Shri Vile Parle Kelavani Mandal's

MITHIBAI COLLEGE OF ARTS, CHAUHAN INSTITUTE OF SCIENCE & AMRUTBEN JIVANLAL COLLEGE OF COMMERCE AND ECONOMICS (AUTONOMOUS)

NAAC Reaccredited 'A' grade, CGPA: 3.57 (February 2016),
Granted under RUSA, FIST-DST & -Star College Scheme of DBT, Government of India,
Best College (2016-17), University of Mumbai

Affiliated to the

UNIVERSITY OF MUMBAI

Program: Master of Science

Course: BIOTECHNOLOGY

Semester I, II (2021 – 2022)

Choice Based Credit System (CBCS) with effect from the Academic year, 2021-22

PROGRAMME SPECIFIC OUTCOMES (PSO'S)

On completion of the M.Sc Biotechnology, the learners should be enriched with knowledge and be able to-

PSO1: Analyze and interpret scientific data to solve technical, conceptual and abstract scientific problems including prediction and modeling to complex molecular and biotechnological activities.

PSO2: Apply knowledge to develop critical thought and practical understanding in the field of biotechnology to find solutions for human benefits in health care, agriculture, environment and related fields.

PSO3: Identify and analyze a molecular or biochemical problem and formulate, research literature, review existing knowledge to reach substantiated conclusions using principles of Biotechnology independently or in a team

PSO4: Initiate entrepreneurial startups in various basic and applied sectors of biotechnology such as diagnostics, drug designing, stem cell biology, immunology, environmental biotechnology etc.

PSO5: Develop sensitivity to environmental issues and concerns and shall understand principles of ethics within the framework and apply these principles for environmentally and culturally sensitive issues.

PSO6: Understand the importance of quality control, bioethics, intellectual property and know the process to file patents in for inventions in the fields of sciences

Preamble

Biotechnology is a multidisciplinary field that incorporates the exploitation of knowledge regarding biological processes and the concepts in organisms, cells or cellular components to develop new technologies. The new tools and products developed by biotechnologists are useful in research, agriculture, health care and pharmaceutical industry. Biotechnology is a rapidly developing sector and the advancements made at a good pace. The curriculum is prepared by following the prospectus of various national and international universities and standards of national eligibility tests. The course aims at giving overall knowledge, skill to the students through theoratical, practical and hands on experience to develop scientific endeavours as well as startups. Each student will be a thorough researcher as he/she is trained and guided by scientists / industry experts and gains experience in a Scientific project during his 3-4 months research project at reputed research institutes. The syllabue aims at economic and social renaissance its biomedical and cutting edge technological applications are tremendously powerful in shaping this century and exciting biofuture.

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Evaluation Pattern

The performance of the learner will be evaluated in two components. The first component will be a Continuous Assessment with a weightage of 25% of total marks per course. The second component will be a Semester end Examination with a weightage of 75% of the total marks per course. The allocation of marks for the Continuous Assessment and Semester end Examinations is as shown below:

a) Details of Continuous Assessment (CA)

25% of the total marks per course:

Continuous Assessment	Details	Marks
Component 1 (CA-1)	Test / Assignment/ Tutorial/ Visit/ Project/ Presentation	15 marks
Component 2 (CA-2)	Test / Assignment/ Tutorial/ Visit/ Project/ Presentation	10 marks

b) Details of Semester End Examination

75% of the total marks per course. Duration of examination will be two and half hours.

Question Number	Description	Marks	Total Marks
1	Descriptive questions from Unit I	15	15
2	Descriptive questions from Unit II	15	15
3	Descriptive questions from Unit III	15	15
4	Descriptive questions from Unit IV	15	15
5	Short Notes from Unit I, II, III and IV	15	15
		Total Marks	**75**

Signature Signature Signature

HOD Approved by Vice –Principal Approved by Principal

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Program: M.Sc. Biotechnology				**Semester: I**	
Course: IMMUNOLOGY				**Course Code: PSMABT101**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks - 25)**	**Semester End Examinations (SEE) (Marks- 75 in Question Paper)**
4	**4**		**4+2**	**25**	**75**

Learning Objectives:

i. To introduce the students to the different mechanisms that regulate immune responses and maintain immunological tolerance
ii. To understand the processes involved in immunity, in states of health and disease
iii. To integrate knowledge of each immune subsystem and to see their contribution to the functioning of host systems in health and disease

Course Outcomes:

After completion of the course, learners would be able to:

CO1: Gain an advanced knowledge of the underlying principles of immune responses and disorders of the immune system

CO2: Understand the methods of Manipulating Immunity for Therapeutic purposes

Outline of Syllabus: (per session plan)

Module	**Description**	**No. of hours**
1	**Generation, activation and differentiation of lymphocytes**	**15**
2	**Effector responses**	**15**
3	**Immunization**	**15**
4	**Disorders in immunity**	**15**
Total		**60**

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Unit	Topic	No. of Hours/Credits
Module 1	**Generation, Activation, and Differentiation of T- lymphocytes** T-Cell Maturation and the Thymus Thymic Selection of the T-Cell Repertoire Th-Cell Activation T-Cell Differentiation Cell Death and T-Cell Populations **Generation, Activation, and Differentiation of B- lymphocytes** B-Cell Maturation B-Cell Activation and Proliferation The Humoral Response In Vivo Sites for Induction of Humoral Responses Germinal Centers and Antigen-Induced B-Cell Differentiation Regulation of B-Cell Development Regulation of the Immune Effector Response	**15**
Module 2	**Effector mechanisms of Cell mediated immunity** Types of CMI Development of Effector T cells Migration to sites of antigen Effector mechanisms **Effector responses of Humoral immunity** Overview of Humoral immunity Neutralization of microbes and microbial toxins Antibody mediated opsonisation Complement system Mucosal immunity Neonatal immunity	**15**
Module 3	**Methods of Manipulating Immunity for Therapeutic purposes** Artificial Passive Immunization Artificial Active Immunity Principles of Vaccine Preparation Development of New Vaccines Routes of Administration and Side Effects of Vaccines	**15**
Module 4	**Disorders in immunity** The Immune Response Type I Allergic Reactions: Atopy and Anaphylaxis Type II Hypersensitivities: Reactions That Lyse Foreign Cells Type III Hypersensitivities: Immune Complex Reactions Immunopathologies Involving T Cells Autoimmune Diseases	**15**

PRACTICAL 101

1. Preparation of TAB vaccine
2. Determination of TDP
3. Determination of TDT
4. Study of antigen identity by Ouchterlony's method
5. Quantitative determination of antigens by SRID technique
6. Study of immunoelectrophoresis

Suggested Readings

Author	Title of the book	Yr/Edn	published	T/R
Delves, Peter J.; Martin, Seamus J.; Burton, Dennis R.; Roitt, Ivan M.	Roitt's Essential Immunology.	2011).	Hoboken, NJ: Wiley-Blackwell.	R

T-TEXT BOOK R-REFERENCE

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Program: M.Sc (Part -I) Biotechnology (2021-22)				**Semester: I**	
Course: GENOMES TO PROTEOMES				**Course Code: PSMABT102**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks - 25)**	**Semester End Examinations (SEE) (Marks- 75 in Question Paper)**
4	**4**		**4+2**	**25**	**75**

Learning Objectives:

1. The objective of this course is to enable the students to gain an insight into the diverse genome anatomies, their activity and regulation.
2. The coursework deals with the molecular mechanisms of expression machinery and regulation of genome activity translation in prokaryotes and eukaryotes

Course Outcomes:

After completion of the course, learners would be able to:

CO2: Understand the diverse physical and genetic features of genome anatomies from prokaryotic to eukaryotic genomes

CO3: Discuss the mechanisms associated with expression of genome and transcriptome

CO4: Understand how genetic information is stored in genome, how that information is decoded by the cell to form the transcriptome and the proteome

CO5: Discuss the mechanisms associated with regulation of gene expression in eukaryotes

CO6: Understand how the flow of information is controlled in response to the changes in genome activity in Prokaryotes and eukaryotes

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	**GENOME ANATOMIES**	**15**
2	**Genome: expression and processing**	**15**
3	**Proteome : synthesis and processing**	**15**
4	**Regulation of genome activity**	**15**
	Total	**60**
PRACTICALS		

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Unit	Topic	No. of Hours/Credits
Module 1	**Genome anatomies** **An Overview of Genome Anatomies** **The Anatomy of the Eukaryotic Nuclear Genome** Chromosomes Physical features of Chromosomes Genetic features of Eukaryotic Nuclear Genome **The Anatomy of the** Prokaryotic **Genome** Physical features of Prokaryotic genomes Genetic features of Prokaryotic genomes **Genomes of Eukaryotic organelles** Origin, Physical features, Genetic content **Virus genomes** Bacteriophage genomes Eukaryotic viruses **Mobile Genetic Elements** RNA transposons, DNA Transposons	**15**
Module 2	**Genome: expression and processing** **Genome Expression in Outline** **Transcriptomes** :The RNA Content of the Cell **DNA – Protein Interactions during Transcription** **DNA-Dependent Synthesis of** RNA **RNA-Dependent Synthesis of RNA and DNA** **RNA Processing** Processing of mRNA Processing of Non-coding RNAs Processing of Pre-RNA by Chemical Modification Degradation of mRNAs Transport of RNA Within the Eukaryotic Cell	**15**
Module 3	**Proteome : synthesis and processing** **Proteomes**: The Protein Content of the Cell **Protein Synthesis** Bacteria and Eukaryotes **Post-translational Processing of Proteins** Protein Folding Proteolytic cleavage Chemical modification Inteins **Protein Targeting and Degradation**	**15**
Module 4	**Regulation of genome activity** **Transient Changes in Genome Activity** Signal Transmission by import Signal Transmission mediated by Cell surface receptors **Permanent and Semi permanent Changes in Genome Activity**	**15**

	Genome rearrangements Gene conversion Chromatin remodelling Gene Silencing and Genomic Imprinting **Levels of Control of Gene Expression** Activation of Transcription by Activators and Coactivators Combinatorial Gene Regulation Operons in Eukaryotes **Posttranscriptional control** RNA Processing Control Transport Control mRNA Translation Control mRNA Degradation Control Protein Degradation Control **RNA Interference: A Mechanism for Silencing Gene Expression**	

PRACTICAL 102

1. Study of *E.coli* Diauxic Growth Curve- (Lactose and Glucose).
2. Extraction of RNA by Trizol method
3. Estimation of RNA by Orcinol method
4. Extraction of genomic DNA from Bacteria and Blood
5. Estimation of DNA by DPA method.
6. Study of Proteins by Native and SDS PAGE

Suggested Readings

Author	Title of the book	Yr/Edn	published	T/R
Peter J. Russell	iGenetics: A Molecular Approach,	3rd Edn , 2010	Pearson	Text
David L. Nelson, Michael M. Cox	Lehninger Principles of Biochemistry	5th Edn (2008)	W H Freeman & Co	R/T
T. A. Brown	Genomes 4	2018	Garland Science Taylor & Franci Group	T
Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick	Lewin's GENES XII	2017	Jones & Bartlett Learning,	R

T-TEXT BOOK R-REFERENCE

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Program: M.Sc				**Semester: I**	
Course: MOLECULAR and CELL BIOLOGY				**Course Code: new code**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks - 25)**	**Semester End Examinations (SEE) (Marks- 75 in Question Paper)**
4	**4**		**4+2**	**25**	**75**

Learning Objectives:

1. To give overall knowledge on the Membrane systems
2. To make the student realize the prominent role in trafficking of molecules and drugs.
3. To visualize the Communication systems amongst cells that decide the fate of the cell
4. To give a view of cellular and molecular neurobiology and receptors
5. To assess the role biomimicking and development of mimetics and synthetic biology

Course Outcomes:

After completion of the course, learners would be able to:

CO7: know different membrane systems, artificial membranes and their importance,

CO8: put their creative ideas towards developing biomimiking components which can be of use in trafficking of molecules and drugs.

CO9: analyse the role of Communication systems and neurophysiology

CO10: Biomimetics and the future developments in synthetic biology, a science of future Biotechnology

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	**Dynamic organization of cell**	**15**
2	**Differentiation of specialized cells**	**15**
3	**Cellular and molecular Neurobiology**	**15**
4	**Biomimetics – a molecular approach**	**15**
	Total	**60**
PRACTICALS		

Unit	Topic	No. of Hours/Credits
Module 1	**Dynamic organization of cell**: Universal features of cells; cell chemistry and biosynthesis: chemical organization of cells, compartmentalization of cell Chromatin structure and dynamics: DNA interactome, recombination; Writers,-Readers and –Erasers Glycobiology: Sugars and polysaccharides with specific reference to glycogen, amylose and cellulose, glycosylation of other biomolecules - glycoproteins and glycolipids; lipids - structure and properties of important members of storage and membrane lipids; lipoproteins. Molecular mechanisms of membrane transport, nuclear transport, transport across mitochondria and chloroplasts; Cellular interactions: Host parasite interaction: Recognition and entry processes of different pathogens like bacteria, viruses into animal and plant host cells, alteration of host cell behavior by pathogens, cell-cell fusion in both normal and abnormal cells. Cell surface receptors and transduction pathways bacterial and plant -two-component signaling systems, bacterial chemotaxis and quorum sensing.:Cellular communication, cell adhesion and roles. behavior of cancer cells	**15/10**
Module 2	**Differentiation of specialized cells** differentiation of Stem cell , Fibro blasts, Blood cell formation and regulation; Differentiation of cancerous cells and role of Cellular protooncogenes Phase changes in Salmonella; Mating cell types in yeast; Surface antigen changes in Trypanosomes; Heterocyst differentiation in Anabaena; Sex determination in Drosophila; Plant Meristem Organization and Differentiation- Organization of Shoot Apical Meristem(SAM); Organization of Root Apical Meristem (RAM); Pollen germination and pollen tube guidance; Phloem differentiation; Self-incompatibility and its genetic control; Embryo and endosperm development; Heterosis and apomixis	15
Module 3	**Cellular and molecular Neurobiology** Neurons - General morphology of a typical neuron and its membrane receptors, ion channels and pumps, Cytoskeletal elements and 'molecular motors' and role in axonal transport Types of glia based on their structure and function – Astrocytes, Oligodendrocytes, Microglia and Schwann cells and their functions, Neuron-Glial cell cooperation, Na^+ and Ca^{2+} action potentials, Chemical synapses, Neurotransmitter releases, Ionotrophic receptors, somato dendritic processing of post synaptic potentials, firing patterns of neurons, synaptic plasticity, Hippocampal network, Cellular Determination and Differentiation Neuronal progenitors – proneural and neural genes, Generation of neurons and glia (asymmetric divisions) Neuronal migration and organization of cerebral cortex – role of Radial Glial cells Target selection, survival	**15**

	of neurons and their regulation by neurotrophic factors Role of apoptosis in development Neuro-immune interactions- Neural communication to the Immune system and influence of neuroendocrine hormones Immune system communication with the nervous system. Neuroethics	
Module 4	**Biomimetics – a molecular approach** Bio-inspired and bio-hybrid materials: Biomimetic functional materials, Microorganism-synthesized biomimetic materials, Biomimetic surfaces – adhesion, wetting, color and photonics, Biosensing, Tissue Engineering, scaffolds, Tissue engineered cartilage, Biomineralization and application Synthetic biology- synthetic proteins, synthetic Biomolecules, artificial chromosomes, Engineered microorganisms, Artificial cells-biomimetic membranes, artificial cell division, artificial replication, Biomimetic signalling pathways, artificial muscles, Electronic noses, DNA origami, DNA nanostructures	15/20

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

PRACTICAL Course Code: new code

Measurement of cell size by oculometer and stage micrometre.

1. To quantify number of cells present in given sample and assessment of cell viability.
2. Low speed separation of cells from animal blood.
3. Isolation of cell organelle and identification by appropriate staining techniques
4. Measurement of protein content of cells by performing protein assay.
5. Isolation and Identification of membrane proteins using a suitable methods
6. Case studies on Biomimetics and Neuronoplogy topics

Suggested references

Author	Title	Edn/yr	Publisher	R/T
Lodish, H. F. .	Molecular Cell Biology	8th Ed. 2016	New York: W.H. Freeman.	T
Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P.	Molecular Biology of the Cell	(2008 5th Ed.	New York: Garland Science.	T
Cooper, G. M., &Hausman, R. E.	The Cell: a Molecular Approach	2016	ASM ; Sunderland.	T
Raz Jelinek	Biomimetics- A molecular perspective	(2013	Hubert & co publications	T
Constance Hammond. 2008	Cellular and Molecular Neuro Physiology.	2008	Elsevier Publications	T
Krebs, J. E., Lewin, B., Kilpatrick, S. T., & Goldstein, E. S.	Lewin's Genes XI.	2014	Burlington, MA: Jones & Bartlett Learning.	R

Hardin, J., Bertoni, G., Kleinsmith, L. J., & Becker, W. M.	Becker's World of the Cell.	2012 (8th Ed	Benjamin Cummings.	R
E. Kandel, J Schwartz, T Jessell, S Siegelbaum, A Hudspeth	Principles of Neuroscience	5th Editio n,2013	Mc Graw Hill Medica	R

T-TEXT BOOK R-REFERENCE

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Course: Instrumentation				**Course Code: new code**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks - 25)**	**Semester End Examinations (SEE) (Marks- 75 in Question Paper)**
4	**4**		**4+2**	**25**	**75**

Learning Objectives:

The main objective of this course is to

1.give the state of the art knowledge of the equipment used for research on a broader sense.

2. enable the student to understand different Chromatographic techniques and their application

3. empower with knowledge of recent Spectroscopic techniques used for different biological components

4.abreast the student with principle-working and application of Cellular and molecular techniques

5.update the knowledge on applications and characterization of Nanotechnology based compounds

Course Outcomes:

After completion of the course, learners would be able to:

CO1: conduct phytochemical, biomolecule analytical procedures using Chromatographic techniques

CO2: identify the correct Spectroscopic technique to study, analyse and characterize the given sample

CO3 : understand the principle, approach and working of Cellular and molecular techniques

CO4: analyse the Nanotechnology techniques' experimental results

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	**SPECTROSCOPIC TECHNIQUES**	**15**
2	**CHROMATOGRAPHIC TECHNIQUES**	**15**
3	**CELLULAR AND MOLECULAR TECHNIQUES: PRINCIPLE-WORKING AND APPLICATION**	**15**
4	**NANOTECHNOLOGY TECHNIQUES**	**15**
	Total	**60**
PRACTICALS		

Unit	**Topic**	**No. of Hours/Credits**
Module 1	**SPECTROSCOPIC TECHNIQUES**	**15 L**
	Introduction to spectrophotometers- Single beam, Double beam and split beam. Errors in spectrophotometric analysis. Applications- Basic concepts or principles, overview of components, calibration and applications of- UV-visible spectroscopy; Flame Photometry; Fluorimetry and Phosphorimetry (Spectro fluorimeters and phosphorimeters); IR-	

	Single beam, double beam and FTIR, Raman spectroscopy; NMR; MS;AAS	
Module 2	**CHROMATOGRAPHIC TECHNIQUES**	**15 L/ 1 Credit**
	Introduction to Chromatography- separation procedure b) development procedure classification terminology **basic concepts in chromatography**: requirements of an ideal detector, types of detectors in LC and GC, comparative account of detectors with reference to their applications (LC and GC respectively), qualitative and quantitative analysis**. (2L)** **Concept of plate and rate theories in chromatography**: efficiency, resolution, selectivity and separation capability. Van Demeter equation and broadening of chromatographic peaks. Optimization of chromatographic conditions**. (2L)** **High Performance Liquid Chromatography:** Principles, Instrumentation, operation, calibration, accuracy and applications. Normal phase and reversed phase with special reference to types of commercially available columns (Use of C8 and C18 columns). Diode array type and fluorescence detector, Applications of HPLC. **(5L)** **Supercritical Liquid Chromatography:** Properties of SFE/SFC, Instrumentation, operation, advantages and applications**.** **Gas Chromatography**: Principles, Instrumentation of GC with special reference to sample injection systems – split/split less, column types, solid/ liquid stationary phases, column switching techniques, temperature programming, Thermionic and mass spectrometric detector, operation, calibration, accuracy and Applications. **(5L)** Processing Chromatography data: Chromatogram, Chromatography software. (2)	**15 L/ 1 Credit**
Module -3	**NANOTECHNOLOGY TECHNIQUES**	15 L
	Nanotechnology: Definition, Different classes of nanomaterials, synthesis of nanomaterials, nano structures and **applications,** Nanophotonics, Imaging & diagnostic techniques from nano to Micro scale Characterization using optical and chromatography techniques Microscopy: Scanning Probe Microscopes - scanning tunnelling microscope (STM), atomic force microscope (AFM), magnetic force microscope (MFM), scanning near field microscope (SNOM), Electron Microscopy: SEM, TEM ,CCD camera and application Diffraction Techniques: X-ray diffraction (XRD) Photoluminescence Spectroscopy: X-ray and UV photoelectron spectroscopies (XPS)/Auger electron spectroscopy ,	
Module 4	**CELLULAR AND MOLECULAR TECHNIQUES: PRINCIPLE-WORKING AND APPLICATION**	**15 L**
	Centrifugation : Principles and applications of Preparative, Differential Density-gradient centrifugations, Gradient media and techniques, Isopycnic, Rate-zonal centrifugation, Assay of	

	fractions ,Applications of preparative Analytical centrifugation: Essential theoretical aspects- Sedimentation velocity and sedimentation equilibrium Practical aspects 5L Fluorescence and Phosphorescence, Advanced fluorescence techniques: FLIM, FRET, and FCS Radio isotopes and applications in biology, fundamentals of tracing. Autoradiography, Principles, Instrumentation, working and applications of Flow Cytometry Advanced Cytogenetic techniques and applications - FISH , M-FISH , ISRT-FISH, CARD-FISH, FISH-MAR, SKY, CGH, Marker Chromosomes, Chromogenic In Situ Hybridization and FISH in Pathology, Disease based diagnostics using pcr- case studies, Genomic arrays, NGS platforms, tissue based Maldi, spcetroscopy using Maldi, CRISPR based diagnostics.	

Suggested books:

Author	Title of the book	Yr/Edn	published	T/R
Dubey, R. C.	Advanced Biotechnology	1st Edn (2014)	S Chand & Co	T
Das, H. K.	Textbook of Biotechnology		Wiley India	T
Bhargava, Atul	Biotechnology - recent trends and emerging dimensions		CRC Press	T
Wilson & Walker	Principles and Techniques of Biochemistry and Molecular Biology	7th Edn	Cambridge University Press	T
A. K. SRIVASTAVA and GHOSAL, SABARI	Fundamentals of bioanalytical techniques and instrumentation	2010	PHI Learning	T
Vasant Pattabhi and N. Gautham	Biophysics	2002	Narosa Publishing House,	T
Das, H. K.	Textbook of Biotechnology	5th Edn	Wiley India	T
Campbell, I. D. (2012). Biophysical Techniques.	Biophysical Techniques.	2012	Oxford University Press	T
Coleman, W. B., & Tsongalis, G. J.	Molecular Diagnostics: for the Clinical Laboratorian.	2010	Humana Press.	T
David H. Persing and Fred C. Tenover	Molecular Microbiology Diagnostic Principles and practice	3rd edn, 2016	ASM Press	T
Edited by: Y. S. Fan	Molecular Cytogenetics: Protocols and Applications,	2003	Humana Press	T
Kuhse, Helga	Bioethics - an anthology	3rd Edn, 2015	Wiley Blackwell	R
Serdyuk, I. N., Zaccai, N. R., & Zaccai, G.	Methods in Molecular Biophysics: Structure, Dynamics, Function.	2007	Cambridge University Press.	R
Phillips, R., Kondev, J., & Theriot, J.	Physical Biology of the Cell.	2009	New York: Garland Science.	R

T-TEXT BOOK R-REFERENCE

Practical
Analysis of given sample using HPTLC

- Characterizing the phytochemical constituents using GC
- Estimating the concentration of drug in the given sample HPLC
- Phytochemical analysis of medicinal plant extracts using FTIR
- 1case studies of Disease based diagnostics using pcr-
- case studies, tissue based Maldi,
- case studies on spcetroscopy using Maldi,
- case studies on CRISPR based diagnostics.
- Prenatal Diagnosis of Common Aneuploidies,
- Preimplantation FISH Diagnosis of Aneuploidies,
- Molecular Cytogenetics in Reproductive Pathology
- Interphase FISH Studies of Leukemia,
- FISH Detection in diagnosis/ progression of oncogenesis/ Breast Cancer,
- Synthesis and characterization of nano practical
- Isolation / separation of cell organelle using centrifugation techniques
- Ficol Hypaque/ sucrose based separation of blood cells.

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Program: M.Sc Biotechnology	**Semester: II**
Course: BIOTECHNOLOGY : RECENT TRENDS AND EMERGING DIMENSIONS	**Course Code: PSMABT201**

Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks - 25)**	**Semester End Examinations (SEE) (Marks- 75 in Question Paper)**
4	4	-	4+2	25	75

Learning Objectives:

1. To provide students with a sound coverage of human reproductive biology within the framework of Human Biology and also provides an important foundation to consider sexual differentiation and development, contraception, infertility and current reproductive technologies.
2. This course also introduces the fundamentals of nanoscience and its current and future applications with respect to their impact in commercial products and technologies.
3. Nutritional genomics offers great promise to personal health management based on the understanding of the relationship between diet, gene expression and health outcomes.
4. Introduction to Green Technology offers students a real world opportunity to discover and understand principles of physics, engineering, design and green-clean technologies for generating energy to non-toxic cleaning products.

Course Outcome:

CO1.Students will have gained an overall understanding of human reproduction, its associated technologies and emerging trends in developmental biology

CO2. Nanotechnology unit will offer globally-relevant, industry-linked, research-focused, technology- enabled seamless education at the postgraduate and research levels which provide relevant knowledge about fundamental principles of nanotechnology and their application to medicine, healthcare, environment and biomedical and cosmetic industries to achieve the global technological needs.

CO3. Nutrigenomics is the application of high-throughput genomics tools in nutrition research. It will promote an increased understanding of how nutrition influences metabolic pathways and homeostatic control. Students will be able to demonstrate the appreciation for the methods and strategies used to study complex trait genetics and nutrition.

CO4. Develop a thorough understanding of the concepts of sustainability and cleaner production, and the challenges that engineers face in applying these concepts in an industrial and societal context.

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	**Reproductive Biotechnology**	15
2	**Current Trends in Nanotechnology**	15
3	**Foodomics**	15
4	**Green Technology**	15

	Total	**60**
PRACTICALS		

Unit	Topic	No. of Hours/ Credits
Module 1	**Reproductive Biotechnology** **Handling and Preparation of the Sperm and Oocytes** Preparation and evaluation of sperm Preparation and evaluation of oocytes for intracytoplasmic sperm injection Oocyte in vitro maturation **Micromanipulation** Equipment and general technical aspects of micromanipulation of gametes and embryos **Culture systems and transfer techniques for the human embryo** **Cryopreservation of Gametes, Embryos and Spermatozoa** **Infertility and reproductive vaccines.**	**15**
Module 2	**Current Trends in Nanotechnology** **Applications and implications:** **Medicine and healthcare sector-**diagnosis, therapy **Nanoparticles- drug delivery and drug delivery systems** **Surgical techniques and innovations** **Environment -**Remediation and protection, pollution prevention, environment sensing **Cosmetics industry**-formulations, Nano cosmetics, Benefits vs risks	**15**
Module 3	**Foodomics** **Nutrigenomics: the future of human health** The Nutrigenomics Science Tools and Techniques for Nutrigenomics Research Important Initiatives in Nutrigenomics Research Development The Human Variome Project The Nutritional Phenotype Database The Nutrigenomics Organization The HapMap Project Advantages of Nutrigenomics Issues, Uncertainties, and Risks Opportunities and Challenges Future of Nutrigenomics	**15**
Module 4	**Green Technology** **Biofuels-** Types of biofuels Solid biofuels Liquid biofuels Gas biofuels **Bio pesticides-** Types of Bio pesticides Mode of action Advantages and disadvantages of microbial insecticides **Bio fertilizers-**	**15**

	Types of Bio Fertilizers-Bacterial, Fungal and Algal **Biosorption-** Microorganisms in metal absorption Mechanisms in bio absorption Factors affecting bio absorption Bioreactors in bio absorption	

PRACTICALS 201

1. Study of culture systems and embryo transfer techniques used in Assisted reproductive technology
2. Study of the new technological applications and societal implications in the field of nanotechnology
3. Study on recent trends in Nutrigenomics - Opportunities and Challenges
4. Report on GM Crops: Boon or Bio-hazard?
5. Report on emerging green technologies in India.

Suggested books :

Author	Title of the book	Yr/Edn	published	T/R
Thakur. Indu Shekhar	Environmental Biotechnology	2019	Dreamtech Press	T
A. K. Chatterji	Introduction to Environmental Biotechnology	2011	PHI Learning Pvt. Ltd.,	T
M. H Fulekar, K Allen , Monika Jain	Environmental Biotechnology	2018	Taylor & Francis	T
Dubey, R. C.	Advanced Biotechnology	1st Edition (2014)	S. Chand & Co	T
C.J. Barrow.	Environmental management for sustainable development	2nd ed. 2006	Taylor & Francis e-Library,	T
M.H. Fulekar:	Environmental Biotechnology	2010	CRC Press and Science Publisher, USA	R

T-TEXT BOOK R-REFERENCE

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Program: MSC BIOTECHNOLOGY				**Semester: IV**	
Course: Culture Techniques and Genetic Engineering				**Course Code: PSMABT 202**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks - 25)**	**Semester End Examinations (SEE) (Marks- 75 in Question Paper)**
4	**4**		**4+2**	**25**	**75**

Learning Objectives:

1. To introduce students to the principles, practices and application of animal biotechnology, tissue culture, and animal genomics, genetic transformation.
2. To give an idea of advances in plant tissue culture with its commercial aspects and cryopreservation techniques
3. To study gene flow in plants, the commercial aspects of transgenic plants and their applications

Course Outcomes:

At the end of the course the student will:

CO1: Gain fundamental knowledge in animal biotechnology
CO2: Gain knowledge in the initiation of primary culture, culturing on a large scale and their applications.
CO3: Understand the importance of animal cell culture in different applications
CO4: Able to carry out successful and specialized plant tissue culture and cryopreservation
CO5: Gain knowledge of marker assisted breeding as well as use of plants as vaccines

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	**Advances in Animal cell culture**	**15**
2	**Animal biotechnology -applications**	**15**
3	**Advanced Techniques in PTC**	**15**
4	**Plant Genetic Engineering**	**15**
	Total	**60**
PRACTICALS		

Unit	Topic	No. of Hours/Credits
Module 1	**Animal cell culture** Laboratory design layout: cell culture media and reagents; culture of mammalian cells, tissues and organs; primary culture, secondary culture, continuous cell lines, suspension cultures; stem cell cultures, cancer cell cultures-spheroids, Types and routes of contamination, growth parameters; Quantitation –cell counting and cell weight; phases of growth cycle-cell cycle with check points; Cell culture reactors; Scale-up in suspension; Rotating chambers; Perfused suspension cultures; Fluidized bed reactors for suspension culture; Scale-up in monolayers; Multisurface propagators; Multiarray disks, spirals and tubes; Roller culture; Microcarriers; Perfused monolayer cultures; Membrane perfusion; Hollow fibre perfusion; Matrix perfusion; Microencapsulation; Growth monitoring. Specialized cell cultures; contamination, controls; Concept of tissue engineering and regenerative medicine - applications	**15**
Module 2	**Animal Biotechnology –** Commercialization of animal Biotechnology; genomics-ovum pickup- In-vitro fertilization wild animals and cattle – methods , embryo transfer technology and application in wild animals and cattle, story of Noori, Garima, etc; Animal cloning - basic concept, cloning for conservation of endangered species; hazards of artificial breeding applications of animal cloning Transgenic animals in agriculture and research models Animal forensics: Animal species identification in religious disputes, adulteration of meat, theft of farm animals and pets etc., advantages, disadvantages and limitations of DNA forensics.-case studies Human and animal health: conventional methods of animal vaccine production, Application of animal cell culture for virus isolation and in vitro testing of drugs, Testing of toxicity of environmental pollutants in cell culture Clinical applications of stem cells: e.g. ACT and London Eye project: retinal pigmented epithelium, Cancer stem cells, Organ on chips and organoids - role in future clinical research	**15**
Module 3	**Advanced techniques in PTC:** Protoplast isolation, culture and regeneration and usage; Protoplast fusion;Somatic hybrids; Cybrids – biochemical method,	**15**

	auxotrophic mutant selection method, visual selection, applications, somaclonal variation; androgenesis, applications in genetics and plant breeding; Somatic embryogenesis and encapsulated artificial seeds, methods, types, factors influencing somatic embryogenesis, advantages. Anther and pollen culture, production of monoploid plants, triploid plants, ovary culture, embryo culture, embryo rescue. Commercial aspects of tissue culture – for forestry, floriculture, large scale cultivation of economically important plants, Soilless growth of plants and green house technology Cryopreservation: Principle, types, methods. Plant germplasm conservation, Germplasm bank	
Module 4	**Plant Genetic Engineering:** Organization of a typical plant gene, transcription start site, reporter, marker genes, promoter genes, Methods for transformation, - satellite RNA and its use in transformation. Gene flow in plants: Marker Assisted Selection (MAS), organelle genome and markers, screening and validation; QTL mapping; Gene pyramiding, Marker Assisted Breeding for various traits. Strategies for Introducing genes of biotic and abiotic stress resistance in plants Commercial status of transgenic plants: Herbicide resistance – microbial EPSP synthase, EPSP resistant GM plants, Virus resistant plants, expression of viral genes, Protease inhibitor, GNA and other lectins; a-amylase inhibitor; nematode resistance. Improved seed storage proteins; Improving and altering the composition of starch and plant oils Molecular plantibodies, plant based expression systems, plant based vaccines.	**15**

PRACTICAL 202

1. Count cells of an animal tissueculture suspension and check their viability.
2. Prepare culture media with various supplements for animal tissue culture.
3. Prepare single cell suspension from spleen and thymus.
4. Isolate DNA from animal tissue by SDS method.
5. Study of animal cell fusion using PEG.
6. Primary culture initiation from tissues and cultures and development of cell line.
7. Protoplast isolation from plant tissue
8. Protoplast culture
9. Somatic embryogenesis and production of synthetic seeds
10. Anther and Pollen grain culture
11. PCR to identify GM plants
12. Soilless growth of plants -HYDROPONICS

Suggested Readings

Author	Title of the book	Yr/Edn	published	T/R
Freshney, R. I	.CulturE of Animal Cells.	2010	John Wiley and Sons Inc.	T
Rudin N & Inman K. (). 2nd Ed.	An Introduction to Forensic DNA Analysis.	2002 2ND EDN	CRC Press.	T
Pörtner, R.	Animal Cell Biotechnology: Methods and Protocols	2007)	Totowa, NJ : Humana Press	T

T-TEXT BOOK R-REFERENCE

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Program: Master of Science (Biotechnology)				**Semester : 2**	
Course :Environmental Biotechnology and Sustainable Development				**Course Code: PSMABT203**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks - 25)**	**Semester End Examinations (SEE) (Marks- 75 in Question Paper)**
4	4		4+2	25	75

Learning Objectives:

1. Environmental biotechnology is a fundamental component required to address environmental problems.
2. This course includes several topics pertaining with solutions to certain difficult environmental problems.
3. The course covers important topics with respect to current trends in biotechnology, such as treatment and disposal of solid waste and its management.
4. The course deals with recent developments for monitoring and restoring the environment employing biotechnology through biological detoxification, remediation and ecofriendly substitutes for specific pollution problems.
5. This course explores the nature, scope and role of environmental management, with a strong focus on sustainable development through environmental policy, planning and implementation of biotechnology.

Course Outcomes:

After completion of the course, learners would be able to:

CO1: Existing and emerging technologies for solid waste management and degradation of natural and xenobiotic compounds

CO2: The modern trends in environmental biotechnology, such as novel applications of biological systems in mining, hydrometallurgy and ecofreindly solutions of higher efficiency for a few industrial processes

CO3: Environmental management approaches and develop an ability to analyze environmental management in relation to the major principles of sustainable development

CO4: Theoretical and conceptual issues relating to environment and implement appropriate process for controlling any potential negative impact on the environment by industries

Outline of Syllabus: (per session plan)		
Module	**Description**	**No of Hours**
1	**Hazardous, medical and e-waste management**	**15**
2	**Clean up Technology**	**15**
3	**Integrated Applications:**	**15**
4	**Environmental management for sustainable development**	**15**
	Total	**60**
PRACTICALS		
Unit	**Topic**	**No. of Hours/Credits**
Module 1	**Hazardous, medical and e-waste management:** **Solid waste** Types of solid waste Waste monitoring Management of Solid waste Treatment and Disposal **Non-hazardous solid Waste** Methods and biodegradation **Management of non-degradable solid waste** **Medical solid waste management** Evaluation, processing, disposal and geneal remedial measures **Hazardous waste management** **Electronic waste management** Components , treatment options , technologies in India	**15**
Module 2	**Clean up Technology:** **Eutrophication and biological control** Algal blooms Removal of phosphorus and nitrogen **Biodegradation** Aerobic vs Anaerobic Testing for biodegradability **Biodegradation and bioconversion of natural compounds** Bioconversion and bio utilization of effluent for products Biomethanation **Biodegradation and bioconversion of Xenobiotic compounds** Factors influencing biodegradability Persistance of Xenobiotics Biodegradation of Hydrocarbons	**15**
Module 3	**Integrated Applications:** **Pollution monitoring** Indicators of pollution Detection of pollutants – Biosensors **Bio Hydrometallurgy and Bio Mining** Bioleaching Sulphur Removal from Acid Mine Drainage,	**15**

	Cyanide Removal, Coal-tar Distillation **Bio Quenching** of Toxic Metal **Biosorption**– Biosorption of Heavy Metals Biosorbents - Microbial Groups Bacteria, Fungi, Algae, Macrophytes **Remedial techniques for specific pollution problems** Biopulping Biofiltration Biodegradation of Polymers Bioremediation of crude oil spills	
Module 4	**Environmental management for sustainable development:** **Environmental management fundamentals and goals** Process and goals Challenges Approaches to environmental management **Sustainable development** Ecological concepts and parameters Environmental system and ecosystem planning and management Environmentalism and the Green Movement Participants in environmental management **Environmental management and business** 'Greening' of economics Business Charter for Sustainable Development **Measuring sustainable development** Standards, indicators and benchmarks Eco-audit Ecological foot-printing Environmental Hazard and risk management Environmental impact assessment **Global challenges and Role of Biotechnology**	**15**

PRACTICAL 203

1. Determination of BOD
2. Determination of COD
3. Study of bioremediation
4. Enrichment and isolation of phosphate solubilizers
5. Enrichment and isolation degraders of natural compounds (any one)
6. Enrichment and isolation of nitrifying bacteria
7. Study of nitrification
8. Case study for Integrated approaches, environmental management and sustainable development

Suggested Readings

Author	Title of the book	Yr/Edn	published	T/R
Thakur. Indu Shekhar	Environmental Biotechnology	2019	Dreamtech Press	T
A. K. Chatterji	Introduction to Environmental Biotechnology	2011	PHI Learning Pvt. Ltd.,	T
M. H Fulekar, K Allen , Monika Jain	Environmental Biotechnology	2018	Taylor & Francis	T
Dubey, R. C.	Advanced Biotechnology	1st Edition (2014)	S. Chand & Co	T
C.J. Barrow.	Environmental management for sustainable development	2nd ed. 2006	Taylor & Francis e-Library,	T
Hugo W.B Russell	Pharmaceutical microbiology	6th edition,	Oxford black Scientific publishers	T
A.H Patel	Industrial microbiology	2nd Revised Edition, 2011	Laxmi Publications	T
RC Dubey	Advances in Biotechnology	2009	S. Chand & Co	T
Robert. W. Hutkins	Microbiology and Technology of fermented foods	1st edition , 2006	IFT Press, Blackwell publising	T
Okafor Nduka	Modern Industrial Microbiology and Biotechnology	2nd edition, 2018	CRC Press, Taylor and company	T
M.H. Fulekar:	Environmental Biotechnology	2010	CRC Press and Science Publisher, USA	R
Sambamurthy K and Aushotosh Kar	Pharmaceutical biotechnology-- , 2006			R
T-TEXT BOOK R-REFERENCE				

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Program: M.Sc. (2021-22)	
Program: Master of Science (Biotechnology)	**Semester : 2**
Course: Research Methodology	**Course Code: New**

Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks - 25)**	**Semester End Examinations (SEE) (Marks- 75 in Question Paper)**
04	04	-	04	25	75

Learning Objectives:

1.

Course Outcomes:

After completion of the course, learners would be able to:

CO1: identify a scientific problem, decide the objectives, design the proposal after literature research.

CO2: incorporate the ethical values in organizing and implementing the research procedures

CO3: able to choose authentic publishers and publish their quality research work

CO4: establish good statistical background that supports the good and value based research

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	Research Methodology	15
2	Biostatistics -introduction	15
3	Theory of Probability	15
4	Hypothesis testing	15
	Total	60
PRACTICALS		60

Unit	**Topic**	**No. of Hours/Credits**
Module 1	**1.RESEARCH METHODOLOGY** 1.1. Strategies, planning and analysis 1.1.1. Scientific problem 1.1.2. Objectives of research 1.1.3. Short term and long term goals 1.1.4. Research conditions 1.1.5. Research design- characteristics of a good research design, types of research design 1.1.6. Repeatability, reproducibility and reliability 1.1.7. Experimental protocols 1.2. Literature search 1.2.1. Information literacy 1.2.2. Systematic literature search 1.2.3. How to formulate a query: PICO	**15**

	1.2.4. Search techniques 1.2.5. Methodology filters 1.2.6. Critical appraisal 1.2.7. Impact factor 1.2.8. Medical and scientific internet 1.2.9. Principal bibliographic databases 1.2.10. Citation style 1.2.11. Reference management software e.g. Mendeley, Zoreto 1.3. Ethics in science 1.3.1. Introduction to ethics 1.3.2. Scientific conduct and misconduct 1.3.3. Authorship issues 1.3.4. Plagiarism 1.4. Basic principles of human research ethics- international regulation Ethics of animal research- CPCSEA, Institutional ethics committee, OECD guidelines	
Module 2	**2.BIOSTATISTICS- INTRODUCTION** 2.1. Introduction- definition, scope and limitations 2.2. Sampling-sampling frame, importance of probability sampling, simple random sampling, systemic sampling, stratified random sampling, cluster sampling 2.3. Collection of data, classification & tabulation-diagrammatic & graphical representation 2.4. Measurement scales, variables & their measurements 2.5. Measures of central tendency -mean, median, mode, geometric mean 2.6. Measures of dispersion- Range, Q.D., M.D., variance, standard deviation Correlation and Regression analysis: Correlations and regressions-: Relation between two variables, scatter diagram, definition of correlations & their equations, interpretation of regression coefficients, principles of least squares, Two regression lines, curve fitting Karl Pearson's coefficient of correlation, Spearman's coefficient of correlation	**15**
Module 3	**3.THEORY OF PROBABILITY** Random experiments, sample space of an experiment, event, mutually exclusive events, exhaustive events, independent events, additional theory(statement only), conditional probability, multiplication theorem(statement only), Bayes' theorem. Discrete distribution- Binomial distribution, Poisson distribution Continuous distribution- Normal distribution and its properties	**15**
Module 4	**4.** 4.1. HYPOTHESIS TESTING 4.1.1. Null and alternate hypothesis 4.1.2. Type-I & Type-II errors 4.1.3. Level of significance, 4.1.4. Power of test 4.1.5. p value 4.2. PARAMETRIC TESTS	**15**

	4.2.1. Large sample Tests 4.2.1.1. Testing significance of single population mean 4.2.1.2. Testing significance of single population proportion 4.2.1.3. Testing significance of two population mean 4.2.1.4. Testing significance of two population proportion 4.2.2. Small sample Tests 4.2.2.1. Testing significance of single population mean 4.2.2.2. Testing difference between two independent normal population mean 4.2.2.3. Testing difference between two correlated normal population mean 4.2.2.4. Testing significance of correlation coefficient 4.2.3. χ^2 test 4.2.3.1. Testing single population variance 4.2.3.2. Testing Goodness of fit 4.2.3.3. Testing association between two attributes 4.2.4. F-test- Testing equality of variance 4.2.5. ANOVA- one-way classification, two-way classification 4.3. INTRODUCTION TO NON-PARAMETRIC TESTS 4.3.1. The Wilcoxon Signed-Rank test for location 4.3.1.1. Testing single population mean 4.3.1.2. Testing difference between correlated(match pair) population means 4.3.1.3. Testing difference between two independent population means 4.3.2. The Mann-Whitney Test(Mann-Whitney-Wilcoxon test -for equality of medians) 4.3.3. The Kolmogorov-Smirnov Goodness- of -Fit Test 4.3.4. The Kruskal-Wallis One-Way Analysis of Variance by Ranks The Friedman Two-Way Analysis of Variance by Ranks	

Practicals **Course Code: New**

- SPSS
- Xl based statistical problem solving
- Case studies to decide the type of test or analysis that should be incorported

Suggested books:

Author	Title of the book	Yr/Edn	published	T/R
Petter Laake, Haakon Benestad and Bjorn Reino Olsen	Research Methodology in medical and Biological sciences -edited	2019	Academic Press	T
Pradipkumar Sahu.	Research Methodology: A guide for Researchers in Agricultural Science, Social Science and other related fields.	2006	Springer	T
Ranjit Kumar	Research Methodology- A step-by-step Guide for beginners,	3rd Edition, 2005	Sage publications	T

Daniel WW, Cross CL	Biostatistics: A foundation for analysis in health sciences.	10th Edn, 2013	Wiley	T
Zar JH.	Biostatistical Analysis.	5th Edition, 2010	Pearson Education	T
Pagano M., Gauvreau K.	Principles of Biostatistics.	2nd Edn. 2010	Cargege Learning,	T
Gupta SP.	Statistical Methods	4th Edn, 2011	Edn Sultan Chand & Co	T
Rosner B.	Fundamentals of Biostatistics.	7th Edn. 2011	Duxbury Thomson	T
D'Agostino RB., Sullivan LM., Beiser AS.	Introductory Applied Biostatistics	2006	Thomson Brooks/Col e	R

T-TEXT BOOK R-REFERENCE