ಬೆಂಗಳೂರು
ನಗರ ವಿಶ್ವವಿದ್ಯಾನಿಲಯ

BENGALURU CITY UNIVERSITY

Office of the Registrar, Central College Campus, Dr. B.R. AmbedkarVeedhi, Bengaluru – 560 001.
PhNo.080-22131385, E-mail: registrar@bcu.ac.in

No.BCU/BoS/SEP/Micro-Biotech-UG/ 146 /2025-26 Date: 24.07.2025.

NOTIFICATION

Sub: B.Sc. III & IV Semesters Microbiology & Biotechnology Syllabus of Bengaluru City University-reg.

Ref: 1. Recommendations of Board of Studies in the Microbiology & Biotechnology (UG)
2. Academic Council resolution No.03 dated. 09.07.2025
3. Approval of the Vice-Chancellor dated.24.07.2025

****

In pursuance of the resolution of the Academic Council under ref (2) above and with the approval of the Vice-Chancellor the Syllabus of III & IV Semester Microbiology and Biotechnology subject, recommendation in the BoS in Microbiology & Biotechnology (UG) is hereby notified for information of the concerned. This Syllabus will be effective from the academic year 2025-26.

The copy of the Syllabus is notified in the University Website: www.bcu.ac.in for information of the concerned.

REGISTRAR

To:
The Registrar (Evaluation), Bengaluru City University, Bengaluru.

Copy to;
1. The Dean, Faculty of Science, BCU.
2. The Chairman & Members of BoS in Microbiology and Biotechnology (UG), BCU.
3. The P.S. to Vice-Chancellor/Registrar/Registrar (Evaluation), BCU.
4. Office copy / Guard file / University Website: www.bcu.ac.in

ಬೆಂಗಳೂರು ನಗರ ವಿಶ್ವವಿದ್ಯಾಲಯ
BENGALURU CITY UNIVERSITY

CHOICE BASED CREDIT SYSTEM
(As per SEP 2024)

Syllabus for III & IV Semester
B.Sc. Microbiology (2025-26)

BENGALURU CITY UNIVERSITY
REGULATIONS & SYLLABUS FOR MICROBIOLOGY
in
Three-Year B.Sc. Course (SEP 2024)

Scheme of Instruction/ Examination:

1. The theory question paper for each paper shall cover all the topics in the pertaining syllabus with proportional weightage to the number of hours of instruction prescribed.
2. The practical Classes are to be conducted in batches of 10 students per batch (maximum 12) per teacher as per the University norms for the faculty of science for giving instructions, explaining the principles of experiments, supervising the conduct of experiments and correction of Records.
3. It is expected that each student conducts and learns the experiments in the practical classes.
4. Students are required to use biotechnology instruments and tools to run the experiments and record the outputs to the practical records in each practical class.
5. Maximum marks for practical records in the examinations is 5.
6. A study tour or visit to industries and research institutes for the students is strongly recommended to gain practical knowledge of applications of Biotechnology in Industries/Agriculture/Medical field and research.

B.Sc. CREDIT BASED SEMESTER SCHEME

MICROBIOLOGY

SCHEME OF INSTRUCTIONS AND CREDITS

Paper No.	Title of the paper	Type of paper	Hours/ Week	Duration of Exam (Hours)	IA	Exam	Total Marks	Credits
III SEMESTER								
MBT -301	Biomolecules, Bioenergetics & Metabolism	T	4	3	20	80	100	3
MBP -302	Biomolecules, Bioenergetics & Metabolism	P	3	3	10	40	50	2
Elective – I	Biostatistics and Intellectual Property Rights	T	2	1½	10	40	50	2
							200	7

IV SEMESTER								
MBT -401	Genetics & Molecular Biology	T	4	3	20	80	100	3
MBP -402	Genetics & Molecular Biology	P	3	3	10	40	50	2
Elective – II	Computational Biology with AI Applications	T	2	1½	10	40	50	2
Compulsory Practical	Computational Biology with AI Applications	P	3	3	10	40	50	2
							250	9

Internal assessment:
Theory: (20)
(a) Tests and assignments – 15
(b) Attendance - 05

Practical: (10)
(a) Tests – 10

B.Sc. SEMESTER SCHEME (SEP 2024)
MICROBIOLOGY
SCHEME OF THEORY EXAMINATION

Duration: 3 Hours **Max.Marks: 80**

I.	Answer any 10 of the following: (out of 12) Questions 1 to 12	10 x 2 marks = 20 Marks
II.	Answer any 6 of the following: (out of 8) Questions 13 to 20	6 x 5 marks = 30Marks
III.	Answer any 3 of the following: (out of 5) Questions 21 to 25.	3 x 10 marks = 30 Marks

BANGALORE UNIVERSITY, BANGALORE
Syllabus for B.Sc., Microbiology
CBCS, SEMESTER III

MBT-301 – Biomolecules, Bioenergetics & Metabolism

Sessions Per Week	Total Contact Hours	Marks		Duration of Examination	Total Marks
		Internal Assessment	End Semester Exam		100 Marks
4	56	20 marks	80 marks	3 hours	

Unit 1: Biochemical Concepts & Biomolecules	**14 hours**
Biological Solvents: Structure and properties of the water molecule; water as a universal solvent; polarity of water; hydrophilic and hydrophobic interactions; acids, bases, and electrolytes; concepts of pH and biological buffers.	**4**
Biomolecules – Carbohydrates: Definition, classification, structure and properties.	**3**
Amino acids and proteins: Definition, structure, classification and properties of amino acids, structure and classification of proteins.	**4**
Lipids and Fats: Definition, classification, structure, properties and importance of lipids; fatty acids: types and classification.	**3**
Unit 2: Basics of Enzymes	**14 hours**
Introduction to enzymes – Definition, enzyme unit, specific activity and turnover number, exo/endoenzymes, constitutive/ induced enzymes, isozymes. Monomeric, Oligomeric and Multimeric enzymes.	**3**
Multienzyme complex: Pyruvate Dehydrogenase; Isozyme: Lactate Dehydrogenase. Ribozymes, Abzymes.	**3**
Structure and Function of Enzymes: Structure of enzymes: Apoenzyme and cofactors; prosthetic groups (e.g., TPP); coenzymes (e.g., NAD); metal cofactors. **Classification of enzymes:** Mechanism of enzyme action: active site, transition state complex, and activation energy. **Models of enzyme action:** Lock and Key hypothesis and Induced Fit hypothesis. **Enzyme inhibition:** Competitive, non-competitive, uncompetitive, and feedback inhibition.	**8**
Unit 3: Bioenergetics and Respiration	**14 hours**
Bioenergetics: High energy compounds: classification, structure and significance, oxidation reduction reactions, equilibrium constant, redox potential.	**3**
Microbial Respiration: Electron transport chain, substrate level phosphorylation, oxidative phosphorylation, structure and function of ATP synthase and ATP synthesis.	**4**
Chemolithotrophic metabolism: Oxidation of Hydrogen, Sulphur, Iron and Nitrogen. Anaerobic respiration with special reference to dissimilatory nitrate reduction and sulphate reduction.	**3**
Microbial Photosynthesis: Light reaction: Light harvesting pigments, Photophosphorylation, CO_2 fixation pathways: Calvin cycle, CODH pathway, Reductive TCA pathway.	**4**
Unit 4: Metabolism	**14 hours**
Breakdown of carbohydrates – Glycolytic pathways – EMP, HMP shunt/pentose phosphate pathway and ED pathway and TCA cycle (5)	**4**
Fermentation – Fermentative modes in microorganisms – alcoholic, Lactic acid – hetero and homo, acetic acid, propionic acid, butyric acid, mixed acid and butane diol fermentation. (5)	**4**

Nitrogen Metabolism: Introduction to biological Nitrogen fixation, Ammonia assimilation and denitrification. (1)	**1**
Amino acid degradation and biosynthesis: Deamination and decarboxylation- An overview of amino acids biosynthesis. (2)	**2**
Lipid degradation and biosynthesis: β-oxidation of Palmitic acid; Biosynthesis of Palmitic acid.	**3**

SEMESTER III

MBT-302 – Biomolecules, Bioenergetics & Metabolism

Sessions Per Week	Total Contact Units	Marks		Duration of Examination	Total Marks
		Internal Assessment	End Semester Exam		50 Marks
3	10	10 marks	40 marks	3 hours	

No.	Experiments	Units
1	Preparation of buffers-citrate and phosphate buffers	1
2	Estimation of reducing sugar glucose - by DNS method	1
3	Estimation of protein by Lowry's method	1
4	Determination of growth curve for fungi by colony diameter method	1
5	Identification of fatty acids and other lipids by TLC	1
6	Effect of variables on enzyme activity (amylase): a. Temperature b. pH c. substrate concentration d. Enzyme concentration	2
7	Determination of Km and Vmax of amylase (Line weaver- Burk plot; Michaelis -Mentonequation)	1
8	Biochemical tests used for the identification of bacteria a) IMViC b) Fermentation of glucose, sucrose, and lactose- acid and gas production c) Mannitol motility test d) Starch hydrolysis e) Catalase test f) Oxidase test	4

Text Books/References

1. Atlas, R.M. 1984. Basic and practical Microbiology. Mac Millan Publishers, USA. 987 pp.
2. Black, J.G. 2008. Microbiology principles and explorations. 7th edition. John Wiley and Sons Inc., New Jersey 846 pp.
3. Boyer, R. 2002, Concepts in Biochemistry 2nd Edition, Brook/Cole, Australia.
4. Caldwell, D.R. 1995 - Microbial Physiology and Metabolism. Brown Publishers
5. Dubey R.C. and Maheshwari D.K. 1999. A Textbook of Microbiology, 1st edition, S. Chand & Company Ltd.
6. Felix Franks, 1993. Protein Biotechnology, Humana Press, New Jersey.
7. Harper, 1999. Biochemistry, McGraw Hill, New York
8. Lodish, H.T. Baltimore, A. Berck B.L. Zipursky, P. Mastsydaire and J. Darnell. 2004. Molecular Cell Biology, Scientific American Books, Inc. Newyork
9. Madigan, M.T., Martinko J.M., Dunlap P.V., Clark D.P. 2009. Brock Biology of Microorganisms, 12th edition, Pearson International edition Pearson Benjamin Cummings
10. Michael Pelczar, Jr., Chan E.C.S., Noel Krieg 1993. Microbiology - Concepts and Applications, International ed, McGraw Hill.
11. Moat, A. G., Foster, J.W. Spector. 2004. Microbial Physiology 4th Edition Panama Book Distributors.
12. Nelson, and Cox, 2000. Lehninger Principles of Biochemistry, Elsevier Publ.
13. Palmer, T. 2001. Biochemistry, Biotechnology and Clinical Chemistry, Harwood Publication, Chichester.
14. Pommerville, J.C. 2013. Alcamo's Fundamentals of Microbiology. Jones and Bartlett.
15. 16. Schlegel, H.G. 1995. General Microbiology. Cambridge University Press Cambridge, 655 pp.

16. Stanier, Ingraham et al. 1987. General Microbiology, 4[,h] and 5[lh] edition Macmillan education limited. International, edition 2008, McGraw Hill.
17. Stryer, L, 1995. Biochemistry, Freeman and Company, New York.
18. Talaro, K.P. 2009. Foundations in Microbiology, 7[lh] International edition McGraw Hill.
19. Tortora, G.J., Funke, B.R., Case, C.L. 2008. Microbiology-An Introduction, 10[th] ed. Pearson Education.
20. Voet and Voet, 1995; Biochemistry, John Wiley and Sons, New York.
21. Willey, J. M, Sherwood, L., Woolverton, C. J., and Prescott, L. M. (2008). Prescott, Harley, and Klein's microbiology. New York: McGraw-Hill Higher Education.

SEMESTER III
ELECTIVE – I – BIOSTATISTICS AND INTELLECTUAL PROPERTY RIGHTS

Sessions Per Week	Total Contact Hours	Marks		Duration of Examination	Total Marks
		Internal Assessment	End Semester Exam		50 Marks
2 hours	26 hours	10 marks	40 marks	1.30 hours	
Unit-1 Biostatistics					**13 Hours**
Introduction to Biostatistics- Definition, scope, and importance in microbiology, Types of data: Qualitative vs. Quantitative, Scales of measurement: Nominal, Ordinal, Interval, Ratio					**2**
Data Collection and Presentation - Methods of data collection, Tabulation and classification, Graphical representation: bar diagram, histogram, pie chart, line graph					**2**
Descriptive Statistics - Measures of central tendency: Mean, Median, Mode, Measures of dispersion: Range, Variance, Standard deviation					**3**
Probability and Distributions - Basic concepts of probability, Normal and binomial distribution: applications in biological data					**2**
Statistical Testing - Hypothesis testing, t-test, chi-square test (concept and application only)-p-value and significance, Introduction to ANOVA (basic concept only)					**4**
Unit-2 Intellectual Property Rights (IPR)					**13 Hours**
Introduction to IPR -Definition and importance of IPR in science, Types of intellectual property: Patents, Copyrights, Trademarks, Trade Secrets					**2**
Patents and Patent Filing Process -Criteria for patentability (novelty, non-obviousness, utility), Patent filing process (Indian and international overview), Microorganisms and patents: special considerations (e.g., Budapest Treaty)					**3**
Biological Material and IP - Protection of genetically modified organisms (GMOs), Traditional knowledge and benefit sharing, Role of IPR in microbiology and biotechnology research					**2**
Biosafety, Bioethics, and Legal Aspects - Biosafety levels and risk groups in microbiology, Ethical issues in the use of biological data and research, Regulations related to bioprospecting and biodiversity (CBD, Nagoya Protocol)					**3**
Case Studies and Applications - IPR in vaccines and antibiotic discovery, Famous patent disputes (e.g., CRISPR, Bt cotton), Role of IPR in academic and industrial microbiology					**3**

References

1. **Miller, Arthur R. & Davis, Michael H.** – *Intellectual Property: Patents, Trademarks and Copyright in a Nutshell*, 7th Edition, **2020**
2. Wadehra, B.L. 2016. Law relating to patents, trademarks, copyright designs and geographical indications. 5th edition, Universal Law Publishing.
3. **Rosner, Bernard** – *Fundamentals of Biostatistics*, 8th Edition, **2015**
4. **Triola, Marc M. &Triola, Mario F.** – *Biostatistics for the Biological and Health Sciences*, 2nd Edition, **2018**

5. **Pandey, Neeraj&Dharni, Khushdeep**– *Intellectual Property Rights*, 2nd Edition, **2014**
6. **Bouchoux, Deborah E.** – *Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets*, 6th Edition, **2019**

BANGALORE UNIVERSITY, BANGALORE
Syllabus for B.Sc., Microbiology
CBCS, SEMESTER- IV

MBT-401: GENETICS & MOLECULAR BIOLOGY

Sessions Per Week	Total Contact Hours	Marks		Duration of Examination	Total Marks
		Internal Assessment	End Semester Exam		100 Marks
4	56	20 marks	80 marks	3 hours	

Unit 1: Genetics	**14 Hours**
Nucleic acids: Chemical compositions of DNA & RNA, Watson & Crick model of DNA, **Types of DNA:** A, B, and Z, Supercoiling of DNA, **Types of RNA:** mRNA, rRNA & t RNA.	**4**
DNA replication in Prokaryotes: Semi, Conservative methods, rolling circle model, origin of replication, primers and templates, replication fork, unidirectional and bidirectional (Theta model).	**5**
Genetic recombination in bacteria:Conjugation: F+ vs F- , Hfr vs F-, F` vs F-, **Transformation:** Griffith's experiment and mechanism, **Transduction:** generalized and specialized.	**5**
Unit 2: Regulation of gene expression & Mutations	**14 Hours**
Regulation of gene expression in Prokaryotes and Acellular Microbes. **Regulatory mechanisms** in bacteria- Positive and negative regulation. Operon concept,polycistronic mRNA. Lac-Operon, Trp-Operon, Catabolic repression and Attenuation.	**6**
Regulation oflytic & lysogenic life cycle in bacteriophage (λ phage). Control of lytic cycle by regulatoryproteins.	**2**
Mutations- Molecular basis of mutation, spontaneous and induced mutations, detection and isolation of mutants (Replica plate method).	**6**
Unit 3: Molecular Biology – Transcription	**14 Hours**
Prokaryotic Transcription: Transcription bubble, Stages of transcription, Bacterial RNA polymerase - structure and mechanism, Recognition of promoters and DNA melting, Initiation, Elongation, Termination, Abortive, Transcription inhibitors.	**5**
Eukaryotic Transcription:RNA polymerases in Eukaryotes- Types and Mechanism of RNA polymerase.Promoters, Transcription factors, basal apparatus, Enhancers, silencers. Initiation, elongation,termination. Transcription inhibitors.	**5**
RNA Splicing and Processing: mRNA capping, pre-mRNA splicing, snRNPs, spliceosome, types of splicing, polyadenylation, RNA maturation, Catalytic RNAs - auto splicing, ribozymes.	**4**
Unit 4: Molecular Biology – Translation	**14 Hours**
Translation: structure of ribosome, charging of tRNA, differences between initiator tRNA and elongator tRNA. **Steps in translation** - Initiation, elongation, and termination.	**7**
Role of initiation factors in bacterial translation, Formation of initiation complex, polypeptide, peptide bond formation, peptidyl transferase activity, translocation, termination.	**4**
Differences between prokaryotic and eukaryotic translation. Regulation of translation. Post translational modifications of proteins.	**3**

SEMESTER IV
MBT-402 – GENETICS & MOLECULAR BIOLOGY

Sessions Per Week	Total Contact Units	Marks		Duration of Examination	Total Marks
		Internal Assessment	End Semester Exam		50 Marks
3	12	10 marks	40 marks	3 hours	

No.	Experiments	Units
1	Preparation of buffers used in Molecular Biology - PBS, TAE, TBE, and TE buffers	1
2	Estimation of DNA by DPA method	1
3	Estimation of RNA by Orcinol method	1
4	Determination of MIC of antimicrobial agents	2
5	Evaluation of antimicrobial antibiotic sensitivity tests-paper disc plate method	1
6	Development of antibiotic resistance in bacteria	1
7	Extraction of crude DNA from bacteria by phenol-chloroform method	1
8	Isolation of plasmid DNA from bacteria and separation by gel electrophoresis	1
9	Measurement of β-galactosidase activity in stimulated and control cells of *E.coli*	2
10	Charts on genetic recombination in bacteria a) Conjugation- F+ v/s F–, Hfr+ v/s F–, F' v/s F– b) Transformation- Griffith's experiment and mechanism c) Transduction- generalized and specialized	1

Text Books/References

1. **Verma, P.S. & Agarwal, V.K.** (2018). *Cell Biology, Genetics, Molecular Biology, Evolution and Ecology* (19th ed.). S. Chand & Company Ltd.
2. **Gupta, P.K.** (2020). *Genetics: Classical to Modern* (5th ed.). Rastogi Publications.
3. **Rastogi, S.C.** (2019). *Cell and Molecular Biology* (8th ed.). New Age International Publishers.
4. **Satyanarayana, U., & Chakrapani, U.** (2016). *Genetics* (1st ed.). Elsevier Health Sciences.
5. **Singh, B.D.** (2018). *Genetics* (11th ed.). Kalyani Publishers.
6. **Pierce, B.A.** (2020). *Genetics: A Conceptual Approach* (7th ed.). W.H. Freeman and Company.
7. **Russell, P.J.** (2016). *iGenetics: A Molecular Approach* (3rd ed.). Pearson Education.
8. **Brown, T.A.** (2017). *Genomes 4* (4th ed.). Garland Science, Taylor & Francis Group.
9. **Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P.** (2014). *Molecular Biology of the Cell* (6th ed.). Garland Science.
10. **Freifelder, D.** (1987). *Molecular Biology* (2nd ed.). Narosa Publishing House (Indian Edition), originally published by Jones and Bartlett Publishers.
11. **Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., &Losick, R.** (2017). *Molecular Biology of the Gene* (7th ed.). Pearson Education.
12. **Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., &Matsudaira, P.** (2021). *Molecular Cell Biology* (9th ed.). W.H. Freeman and Company.
13. **Snustad, D.P., & Simmons, M.J.** (2018). *Principles of Genetics* (7th ed.). Wiley India Pvt. Ltd.
14. **Lewin, B.** (2017). *Genes XII* (12th ed.). Jones and Bartlett Learning.
15. **Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., &Doebley, J.** (2019). *Introduction to Genetic Analysis* (12th ed.). W.H. Freeman and Company.

SEMESTER IV

ELECTIVE – II – COMPUTATIONAL BIOLOGY WITH AI APPLICATIONS

Sessions Per Week	Total Contact Hours	Marks		Duration of Examination	Total Marks
		Internal Assessment	End Semester Exam		50 Marks
2 hours	26 hours	10 marks	40 marks	1.30 hours	

Unit-1 Introduction to Bioinformatics	**13 Hours**
Introduction to Bioinformatics: Definition, scope, and interdisciplinary nature, Importance in microbiology and life sciences, and applications of Bioinformatics.	**2**
Biological Databases & Types: Primary, secondary, and specialized databases, Nucleotide databases: Genbank, EMBL, DDBJ, Protein databases: UniProt, Swiss-Prot, TrEMBL, Structure databases: PDB, Microbial genome database (MBGD)	**5**
Sequence Alignment: Concept of sequence similarity.Tools for sequence comparison: FASTA and BLAST.Pairwise alignment: global alignment (Needleman–Wunsch algorithm) and local alignment (Smith–Waterman algorithm).Multiple sequence alignment using Clustal Omega.	**5**
Data Formats - FASTA, GenBank, PDB file formats.	**1**
Unit-2 Applications of Bioinformatics & AI	**13 Hours**
Genomics and Genome Annotation – Restriction mapping, ORF prediction and gene annotation, Tools: NEB cutter and ORF finder	**3**
Phylogenetics and Evolutionary Analysis: Fundamentals of phylogenetic tree construction. Tree-building methods: UPGMA, WPGMA, Centroid, Neighbor-Joining, Maximum Likelihood, and Maximum Parsimony.	**3**
Structural Bioinformatics – Protein structure basics (primary to quaternary), Homology modelling and Threading methods of protein structure prediction	**2**
Applications in Microbial Research -Introduction to molecular docking and drug discovery methods.	**3**
Emerging Areas and Case Studies – Role of AI/ML in bioinformatics,Bioinformatics in outbreak tracking (e.g., SARS-CoV-2), Ethical considerations and data sharing	**2**

SEMESTER IV
COMPULSORY PRACTICAL
COMPUTATIONAL BIOLOGY WITH AI APPLICATIONS

Sessions Per Week	Total Contact Units	Marks		Duration of Examination	Total Marks
		Internal Assessment	End Semester Exam		50 Marks
3	10	10 marks	40 marks	3 hours	

No.	Experiments	Units
1	Retrieval of Nucleotide and protein sequences from databases.	1Unit
2	Restriction mapping by NEBCUTTER.	1Unit
3	Pairwise and multiple alignment of sequences.	1Unit
4	Sequence similarity search-FASTA and BLAST.	1Unit
5	Evolutionary studies / Phylogenetic analysis.	1Unit
6	Identification of genes in genomes.	1Unit
7	Primer design by primer BLAST.	1Unit
8	Protein databank retrieval and visualization using RasMol.	1Unit
9	Secondary structure prediction of proteins.	1Unit
10	Ramachandran plot analysis of protein 3D structures.	1Unit

References

1. Benjamin Lewis. Genes IX (10th Ed.). Jones and Bartlett publishers. USA. 2018.
2. Dubitzky W et al. Fundamentals of data mining in genomics and proteomics (2nd Ed.) Springer publishers.USA.2013.
3. Griffiths AJF. An Introduction to Genetic Analysis (11th Ed.). W. H. Freeman publisher. NY. 2015.
4. Josip Lovric Introducing Proteomics: From concepts to sample separation, mass spectrometry and data analysis. 2nd edition. Wiley-Blackwell publishers.UK.2016.
5. Liebler D C. Introduction to Proteomics-Tools for the New Biology (3rd Ed.). John R. Humana Press Totowa. NJ. 2017.
6. Michel Blot. Prokaryotic Genomics (1st Ed.) Springer publishers.2002.
7. Peter M Gresshoff. Plant Genome Analysis (1stEd.), CRC Press.UK.1994.
8. Principles of Gene Manipulation and Genomics, SB Primrose and RM. Twyman, 7th Ed.). Blackwell Publishers.UK.2007.
9. Richard Twyman, Principles of Proteomics (1st Ed.). Wiley-Blackwell publishers.UK.
10. Smith D.W. Bio-computing Informatics and the Genome Projects (1st Ed.) AcademicPress.USA.1993.
11. John R S Finchman. Genetic Analysis – Principles, Scope and Objectives (1st Ed.). Blackwell Science. Singapore.1994.
12. Terence A B.Genomes (2nd Ed.). Bios Scientific Publishers.UK.2002.