**GONDWANA UNIVERSITY**
**GADCHIROLI**

# SYLLABUS

**For**

## M. Sc.

# MICROBIOLOGY

**SEMESTER III & IV**

**Under**
**Choice Based Credit System**

# (CBCS)

**(With effect from: 2017-18)**

**Scheme of teaching and examination under semester pattern Choice Based Credit System (CBCS) for M.Sc. Program in Microbiology.**

## Semester III

| | Theory/ Practical | Teaching Scheme Hrs/week | | | Credit | Examination Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Duration in hrs. | Max. Marks | | Total | Min. Marks | |
| | | Theory | Practical | Total | | | External | Internal | | Theory/ Seminar | Practical |
| | Paper - IX | 4 | - | 4 | 4 | 3 | 80 | 20 | 100 | 40 | |
| | Paper - X | 4 | - | 4 | 4 | 3 | 80 | 20 | 100 | 40 | |
| | Paper - XI | 4 | - | 4 | 4 | 3 | 80 | 20 | 100 | 40 | |
| | Paper - XII | 4 | - | 4 | 4 | 3 | 80 | 20 | 100 | 40 | |
| Pract-V | Practical - V | - | 8 | 8 | 4 | 6 | 80 | 20 | 100 | | 40 |
| Pract-VI | Practical - VI | - | 8 | 8 | 4 | 6 | 80 | 20 | 100 | | 40 |
| Seminar - III | Seminar - III | 2 | - | 2 | 1 | | | 25 | 25 | 10 | |
| **TOTAL** | | **18** | **16** | **34** | **25** | | **480** | **145** | **625** | **170** | **80** |

## Semester IV

| | Theory/ Practical | Teaching Scheme Hrs/week | | | Credit | Examination Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Duration in hrs. | Max. Marks | | Total | Min. Marks | |
| | | Theory | Practical | Total | | | External | Internal | | Theory/ Seminar | Practical |
| | Paper - XIII | 4 | - | 4 | 4 | 3 | 80 | 20 | 100 | 40 | |
| | Paper - XIV | 4 | - | 4 | 4 | 3 | 80 | 20 | 100 | 40 | |
| | Paper - XV | 4 | - | 4 | 4 | 3 | 80 | 20 | 100 | 40 | |
| | Paper - XVI | 4 | - | 4 | 4 | 3 | 80 | 20 | 100 | 40 | |
| Pract-VII | Practical - VII | - | 8 | 8 | 4 | 6 | 80 | 20 | 100 | | 40 |
| Pract-VIII | Practical - VIII | - | 8 | 8 | 4 | 6 | 80 | 20 | 100 | | 40 |
| Seminar - IV | Seminar - IV | 2 | - | 2 | 1 | | | 25 | 25 | 10 | |
| **TOTAL** | | **18** | **16** | **34** | **25** | | **480** | **145** | **625** | **170** | **80** |

# SEMESTER III

# Semester III

**Course code- ……..**

**PAPER –IX:** GENETICS AND MOLECULAR BIOLOGY (GMB)

**Unit -I: Replication, Repair and Recombination**

General concept of Genes, Genome, Recon, Cistron, muton, overlapping genes, genes within genes.

Replication—i) Initiation, priming in prokaryotes and eukaryotes, ii) Elongation of DNA chain, holoenzyme, processivity of replication, sub units of DNA pol-III,iii)Termination of replication in prokaryotes and eukaryotes iv) DNA repair:-BER,NER and Photoreactivation.

**Unit -II: Gene Expression**

Genetic code-Basic features

Transcription:- i) Comparative study of prokaryotic and eukaryotic transcription ii)Promoter classes I,II,III,-35 and -10 sequences, iii)RNA Polymerase, iv) Interaction of RNA polymerase with promoter. Initiation of RNA synthesis and promoter escape, v) Elongation of RNA chain. Enhancers and silencers, general and specific factors, vi)Termination of transcription—Extrinsic and intrinsic.

Post-transcriptional events:- mRNA, rRNA and tRNA processing through splicing mechanism, trans splicing , RNA editing, post transcriptional control of gene expression, RNA interference, catalytic RNA and anti-sense RNA.

Translation—Initiation, elongation and termination, mechanisms, Post translational modifications. chapperons.

**Unit -III: Gene Regulation**

Operon concept, *Lac* operon, *Arabino* and *trp* operon

Chromatin remodeling and mRNA and protein degradation control

Regulation of translation—Autogenous control of r-proteins, Phage$T_4$ Proteins, p32 translational regulation

**Unit -IV: Gene Recombinations**

Gene recombinations -Preliminary concept

Recombinations in microbes—transformation, conjugation and transduction

Gene mapping in bacteria by –transformation, conjugation and transduction

Mapping bacteriophage gene by recombination analysis, deletion mapping and complementation.

Transposons:- Bacterial P elements and retroposons

# Semester III

**Course code-**

**PAPER –X:**

**Recombinant DNA Technology (RDT)**

**Unit I: Techniques and Enzymes in Genetic Recombination**

Core techniques and enzymes in genetic recombination: restriction endonucleases,type I, II, III, recognition sequences, properties, nomenclature, classification of type II endonucleses, their activity, DNA ligase: properties and specificity, SI nuclease, BAL-31nuclease, DNA polymerase, polynucleotide kinase, phosphatase, reverse transcriptase, its activity and mode of action, chemical synthesis of DNA, restriction digestion, ligation and transformation.

**Unit II: Cloning Vectors**

Basic strategy of cloning-vectors (lambda gt10, gt11Bacteriophage, lambda replacement vectors, phage P1 vector, BACs, YACs, DNA cloning with single stranded DNA vectors, (M13 vectors), Cosmids, plasmid as a vector for gene cloning, phasmids and other advanced vectors, specialist purpose vectors for amplification and for expression (pETvector, pBAD vector), cloning and selection of individual gene, gene libraries: cDNA and genomic libraries, concept of library construction, differences and ideal examples of each library

**Unit III: Specialised Cloning Strategies**

Expression vectors, promoter probe vectors, vectors for library construction-artificial chromosome, recombinant DNA technology with reference to cloning and production of interferon and insulin, Miscellaneous applications of genetically engineered microorganisms (GEMS)/ genetically modified organisms (GMOs)

**Unit IV: PCR and DNA Sequencing Method**

PCR- principle and procedure, optimization of PCR, Designing of primers, identification of PCR products, variation in basic PCR- inverse, asymmetrical, multiplex, hot start, ligation mediated, RT, real-time quantitative PCR, DD PCR and immune PCR, applications of PCR

DNA sequencing method-dideoxy and chemical method, sequence assembly, automated sequencing, genome sequencing and physical mapping of genomes

# Semester III

**Course code- (DSE-I)**

**PAPER –XI:**

**Bioprocess Technology (BT)**

**Unit -I: General Principles of Fermentation**

Fermentations and Types- Definition of fermentation, industrial fermentations, classification of industrial fermentations based on different criteria

Concept of batch and continuous fermentation, mode of conduct of continuous fermentation and its type. Examples of growth associated and non growth associated fermentations.

Bioreactors- i) materials used in construction of fermentors, ii) design and parts of batch fermentor, their functions, iii) Geometry of fermentor , propellers, aerators their types, iv) types of bioreactors –plug flow reactors, CSTR, loop reactors, air-lift, fedbatch, fluidized bed reactors, rotary disc reactors, solid-state fermentors.

Process optimization—Mass and heat transfer, $Kl_a$, factors affecting oxygen transfer-rotational speed, rheology, liquid density, oxygen transfer rate , oxygen requirement, Newton number, Reynold number, Power number, mean resistance time, substrate utilization rate, oxygen snag, yield coefficient.

Fermentation Kinetics—Growth kinetics and Monods model, specific growth rate , growth limiting substrates , growth yield and kinetics of product formation.

Immobilized systems ,kinetics of immobilized reactors.

**Unit -II: Down Stream Processing and Scale Up**

Basic principles of scale up working parameters, geometric constants, Pi-relations.

Productivity , power requirements.

Downstream processing- i) Bioseperation—filtration, types of filters, membrane filters , centrifugation , sedimentation, flocculation. ii) Purification--- solvent extraction- concurrent & countercurrent extractors with examples. Distillation—single stage and fractional iii) Chromatographic techniques—ion exchange, affinity, gel filtration ,adsorption chromatography, principles and applications with examples. iv) Concentration , crystallization, reverse osmosis, ultrafiltration with one example each. v) Drying- techniques and process with example, Storage and packaging.

**Unit -III : Industrial Fermentations**

Biofuels—Ethanol from different sources such as saccharine, cellulosic, starchy waste by using *Saccharomyces cerevisiae & Zymomonas mobilis*, r-DNA technology for ethanol production.

Methane production.

Antibiotics—production of Streptomycin, Chloramphenicol, Cephalosporine

Biopreservatives – *L.sakei* , polyhydroxyalkanotes,

Biopolymers- Dextrans, xanthan

Steroid transformations

**Unit -IV: Industrial Production of Enzymes, Acids and Growth Factors**

Amylases—Deep tank and solid state fermentation and applications

Glucose oxidase – production and applications

Lactic acid from whey and its applications, vinegar

Vit-$B_{12}$

Riboflavin

Gibberlins

Carotenoides

# Semester III

**Course code-**

**PAPER –XII: Food Microbiology and Food Safety (FMFS)**

**Unit -I: Food Spoilage**

Introduction to food spoilage
Factors affecting food spoilage in general.
Spoilage of vegetables and fruits -factors and effects.
Spoilage of meat and meat products-factors and effects.
Spoilage of poultry products-factors and effects.
Spoilage of canned foods- meat and milk products- factors and effects.

**Unit -II: Food Safety and Quality Assurance**

Food infections and intoxications-
i )*Clostridium ii) B.cereus iii) Salmonella and Shigella iv) Staphyllococcus, v)Listeria, vi)Mycotoxins*
Foods involved, sources of these in food and pathological effects
Quality Assurance
i ) Microbiological quality and standards of food
ii) Food safety in food service establishments and other food areas—premises, equipments and utensils, storage, sanitary facilities, cleaning agents, disinfectants and sanitizers , health status of food handlers , waste disposal
Food Standards and Regulations in India and abroad--
i ) PFA ii) Food Safety and Standards Act in brief iii) BIS, iv) CODEX Allimantarius v) Risk analysis and HACCP in detail.

**Unit -III: Food Processing and Preservation**

Thermal processing—i) Cooking ii) Blanching iii) Commercial sterilization
Drying or dehydration---Theory and principles of drying
Drying techniques—i) Solar drying ii) Atmospheric drying iii) vacuum drying—tray dryers, tunnel dryers, belt dryers iv) drum dryers
Microwave drying, irradiation
Chemical and naturally occurring antimicrobials.
Biosensors in food industry.

**Unit -IV: Food Fermentations**

Fermented vegetables—Saurkraut and Pickles
Fermented fish
Fermented meat--Sausages
Curd and Shrikhand,
Probiotic foods- Youghurt, Applications of probiotic food as nutraceuticals
GM Foods

**Practical V**

1) Isolation of Genomic DNA from Bacteria.
2) Agarose Gel Electrophoresis.
3) Isolation of Plasmid DNA.
4) Restriction Digestion of λ DNA.
5) Amplification of DNA by PCR.
6) Gene Cloning: - Cloning of GFP Gene
7) Southern Hybridization (Demonstration).

8) RFLP Analysis.
9) Detection of gene transfer by transformation in *E.coli.*
10) Detection of gene transfer by conjugation in *E.coli.*
11) Demonstration of transduction.
12) SDS- PAGE and protein separation.
13) Demonstration of UV induced mutagenesis in E.coli.
14) Testing of chemicals for mutagenesis by Ame,s test.
Minimum **seven** experiments must be performed

**Practical VI**

1) Determination of microbial kinetics for an inhibitory substrate in a fed batch.
2) Determination of Oxygen Transfer Rate (OTR) in submerged fermentation.
3) Determination of Specific Growth Rate and Growth yield ( $Y_{x/s}$) of biomass production by yeast.
4) Product yield for Ethanol production.
5) Production of microbial products in Bioreactors
a. Amylase and Protease production
b. Assay of Amylase and Protease
6) Microbiological assays Vit.$B_{12}$/Vit$B_2$ .
7) Microbial production of Dextran and assay by spectrophotometric / Viscometric methods.
8) Saurcraut fermentation.
9) Extraction of Aflatoxin by TLC.
10) Determination of microbial quality of packed foods by BIS methods
11) Proximate Analysis of foods.
12) Determination of TDP and TDT.
13) Extraction of carotenoides and spectrophotometric assays.
14) Production & assay of Penicillin.

Minimum **seven** experiments must be performed

# SEMESTER IV

# Semester IV

**Course code-**

**PAPER –XIII: MEDICAL MICROBIOLOGY AND PARASITOLOGY (MMP)**

**Unit – I: Basic Medical Microbiology**

Infection, types of infections, infection process, bacteremia, septicemia, pyaemia, sapremia, toxemia.

Disease, types of diseases, stages of infectious disease, sign and symptoms.

Establishment of causative agent of disease, Koch's postulates, Rivers's postulates.

Normal flora of human body, skin, mouth, eye, respiratory tract, digestive tract, urogenital tract, beneficial and harmful roles.

Concept of epidemiology, control of communicable diseases.

Pathogenicity and Virulance, factors responsible for virulence, attenuation, methods of attenuation.

**Unit II : Clinical Microbiology.**

Collection, isolation and identification of pathogenic bacteria from the specimens.

a) Blood b) Urine c) Feces/Stool d) Sputum e) Wound/Burn f) CSF g) Throat swab.

Study of pathogenic bacteria (morphology, cultural characters, antigenic structure, pathogenesis and Laboratory diagnosis a) *Streptococcus pyogenes* b) *Diplococus pneumoniae* c) *Corynbacterium diptherae* d) *Clostridium tetani* e) *Yersinia pestis* F) *Coxiella burnetti*

**Unit III : Medical Mycology**

Morphology cultural characters, pathogenesis and Laboratory diagnosis of

*a) Sporotrichum schenkii b) Histoplasma capsulatum c) Blastomyces dermatidis d) Trichophyton rubrum. e) Candida albicans f) Cryptococcus neoformans*

**Unit IV: Parasitology**

Study of pathogenic protozoa, helminths and Cestodes.

Protozoa- *a) E. histolytica b) Leishmania donovani c) Trypanosoma gambiense d)Plasmodium vivax.*

Helmiths and Cestodes : *a) Ascaris lumbricoides b) Taenia solium c) Ancylostoma duodenale d)Wuchereria bancrofti e) Schistosoma haematobium.*

# Semester IV

**Course code-**

**PAPER –XIV: Virology (VIR)**

**Unit I: Basic Virology**

History and principle of virology, Origin and evolution of viruses, Differentiation with other group of microorganism, Nomenclature and classification of viruses- criteria used for naming, classification of viruses, recent ICTV classification of viruses ( as per 9th edition, 2008), Morphology and structure of viruses- enveloped and non enveloped viruses, Capsid symmetry- icosahedral, polyhedral and helical, Brief account of multiplication of viruses, virus related agents (viroids and prions), modes of transmission of viruses

**Unit II: Cultivation and Assay of viruses**

Cultivation of viruses using embryonated egg , experimental animal and cell culture (cell lines, cell strains and transgenic systems), Purification of viruses by adsorption, precipitation, enzymes, serological methods-haemagglutination and ELISA, Assay of viruses: physical and chemical methods (protein, nucleic acid studies, radioactivity tracers and electron microscopy ), infectivity assay( plaque method and end point method)

**Unit III: Bacterial And Plant Viruses**

Bacterial Viruses- Classification and nomenclature, Bacteriophage structural organization; life cycle: lytic and lysogenic cycle, application of bacteriophages; brief details on M13,Mu,T3,T4, and Lamda P1. Viruses of cyanobacteria, algae, fungi. Plant Viruses- Classification and nomenclature;Structureand life cycle of plant viruses. Propagation, purification, characterization, identification and genomics of plant viruses like TMV, Cauliflower MosaicVirus ,Gemini virus and Potato Virus X Symptoms of plant virus diseases, Transmission of plant viruses,Viral diseases and their control.Some common viral diseases of plants.

**Unit IV: Animal viruses, Antivirals And Viral Vaccine**

AnimalViruses-Classification and nomenclature;Structure and lifecycle of animal viruses. Replicative strategies employed by DNA and RNA viruses. Epidemiology, pathogenicity, diagnosis, prevention and treatment of picorna, Ortho myxo, Paramyxo, Toga, Rhabdo, Rota, Pox, Herpes, Adeno, Hepatitis, HIV and other Oncogenic viruses; viral vaccines (conventional vaccines,genetic recombinant vaccines used in national immunisation programmes with examples, newergeneration vaccines including DNA Vaccines with examples) interferons, and antiviral drugs.

# Semester IV

**Course code-**

**PAPER –XV: Immunology**

**Unit -I: Basic Immunology**

Structure and functions of primary and secondary lymphoid organs and lymphoid tissues.

Development, structure and functions of lymphoid cells, B-lymphocytes, T-lympholyte, types of T-lymphocyte, comparision between B and T lymphocyte, other lymphoids cells – macrophage, Ag presenting cells, killer cells.

Humoral and cellular immune response, $I_{ry}$ and $II_{nry}$ immune response, comparision, mechanism of humoral and cellular immunity, thymus dependent and independent antigens, biological functions active and passive immunity, comparision.

Complement system, activation pathways, regulation and biological functions.

MHC complex and MHC molecules.

**Unit -II : Antigens, Antibodies and Antigen-Antibody Reaction**

Antigen – Complete antigen, hapten, Adjuvant, types of antigens, characters determining antigenicity, Blood group antigens.

Antibody – general structure of antibody/Immunoglobulin molecule, digestion, types of immunoglobulins, structure and functions, idiotypic, allotypic determinants,isotypic.

Theories of Antibody production, monoclonal antibodies and their applications, hybridoma technology.

Antigen- Antibody reactions : Mechanism and applications i) Agglutination ii) Precipitation iii) Complement fixation

Other immunological techniques – Immunofluorescence, ELISA, RIA, Western blotting, Southern blotting .

**Unit –III : Hypersensitivity and Autoimmunity**

Classification of hypersensitivity, Immediate and delayed hypersensitivity, examples, pathogensis of anaphylaxis, Sytemic Lupus Erythematosus, Arthus reaction and Serum sickness, immune complex, Contact dermatitis, tests to detect hypersensitivity.

Immunological tolerance and Immunosuppression, B-cell tolerance, T-cell tolerance, Artificially induced tolerance.

Antoimmunity, causes, autoimmune disorders, types and examples, organ specific and non organ specific.

Pathogenesis of Rheumatid arthritis, Myesthenia gravis, Hashimoto's disease, Graves disease.

**Unit -IV : Tumour and Transplant Immunology.**

Tumours of lymphoid cell – Lymphoma, Myeloma, Hodgkin disease.

Host's immune response to tumour, mechanism, oncogenes and cancer induction, tumour antigens, immunesurveillance.

Diognosis of tumour – biochemical and immunological tumour markers.

Approaches in cancer immunotherapy.

Immunology of graft rejection, Allograft, heterograft, mechanism of graft rejection.

Immunosuppresive therapy, specific and non specific.

Clinical transplant.

# Semester IV

**Course code-**

**PAPER –XVI: Biostatistics and Bioinformatics**

**Unit – I: Biostatistics I**

Basic concepts: definitions – statistics and biostatistics, population, sample, variable and the various types, statistic and parameter.

Tabular and diagrammatic presentation – arrays, frequency distribution, bar diagrams, histograms and frequency polygons.

Descriptive statistics: measures of central tendency, dispersion, skewness and kurtosis.

Probability: definition, elementary properties, types , rules, applications to biological problems, distributions – Binomial, Poisson, Normal, chi-square ($\chi_2$) distribution and test.

Inference about populations: sample size, sampling distribution, standard error, estimation of population mean-confidence interval, Student's t-distribution and its applications (t-test).

Sampling methods: principles of sampling, necessity – merits and demerits, random sampling – lottery, geographical arrangement random number; deliberate or nonrandom sampling, stratified sampling, cluster sampling.

**Unit – II: Biostatistics II**

Hypothesis testing: definition of hypothesis, hypotheses- null and alternate hypotheses, general procedure, type I and type II errors.

Analysis of Variance (ANOVA) : basic concepts, experimental designs – CRD, RBD, factorial experiment, repeated measures, other designs, general method, F-test, multiple comparison tests.

Correlation: introduction, types, methods of study – scatter diagram, correlation graph, Karl Pearson's coefficient of correlation and its interpretation, test of significance.

Regression: introduction, simple linear regression – model, equation, least-squares line, evaluating and using the multiple regression equation.

**Unit – III: Bioinformatics**

Bioinformatics : Definition, Components, Databases – definition, biological databases, types and examples data base management. system (DBMS)

The biological sequence, expressed sequence tag (EST) Protein Data Bank (PDB)

Folding problems, chaperons Sequence analysis.

Homology and analogy.

Information networks – Web browser, HTTP, HTML and URLs.

EMB-net, The national Center for Biotechnology Information – NCBI.

**Unit – IV: Proteomics and Genomics**

Biological databases, Primary sequence databases.

Composite protein sequence databases, secondary databases, Sequence analysis – Pairwise sequence comparison, protein data bank, Swiss prot, composite protein pattern databess.

Sequence queries against biological databases BLAST and FASTA, Multiple sequences alignments, Phylogenetic alignment.

Genome information resources –DNA sequence databases, specialized genemic resources.

DNA sequence analysis – Gene structure and DNA sequences, features of DNA sequence analysis, Issues in the interpretation of EST searches, approaches to gene building expression profile of a cell. cDNA libraries and ESTs, Different approaches to EST analysis- A practical example of EST analysis.

Predicting protein structure and function from sequence- Determination of structure $II_{ry}$ and 3D structure protein modeling, Drug discovery and development: Fundamental Principles,

rational drug design, role of protein interaction resources, chemoinformatics and pharmo informatics resources, Pharmacogenomics.

**PRACTICAL**

1. Diagnostic method for isolation and identification of pathogenic microorganism from following specimens.

a) *S. aureus* from pus/wound/burn.

b) *Coryobacterium diptherae* from throat swab.

c) *M. tuberiulosis* from sputum.

d) *V.cholerae/Sh. dysenteric/ E. histolytica* from stool

e) *S.typhi and S.paratyphi* A B from blood/urine

f) *N.meningitidis* from C S F

g) Dermatophytes from skin scrapings.

2. Diagnosis of Typhoid and Paratyphoid A, B fever by Widal tube test.

3. Diagnisis of Hepatis B by Australia latex Antigen test.

4. Rheumatoid arthritis (RA) test.

5. ELISA test to detect HIV and HBs

6. Kahn tube test to detect Syphilis

7. Treponema palladium haeagglutination test(TPHA)

8. Immunoelectrophoresis(Demonstration)

9. Quantitative determination of plasma proteins by immunoelectrophoresis.

10. Single radial immunodiffusion ( RIA)

11. Ouchterlony Immuno- double diffusion .

12. Estimation of infectivity titre of a virus sample using plaque assay.

13. Study of virus infected plant material

14. Cultivation of animal viruses by different routes in embryonated chicken/duck eggs Yolksac, Allantoic and Chorio allantoic membrane (CAM) routes.

15. Representation of Statistical data by

a) Histograms b) Ogive Curves c) Pie diagrams d) Use of statastical software (SPSS)

16. Determination of Statistical averages/ central tendencies.

a) Arithmetic mean b) Median c) Mode

17. Determination of measures of Dispersion

a) Mean deviation

b) Standard deviation and coefficient of variation

c) Quartile deviation

18. Tests of Significance-Application of following

a) Chi- Square test b) t- test c) Standard error

19. Using biological databases - Swissprot - Protein Data Bank and Genbank.

20. Different types of sequence analysis queries in BLAST and FASTA.

21. Genomes and Proteomes available on the web and their use.

Minimum **Ten** experiments must be performed in the semester.

**Project/Seminar**

**LIST OF RECOMMENDED BOOKS FOR THEORY AND PRACTICALS (Semester III & IV)**


1) Microbial Genetics –Maloy et.al-1994 ,Jones –Bartlet learning .

2) Molecular Genetics of Bacteria – Dale 1994 ,John Wiley & Sons.

3) Modern Microbial Genetics ,1991-Strepis & Yasbin ,Niley Ltd.

4) Gene VII by Lewin Oxford University Press 2000.

5) Bacteria & Bacteriophage Genetics 4th Ed.—Birge

6) DNA repair & Mutagenesis, 1995—Errol C.Friedberg, Grahm C.Walker & Wolfram ,Siede,ASM Publications.

7) Molecular Genetics of Bacteria, 1997—Larry ,Snyder & Wendy Champness ,ASM Publications

8) Methods of General & Molecular Bacteriology ,1993 Edited by Philip,Gerhardt,ASM Publications

9) Recombinant DNA by Watson ,J.D.

10) Essentials of Molecular Biology – Malcimski

11) Mobile DNA II—Nancy Craig, Martin Gellet , Allam Lambowitz.

12) Principles of Gene Manipulations 1994 by Old and Primrose Blackwell Scientific Publications.

13) DNA Cloning: A Practical Approach by D.M. Glower and B.D. Hames, IRL Press, Oxford. 1995.

14) Molecular Biotechnology 2nd Edition by S.B. Primrose. Blackwell Scientific Publishers, Oxford. 1994.

15) Genetic Engineering and Introduction to Gene Analysis and Exploitation in Eukaryotes by S.M. Kingsman and A.J. Kingsman, Blackwell Scientific Publications, Oxford 1998.

16) PCR Technology - Principles and Applications for DNA Amplification by Henry A. Erlich (Ed.) Stockton Press. 1989.

17) Biotechnology: A Guide to Genetic Engineering by Peters.

18) Genetic Engineering – 2000 by Nicholl.

19) Recombinant DNA and Biotechnology: Guide for Teachers. 2nd Edition by Helen Kreuz. 2001.ASM Publications.

20) Cell and Molecular Biology by E.B.P. De Robertis, Lippincott Williams & Wilkins.

21) Molecular Cell Biology by Lodish & Baltimore.

22) Molecular Biology of the Gene by Watson Roberts, Steitx Wainer, The Benjamin/Cummings Publishing Company Inc.

23) Microbial Genetics by Stanley R. Maloy, John E Cronan Jr., David Freifelder Jones and Bartleh Publishers Inc.

24) Essentials of Genetics by Russell.

25) Genetics by Gardener.

26) Genetics by Tamrin.

27) Genetics by Strickberger.

28) Modern Genetic Analysis by Griffith.

29) Bacterial and Bacteriophage genetics by E.A. Birge Springer.

30) Biochemistry (2002) Styer, 5th Edition, W.H. Freeman and Co.

31) Molecular Biology (1999) by Robert F.Weaver. 1st Edition. WCB –Mc Graw Hill.

32) Molecular Biotechnology: Principles and Applications of Recombinant DNA. 2 nd Edition. 1998 by Bernard R. Glick and Jack J. Pastemak, ASM Publications.

33) From genes to clones by Winnaker.
34) Manipulations and expression of recombinant DNA by Robertson.
35) Gene targeting – A practical approach by Joyner.
36) Bacterial and Bacteriophage Genetics.By:EdwardA.Birge.
37) Molecular Biology of the geneBy:J.D.Watson,N.h.Hoppkins,J.W.Roberts,J.A.Steitz
38) Microbial Genetics.By:Maloy{T.A}.Jones and Bartlett publications.
39) Methods of General and Molecular biotechnology.By:Philip Gerhardt ASM publication.
40) Genome- T.A.Brown
41) Molecular biology.By;F.Weaver.WCB/MCGraw Hill.
42) Genetic EngineeringBy: SandyaMitra.
43) Environmental MicrobiologyBy: RalphMitchell, John Wiley and Sops.Inc.
44) Environmental BiotechnologyBy:C.F.Froster and D.A.JohnWase,ElisHorwood.
45) Genetics A Molecular Approach.By:PeterJ.Russell.
46) Brock Biology of Microorganisms.By:John M. Martinko.
47) Molecular characterization of bacterial isolates from RAM(measuring microbiome)-Vijay wadhai and Hariom Powar- Lambert Academic Press, Germany
48) Principles of fermentation Technology by Stanbery,P.P.,Whitekar A.& Hall 1995, Pregman ,McNew & Harvey.
49) Fermentations –A Practical approach IRL
50) Bioprocess Technology: Fundamentals & Applications ,Stockholm KTH.
51) Biochemical Reactions by Atkinson B., Pion Ltd. London
52) Fermentation BioTechnology : Industrial perspectives by Chan.
53) Biochemical Engineering Fundamentals by Bailey & Ollis ,TMH, N.Y.
54) Biotechnology Vol-3 Edited by H.J.Rehm & G.Reed ,Verlag Chemie,1983
55) Advances in Biochemical Engineering by T.K.Ghosh. A. Fichter & N.Blackbrough, Springer Verlag N.Y.
56) Biotechnology –A Text Book of Industrial Microbiology by Crueger & Cruger, Sinaeur Associates
57) Bioprocess Engineering Kinetics , Mass Transport Reactions & Gene expression By Veith W.F.,Jhon Wiley & sons.
58) Industrial Microbiology by Casida L.E.Jr. Wiley Eastern
59) Bioseperation : Downstream processing for Biotechnology by Belter P.A.,Cussler E L.& Hu,W.S Jhon Wiley & Sons N.Y.
60) Seperation Processes in Biotechnology by Asenja,J.A. ,Marcel Dekkar N.Y.
61) Bioprocess Engineering Principles by Doran Aconad.Press ,London
62) Biotechnological Innovations in Chemical Synthesis BIOTOL. Publisher/ Butterworth – Heinman
63) Industrial Microbiology by G.Reed (Ed.) CBS Publishers (AVI Publishing)
64) Biology of Industrial Microorganisms by A.L.Demain.
65) Annual Reports in Fermentation Process by D.Pearlman, Academic Press
66) Annual Review of Microbiology by Charles E. Cliffton
67) Manual of Industrial Microbiology & Biotechnology 2nd Edition by Davis J.E.& Demain A.L.ASM
68) Banwart G.J.(1980) Basic Food Microbiology, AVI, New York

69) Holds Worth S.D.(1992) ,Aseptic Processing & Packaging of Food Products, Elsevier Applied Science N.Y.
70) Jay, James M. (1996), Modern Food Microbiology, AVI, N.Y.
71) Roberts D., Hooper,W.& Greenwood,M.(1995) Practical Food Microbiology,PHLS,London.
72) Varnam,A.H., Evans, M.G.(1991), Food borne pathogens, Wolfe Publish.Jing,USA.
73) Forsythe,S.J.(2000) Basic aspects in the Microbiology of safe food, Blackwell Science Ltd.
74) Frezier W.C. & Westoff D.C.(1992), Food Microbiology,TMH.
75) Garbutt J.,(1997) Essentials of Food Microbiology,Arnold
76) Ray,B.(2001), Fundamentals Food Microbiology 2nd Ed.CRC Press, Boca Ranton Fl
77) FAO Statement on Biotechnology, March 2000,"CODEX ALIMANTARIUS Ad Hoc Intergovernmental Task Force on foods derived from Biotechnology"
78) Marriot, G.Norman (1997), Essentials of food sanitation, Chapman & Hall
79) The Prevention Food Adulteration Act,1954 & 1955 Rules
80) Martimore,Sara & Wallace, Carol(1994),HACCP—A Practical Approach, Chapman & Hall
81) Risk Management & Food safety (1997), Report of a Joint FAO/WHO Cosultation Rome, Italy 27-31January 1997
82) Brooker, B.E.(1985), Food Theory & Application, 2nd Ed. Macmillon N.Y.
83) Charley Helen (1982) Food Science, 2nd Ed Jhon Wiley & Sons N.Y.
84) Potter, Norman N.& Hotchkiss (1996) Food Science ,5th Ed. CBS Publishers.
85) Kirk ,Ronald R & Sawyer(1991), Composition & Analysis of Foods, 9th International Ed., Addison Wesley Longman Ltd.
86) Manay,N., Shakuntala & Shadaksharaswamy N(1987) Food: Facts & Principles Wiley Eastern.
87) Gaman, P.M. & Sherington ,K.B.(1996), The Science of Food,Oxford, Butterworth-Heinmann.
88) Jellinick,G(1985) Sensory Evaluation of Food: Theory & practice, Ellis Howard Ltd. England.
89) Winton, Andrew L & Winton , Kate Barber(1999), Techniques in Food Analysis, Allied Publishers.
90) Sanjeev Patankar (2011) Food Fermentations: Micronutrient Fortification For Tribal Food, Lambert Academic Publishing House , Germany
91) Paul L.Knechtges, Food Safety Theory & Practice, Jones-Bartlet learning,5,Wall street,Burlington MA 01803 800-832-0034
92) Probiotic Foods in Health & Diseases—Editors- G.Balkrish Nair, Yoshifumi Takeda , Oxford & IBH Publishing , New Delhi.( 2011)
93) Bioinformatics. 1998 by Baxevanis
94) Bioinformatics 2000 by Higgins and Taylor OUP.
95) Nucleic acid Research 2001. Jan. Genome database issue.
96) The Internet and the new Biology: Tools for Genomics and Molecular Research by Peruski, Jr. and Peruske (ASM) 1997.
97) Functional Genomics. A Practical Approach Edited by Stephen P Hunt and Rick Liveey (OUP) 2000.
98) DNA microarrays: A practical approach edited by Mark Schena (OUP)
99) Bioinformatics - A Practical Guide to the Analysis of Genes and Proteins. 2nd Edition by Baxevanis.
100) Bioinformatics: Sequence, structure and Data Bank: A Practical Approach by Higgis.
101) Bioinformatics - from Genomes to drug. 2 volumes by Lenganer.

102) Bioinformatics Methods and Protocols - Misener.
103) Bioinformatics: Sequence and Genome analysis.
104) Introduction to Bioinformatics by Altwood.
105) Fundamental Biostatistics- Sadguru Prakash, Emkay Prakashan, New Delhi
106) Proteome Research: New Frontiers in Functional Genomics: Principles and Practices.
107) Genomics: The Science and Technology behind the human project.
108) Protein Biotechnology. Edited by Felix Franks. Humana Press, Totowa, New Jarsey.
109) Protein Engineering: Principles and Practice by Cleland.
110) Computer analysis of sequence data by Colte.
111) Bioinformatics and molecular evolution – P.G. Higgs & T. K. Attwood, 2005 Blackwell Publishing
112) Bioinformatics by David Mount
113) Bioinformatics- Introduction to Bioinformatics by Pevzner
114) Microarray- Gene expression Data analysis by Causton, Brazma 2003 Blackwell Publishing
115) Essential Bioinformatics by JIN XIONG 2006 Cambridge University press.
116) Microarray Data Analysis Methods and Applications Edited by Michael J. Korenberg 2007 Humana Press Inc.
117) Virology: 1994. 3rd Edition. Frankel-Conrat . Prentice-Hall
118) Principles of Virology: 2004 Second Edition by S.J.Flint et al., ASM press
119) Introduction to Modern Virology: 2001.5th edition. Dimmock et al., Blackwell Sci.Publ
120) Principles of Molecular Virology, 2001, 3rd edition A.Cann. Academic Press
121) Basic Virology, 1999, by Waginer and Hewelett, Black Well Science Publ
122) Medical Virology, 1994, 4th edition. D.O.White and F.J.Fenner, Academic Press.
123) Plant Virology, 2001, 4th edition by R.Hull, Academic Pres.
124) Fundemental Virology, 4th edition 2001, D.M.Knipe and P.M.Howley.
125) Veterinary Virology. 3rd edition 1999, Murphy et al., Academic press.
126) Encyclopedia of Virology. 1994. R.G.Webster and Allan Granoff Vol I, II, III,Academic Press.
127) Kuby ImmunologyBy:Kindt,Goldsey,Osborne.
128) ImmunologyBy:DavidMale,Jonathanbrostoff,DAVID B ROTH,IvanRoitt.
129) ImmunologyBy:Roitt,Brostoff,male.
130) The elements of ImmunologyBy:FahimHalim Khan.
131) Immunology By:RichardA.Goldsby,Thomas J Kindt,Barbaraa.Osborne,Janiskuby.
132) Fundamental immunology -WilliamE.Paul.
133) Immunology and Immunopathology by Stewart.
134) Cellular and Molecular Immunology by Abul K. Abbas *et al.*
135) Textbook of Immunology by Barret.
136) Essential Immunology by Roitt, Brostoff, Male, Harcourt Brace & Company (5thEdition), Mosby (6th Edition)
137) Immunobiology – The immune system in Health disease by Janeway andTravers. 1994.
138) Immunology – An introduction by Tizard.
139) Text book of Imunology by Unani and Benacerraf
140) Immunology – A short course by Benjaini, Sunshine and Lesrowitz.
141) Basic and Clinical Immunology by Stites, Terr and Parslow.

142) Immunology by Herman N. Eosen.
143) Molecular Basis of Immunology by Constantin Bena.
144) Immunology – The science of self-Non-self discrimination by Jan Klein.
145) Fundamental Immunology by R.M.Coleman, M.F. Lombard and R.E. Sicard.Wm.C.Brown Publishers.
146) Immunology by R.M. Hyde, B.I. Waverly Pvt. Ltd.
147) viruses.2006.M.V.Nayudu. Prentice Hall Publication slides
148) Microbiology: A laboratory manual by CAPPUCCINO & SHERMAN
149) Laboratory Experiments in Microbiology by Gopal Reddy, M.N.Reddy, D.V.R. Sai Gopal and K.V.Mallaiah,
150) Microbiology -Practical Manual by Reddy S.M. & Reddy S.R., Books Selection
151) Centre, Hyderabad.
152) Laboratory Exercises in Organismal and Molecular Microbiology by S.K.
153) Alexander, D.Strete and M.J. Mily, Mc. Graw Hill, USA.
154) Microbiology – A Laboratory Manual by J.G. Cappunico and N.Sherman, 4th Edition, Addison Welsley Longman Inc., England.
155) Laboratory Manual in Microbiology by P.Gunashekaran, New Age International Private Limited Publishers, New Delhi.
156) Laboratory Manual in General Microbiology by N. Kannan, Panima Publishing Cooperation, New Delhi.
157) Practical Microbiology by R.C. Dubey and D.K. Maheswari, S.Chand & Company Limited, New Delhi.
158) Bergy's Manual of Determinative Bacteriology By J.G.Holt, N.R.Krieg, P.H.A.
159) Microbiology Laboratory Exercises BY Barnett, Mc. Graw Hill, U.S.A.
160) Microbiology applications: a Laboratory Manual in General Microbiology by Benson, Mc. Graw Hill, U.S.A.
161) Medical microbiology-Mims, Playfair,Roitt, Wakelin & William( Mosby)
Schaums Outline-Microbiology(TMH)