AC/24.02.2024/RS1

SIES College of Arts, Science & Commerce (Autonomous)

RISE WITH EDUCATION

NAAC REACCREDITED - 'A' GRADE

**SION (WEST), MUMBAI- 400022**

**FACULTY: Science**

**PROGRAM: MSc Part II**

**Subject: Biotechnology**

**Academic year: 2024-2025**

**Semester III and IV**

**Credit-based semester and grading syllabi approved by the Board of Studies in Biotechnology to be brought into effect from June 2024.**

# PREAMBLE

Biotechnology, broadly defined, includes any technique that uses living organisms, or parts of such organisms, to make or modify products, to improve plants or animals, or to develop microorganisms for specific use. The interdisciplinary nature of biotechnology integrates living systems including animal, plant and microbes and their studies from molecular biology to cell biology, from biochemistry to biophysics, from genetic engineering to stem cell research, from bioinformatics to genomics-proteomics, from environmental biology to biodiversity, from microbiology to bioprocess engineering, from bioremediation to material transformation and so on.

Biotechnology is the science of today and tomorrow. It has applications in all major service sectors. i.e. health, agriculture, industry, environment etc. Biotechnology as an application science has taken firm footing in many countries, abroad where a number of transgenic crops, genetically modified food and recombinant therapeutic molecules for human and animal health are available in the market. Biotechnology as a science of service to human society is yet to make inroads in India

With the advent of the World Wide Web in the early nineties and its subsequent growth, the latest research trends have become accessible from drawing rooms across the globe. This acted as a positive feedback mechanism in increasing the pace of research in all fields including Chemical Engineering and Bio-technology. This was the motivation for an in depth analysis of what is actually required for today's technology. It is also important to take advantage of the freely available software to enhance the quality and quantity of material that can be covered in the classroom.

This restructured syllabus is therefore intended to combine the principles of physical, chemical and biological sciences along with developing advanced technology. The postgraduate curriculum is prepared to impart primarily basic knowledge of the respective subject from all possible aspects. In addition, students will be trained to apply this knowledge particularly in day-to-day applications of biotechnology and hence get a flavor of research

## PROGRAM OUTCOMES

The expected graduate attributes are directed towards the following:

- Applying the knowledge of various courses learned under the program to break down complex problems to simple components by designing processes for problem solving
- Utilizing the acquired contextual knowledge in an interdisciplinary framework. Integrating research-based knowledge and research-based methods involving problem definition, analysis and interpretation of data followed by its consolidation to arrive at valid conclusions
- Facilitating to write and document effectively; make crisp presentations and reports and convey the message/ instructions/findings clearly
- Equipping to select, create and apply the appropriate tools and techniques through electronic media for the purpose of understanding and analyzing data and drawing inference keeping in mind its limitations and disadvantages
- Understanding the need for sustainable development and concern for environmental issues
- Applying the acquired contextual knowledge in assessing public health and safety; addressing gender, ethnic and environmental issues in addition to performing with decisive responsibility.

## PROGRAM SPECIFIC OUTCOMES

The program has been designed to expose the students to the latest developments in the areas of diagnostics, therapeutic techniques and instrumentation. This program is aimed at empowering students for a career in research and also to provide trained manpower for the fast-growing Biotech companies.

A Postgraduate student upon completion of this program is expected to gain the following attributes:

- Competence for research and innovation in the field of Biotechnology
- Design and execute experiments applying the concepts learnt and thereby being able to translate theoretical knowledge to practical knowledge
- Prepare, plan and execute a research project independently.
- Critically evaluate and interpret results

**Semester III**

| Course Category | Course code | Course Title | Credits | Lectures (Hrs.)/week |
|---|---|---|---|---|
| Core Course 1 | SIPBTCC611 | PTC and ATC | 4 | 4 |
| Core Course 2 | SIPBTCC612 | Medical Biotechnology | 4 | 4 |
| Core Course 1 | SIPBTCCP611 | Practical | 2 | 4 |
| Core Course 2 | SIPBTCCP612 | Practical | 2 | 4 |
| Discipline-specific Elective | SIPBTEL611 | Biostatistics | 3 | 3 |
| Discipline-specific Elective | SIPBTELP611 | Practical | 1 | 2 |
| RP | SIPBTCRP611 | Research Proposal | 6 | |
| | | | Total Credits 22 | |

**Semester IV**

| Course Type | Course code | Course Title | Credits | Lectures (Hrs.)/week |
|---|---|---|---|---|
| Core Course1 | SIPBTCC621 | Omics and Bioinformatics | 4 | 4 |
| Core course 2 | SIPBTCC622 | Nanotechnology and Clinical Studies | 4 | 4 |
| Core course 1 | SIPBTCCP621 | Practical | 2 | 4 |
| Core course 2 | SIPBTCCP622 | Practical | 2 | 4 |
| Discipline-specific Elective | SIPBTEL621 | Biosafety | 3 | 3 |
| Discipline-specific Elective | SIPBTELP621 | Practical | 1 | 2 |
| RP | SIPBTCRP621 | Research Project | 6 | |
| | | | Total Credits 22 | |

Draft syllabus (MSc Part II)

**Semester III**

| **Course Type** | **Course Title** | **Course description** | **Credits** | **Lectures (Hrs.)/ week** |
|---|---|---|---|---|
| Core Course 1 | PTC and ATC | **Unit I -**<br>Biosynthesis- batch, continuous cultures, immobilized plant cells, Biotransformation of precursors by cell culturing, metabolic engineering for the production of secondary metabolites, Hairy root culture, elicitation, synthetic seeds. Genetic markers in plant breeding-- Classical markers, DNA markers (RFLP, RAPD, AFLP, SSR, SNP)<br>**Unit II-**<br>Cryopreservation - Principle and types. Germplasm conservation, Transgenic plants -Edible vaccine, Golden rice Virus, herbicide, fungus and bacteria resistant plants, Genetic manipulations for fruit ripening, flower wilting & flower pigmentation. Plants as bioreactors<br>**Unit III-**<br>Biology of cultured cells – cell adhesion, cell proliferation, Differentiation, Cell signaling and senescence, Culture vessels, substrates and specialized systems, Culture Media and supplements, Serum-free media, Primary culture: Types, isolation of tissues, culturing of different cells, Microbial contamination and Cross contamination. | 4 | 4 |

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| | | **Unit IV-**<br><br>Cell lines: cell line designation, choosing a cell line, routine maintenance, replacement of media, Subculture and propagation, Split ratio, Organotypic culture, Transformation & immortalization of cell line, Cytotoxicity & Quantitation. | | |
| Core Course 2 | Medical Biotechnology | **Unit I -**<br><br>Molecular Diagnostic methods: Fluorescent in situ hybridization (FISH), MFISH, chromosome painting, CGH, Microarray.<br>Target amplification methods- PCR and RT PCR, Isothermal methods- NASBA, TMA, Strand displacement amplification, LAMP.<br>Probe amplification reaction – LCR.<br>Signal amplification method- bDNA assay<br><br>**Unit II-**<br><br>Pathogenesis (Mechanism of infection) and Acute Clinical manifestations (Signs and symptoms) laboratory diagnosis & treatment of Pneumonia, Tuberculosis, MOTT, *Helicobacter pylori*, Nosocomial (*Pseudomonas)*<br><br>Biofilms in medicine: Structure of Biofilm – Extracellular polymeric substances, Biofilm architecture, Stages in formation of Biofilm, Microbial interactions in Biofilms (Quorum sensing), Need for formation of Biofilms by microorganisms, Microorganisms commonly associated with biofilms on indwelling medical devices, Response of biofilms to host defense mechanisms & antimicrobial agents and Recent advances in biofilm management. | 4 | 4 |

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| | | **Unit III-**<br><br>Concept of Host, Reservoir, Source of infection, Carrier, Epidemic, Endemic, Pandemic, Outbreak, importance of epidemiology, Measures of disease frequency – Concept of incidence, prevalence, Incidence rate, cumulative incidence, case fatality, Epidemiological case studies<br>Structure of the virus-coat and envelope protein, genome composition Pathogenesis (Mechanism of infection) and Acute Clinical manifestations (Signs and symptoms), laboratory diagnosis & treatment of HIV, Hepatitis (A,B,C), Influenza (HINI, H5N5), Ebola, HSV, HPV Corona virus (Covid 19) and zoonotic infections.<br><br>**Unit IV-**<br><br>Antigenic structure, virulence factors, source of infection, Transmission, Pathogenesis, Life-cycle, Clinical manifestations, Laboratory diagnosis, Treatment, Prophylaxis, Current research and developments for:<br><br>Fungal infections- Candidiasis, Tinea<br><br>Protozoan infections -Malaria, Toxoplasmosis, Amoebiasis, Trypanosomal infection<br><br>Chlamydia and Rickettsial infections | | |
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| Core Course 1 | Practical | PTC and ATC<br>**1. PTC**<br>a. Media preparation<br>b. Seed sterilization<br>c. Callus induction<br>d. Isolation and induction of anther cultures using Hibiscus flowers.<br>e. Protoplast isolation<br>f. Somatic embryogenesis<br>**2. ATC**<br>a. Trypsinization and staining of animal cells<br>b. Monolayer formation (fibroblast)<br>c. To assay the radical scavenging activity of a tissue hydrolysate – DPPH method<br>d. Techniques of cell preservation | 2 | 4 |
| Core Course 2 | Practical | **Medical Biotechnology**<br>Medical diagnostic – Identification of organisms from specimens (Multidrug resistant *S. aureus*, *Pseudomonas* spp., *Klebsiella pneumoniae*, *E. coli*)<br>Qualitative and quantitative estimation of biofilm production by microorganisms. | 2 | 4 |

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| Discipline Specific Elective | Biostatistics | **Unit I -**<br><br>Statistical population, Types of data, Census survey, Sample survey, Random sample. Central Tendency: Mean, Median and Mode. Absolute measures of dispersion: Range, Quartile deviation, Mean deviation, Standard deviation. Relative measures dispersion. Coefficient of skewness and kurtosis based on moments, Karl Pearson and Bowley's measure of skewness<br><br>Correlation: Definition, Scatter plot, Relationship with covariance, Karl Pearson's correlation coefficient, Simple linear regression, Coefficient of determination ($R_2$), Concept of multiple correlation and regression.<br><br>**Unit II-**<br><br>Probability distribution: Discrete (e.g., Binomial) and Continuous (e.g., Normal)<br><br>Sampling distribution: Definition, Sampling from normal and non- normal population, Concept of standard error, The Central Limit Theorem<br><br>Concept of estimation & confidence limits<br>Hypothesis testing: Null and alternative hypothesis, test of a statistical hypothesis, Type I and Type II errors, Power of a test, level of significance of a test. Concept of p-value.<br>Large sample tests for the significance of: i) single population – a) mean and b) proportion ii) difference in two population a) means and b) proportions<br>t-test for the significance of: i) single population mean ii) difference in two population means– independent and dependent samples. One way analysis of variance | 3 | 3 |

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| | | **Unit III**<br><br>Non-parametric tests: Definition, Merits, Demerits, Characteristics of Non-parametric Tests, Comparable tests for the parametric tests, Single sample: Sign test, Wilcoxon test, Run test for randomness Two sample: Sign test, Wilcoxon test, Mann-Whitney test, k sample: Kruskal-Wallis test, Friedman Test. | | |
| Discipline Specific Elective | Practical | 1. Use of MS Excel for basic calculations<br>2. Graphical representation using Excel<br>3. Correlation and regression analysis<br>4. Finding p-value for a statistical test<br>5. Research paper presentation with statistical analysis | 1 | 2 |

Draft syllabus (MSc Part II)

**Semester IV**

| Course Type | Course Title | Course description | Credits | Lectures (Hrs.)/ week |
|---|---|---|---|---|
| Core Course 1 | Omics and Bioinformatics | **Unit I -**<br>Introduction to Omics, Genomics and epigenomics; Transcriptomics; Structural genomics; Functional genomics. Metagenomics: concept, strategies. Large scale genome sequencing strategies, Genome databases, Human genome project- goals, conclusions and application.<br>Tools and techniques: NGS, Microarrays, SAGE, RAGE, ChIPseq, qPCR, RNA sequencing, ENCODE. Epigenomic analyses and cancer/ diseases. Bisulfite sequencing Applications in environmental biotechnology, agriculture and health.<br><br>**Unit II-**<br>Proteomics and Interactomics -protein- protein interaction and identification of interactions by various methods. Yeast two hybrid systems; Synthetic genetic array (SGA) analysis; Protein microarrays; Reverse phase protein array; NAPPA; Halotag array; SPR; label free assays; biolayer interference; PISA. Application of Proteomics and Genomics in human diseases – screening, testing and treatment of diseases, personalized medicine.<br><br>**Unit III-** Biological databases and its types. Submission of data to databases, Querying in databases – Retrieval of desired data; Types of sequence alignment – BLAST – Nucleotide blast and protein Blast – Applications Multiple sequence alignment – Principle, methods, phylogenetic analysis.Protein sequence analysis – Secondary structure analysis protein motifs, protein families Protein structure analysis and applications: Protein | 4 | 4 |

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| | | databank, Structural classification of proteins -CATH, Protein, Structure visualization and importance. Introduction to Docking studies.<br><br>**Unit IV**-<br><br>Gene Prediction: Categories of Gene Prediction Programs, Gene Prediction in Prokaryotes, Gene Prediction in Eukaryotes, Gene clusters and fusions, DNA motif finding<br><br>Promoter and Regulatory Element Prediction- Promoter and Regulatory Elements in Prokaryotes, Promoter and Regulatory Elements in Eukaryotes, Prediction Algorithms<br><br>Designing primers for gene sequence. | | |
| Core Course 2 | Nanotechnology and clinical studies | **Unit I -**<br><br>Introduction, Examples of nanostructures found in nature, Nanorobotics devices of nature: ATP synthase, motor proteins of cytoskeleton, flagella. Nanometer-scale materials, Quantum dots, Carbon nanotubes Synthesis of nanomaterials: Top-down and bottom-up approaches, Biodirected synthesis, Synthesis using bio-derived templates, Self- assembly of nanoparticles.<br><br>**Unit II-**<br><br>Applications: Nanomedicine, drug delivery, nanosensors, food, cosmetics, agriculture, environment<br>Nanotoxicology: Unique Properties, Factors Responsible for Nanomaterial Toxicity, Mechanisms of Nanoparticle Toxicity, In Vitro Testing Methods for Nanomaterials, Ecotoxicity Analyses of Nanomaterials. | 4 | 4 |

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| | | **Unit III –**<br><br>Pre-clinical toxicology: General principles, systemic toxicology (single dose and repeat dose toxicity studies), Carcinogenicity, Mutagenicity, Teratogenicity, Reproductive toxicity, Local toxicity, Genotoxicity, Animal toxicity requirements.<br><br>Clinical study reports, Principles in softwares in CDM (Clinical Data Management)<br><br>**Unit IV** –<br><br>Types of clinical trials, single blinding, double blinding, open access, randomized trials and their examples, interventional study.<br><br>Adverse Drug Reactions (ADR) - ADR classification, Nature and mechanism of ADR, Concept of safety, Phases and types of DATA. The process of Pharmacovigilance - Signal detection, evaluation and investigation, Communication Methods of evaluating effectiveness of action. | | |
| Core Course 1 | Practical | Omics and Bioinformatics<br><br>1. Multiple alignment – Phylogenetic tree<br>2. BLAST – homologs, orthologs and paralogs<br>3. Motif finding<br>4. KEGG<br>5. Structure of proteins – identification of chains, helices, special groups, metal ions, etc.<br>6. CATH / SCOP classification of a given protein<br>7. Signal Peptide detection using TargetP tools | 2 | 4 |
| Core Course 2 | Practical | Nanotechnology Practical<br><br>1. Nanoparticles synthesis by chemical reduction | 2 | 4 |

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| | | 2. Nanoparticles synthesis by biological methods<br>3. Spectroscopic analysis of nanoparticles | | |
| Discipline Specific Elective | Biosafety | **Unit I -**<br><br>Genetically modified microorganisms, examples and methods, Humulin, Ice minus bacteria, GM bacteria in bioremediation, use of PCR as GMO identification tool, risks and controversies related to use of GMO. Indian GM research information system, About Indian GMO research information system (IGMORIS) Biosafety data of any two approved genes available on the database<br><br>GE crops – Arabidopsis as a model plant for studies in genetic engineering<br><br>**Unit II-**<br><br>Introduction; Biological Risk Assessment, Hazardous Characteristics of an Agent; Genetically modified agent hazards; cell cultures; Hazardous Characteristics of Laboratory Procedures; Potential Hazards Associated with Work Practices; Safety Equipment and Facility Safeguards; Pathogenic risk and management. Concept of GLP; Guidelines to GLP; Documentation of Laboratory work; Preparation of SOPs; Calibration records; Validation of methods; Documentation of results; Audits & Audit reports<br><br>**Unit III-**<br><br>Microbiological Assays for pharmaceutical products; Regulatory Microbiological testing in pharmaceuticals<br><br>Concepts on biosafety in Biotechnology; Regulating rDNA technology; Regulating food and food ingredients; | 3 | 3 |

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| | | Genetically engineered crops, livestock Bioethics; Contemporary issues in Bioethics | | |
| Discipline Specific Elective | Biosafety Practical | Biosafety<br>1. GMO kit-based validation<br>2. Biosafety practices in a Biotechnology laboratory<br>3. Writing SOP for laboratory instruments<br>4. Validation of HPTLC, GC HPLC, and micropipettes.<br>5. Sterility testing of injectables | 1 | 3 |

**References:**


1. Abbas, A. K., Lichtman, A. H., & Pillai, S. (2014). Cellular and molecular immunology E-book. Elsevier Health Sciences.
2. Ahmed, F. E. (2002). Detection of genetically modified organisms in foods. TRENDS in Biotechnology, 20(5), 215-223.
3. Amarger, N. (2002). Genetically modified bacteria in agriculture. Biochimie, 84(11), 1061-1072.
4. Ananthanarayan, R. (1984). Introduction to medical microbiology. Orient Longman Limited
5. Bailey, J. E., & Ollis, D. F. (2006). Biochemical engineering fundamentals. New York: McGraw-Hill.Berg, J. M., Stryer, L., & Tymoczko, J. L. (2012). Biochemistry: 7th Edition, W.H.Freeman and company, NY
6. Berg, J. M., Tymoczko, J. L., & Stryer, L. (2002). Biochemistry, ; W. H.
7. Berne, R. M., & Levy, M. N. (2000). Principles of physiology. Mosby Incorporated.
8. Boyer, R., & Boyer, R. (2005). Modern Experimental Biochemistry. Delhi: Pearson Education (Singapore) Pvt. Ltd.
9. Campbell, A. M., & Heyer, L. J. (2006). Discovering genomics, proteomics, and bioinformatics. San Francisco, Calif. [u.a.: CSHL Press.
10. Conn, E., & Stumpf, P. (2009). Outlines of biochemistry. John Wiley & Sons.
11. Daniel, W. W. (1999). Biostatistics: A Foundation for Analysis in the Health Sciences, 7thedR Wiley. New York.
12. Davidson, S. S., Meiklejohn, A. P., & Passmore, R. (1960). Human Nutrition and Dietetics. Academic Medicine.
13. Delves, P. J., & Roitt, I. M. (1994). Roitt's essential immunology. Oxford, Blackwell Scientific Pub.
14. Devlin, R. M., & Withan, F. H. (1988). Plant physiology 4th Ed.
15. Devlin, T. M. (Ed.). (2006). Textbook of biochemistry: with clinical correlations.
16. Dey, P. M., & Harborne, J. B. (Eds.). (1997). Plant biochemistry. Elsevier

17. Diwan, P., & Bharadwaj, A. (Eds.). (2005). The Nanoscope: Encyclopedia of Nanoscience and Nanotechnology Vol: 1,V,VI. Pentagon Press.
18. Dubey, R. C. (1999). A text book of biotechnology, Publication, S. Chand and Co., New Delhi.
19. Freshney, R. I. Culture of animal cells: a manual of basic technique. Wiley-Liss
20. Friedman, H., Klein, T. W., & Friedman, A. L. (1995). Psychoneuroimmunology, stress, and infection. CRC Press
21. Gangal, S. (2007). Principles and practice of animal tissue culture. Universities Press.
22. Gerstman, B. B. (2014). Basic biostatistics. Jones & Bartlett Publishers.
23. Gilbert, S. F., & Barresi, M. J. F. (2018). Developmental biology.8th edn. Sinauer Associates, Inc.
24. Godkar, P.B. (2005).Text Book of Medical Biochemistry. Bahalani Publishers.
25. Goodsell, D. S. (2004). Bionanotechnology: lessons from nature. John Wiley & Sons.
26. Goodwin, T. W., & Mercer, E. I. (1972). Introduction to plant biochemistry (No. 572.82 G6I5).
27. Grahame-Smith, D. G., & Aronson, J. K. (2002). Oxford textbook of clinical pharmacology and drug therapy. Oxford: Oxford University Press.
28. Granner, D. K., Murray, R. K., Mayes, P. A., & Rodwell, V. W. (1988). Harper's Biochemistry (Vol. 21) 27th edn. Appleton & Lange.
29. Gurumani, N. (2005). An Introduction to Biostatistics. 2ndedR. MJP Publishers.
30. Guyton, A., & Hall, J. (2006). Textbook of medical physiology, 11th.
31. Hall, J. E. (2015). Guyton and Hall textbook of medical physiology e-Book. Elsevier Health Sciences.
32. Hamsten. Drug interaction. Kven stockley
33. Hatch, R. T. (July 01, 1974). Biochemical engineering, second edition, S. Aiba, A. E. Humphrey, and N. F. Millis, Academic Press, Inc., New York(1973)
34. Heldt, H. W., & Piechulla, B. (2004). Plant biochemistry 3rd edn. Elsevier.
35. Hudson, L., Hay, F. C., & Hudson, L. (1989). Practical immunology (pp. 348-350). Oxford: Blackwell Scientific Inc. USA
36. IGMORIS. (2013). Indian GMO Research Information System.
37. Jackson, A.T. (1991). Bioprocess Engineering in Biotechnology. Englewood Cliffs, Prentice Hall.
38. Katzung, B. G., Masters, S. B., & Trevor, A. J. (2012). Basic and Clinical Pharmacology (LANGE Basic Science). McGraw-Hill Education.
39. Kindt, T. J., Goldsby, R. A., Osborne, B. A., & Kuby, J. (2007). Kuby immunology. Macmillan.
40. Krebs, J. E., Lewin, B., & Goldstein, E. S. (2012). Genes XI, 11th edition. Jones & Bartlett Publishers
41. Krishna, D. R., & Klotz, U. (1990). Clinical Pharmacokinetics: A Short Introduction. Springer.
42. Kulkarni, S. K. (2015). Nanotechnology: principles and practices (p. 403). Berlin, Germany:Springer.
43. Laurence, D. R., Bennet, P. N., & Brown, M. J. (1997). Clinical Pharmacology 8th edition Churchill Livingstone.

44. Maniatis, T., Fritsch, E. F., & Sambrook, J. (1982). Molecular cloning: a laboratory manual (Vol. 545). Cold Spring Harbor, NY: Cold Spring Harbor Laboratory.
45. Mehra. Drug interaction. Basic Business Publ
46. Meneely, P. (2014). Genetic analysis: genes, genomes, and networks in eukaryotes. Oxford University Press.
47. Moo-Young, M. (1985). Comprehensive Biotechnology: The principles, applications and regulations of biotechnology in industry, agriculture, and medicine. Oxford [etc.: Pergamon Press.
48. Moore, T. C. (2012). Biochemistry and physiology of plant hormones. Springer Science & Business Media.
49. Mount David, W. (2001). Bioinformatics–Sequence and Genome Analysis. CSHL, New York.
50. Mu, P., & Plummer, D. T. (1988). Introduction to practical biochemistry. Tata McGraw-Hill Education.
51. Nelson, D. L., Lehninger, A. L., & Cox, M. M. (2008). Lehninger principles of biochemistry. 5th ed. Macmillan.
52. Norman, G. R., & Streiner, D. L. (2008). Biostatistics: the bare essentials. Hamilton: BC Decker Inc, 3.
53. Orten, J. M., Neuhaus, O. W., & Kleiner, I. S. (1975). Human biochemistry (No. 574.192 O7). CV Mosby.
54. Pal, J. K., & Ghaskadbi, S. S. (2009). Fundamentals of molecular biology. New Delhi: Oxford University Press.
55. Palmer, T., & Bonner, P. L. (2007). Enzymes: biochemistry, biotechnology, clinical chemistry. Elsevier.
56. Paul, W. E. (2013). Fundamental immunology. Philadelphia: Wolters Kluwer Health/Lippincott Williams & Wilkins.
57. Payne, G. F., Bringi, V., Prince, C., & Shuler, M. L. (1992). Plant cell and tissue culture in liquid systems (Vol. 13). Munich: Hanser Publishers.
58. Pevsner, J. (2003). Bioinformatics and Functional Genomics. Hoboken: John Wiley & Sons
59. Prokscha, S. (2006). Practical guide to clinical data management. CRC Press.
60. Rastogi, V. B. (2009). Fundamentals of Biostatistics 2Nd Ed. Ane Books Pvt Ltd.
61. Remington, J. P. (2006). Remington: the science and practice of pharmacy (Vol. 1). Lippincott Williams & Wilkins.
62. Rondel, R. K., Varley, S. A., & Webb, C. F. (Eds.). (2000). Clinical data management. John Wiley & Sons.
63. Sadasivam, S. (1996). Biochemical methods. New age international.
64. Sadler, T. W. (2011). Langman's medical embryology. Lippincott Williams & Wilkins.
65. Salisbury, F. B., & Ross, C. W. (1992). Plant physiology. 4th. Edn. CBS publishers and Distributors
66. Sauer, K. (1995). Biochemical spectroscopy. Vol 246 of Methods in Enzymology. San Diego, Calif. USA: Acad. Press.
67. Sharon, M., & Sharon, M. (2007). Nano Forms of Carbon and its Applications, Monad Nanotech Pvt. Ltd., Mumbai, India.
68. Shortliffe, E. H., & Cimino, J. J. (Eds.). (2013). Biomedical informatics: computer applications in health care and biomedicine. Springer Science & Business Media.
69. Shuler, M. L., Kargi, F., & DeLisa, M. (2002). Bioprocess engineering: Basic concepts, 2nd edn. Engelwood Cliffs, Prentice Hall.
70. Slack, J. M. (2009). Essential developmental biology. John Wiley & Sons.
71. Smyth, M. R. (1998). Analytical Biochemistry: David J. Holme and Hazel Peck, 3rd edn., Longman, Harlow
72. Stanbury, P. F., Whitaker, A., & Hall, S. J. (1995). Principles of fermentation technology. Oxford u.a.: Pergamon.

73. Swaminathan, M. (1974). Essentials of food and nutrition. Vol. II. Applied aspects. Essentials of food and nutrition. Vol. II. Applied aspects.
74. Talwar, G. P., & Gupta, S. K. (Eds.). (2009). A Handbook of practical and clinical immunology. CBS Publishers & Distributors.
75. Talwar, G. P., & Srivastava, L. M. (2002). Textbook of biochemistry and human biology. PHI Learning Pvt. Ltd.
76. Taylor, R. B. (2011). Medical writing. Springer Fachmedien.
77. Tropp, B. E. (2011). Molecular Biology. Jones & Bartlett Publishers.
78. Varley, H. (2006). Practical clinical biochemistry.6th edn. Practical clinical biochemistry.
79. Voet, D., Voet, J. G., & Pratt, C. W. (2002). Fundamentals of Biochemistry 2002 Update. John Wiley & Sons.
80. Walsh, G. (2002). Proteins: biochemistry and biotechnology. John Wiley & Sons.
81. Watson, J. D. (2008). Molecular biology of the gene. San Francisco: Pearson education.
82. Weaver, R. F., & Wassarman, D. A. (2011). Molecular biology. McGraw Hill Science. USA
83. Wilson, K., & Walker, J. (2010). Principles and techniques of practical biochemistry and molecular biology. Cambridge: Cambridge University Press.
84. Wilson, M., Kannangara, K., Smith, G., Simmons, M., & Raguse, B. (2002). Nanotechnology: basic science and emerging technologies. CRC Press.
85. Zubay, G. (1983). Biochemistry Addison-Wesley. Read Mass, 138-206.

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