA typing, GVH reaction, Xenotransplantation & Immunosuppressive drugs; Immunodeficiencies: B cell deficiencies, SCID,MHC class II deficiencies & AIDS.

Unit IV

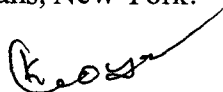
Immunization of test animals, hyper immunization, prophylactic immunization; Preparation of antigen, Antigen antibody reaction, *in vitro* agglutination reactions (Widal Haemagglutination), Precipitation reactions (Immuno diffusion, Immuno electrophoretic method), Immunoblotting, ELISA, RIA, Fluorescence immunosorbent assay, immune electronmicroscopy; Hybridoma technology and application of monoclonal antibodies.

Practicals:

1. Study of blood (a) Identification of various types of WBC (b) Determination of total leukocyte count (TLC) & differential count (DLC).
2. Study of routes of immunization & procedures for collection of blood sample from immunized animal.
3. Separation of serum from the blood sample.
4. Widal test.
5. Ouchterlony's double diffusion.
6. Radial Immunodiffusion.
7. Titre Test.
8. ELISA.
9. Immunoelectrophoresis.
10. Histological studies of Spleen, Lymph nodes, Thymus gland & Bone marrow.

Books Recommended:

1. Abbas A.K., Lichtman A.H., and Pillai S., 2007, Cellular and Molecular Immunology, Elsevier / Saunders.
2. Abbas A.K., Lichtman A.H. and Pillai S., 2012, Cellular and Molecular Immunology, 7th Edition, ASM Press.
3. Abbas A.K., Lichtman A.H. and Pillai S., 2015, Cellular and Molecular Immunology, 8th Edition Elsevier / Saunders.
4. Benjamin Eli, Coico R, and Sunshine G., 2000, Immunology: A short course. 4th Edition, Wiley Inter Science.
5. Coico R, and Sunshine G., 2008, Immunology: A short course, 6th Edition, Wiley-Blackwell.
6. Delves P.J., Martin S.J., Burton D.R. and Roitt I.M., 2006, Roitt's Essential Immunology, 11th Edition, Blackwell Publishing/Oxford University Press.
7. Elgert K.D., 1996, Immunology- Understanding of Immune System, Wiley-Liss, New York.
8. Elgert K.D., 2009, Immunology- Understanding of Immune System, 2nd Edition, Wiley-Backwell, Publishers.
9. Kindt T.J., Goldsby R.A., Osborne B.A. and Kuby J., 2006, Kuby Immunology, 6th Edition, WH Freeman, New York.
10. Levinson W. and Jawetz E., 2001, Medical Microbiology and Immunology, Lange Publications.
11. Owen J., PuntJ. And Stranford S., 2013, Kuby Immnology, 7th International Edition, W.H. Freeman.
12. Paul W.E., 2000, Fundamental Immunology, 4th Edition, Raven Press, New York.
13. Paul W.E., 2008, Fundamental Immunology, 6th Edition, Welters Kluwer/Lippincott Willians & Willians, New York.



MBC 303: Agricultural Microbiology

Unit: I

Microbial biofertilizers and biopesticides; Production of bacterial biofertilizer; Algal and other biofertilizers; Biofertilizers aiding phosphorus nutrition; Production of mycorrhizal biofertilizers, microbial herbicides, bacterial insecticides, viral insecticides; Entomopathogenic fungi; Microbial nematodes.

Unit: II

Disease forecasting and basic principles of plant disease control: Pathology, etiology and control of economically important crop diseases of wheat (Rust, smut), paddy (Blast), barley (Smut), bajra (Ergot), maize (Downy mildew), sugarcane (Red rot) and vegetable potato (Late blight and early blight); Management & storage of agricultural products; Post harvest diseases, their prevention and control.

Unit III

Microbial diseases of farm animals (Anthrax & fowl cholera) their prevention and control; Principles and mechanism of biological control; Commercial production of biopesticides with reference to *Bacillus thuringiensis*; Integrated pest management, their application and limitations for Indian agriculture organic farming.

Unit IV

Soil microbiology: Soil microbes (algae, bacteria, actinomycetes, protozoans, nematodes & fungi); Rhizosphere micro organisms, Rhizosphere effect; Microflora effect on host plant; Factors affecting microbial community in soil, organic matter decomposition & factors affecting organic matter decomposition; Microbial biomass as an index of soil fertility; Biogeochemical cycles (Sulphur, carbon & phosphorus).

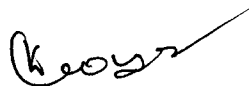
Practicals:

1. Enumeration of soil microorganisms.
2. Rhizosphere micro-organisms.
3. Commercial production of biofertilizers.
4. Standard ISI regulations for mass cultivation of biofertilizers.
5. Crop diseases of fungi (as listed in the syllabus).
6. Farm animal diseases (any two).
7. Physico-chemical testing of soil.
8. Pheromone traps.
9. Bioassay methods.
10. Microbes in composting.

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Books Recommended:

1. Agrios G.N., 1997, Plant Pathology, Academic Press, San Diego.
2. Basu A.N. and Giri B.K., 1993, The Essentials of Viruses, Vectors and Plant Diseases, Wiley Eastern Limited.
3. Christen J.H., 2001, A Manual of Environmental Microbiology, ASM Publications.
4. Cook R.J. and Baker K.F., 1983, The Nature and Practice of Biological Control of Plant Pathogens, America Phytopathological Society Press, St. Paul, MN.
5. Dickinson M., 2003, Molecular Plant Pathology, BIOS Scientific Publishers, London.
6. Froster C.F. and John D.A., 2000, Environmental Biotechnology, Ellis Horwood Publications.
7. George N. A., 1997, Plant Pathology, 4th Edition, Academic Press, New York.
8. Kirk J.L., Beaudette L.A., Hart M., Moutoglis P., Klironomos J.N., Lee H. and Trevors J.T., 2004, Methods of Studying Soil Microbial Diversity, J. Microbial Methods, 54:169-168.
9. Mehrotra R.S., Plant Pathology, Tata McGraw Hills, New Delhi.
10. Paul E.A., 2007, Soil Microbiology, Ecology and Biochemistry. 3rd Edition, Academic Press, New York.
11. Rao N.S.S., 1999, Soil Microbiology, Oxford & ISH Publishing Co., New Delhi.
12. Sigeo D.C., 1993, Bacterial Plant Pathology, Cell and Molecular Aspects, Cambridge University Press.
13. Tate R.L., 2012, Soil Microbiology, Wiley –Blackwell, New York.



MBC 304: Industrial Microbiology

Unit: 1

Historical account of microbes in industrial microbiology: Sources and characters of industrially potent microbes, their isolation, purification and maintenance; Screening of useful strains, primary screening and secondary screening; Strain improvement through random mutation; Microbial growth kinetics in batch, continuous & fed batch fermentation process; Application of genetically engineered bacteria.

Unit: II

Aerobic bioreactor: Principles and designing; Types of bioreactors; Raw materials used in industrial fermentation media; Solid state fermentation and submerged fermentation: their advantages and disadvantages; Microbial transformations of steroids and alkaloids; Microbes used for production of antibiotic; Commercial production of antibiotics with special reference to penicillin, streptomycin & their derivatives.

Unit III

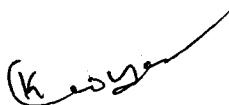
Microbiology and production of alcoholic beverages: Malt beverages, distilled beverages, wine and champagne; Commercial production of organic acids like acetic, lactic, citric & gluconic acids; Commercial production of important amino acids (glutamic acid, lysine & tryptophan), insulin and vitamin (vitamin B12, riboflavin & vitamin A); Industrial enzymes production: Cellulases, xylanases, pectinases, amylases & proteases and their applications.

Unit IV

Immobilisation of microbial enzymes and whole cells and their applications in industries; Bioprocess engineering; Downstream processing; Various steps for large protein purification; Petroleum microbiology; Biofuels (ethanol & methane) from organic residues; Fuels from algae; Mushroom cultivation patent protection and IPR for biological inventions.

Practicals:

1. Study of growth curve.
2. Solid state fermentation.
3. Primary screening techniques (crowded plate).
4. Secondary screening techniques.
5. Amino acid production using *E. coli* mutant strains.
6. Use of growth and production media for citric acid production.
7. Amylase production.
8. Protease production.
9. Enzyme immobilization.
10. Mushroom cultivation.



Books Recommended:

1. Aneja K.R., Jain P. and Aneja R., 2008, A Text Book of Basic and Applied Microbiology, New Age Int. Publications., New Delhi.
2. Bhosh, Fietcher and Blakebrough, 1999, Advanced in Biochemical Engineering, Springer Verlag Publications.
3. Casida L.E., 1997, Industrial Microbiology, Wiley Eastern.
4. Creuger A. and Creuger W., 2002, Biotechnology- A Text Book of Industrial Microbiology, 2nd Edition, Panima Publishing Corporation, New Delhi/Bangalore.
5. El-Mansi E.M.T., Bryce C.F.A., Dahhou B., Sanchez S., Demain A.L. and Allman A.R., 2011, Fermentation Microbiology and Biotechnology, 3rd Edition, CRC Press, Taylor and Francis Group.
6. Glazer A.N. and Nikaido H., 1995, Microbial Biotechnology: Fundamentals of Applied Microbiology, W.H. Freeman and Co., New York.
7. El-Mansi E.N.T. and Bryce C.F.A., 1999, Fermentation Microbiology and Biotechnology, CRC Press, Taylor and Francis Group.
8. Okafer N., 2007, Modern Industrial Microbiology & Biotechnology, Scientific Publishers, Enfield, USA.
9. Prescott S.C. and Dunn C.G., 1982, Prescott and Dunn's Industrial Microbiology, 4th Edition, AVI Publishing Co. Inc., West Port, Conn.
10. Prescott S.C., Dunn C.G., Waites M.S., Morgan N.L., Rockey J.C. and Highton G., 2001, Industrial Microbiology: An Introduction, Blackwell Science Ltd.
11. Reed G., 1997, Industrial Microbiology, CBS Publishers (AVI Publishing Co.).
12. Saha B.C., 2003, Fermentation Biotechnology, American Chemical Society, The University of Michigan.
13. Stanbury P.F., Whitaker A. and Hall S.J. 1995, Principles of Fermentation Technology, 2nd Edition, Elsevier Science Ltd.
14. Stanbury P.F., Whittaker W. and Hall S.J., 1997, Principles of Fermentation Technology, Aditya Books (Pvt.) Ltd., New Delhi.
15. Ward O.P., 1988, Fermentation Biotechnology, Open University Press, Milton Keynes, U.K.

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MBC 401: Environmental Microbiology

Unit-I

Microbial diversity; Microbiology of air, soil & water; Microbes in extreme environments; Environment induced genetic and physiological adaptation in microbes; Characteristic features of thermophiles, psychrophiles, methanogens, methylotrophs, acidophiles, alkophiles, halophiles and their survival strategies.

Unit-II

Biodegradation and Bioremediation: Microbial degradation of lignocellulosic substances, keratin and chitin; Bioremediation: Microbial degradation of herbicides, pesticides, hydrocarbons including polycyclic (petroleum, gas production, fossil fuel & polychlorinated biphenyls etc.), oil spills, heavy metals, chlorinated and polychlorinated compounds; Biological treatment of effluents of sugar, pulp and paper industry.

Unit -III

Biodeterioration: Biodeterioration of buildings and monuments of cultural heritage, microbial deterioration of paper, textile, leather, rubber, glass, paints and metals; Principal methods for their protection.

Unit -IV

Disinfection of potable water supplies and hospital wastes; Bacterial indicators of water safety ; Microbial assessment of water quality; Standard for tolerable levels of fecal contamination; Techniques in environment microbiology : Methods for determination of numbers, biomass and activities of microbes in soil, water, plant surfaces and dead organic materials; Bioremediation techniques:*in situ* (Bioventing, air sparging , liquid delivery system, aerobic bioremediation & phytoremediation) and *ex situ* (land farming, composting, biopiling & slurry -phase).

Practicals:

1. Study of Thermophiles & Psychrophiles.
2. Study of Halophiles.
3. Enumeration of micro-organisms from air/soil.
4. Micro-organisms degrading oil/textile dyes/petrol.
5. Biodeterioration of paper/textile.
6. Membrane filtrations.
7. Bacteriological examination of water (Potable /hospital wastes):
 - a. Presumptive test
 - b. Confirmed test
 - c. Completed test
8. IMViC test.
9. Pathogen identification.
10. Chemical Oxygen Demand (COD) & Biological Oxygen Demand (BOD).

Books Recommended:

1. Atlas R.M. and Bartha R., 1993, Microbial Ecology, Benjamin Cummings Publishing Co, Redwood City, CA.
2. Baker K.H. and Herson D.S., 1994, Bioremediation, McGraw Hills Inc., NY.
3. Bertrand J.C., 2015, Environmental Microbiology: Fundamentals and Applications: Microbial Ecology, Springer-Dordrecht.
4. Campbell R., 1989, Biological Control of Microbial Plant Pathogens, Cambridge University Press.
5. Colwd D., 1999, Microbial Diversity, Academic Press.
6. Connell D.W., and Niller G.J. 1984, Chemistry and Ecotoxicology of Pollution, Wiley Interscience Publications.
7. Foster C.F. and Wase D.A.J., 2000, Environmental Biotechnology, Ellis Horwood Ltd. Chichester, U.K.
8. Foster C.F. and Wase D.A. J., 2001, Environmental Biotechnology, Ellis Horwood Ltd., Publication.
9. Grant W.D. and Long P.E., 1981, Environmental Microbiology, Kluwer Academic Publishers.
10. Hurst C.J. 2001, A Manual of Environmental Microbiology, ASM Publications.
11. Hurst C.J., Crawford R.L., Garland J.L., Lipson D.A., Mills A.L. and Stetzenbash L.D. 2007, Manual of Environmental Microbiology, 3rd Edition, ASM Press.
12. Jjemba P.K., 2004, Environmental Microbiology: Principles and Applications, Science Publishers Inc., Enfield N.H.
13. Johri B.N., 2000, Extremophiles, Springer -Verlag, NY.
14. Madigan M.T., Martenko J.M. Bender K.S. Buckley D.H. and Stahl D.A., 2014, Brock Biology of Microorganisms, 14th Edition, Benjamin Cummings Publishers.
15. Madigan M.T., Martenko J.M., Dunlp P.V. and Clark D.P. 2008, Brock Biology of Microorganisms, 12th Edition, Benjamin Cummings Publishers.
16. Madsen E.L., 2008, Environmental Microbiology, Blackwell Publishers, Malden MA.
17. Madsen E.L., 2015, Environmental Microbiology: From Genomes to Biogeochemistry, 2nd Edition, John Wiley & Sons Inc., NJ.
18. Maier R., Pepper I., and Gerba C., 2008, Environmental Microbiology, Academic Press.

19. Maier R.M., Pepper I.L, and Gerba C.P. 2009, Environmental Microbiology, 2nd Edition, Academic Press.
20. Marshall K., 1986, Advances in Microbial Ecology Volume 9, Springer Science.
21. Mitchel R., 2009, Environmental Microbiology, 2nd Edition, Wiley-Blackwell.
22. Mitchell R.A. and Ji - Dong Gu, 2010, Environmental Microbiology, 2nd Edition, Wiley – Blackwell.
23. Nathanson J.A., 2008, Basic Environmental Technology: Water supply, Waste Management and Pollution Control, 5th Edition, Pearson/Prentice Hall Upper Saddle River, NJ.
24. Pepper I., Gerba C.P. and Brusseau M.L., 2006, Environmental and Pollution Science, 2nd Edition, Elsevier / Academic Press, USA.
25. Pepper I.L, Gerba C.P. and Gentry T.J., 2014, Environmental Microbiology, 3rd Edition, Academic Press.
26. Pepper IL, Gerber C.P., Gentry T.J. and Maier R.M., 2008, Environmental Microbiology, 2nd Edition, Academic Press.
27. Singh A., Kuhad R.C. and Ward O.P., 2009, Advances in Applied Bioremediation, Springer.
28. Varman A.H. and Evans M.G., 2000, Environmental Microbiology, Manson Publishing Ltd.

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MBC 402: Food and Dairy Microbiology

Unit: 1

Important microbes involved in spoilage of food: Meat, poultry, vegetables & dairy products; Food preservation; Microbial deterioration of cereals, pulses, fish & sea foods during storage; Feed for cattle: Use of microbes and microbial enzymes in the improvement of nutritive quality of feed.

Unit: II

Toxins: Bacterial and mycotoxins, important microbes secreting toxins, chemical nature of important toxins, their role in food poisoning; Physiology and mechanism of action, modification and detoxification, prevention and control of toxin contamination.

Unit III

Microbial biomass and single cell proteins; Uses of microbes in meats and poultry products vegetables etc.; Use of microbial enzymes in food; Low calorie sweeteners, flavour modifiers & food additives; Food quality monitoring Indian fermented food; Single cell Protein.

Unit IV

Role of microbes in milk and dairy products; Microbiological examination of raw / pasteurized milk, standard plate count, direct microscopic count and reductase test, composition of milk, sources of contamination of milk, ability of milk to cause diseases; Manufacture of different types of cheese, butter, yoghurt & fermented milk.

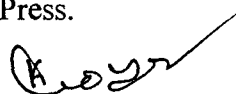
Practicals:

1. Microorganisms in food spoilage.
2. Pathogens causing food poisoning.
3. Single cell Protein (SCP) cultivation.
4. Methylene Blue Reduction Test (MBRT).
5. Statutory tests for microbiological analysis of canned foods.
6. Presumptive test for coliforms in butter.
7. Fermented milk production.
8. Preparation of Sauer Kraut, Koji & Soya sauce.
9. Sampling & analysis of microbial load on food contact surfaces.
10. Aflatoxin production from fungi.



Books Recommended:

1. Adams M.R. and Moss M.O., 2008, Food Microbiology, Royal Society of Chemistry.
2. Banwart G.J., 1993, Basic Food Microbiology, CBS Publisher and Distributors, Delhi.
3. Creuger A. and Creuger W., 2000, Biotechnonology- A Text Book of Industrial Microbiology, Panima Publications Co., New Delhi.
4. Doyle M.P. and Buchanan R.L., 2012, Food Microbiology, ASM Press Washington.
5. Doyle M.P., Beuchat L.R. and Montville T.J., 2001, Food Microbiology: Fundamentals and Frontiers, 2nd Edition, ASM Press.
6. Frazier W.C. and Werthaff D.C., 1998, Food Microbiology, 4th Edition, Tata McGraw Hills, New Delhi.
7. Hobbs B.C. and Roberts D., 1993, Food Poisoning & Food Hygiene, Edward Arnold Publishers, London
8. Jay J.M., 2006, Modern Food Microbiology, 4th Edition, Springer.
9. Joy J.M. Loessner M.J. and Golden D.A., 2005, Modern Food Microbiology, 7th Edition, Springer –Verlag, New York
10. Marwala S.S. and Arora J.K., 2000, Food Processing: Biotechnological Applications, Asia Tech Publishers Inc., New Delhi.
11. Ray B. and Bhunia A., 2013, Fundamental Food Microbiology, 5th revised Edition, CRC Press Inc.
12. Ray B., 2006, Fundamental Food Microbiology, 3rd Edition, CRC Press, 2006.
13. Robinson R.K., 1990, Dairy Microbiology, Elsevier Applied Sciences, London.
14. Stanbury P.E., Whittaker A. and Hall S.J., 1995, Principles of Fermentation Technology, 2nd Edition, Permagon Press.



MBC 403: Microbial Genetics

Unit-I

Gene: Seymour Benzer experiment, complementation test, cistron, recon & muton; Mutation mapping at molecular level; Mutation: Spontaneous mutation, induced mutation and mutagens, molecular mechanism of mutagens, suppressor, intragenic & intergenic mutation, Isolation and detection of bacterial mutants; DNA repair: Direct repair, excision repair (base and nucleotide), mismatch repair, SOS repair and translesion DNA synthesis.

Unit -II

Homologous recombination: Holliday junction (single strand & ds break); homologous recombination protein: Rec A, Ruv AB complex & Ruv C, Rec BCD pathway and Rec F pathway, FLP/FRT and Cre/Lox system; Transposable elements: Classes and genetic organisation of transposable elements, insertion sequences (IS elements), composite and complex transposons & mechanism of transposition.

Unit-III

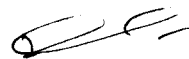
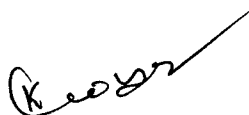
Gene transfer mechanisms: Bacterial transformation (mechanism of transformation, transfection & competence); Transduction: Generalized transduction, specialized transduction & abortive transduction; Conjugation: Effective contact & pili in conjugation, the "F" factor, conjugal transfer process, high frequency recombination (Hfr) strains, the order of chromosome transfer, formation of F'(F prime), mapping by using transformation, transduction and conjugation.

Unit IV

Genome organisation: Prokaryotic genome- nucleoid; Eukaryotic genome: Structure of chromatin, nucleosome, organisation & remodelling and high order organization of chromosomes, centromere & telomere; Chloroplast and mitochondrial DNA; DNA methylation and gene imprinting; C value paradox and Cot curves; repetitive and non repetitive DNA sequences; Cot $\frac{1}{2}$ and Rot $\frac{1}{2}$ values; Pseudogenes, gene families & gene cluster super families.

Practicals:

1. Study of conjugation in *E. coli*.
2. Effect of UV radiations and repair mechanisms in bacteria.
3. Isolation of antibiotic resistant mutants by disc methods.
4. Isolation of antibiotic resistant mutants by gradient plate method.
5. Isolation of mutants by replica plate method.
6. Ames test.
7. Preparation of competent cells.
8. Perform transformation of *E. coli* cells.
9. Transduction.
10. Isolation of plasmid DNA.

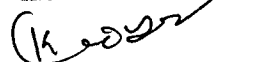


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Books Recommended 403:

1. Berg J.M., Tymoczko J.L. and Stryer L., 2006, Biochemistry, 6th Edition, W.H. Freeman and Company, New York.
2. Berg J.M., Tymoczko J.L. and Stryer L., 2012, Biochemistry, 7th Edition, W.H. Freeman and Company, New York.
3. Berg J.M., Tymoczko J.L., Gatto Jr. G.J. and Stryer L. 2015, Biochemistry, 8th Edition, Macmillan Education.
4. Brown T.A., 2006, Gene Cloning and DNA Analysis, 5th Edition, Blackwell Scientific Publishing, Oxford.
5. Glick B.R. and Pasternak J.J., 2003, Molecular Biotechnology, ASM Press Washington D.C.
6. Hartt D.L. 2012 Essentials of Genetics, 8th Edition, Jones and Bartlett Publishers London.
7. Klug W.S., Cummings M.R., Spencer C.A. and Palladino M.A., 2012, Concepts of Genetics, 10th Edition, Pearson Education Singapore.
8. Lewin B., 2007, Gene IX, Jones and Bartlett Publishers, Sudbury, Massachusetts.
9. Maloy S.R., Cronan J.R. and Freifelder D., 2009, Microbial Genetics, 2nd Edition, Narosa Publishing House, New Delhi.
10. Snustad P.D. and Simmons M.J., 2011, Principles of Genetics, 6th Edition, John Wiley & Sons.
11. Snyder L, Peters J.E., Henkin T.M. and Champness W., 2013, Molecular Genetics of Bacteria, 4th Edition, ASM Press.
12. Snyder L. and Champness W., 2007, Molecular Genetics of Bacteria, 3rd Edition, ASM Press.
13. Streips U.N. and Yasbin R.E., 2002, Modern Microbial Genetics, 2nd Edition, Wiley Publishers.
14. Trun N. and Trempey J., 2004, Fundamental Bacterial Genetics, 1st Edition, Blackwell Science Publishers.
15. Willey J., Sherwood L.M. and Woolverton C., 2007, Prescott/Harley/Klein's Microbiology, 7th Edition, McGraw Hill.



MBC 404: Genetic Engineering

Unit I

Basics of recombinant DNA technology: Enzymes used in recombinant DNA technology: Nuclease, DNA ligase, polymerase, reverse transcriptase, terminal deoxy-nucleotidyl transferase, alkaline phosphatase; Modification of restriction fragment ends: Sticky and blunt end ligation with linkers & adapters and homo-polymer tailing.

Unit-II

Cloning vector: Properties of plasmids, yeast plasmid (YAC), shuttle vectors, bacteriophages, cosmids, bacterial artificial chromosomes, Ti based vectors & retroviruses; Isolation and purification of genomic and plasmid DNA; Gene libraries: Genomic library, screening of libraries (shot gun approach) & cDNA library.

Unit –III

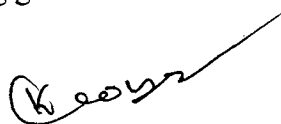
Introduction of recombinant vectors into bacterial and non bacterial cells; Selection of recombinant clones; Colony hybridization, Plaque hybridization, Immunochemical methods; Application of genetic engineering: Scientific, medical, industrial, agricultural and environmental applications; Human genome project.


Unit-IV

Polymerase chain reaction (PCR): Basic principle, components of PCR, PCR techniques: Standard PCR, Inverse PCR reverse transcriptase mediated PCR, Anchored PCR, Asymmetric PCR & Real time PCR; DNA sequencing: dideoxy method (Sanger sequencing), Chemical degradation (Maxam-Gilbert method); Strategies for sequencing large DNA fragments; Automated sequencing and pyro-sequencing; Brief description of probes: Types; RFLP, AFLP and RAPD; Southern, Western and Northern blotting, DNA Chip Technology & DNA Microarrays (Brief account).

Practicals:

1. Isolation of genomic DNA.
2. Restriction digestion of DNA.
3. Ligation of restricted DNA sample.
4. Perform agarose gel electrophoresis of DNA sample.
5. Visualization and documentation of genomic DNA using gel doc system.
6. Recovery of genomic DNA embedded in Agarose gels.
7. Separation of proteins using SDS PAGE.
8. Single colony isolation and checking genetic markers.
9. Southern hybridization technique.
10. Basic PCR technique.




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Books Recommended:

1. Adams M.R. and Moss M.O., 1995, Food Microbiology, Royal Society of Chemistry Publications, Cambridge.
2. Alberts B., Bray D., Hopkin D., Johnson A.D., Lewis J., Raff M., Roberts K., and Walter P., 2013, Essential Cell Biology, 4th Edition, Garland Sciences.
3. Alberts B., Johnson A., Lewis J., Raff M., Roberts K. and Walter P., 2007, Molecular Biology of the Cell, 5th Edition, Garland Science, New York and London.
4. Banwart G.J., 1993, Basic Food Microbiology, CBS Publishers and Distributors, Delhi.
5. Berg J.M., Tymoczko J.L. and Stryer L., 2002, Biochemistry, 5th Edition, W.H. Freeman and Company, New York.
6. Berg J.M., Tymoczko J.L. and Stryer L., 2006, Biochemistry, 6th Edition, W.H. Freeman and Company, New York.
7. Berg J.M., Tymoczko J.L. and Stryer L., 2012, Biochemistry, 7th Edition, W.H. Freeman and Company, New York.
8. Berg J.M., Tymoczko J.L., Gatto Jr. G.J. and Stryer L. 2015, Biochemistry, 8th Edition, Macmillan Education.
9. Brown T.A., 2010, Gene Cloning & DNA analysis, 6th Edition, Wiley Blackwell, New York.
10. Cruegar A. and Cruegar W., 2002, Biotechnology: A Text Book of Industrial Microbiology, 2nd Edition, Panima Publishing Corporation, New Delhi/Bangalore.
11. Frazier W.C. and Westhoff D.C., 1998, Food Microbiology, Tata McGraw Hill Publishing Company Ltd, New Delhi.
12. Hobbs B.C and Roberts D., 1993, Food Poisoning and Food Hygiene, 6th Edition, Edward Arnold (A division of Hodder and Stoughton, London).
13. Jay J.M., 1992, Modern Food Microbiology, 4th Edition, Van Nostrand Reinhold Co., New York.
14. Lewin B., 2007, Gene IX, Jones and Bartlett Publishers, Sudbury, Massachusetts.
15. Primrose S.B. and Twyman R., 2006, Principles of Gene Manipulation & Genomics, 7th Edition, Wiley –Publishers.
16. Robinson R.K., 1990, Dairy Microbiology, Elsevier Applied Sciences, London.

17. Sambrook J., Fritsch E.F. and Maniatis T., 2000, Molecular Cloning: A Laboratory Manual, Cold Spring Harbor Laboratory Press, New York.
18. Stanburg P.E., Whittaker A. and Hall S.J., 1995, Principles of Fermentation Technology, 2nd Edition, Pergamon Press.
19. Watson J.D., 2009, A Passion for DNA: Genes, Genomes & Society, Cold Spring Harbor Laboratory Press New York.
20. Watson J.D., Baker T.A., Bell S.P., Gann A., Levin M. and Losick R., 2007, Molecular Biology of the Gene, 6th Edition, Benjamin Cummings, San Francisco, USA.
21. Weaver R.F., 2007, Molecular Biology, 4th Edition, McGraw Hill, New York, USA.

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