

SYLLABUS FOR CREDIT BASED SEMESTER SYSTEM



M.Sc. BIOMEDICAL TECHNOLOGY – 2021

DEPARTMENT OF ZOOLOGY
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M.Sc. IN BIOMEDICAL TECHNOLOGY

SYLLABUS FOR CREDIT BASED SEMESTER SYSTEM

SEMESTER – I

SYLLABUS EFFECTIVE FROM JUNE 2021

Sl. No.	Course Code	Name of the Course	Hours per Week	Internal Marks	External Marks	Total Marks	Credits
1.	BMT-401	CYTOLOGY	3+1	30	70	100	04
2.	BMT-402	BIOCHEMISTRY & HUMAN PHYSIOLOGY	3+1	30	70	100	04
3.	BMT-403	MICROSCOPY & CLINICAL TECHNIQUES	3+1	30	70	100	04
4.	BMT-404	PARASITOLOGY & MICROBIOLOGY	3+1	30	70	100	04
5.	BMT-405PR	PRACTICAL -1	06	30	70	100	04
6.	BMT-406PR	PRACTICAL – 2	06	30	70	100	04
		TOTAL	28	180	420	600	24

M.Sc. in Biomedical Technology

PROGRAMME OUTCOME

The programme of master's in **Biomedical Technology**, imparting theoretical and experimental skills and enabling young minds to pursue higher studies and become teaching faculties in the Universities and Research Centers. This programme, with dissertation projects, imparts competent skills to thrive in research institutions and pharmaceutical industries and various diagnosis laboratories. Also teaches students for better living, challenges and opportunities, skill upgradation, ethics and research and career in science.

COURSE OUTCOME:

Semester I:

BMT 401: The students would be able to learn comprehensive picture of cells, sub cellular organelles, cell function, cell division and cell death. They will understand the basics of cell and tissue culture including infrastructure, equipments, materials and sterile technology and different cell based assay protocols.

BMT 402: The students would be able to know metabolism and energy generating pathways and metabolism associated diseases in human. They will be also taught about human physiological process and its related diseases.

BMT 403: The students would be able to learn various techniques like microscopy, electrophoresis, chromatography, spectrophotometry, centrifugation and different clinical instruments for diagnosis.

BMT 404: The students would be able to learn medical parasitology and microorganisms and diseases related to microorganisms.

BMT 405 PR & 406 PR. The students will attain on hand practical experiences of various topics covered in the theory papers.

M.Sc in BIOMEDICAL TECHNOLOGY

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M.Sc. BIOMEDICAL TECHNOLOGY SEMESTER – I JUNE 2021 ONWARDS

BMT-401: CYTOLOGY

UNIT I: Cell Organelles:

Membranes of cells and transport across membranes; Energy generation in mitochondria and chloroplast; Cytoskeleton; General organization of protein transport within and outside the cell; Protein sorting and secretion; Mechanism of intracellular digestion; Structure and function of peroxisome; Nucleus; Nucleolus and biogenesis of ribosome.

UNIT II: Cell Junctions, Cell Cycle, Cell Death, Cancer and Stem Cells:

Cell adhesions, adherence, tight and gap junctions; Extracellular matrix and its association with cells; Cell cycle and its regulation; Cell death, apoptosis, necrosis, terminal differentiation and cell aging; Cancer, metastasis and angiogenesis; Stem cells, its types and application.

UNIT III: DNA, Chromatin and Chromosome:

Structure, properties, types of DNA and its isolation; Types and properties of histone and non-histone proteins; Nucleosome, Solenoid structure, Loop and domain, Organization of DNA in the chromosome; Types of chromosomes; Types and properties of heterochromatin; Lyon hypothesis; X-chromosome inactivation; Sex chromatin and its importance.

UNIT IV: Cell, Histotypic and Organotypic Culture of Animal cells:

Basics of cell culture; Culture environment, Sterilization techniques; Factors affecting cell culture, Contamination and its remedies; Serum and serum-free media; Primary and secondary cultures; Cell lines; Cell strains and Techniques for production of cell strains; Monolayer cultures; Suspension cultures; Cell synchronization and characterization; Measurement of cell growth; Scaling-up of animal cells in culture; Cryopreservation, Histotypic and organotypic cultures; 3-D cell culture.

BMT-402: BIOCHEMISTRY & HUMAN PHYSIOLOGY

Unit-I: Enzymology:

Significance of Enzymes in Biological systems; Nomenclature and Enzyme Classification; Enzyme structure and function; Properties of Enzymes; Mechanism of Action of Enzymes; Enzyme Kinetics: Unisubstrate enzyme kinetics, K_m , V_{max} ; Linear Plots; Factors affecting Enzyme Activity; Reversible and Irreversible Enzyme Inhibition; Types of Inhibition; Allosteric enzymes; Immobilization and Industrial uses of enzymes; Ribozymes; DNAzymes; Metalloenzymes; Isoenzymes; Clinical Role of Enzymes.

Unit-II: Energy Generation and Associated Diseases:

Reactions, regulation and genetic disorders of glycolysis, Krebs's cycle, Pentose phosphate pathway, Fatty acid oxidation and Glycogen metabolism, Glucose transporters, Diabetes and its effects on the body.

Unit-III: Circulatory, Respiratory and Excretory System:

Cardio-vascular physiology; Functions & Disorders of Circulatory System; Respiratory physiology; Lung volumes and capacities; Control of respiration; disorders of the respiratory system; Role of body fluids; Homeostasis; Structure and function of kidneys; Concentration of urine; Control of urine formation; Disorders of the urinary system.

Unit-IV: Digestive, Nervous and Muscle System:

Physiology of food intake; Digestion and absorption of Carbohydrates, Proteins and Fats; Control and components of secretions in the oral cavity, stomach and intestine; Gastric motility and emptying; Cells and organization of the Nervous system; Nerve impulse transmission; EPSP and IPSP; Neurotransmitters, Cells and organization of the Muscular system; Physiology of Skeletal, Smooth and Cardiac Muscles; Neuromuscular junctions; Muscle contraction and energetic; Neuromuscular Disorders.

BMT-403: MICROSCOPY & CLINICAL TECHNIQUES

Unit-I: Microscopy:

Principle, working and types of light microscope: Bright-field, Dark-field, Phase-contrast, Fluorescence, Confocal, Atomic Force Microscopy; Principle and working of electron microscope – SEM and TEM; Freeze-etch and Freeze fracture technique for EM; Image analysis for microscopy.

Unit-II: Electrophoresis and Centrifugation:

Principle of Electrophoresis; Types of electrophoresis: Agarose gel electrophoresis, polyacrylamide gel electrophoresis, Isoelectric focusing and 2D-PAGE, Pulse field gel electrophoresis, Tube gel electrophoresis, Capillary gel electrophoresis; Factors affecting electrophoresis.

Principle of centrifugation; Types of rotors; Types of centrifuges; Types of centrifugation techniques: Differential, Density gradient and Analytical ultracentrifugation.

Unit-III: Chromatography and Photometry

History and introduction of separation techniques; Fundamentals of chromatographic separation; Chromatographic techniques; Methods of separation and detection; Hyphenated techniques - HPLC, HPTLC, FPLC, UPLC, etc.,

Principle and applications of spectroscopic techniques – UV-Vis; IR; NMR; MS; MALDI-ToF etc.

Unit-IV: Clinical Instrumentation

Biomedical recorders (ECG, EEG, EMG); Sphygmomanometer; Pulse Oximeter; Blood Glucose Monitoring apparatus; Imaging Instrumentation for clinical diagnosis; Sonography, Endoscopy, Ventilator, Dialysis machine, Thermometers, Automated blood and cell analysers.

BMT-404: PARASITOLOGY & MICROBIOLOGY

Unit-I: General introduction & Medical Protozoology:

Divisions of medical parasitology; Classes of Host and Parasites; Parasitic adaptations and Host parasitic interactions; Modes of infection: Oral transmission, Skin transmission, Vector transmission, Direct transmission; Sources of infection: Soil, Water, Food, insect vectors, Animals, Other persons; Diagnostic methods in parasitology: Examination of stools, blood, urine, sputum, Biopsy, Culture methods, Indirect evidences; Medical Protozoology: Classification and silent characters of protozoan parasites; Distribution, Habitat, Life cycle, Pathogenicity, Clinical features, Epidemiology, Laboratory diagnosis and prophylaxis of the following infectious protozoan parasites in human – (1) *Entamoeba histolytica* (2) *Giardia* spp. (3) *Leishmania* spp. (4) *Trypanosoma* spp. (5) *Trichomonas vaginalis* (6) *Balantidium* spp. (7) *Plasmodium* spp.]

Unit-II: Medical Helminthoogy:

Classification of helminthes: Platyhelminthes; Nematelminthes; Salient characters of helminthes: Distribution, Habitat, Life cycle, Pathogenicity, Clinical features, Epidemiology; Laboratory diagnosis and prophylaxis of the following helminth parasites: Platyhelminthes: Trematodes: *Schistosoma mansoni*, *Paragonimus westermani*, *Clonorchis sinensis* Cestodes: *Diphyllobothrium latum*, *Taenia solium*, *Echinococcus granulosus*; Nematelminth: *Trichinella spiralis*, *Trichuris trichiura*, *Ancylostoma duodenale*, *Wuchereria bancrofti*, *Onchocerca volvulus*, *Dracunculus medinensis*; Arthropod vectors and their role in parasitology: Mosquito; Sandfly; Tsetse fly; Bugs; Lice; Fleas.

Unit-III: Basic techniques of Microbiology

Isolation methods-Streak plate; Spread plate and Pore plate methods; Growth in liquid media and solid media; Growth Phases; Environmental factors affecting growth; Definition of sterilization; Physical and Chemical methods of sterilization: Disinfection, sanitization, antisepsis sterilants and fumigation; Mechanism of simple, differential and special staining methods (capsule, flagella, endospore staining); Antibiotic sensitivity testing of the pathogens and its importance.

Unit-IV: Microorganisms and Disease

Pathogenic Microorganisms - General characteristics and Classification of Microbes, Viruses, Bacteria and Fungi; List of common pathogenic bacterial, fungal and viral diseases of human beings. (Name of the disease, causative pathogen, parts affected, clinical aspects of disease, diagnostic methods and treatment); Different morphological, biochemical, molecular and serological methods for identification of pathogenic microorganisms.

BMT – 405 PR:

Practicals based on the theory papers BMT-401 and BMT-402 and Industrial/Laboratory visits

BMT – 406 PR:

Practicals based on the theory papers BMT-403 and BMT-404 and Industrial/Laboratory visits

LIST OF REFERENCE BOOKS

1. Becker's World of the cell.- Jeff Hardin and Gregory Bertoni.
2. Karp's Cell and Molecular Biology Concepts and Experiments.- Gerald Karp, Janet Iwasa and Wallace Marshall.
3. Cell and Molecular Biology.- E.D.P. DeRobertis and EMP De Robertis Geoffrey Cooper.
4. Molecular Biology of the Cell.- Bruce Alberts et al.,
5. Animal cell Culture:Essential methods.- John M. Davis (Ed).
6. Culture of Animal cells:A manual of basic technique and specialized applications.- R. Freshney.
7. Animal cell culture and Technology.- Michael Butler.
8. Animal cell culture.- Mohd. Al-Rubeai (Ed).
9. Animal cell culture.- John R.W. Masters (Ed).
10. Textbook of Physiology.- George Howard Bell, Donald Emslie-Smith, Colin Ralston Paterson. (Eds).
11. Human Physiology, Biochemistry and Basic Medicine.- Laurence cole , Kramer, Peter.
12. Physiology and Biochemistry in modern medicine.- John Macleod.
13. Principles of Biochemistry.- Albert L. Lehninger, David L. Nelson and Michael M. Cox.
14. Textbook of Medical Physiology.- John E. Hall and C. Guyton.
15. Tortora's Priciples of Anatomy and Physiology.- Gerard J Tortora.
16. Fundamentals of Enzyme kinetics.- [Athel Cornish-Bowden](#).
17. Understanding the control of metabolism.- David Fell.
18. Fundamentals of Enzymology.- Nicholas C. Price and Lewis Stevens.
19. Wilson & Walker's Principles and Technique of Biochemistry and Molecular Biology.
20. Instrumental Analysis in the Biological Sciences.- Gordon M.H.
21. Fundamentals of Enzymology-The Cell and Molecular Biology of Catalytic Proteins.- Price, N. C. and Stevans, L.
22. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry.-Bonner, P.L. and Palmer, T.

23. Enzymes: Catalysis, Kinetics and Mechanisms.- Punekar, N. S.
24. Harper's Illustrated Biochemistry Thirty-First Edition.- Rodwell, V.W., Bender, D.
Botham, K.M. et al.
25. Biochemistry- Satyanarayana, U. and Chakrapani, U.
26. Biochemistry & Metabolism.- Davison, A., Milan, A. Phillips, S. and Ranganath, L.
27. Molecular cell biology.- Harvey Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Martin, K. C., Yaffe, M. & Amon, A
28. Techniques in microscopy and cell biology.- Sharma, V. K.
29. A manual of laboratory experiences in cell biology.- Gasque, C.E.
30. Electrophoresis in practice: A guide to methods and applications of DNA and protein separations.- Westermeier, R.
31. Electrophoresis: theory, methods, and applications.- Bier, M. (Ed.).
32. Centrifugal separations in biotechnology.- Leung, W. W. F.
33. Centrifugal Separations in Molecular and Cell Biology.- Birnie, G. D. and Rickwood, D. (Eds.).
34. Encyclopaedia of Separation Science.- Smith, R. M.
35. Parasitology, Protozoology and Helminthology by K. D. Chatterjee
36. Essentials of medical parasitology by Apurba S. Sastry & Sandhya Bhat
37. Paniker's textbook of medical parasitology - C. J. Paniker
38. Textbook of Medical Laboratory Technology - Clinical Laboratory Science and Molecular Diagnosis (3rd Edition); Darshan P. Godkar & Praful B. Godkar
39. Atlas of Medical Parasitology; Shiba Kumar Rai, Shoji Uga, Nobumasa Kataoka, Takeo Matsumura
40. Practical Exercises in Parasitology by David & Jerzey
41. Parasitology (Including Entomology & Acarology) by B. Dasgupta
42. Advances in chromatography. Giddings, J. C
43. Braithwaite, A., & Smith, J .F. Chromatographic Methods. Netherlands. Braithwaite, A., & Smith, J .F
44. Mark, F. V. Chromatography: principles and instrumentation.

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M.Sc. IN BIOMEDICAL TECHNOLOGY

SYLLABUS FOR CREDIT BASED SEMESTER SYSTEM
SEMESTER – II
SYLLABUS EFFECTIVE FROM JUNE 2021

Sl. No.	Course Code	Name of the Course	Hours per Week	Internal Marks	External Marks	Total Marks	Credits
1.	BMT-407	Clinical Genetics & Immunology	3+1	30	70	100	04
2.	BMT-408	Genetic Engineering & Advance Molecular Techniques	3+1	30	70	100	04
3.	BMT-409	Clinical Biochemistry & Serology	3+1	30	70	100	04
4.	BMT-410	Hematology and Radiation biology	3+1	30	70	100	04
5.	BMT-411PR	PRACTICAL -1	06	30	70	100	04
6.	BMT-412PR	PRACTICAL - 2	06	30	70	100	04
		TOTAL	28	180	420	600	24

M.Sc. in Biomedical Technology

PROGRAMME OUTCOME:

The program and syllabus for the Masters degree in Biomedical Technology has been designed keeping in mind the current analytical trends and requirements of Medical Analysis and Diagnostics, as well as Biological research. This syllabus is thus aimed at training a post graduate student with knowledge and practical expertise of the fundamental theoretical concepts in Biomedicine and the technology currently employed in the field. A student of this Course would therefore be prepared and equipped for a career in Biological Research and Medical Research and Diagnostics, with clear basic concepts and sturdy practical expertise.

COURSE OUTCOME: Semester II

BMT 407: The module includes topics in Clinical Genetics and Immunology. The student would gain information on the molecular details, gene complexities and basic molecular mechanisms to understand the Genetic basis of inheritance, chromosomal and gene associated anomalies, as requisite for clinical analysis, interaction and diagnosis of patients with Genetics disorders. Topics under this course would prepare a student for the career essentials in Medical Genetic analysis and provide the expertise required from Lab to Clinic, since this is a rapidly advancing field.

Topics in Immunology would help the student to learn about the details of immune responses, immune function and immune related disorders. In-depth knowledge and working experience in varied Immunotechnologies would fortify the student's opportunity for research and laboratory analysis, which is a vastly expanding area of Medicine, since innumerable clinical conditions and diseases are based on immune attack and dysfunction.

BMT 408:

In the recent past Genetic Engineering and Advanced Molecular Technologies form a major constituent in the Pharmaceutical Industry, Biological Research and Molecular Clinical Diagnostics. A student of this course would therefore have a comprehensive understanding of the underlying theory as well as practical expertise in Molecular Analytical tools, such as Recombinant DNA technology, Next generation sequencing, CRISPER etc., which is an enduring and added asset for a career in Molecular and Clinical Analytics.

BMT 409

This revised curriculum has been planned to guide a student through the intricacies and specificities of Clinical Biochemistry and Serology, which are key areas in Biomedical technology and diagnosis. A student would be furnished with the basic concepts of recent biochemical and molecular laboratory tests, their implications and inferences, requisite for Clinical evaluation. The course lays emphasis on understanding the clinical significance of various diagnostic markers, as well as the laboratory evaluation, precautions and quality control measures, which would therefore enhance a student's prospect for a career in diagnostics.

BMT 410

The growing incidence of Haematological disorders and Haemoglobinopathies warrants accurate analysis and precision diagnostics. This course was thus formulated to equip a post-graduate student in Biomedical Technology with the basic theoretical knowledge, advanced practical information and primary skills required for Hematological Laboratory investigations. This would open newer avenues for a student to explore challenging careers in the areas of Haematological diagnostics and associated transfusion technologies.

The course also includes important topics in Radiation Biology, since the use of radioactive isotopes in Nuclear Medicine and the use of radiation in diagnosis and therapy are pivotal elements in medical diagnosis and therapy. A student of Biomedical Technology should consequently be aware of the technical uses, handling, precautions and exposure effects of radiation based analyticals.

BMT 411 PR & 412 PR. The students will attain hands-on practical experiences of various topics covered in the theory papers.

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M.Sc. BIOMEDICAL TECHNOLOGY SEMESTER – II JUNE 2021 ONWARDS

BMT-407: Genetics & Immunology

Unit-I: Genetics-I

DNA replication, transcription & splicing, Regulation of gene expression in prokaryotes – negative and positive control of lac operon, trp operon and its attenuation, Extra nuclear inheritance and maternal effect, Mutation & mutagenesis, C value, complexity of genomes, Split genes, non-coding genes, overlapping genes, multi-gene families, pseudogenes, overlapping sequences, Unique sequences, Repetitive sequences - satellite DNAs and interspersed repeated DNAs, LINES, SINES, Alu family, Transposons.

Unit-II: Genetics-II

Mendelian inheritance and its extension, epistasis, pleiotropy, incomplete dominance, codominance, multiple alleles, penetrance & expressivity, phenocopy. Linkage & crossing over. Mechanism of sex determination, sex linked inheritance, Y specific genes. Chromosome aberrations, Chromosome syndromes caused by aneuploidy, mosaicism, and structural anomalies, Chromosomal anomalies in malignancy. Polygenic inheritance, Inborn errors of metabolism, Multifactorial disorders.

Unit-III: Immunology-I

An Introduction to the Immune System, Immune response, Antigen, Antibodies, Major Histocompatibility Complex, Primary and secondary immunodeficiencies, Allergy and Hypersensitivity, Autoimmunity, Immunosenescence, Cancer immunology.

Unit-IV: Immunology-II

Immunological diagnostic techniques/Immunochemical techniques, Immunoassays, Immunoelectrophoresis, Future of Diagnostic Immunology, Immunocapture Polymerase Chain Reaction, Immunotherapy, Immunosuppressive therapy, Transplantation, Environmental Allergy and Allergotoxicology, Immunotoxicity Testing.

BMT-408: Genetic Engineering & Advance Molecular Techniques

Unit-I: Genetic Engineering - I

Expression and interaction-based screening of colonies, Principles of hybridization and hybridization-based techniques, CRISPR/Cas9, Recombination-based cloning, Molecular interaction assays including two hybrid assays, Transformation and Transfection methods, Promoter characterization and mutagenesis.

Unit-II: Recombinant DNA Technology

Enzymes used in DNA technology – nucleases, Polymerases, Ligase, kinases and phosphatases, Vectors – Plasmids, Phages, Cosmids, Artificial chromosomes, Shuttle vectors, Expression vectors, Construction of genomic and cDNA libraries, Applications of Recombinant DNA Technology, GMOs.

Unit-III: Advance Molecular Biology Techniques - I

Isolation of DNA, RNA and Plasmid; Polymerase chain reaction and its general applications; Dye and Probe based detection in Real Time PCR; Gene expression study and data analysis in qPCR; DNA fingerprinting; DNA foot-printing.

Unit-IV: Advance Molecular Biology Techniques – II

RFLP and Restriction Mapping; Southern blotting, Northern blotting, Western blotting, Dot Blot technique; DNA sequencing by chain termination method and chemical degradation method, Capillary sequencing technique; Gene transfer techniques.

BMT-409: Clinical Biochemistry & Serology

Unit-I:

Role and significance of Iron, Mechanism and proteins involved in Iron transport and storage; Iron binding capacities: Serum ferritin, D-dimer values and its implications. Iron levels in pregnancy and lactation. Significance of electrolytes, Determination of Na⁺ and K⁺; Role and clinical importance of sodium and potassium; Significance of chloride; Role and clinical significance of calcium and phosphorous; Normal values, clinical range and interpretations. Clinical importance of evaluation of Cerebro-Spinal Fluid (CSF); collection and examination of C.S.F.

Unit-II: Serum lipids and proteins

Blood lipids: Lipid profile, determination of cholesterol, HDL, LDL, TG and ratios Lipoproteins: Gaucher, Tay-Sachs, Niemann Pick disease, A/G ratio, Gamma-globulin measurement, and electrophoretic separation of bloodproteins Serum albumin and fibrinogen estimation, Blood tests for Phenylalanine and 5-hydroxyindole.

Unit-III: Biochemistry & Serology

Concept of Biochemical and molecular tests, Clinical importance of Biochemical and molecular tests, Understanding Qualitative and Quantitative indices, Qualitative and Quantitative estimation of various diagnostic markers.

Unit-IV: Kidney Functions & Serology

Renal Function test, Serology testing including dilutions, titers, agglutination, precipitation, labeled and unlabeled immunoassays, molecular assays, and flow cytometry principles and the application of testing procedures, Diagnostic uses of serological tests in different bacterial, fungal and viral disease, clinical significance of results in diagnosis. In-vitro Diagnostic (IVD) test for diagnosis and monitoring of infectious diseases.

BMT-410: Hematology and Radiation biology

Unit-I: Hematology - I

Blood, blood components and blood cell abnormalities, Methods of blood sample collection, Anticoagulants - their uses & reasons for choice, Hematocrit, Differential count, ESR, PCV, MCV, MCH, MCHC, CT, PT; Bone marrow aspiration, biopsy collection and analysis, Blood coagulation, Disease associated with coagulation factors and pathway; Different types of anemia (Classification, Symptoms, Causes, Diagnosis, Tests, Management, Treatment and Prevention), Leukemia and lymphoma.

Unit-II: Hematology - II

Hemoglobin and its types, Hemoglobinopathies - Normal & Abnormal hemoglobin with nomenclatures, Hemoglobin Electrophoresis; Blood Banks and their functioning, Blood collection and preservation, Blood grouping and its different types, screening of donor, cross matching, Coombs' Test, Blood Donation, Component of Bloods and their uses, Blood storage, Transfusion of RBC, Platelets, WBC, Haemopoietic Cells, Plasma components; Transfusion for the newborn; Blood Transfusion reactions (immediate and delayed), Laboratory Tests for various Transfusion Transmitted disease (TTD).

Unit-III: Radiation Biology - I

Radioactive isotopes, types, properties and application in nuclear medicine and research; Radioactivity, Specific activity, Radioactive decay, half-life; Modes of radioactive decay; Sources of Exposure; Types and properties - Electromagnetic and Particulate forms (α , β , η , protons, positrons); Radiation dosimetry, Measurement modalities and Units of Radiation; Ionising radiation: Types, uses and properties of X-rays; Varied Diagnostic applications of X-rays; Properties of Gamma rays. Interaction of radiation with matter; Non-Ionizing radiation: Types, sources, uses, properties and biological effects of Ultraviolet radiation, Infrared radiation, microwaves and radiofrequency radiation.

Unit-IV: Radiation Biology - II

Law of Radiosensitivity; Differential radiosensitivity; By-stander effect; Effects of Ionizing radiation: Effects on Biomolecules, Cell and Cell organelles; Effects on various organs and organ systems; Radiation Genetics; Radiation syndromes; Radiation and Cancer, Radiotherapy, External Beam radiotherapy and Brachytherapy; Radioprotective agents, radiosensitizing agents, Radiation hormesis; Precautions and ICRP safety rules in handling radiation/radioactive isotopes.

BMT – 411 PR:

Practicals based on the theory papers BMT-407 and BMT-408. Field/ Industrial/ Laboratory visits.

BMT – 412 PR:

Practicals based on the theory papers BMT-409 and BMT-410. Field/ Industrial/ Laboratory visits.

REFERENCE BOOKS

- Textbook of Clinical biochemistry and human biochemistry by GP Talwar
Clinical Chemistry, Quality in laboratory diagnosis by Nichols, Rauch and Laposata by Demos Medical
Tietz textbook of clinical chemistry and molecular diagnostics by Rifai, Horvath and Wittwer by Elsevier
Lewin's Genes XII by Krebs, Goldstein and Kilpatrick by Jones and Bartlett Learning
Synthetic Biology by Meyers, Wiley – Blackwell
Mishra and Alok, A handbook of research methodology by Educreation Publication
Arumugam, Saras publication, Research Methodology for life Sciences
Barbara J. Bain, Imelda Bates & Mitchell Lewis (2006). Dacie and Lewis Practical Haematology. Churchill Livingstone.
Nora C. J. Sun (1983). Hematology: An Atlas and Diagnostic Guide. Saunders.
Martin Howard & Peter Hamilton (2013). Haematology - An Illustrated Colour Text. Churchill Livingstone.
A. Victor Hoffbrand & John E. Pettit (1988). Clinical Hematology. Grower Medical Publishing.
Kanai L Mukherjee, Swarajit Ghosh & Anuradha Chakravarthy (2017). Medical Laboratory Technology (volume-1 & volume-2). Mc Graw Hill India.
Jacqueline H. Carr (2021). Clinical Hematology Atlas (6th Edition). Elsevier.
Rakesh Joshi (2021). A Concise Textbook of Clinical Pathology Hematology & Blood Banking. JBD Publications.
Nanda Maheshwari (2021). Clinical Pathology, Hematology & Blood Banking (4th Edition). Jaypee Brothers Medical Publishers.
Ganga S Pilli (2022). Essentials Of Blood Banking and Transfusion Medicine (2nd Edition). CBS Publishers & Distributors.
Poonam Bachheti & Aruna Singh (2012). Hematology and Blood Banking. Vayu Education of India
Lillian Mundt & Kristy Shanahan (2015). Graff's Textbook of Urinalysis and Body Fluids. Lippincott Williams and Wilkins.
Nancy A Brunzel (2018). Fundamentals of Urine and Body Fluid Analysis (4th Edition). Saunders.
John W. Ridley (2018). Fundamentals of the Study of Urine and Body Fluids. Springer.
Punt, J.; Jones, P.; Owen, J. A. & Stranford, S. (2018). Kuby Immunology. United Kingdom: Macmillan Learning.
Wilson, K.; Hofmann, A.; Walker, J.; Clokie, S. (2018). Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology. United Kingdom: Cambridge University Press.
Paul, W. E. (2013). Fundamental immunology. Philadelphia: Lippincott Williams et Wilkins.
Murphy, K. M. & Weaver, C. (2017). Janeway's Immunobiology. United Kingdom: Garland Science.
Latha, P. M. (2012). A Textbook of Immunology. India: S. Chand & Company.

- Wilson, K.; Hofmann, A.; Walker, J. & Clokie, S. (2018). Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology. United Kingdom: Cambridge University Press.
- Tortora, G. J. & Grabowski, S. R. (2017). Principles of anatomy and physiology. New York, NY: HarperCollins College.
- Praful B. Godkar; Darshan P. Godkar. (2021). Textbook of Medical Laboratory Technology - Vol 1 and 2. Bhalani Publishing House.
- De Robertis, E. D. P. and De Rebartis, E. M. F. 1987. Cell and Molecular Biology. Eighth Edition. Lea and Febiger, Philadelphia.
- Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, D. 1983. Molecular Biology of The Cell. Garland Publishing, New York.
- Lodish, H., Baltimore, D., Berk, A., Zipursky, S. L., Matsudaira, P. and Darhell, J. 1995. Molecular Cell Biology. Third Edition. Academic Press, New York.
- Karp, G. 1999. Cell and Molecular Biology. John Wiley, London.
- Russel, P. J. 1998. Genetics. Beryamin / Cummaings Publishing Company.
- Strickberger, M. W. 1985. Genetics. MacMillan Pub. Co., Philadelphia.
- Gardner, E. J. 1999. Genetics, John wiley & Sons, New York.
- Benjamin, L. 2000. Genes VII. John Wiley & Sons, New York.
- Benjamin L. 2003. Genetics: A Conceptual Approach. Freeman.
- Sambrook and Russell. 2001. Molecular Cloning. Coldspring Harbour
- Pasternak. 2000. An introduction to molecular human genetics. Fritzgerald.
- Wilson and Walker. 2000. Practical biochemistry. Principle and techniques. Cambridge.
- Grifith's et al., 2004. An introduction to genetic analysis. Freeman.
- Brown. 2001. Essential Molecular biology (Volume I & II). Oxford University Press.
- Glick and Pasternak. 1990. Molecular biotechnology. ASM press.
- Miesfield. 1999. Applied Molecular Genetics. Willey.
- Griffith et al. An introduction to Genetic analysis. Published by Freeman
- Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick. Lewin's GENES XII. Published by Jones and Bartlett learning.
- D. Peter Snustad, Michael J. Simmons. Principles of Genetics.
- W S Klug & M R Cummings. Concepts of Genetics.

**BIOMEDICAL TECHNOLOGY-SYLLABUS-SEMESTER III - JUNE 2022 ONWARDS,
GUJARAT UNIVERSITY, AHMEDABAD – 380 009, GUJARAT, INDIA.**

**M.Sc. Biomedical Technology, Semester-III
June, 2022 Onwards**

SR. No.	Course Code	Name of the Course	Hours per Week	Internal Marks	External Marks	Total Marks	Credits
1	BMT – 501	BIostatistics, Bioinformatics AND RESEARCH METHODOLOGY	3+1	30	70	100	04
2	BMT - 502	HISTOLOGY, MOLECULAR MEDICINE AND PATHOLOGY	3+1	30	70	100	04
3	BMT – 503EA	CELL BIOLOGY, CYTOGENETICS AND MOLECULAR BIOLOGY-I	3+1	30	70	100	04
4	BMT – 503EB	ENDOCRINOLOGY AND REPRODUCTIVE TECHNOLOGY – I					
5	BMT – 503EC	ENTOMOLOGY-I					
6	BMT – 503ED	GENETIC COUNSELING – I					
7	BMT – 503EE	TOXICOLOGY-I					
8	BMT – 504EA	CELL BIOLOGY, CYTOGENETICS AND MOLECULAR BIOLOGY-II					
9	BMT – 504EB	ENDOCRINOLOGY AND REPRODUCTIVE TECHNOLOGY – II					
10	BMT – 504EC	ENTOMOLOGY-II					
11	BMT – 504ED	GENETIC COUNSELING – II					
13	BMT – 504EE	TOXICOLOGY-II					
14	BMT - 505PR	PRACTICAL - I	6	30	70	100	04
15	BMT - 506PR	PRACTICAL - II	6	30	70	100	04
		Total	28	180	420	600	24

PROGRAMME OUTCOME

The program and syllabus designed for the third semester for the Master's degree in Biomedical Technology has been framed to provide the student with the essential pre-requisites for the next step in research, for carrying out a dissertation or for pursuing Doctoral research. This would equip a student with the required knowledge of all aspects related to carrying out intrinsic experimental research and analyze and process the data as per current standards. The syllabus designed for the third semester for the Master's degree has been formulated to offer the student an elective paper with promise for future career opportunities. This would enable a student to obtain theoretical and practical knowledge in an area which would have wide applicability in securing a good career option and help the student fulfill their career goals.

BIOMEDICAL TECHNOLOGY COURSE OUTCOME

Biomedical Technology – 501 & 502

This Unit includes topics in Biostatistics. It is well-accepted that no research is accepted or can be validated without substantiation by correctly used Statistical methods. A student equipped with the theory and practical aspects of this curriculum would have a good foundation in precise Sampling and Data Collection, have the ability to represent data effectively and carry out the requisite Descriptive as well as Analytical Statistics to ensure accurate Scientific standards. A student would be able to carry out the Statistical Analysis for both parametric and non-parametric data. A firm foundation in Biostatistics would thus prepare a student for research associated with Industry or Medical or Biological fields.

This Paper also provides a student with the basic concepts in Bioinformatics. basic concepts of biological databases, Resources and Tools. A student would thus be familiar with the use of related software, various Tools for Bioinformatics, Sequence alignment, exploring Sequence & Structure Databases and the applications of Bioinformatics. This knowledge would extremely useful vocations in any Organization or Institution dealing with Molecular Analysis, which is currently ubiquitous in Medical, Forensic Sciences, Pharmaceutical, Biotechnological and several other fields.

The inclusion of Research Methodology is specifically with the forethought of moulding a student for future research. With the discontinuation of the M.Phil. degree, it is now imperative to add this module in the Master's degree syllabus. With this unit a student will comprehend and accurately carry out Experimental design in Research, Measurements and Experimentation with Scientific logic, setting hypothesis with proper rationale and data interpretation with analytical reasoning. This curriculum will also guide a student in the workings for development of pre-proposal and full proposal, Scientific writing and documentation, Ethics in Science and all regulatory processes for Laboratory accreditation.

This paper also provides a student with concept of Histological and histochemical techniques for light and electron microscope. Further, the students would be able to understand various disorders of male infertility, female infertility, disorders of bones, joints, cartilages and skin with fundamental and basic principles of pathogenesis of disease including etiology, pathogenesis, morphologic changes, clinical significance and diagnostic investigations. Students will also have great exposure on topic such as Molecular Medicine. Understanding of fundamentals, approaches and future of molecular medicine will help students advancing their career in research field.

CELL BIOLOGY, CYTOGENETICS AND MOLECULAR BIOLOGY 503 & 504

There have been unprecedented technical advancement in genetics and molecular biology which is continuing and holds a lot of promise. Hence, this course has been designed to include all the basic as well as new emerging techniques in this field. Conventional tools such as pedigree analysis, chromosome identification, Banding techniques etc. have been included which still remain a powerful starting tool. Emphasis has also been given to Cancer Biology and toxicology. Furthermore, students will be taught other important topics of genetics including Human Genome Project, DNA repair, Toxicity and toxicity testing, cell signalling and communication etc. Students will also become proficient in new areas such as Nanotechnology and stem cell biology. In this module, the students will be familiar with the science of toxicology, including hazard identification, exposure assessment, dose-response assessment, and an understanding of the mechanisms of action and effects of toxic chemicals at multiple levels of biological organization. They will also learn technical aspects and experimental approaches in toxicological research, testing, and risk assessment. Students will also learn about molecular techniques such as PCR, sequencing, gene silencing, gene expression analysis using microarray. Our goal is to provide students a broad understanding of all these recent techniques which are important for advanced biological research. We will also be giving students the comprehensive idea of gene therapy to cure the disease which will help them in future career development.

ENDOCRINOLOGY AND REPRODUCTIVE TECHNOLOGY 503 & 504

The course covers details of embryonic development of the Endocrine and Reproductive system and its regulation, as well as anatomical, biochemical, molecular and functional details of the Endocrine organs, male and female reproductive systems. These topics give a student the background and foundation needed for pursuing a research or investigation (diagnostic) career in Endocrinology, Fertility regulation, control and management. The curriculum of the specialization on Endocrinology and Reproductive Technology is designed to provide students with in-depth knowledge of various aspects of Endocrinology and Reproductive Technology. This paper also confers knowledge and practical skill related to Endocrine and Reproductive Technologies, which includes Molecular technologies, Bioassays, Immunoassays and specific laboratory based *in-vitro* technologies. With the growing focus on fertility regulation and management, this is a major thrust area for research and diagnosis.

Genetic Counselling 503 & 504

Genetic counselling is progressing as a subject of great significance today due to rapid and revolutionary advancements in Human Genetics. Hence, these two papers have been designed in a manner to develop a comprehensive knowledge and proficiency apt for Genetic Counselling. Also, care is taken to further hone the practice-based competencies in the students to manage a genetic counselling case before, during, and after the clinic visit. The syllabus includes detailed aspects of pedigree analysis, risk assessment, prenatal diagnosis, genetic testing and interpretation etc. The ethical, legal and social issues arising from developments in Human genetics and the influences on Genetic counselling are also included.

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TOXICOLOGY 503&504

In this module, the students will be familiar with the science of toxicology, including hazard identification, exposure assessment, dose-response assessment, and an understanding of the mechanisms of action and effects of toxic chemicals at multiple levels of biological organization. They will also learn technical aspects and experimental approaches in toxicological research, testing, and risk assessment. They will also get the understanding of how the toxic chemicals harms the specific organs, the kinetics of those hazardous toxicants and how they create certain diseases after getting digested in the body. This course will also provide the platform for those students who want to build their future in pharmaceuticals by understanding the basics of guidelines for animal house facilities and its formation. In this module, the students will be familiar with the science of toxicology, including hazard identification, exposure assessment, dose-response assessment, and an understanding of the mechanisms of action and effects of toxic chemicals at multiple levels of biological organization. They will also learn technical aspects and experimental approaches in toxicological research, testing, and risk assessment. They will get to learn the important toxicological aspect which is ecological or environmental toxicology in which they will understand how the aquatic and terrestrial nature is getting harmed by toxicants and the tests to assess it. This course will also provide the platform for those students who want to build their future in pharmaceuticals by understanding the basics of guidelines and quality standards for animal house facilities and animal experimentation along with applications of Toxicology.

ENTOMOLOGY 503 & 504

The curriculum in Entomology has specifically designed keeping in mind the vast Economic importance of Insects and the immense career opportunities associated with the study of Entomology. Details related to the Insect anatomy, physiology, taxonomy, ecology and toxicology have been included to equip the student with the essential knowledge in Entomology. The second elective paper in Entomology has been framed with emphasis on the commercial and applied aspects of the study of entomology, particularly the Economically important insects since they play a key role in Agriculture and Production. Special importance has been given to the study and applications of Biotechnology in control of insect crop pests. Of key commercial value is Sericulture and Apiculture, which contribute immensely to the commercial value and success of insect species. Medical, Veterinary and Forensic Entomology has been included owing to the vast number of insect related diseases, Insect parasites, insect associated pathology of humans and animals and specifically the control of House pests. This elective also trains a student with the practical expertise in various techniques for entomology such as Inset collection, identification and Preservation. This study has vital significance in today's world and provide good scope for a student to take up a career in Entomology. Government agencies, NGOs, Medical and Research Institutions have recently shown and increased demand to employ study with specialized knowledge and expertise in Entomology.

BMT – 501: Biostatistics, Bioinformatics and Research Methodology

UNIT-I: Biostatistics-I

Data Collection, Representation and Sampling:

Types of Data: Qualitative, Quantitative Data: Discrete and Continuous. Understanding of Population, Sampling and Sampling methods, Methods Data Collection, Grouping of data, Frequencies: Frequency Distributions, Relative Frequencies. Tabulation, Graphical Presentation

Descriptive Statistics:

Measures of Central Tendency-concept; Mean, mode, median for ungrouped and grouped data, Measures of Dispersion: Absolute and Relative measures; Range, Interquartile Range, Variance, Standard Deviation, Standard Error and Coefficient of Variation, Probability: Basic concepts of Probability, Empirical, Theoretical Probability. Addition Rule, Product law. Applications of Probability, Probability Distributions: Binomial, Normal Distribution, Measures of Skewness and Kurtosis

UNIT-II: Biostatistics-II

Tests of Hypotheses:

Parametric, Non-Parametric data, Statistical hypotheses: Null and Alternative hypotheses. Simple and Composite hypotheses. Statistical Tests: Acceptance and Rejection Norms. Sampling Distributions - t, chi-square and F distributions. Significance Tests for Normal Distribution: One sample test (unmatched) – z test and t-test and scores; Confidence Intervals. Bivariate and Multivariate Analysis: Correlation: Methods for Correlation analysis, Pearson's Correlation Coefficient 'r', Rank Correlation, Regression: Linear regressions. Chi Square Analysis, two sample tests for normal distributions: Tests for Means when variances are known or unknown. Paired t-test for equality of means. Student's t test; Analysis of Variance: One-way, Two-way (parametric) ANOVA. Tukey's test for two-way ANOVA, Mann-Whitney U test, Wilcoxon matched pairs tests

UNIT- III: Bioinformatics

Introduction to Bioinformatics, Basic concepts of biological databases, Gene and Protein Databases and Resources (NCBI, EBI, ExPasy, Entrez, RCSB) - NCBI Databases and Tools for Bioinformatics, Sequence alignment - BLAST, FASTA, PSI-BLAST algorithms, Primary & Secondary Sequence & Structure Databases (Genbank, SwissPort/Uniport, EMBL, MMDB & KEGG) and its application, Primer designing.

UNIT -IV: Research Methodology and regulation

Scientific Logic, Biological Thoughts, Methods of Reasoning in Research, Principles of measurements and experiment, Impact assessment and Management, Role of criticism in sciences, Conceptualization and development of research plan, Development of pre-proposal and full proposal, Writing of scientific and popular articles, Case studies, Ethics in Science, Good laboratory techniques, Intellectual property rights, Laboratory accreditations

BMTC: 502 - Histology, Molecular Medicine and Pathology

Unit-I: Histological and Histochemical Techniques (For light and Electron microscope)

Tissue fixation; Embedding; Staining; Basic and Acid Dyes; Mordants; Amphophilic and Neutrophilic tissues; Metachromatic histochemical and immunohistochemical techniques.

UNIT – II: Clinical Pathology-I

General background of Clinical Pathology, Connective tissue diseases, Disorders of respiratory tract - Emphysema, Carbon monoxide (CO)-poisoning; Hypoxia, Disorders of digestive tract - Gastritis, ulcers, diseases of pancreas and liver, Disorders of excretory systems - Nephritis; Acidosis; Disorders of urination.

Unit-III: Clinical Pathology-II

Disorders of Male and female infertility, uterine abnormalities, blocked tubes, Endometriosis, Fibroids, cervical, vaginal, uterine cancers, Mammary gland cancers, Disorders of bones, joints, cartilages and skin.

Unit-IV: Molecular medicine

Introduction to molecular medicine, Molecular pathological epidemiology, Molecular pathology, Approaches and methods in molecular medicine, Future of molecular medicine.

ELECTIVE PAPER - I
CELL BIOLOGY, CYTOGENETICS AND MOLECULAR BIOLOGY

503EA - Cell Biology, Cytogenetics And Molecular Biology-I

Unit-I: Human cytogenetics

Pedigree construction - inheritance patterns and risk assessment, Types and structure of chromosomes, Chromosome identification, ISCN, Banding techniques and karyotyping, FISH and mFISH, Spectral karyotyping, CGH, Chromosomes & diseases, chromosomes and cancer, Chromosomes and evolution, Prenatal diagnosis

Unit-II: Gene Expressions & Regulations

DNA modification & restriction, DNA repair mechanism, DNA repair genes and genetic instability, hereditary diseases caused by defective DNA repair, Regulation of gene expression in eukaryotes, Isolation of gene, Understanding Human Genome Project – organization, gene families

Unit-III: Cancer Biology

Hallmarks of cancer, Mutagens, Carcinogens, Oncogenes and Tumor suppressor genes, Cell transformation and tumorigenesis, Cell cycle checkpoint and cancer, Telomerase and cancer, Angiogenesis and Metastasis, Familial cancers, Chromosomal aberrations in cancer, Genetic predisposition to sporadic cancer, Tumor specific markers, Applications of new technologies in diagnostics, treatment and prevention of cancer.

Unit-IV: General Toxicology and Toxicity Testing

General principles and terminology; Types of toxicity; Factors affecting toxicity; Acute and Chronic toxicity; LD₅₀, LC₅₀, IC₅₀, EC₅₀; Route of administration; Dose response relationship and its evaluation, Risk assessment Introduction and Principle of Free radical toxicity testing methods, Cytotoxicity testing methods and Genotoxicity testing methods.

ELECTIVE PAPER - I
CELL BIOLOGY, CYTOGENETICS AND MOLECULAR BIOLOGY

504EA - Cell Biology, Cytogenetics And Molecular Biology-II

Unit-I: Cell Signaling and communication

Cell signaling, Types of signal molecules, Secondary messengers, Types of receptors, Signal transduction, Component of signaling system, Hormone mechanism of action, KEGG pathway, Scatchard plot, Cell signaling technology

Unit-II: Nanotechnology

Introduction to nanotechnology, Nanotechnology: origin, history and principles, Approaches of nanotechnology in biology, Nanoscale advances, Nanoparticles, Nanodevices, Nanomedicine

Unit-III: Stem Cell Biology

Molecular Basis of stem cells; Different types of stem cells; Stem cells isolation and characterization, Recent advances in stem cell research and regenerative medicine; Application of stem cell therapy in diabetes, skin, dental, bone, heart, reproductive, muscles, neuronal disease.

Unit-IV: Molecular Biology

Variants in PCR and its specific applications; Second and third generation sequencing; Chromosome walking and jumping; Somatic and germ line gene therapy, Criteria for effective gene therapy, General gene therapy strategies; Gene silencing; Transgenic animals; DNA vaccines; Microarray types and applications; Flow cytometry; Recent advances in molecular biology.

ELECTIVE PAPER - II
ENDOCRINOLOGY AND REPRODUCTIVE TECHNOLOGY

BMT--503EB: ENDOCRINOLOGY AND REPRODUCTIVE TECHNOLOGY - I

UNIT – I: General Endocrinology

Origin, Evolution and Classification of Endocrine system. Feedback Mechanisms, Regulation by Signal transduction and Hormones, Nerves' metabolites, Hormones Mechanism of action, Hormone receptors mechanism and metabolism

UNIT – II: Endocrine Glands

Endocrine glands – Hormone synthesis, release, regulation and its pathology. Hormones of extra endocrine sites – GI tract, Kidney, Liver, Heart, Lungs

UNIT – III: Hormonal Control

Hormonal control of carbohydrate, lipid, protein and nucleic acid and mineral metabolism. Hormonal control of growth and development, Endocrine role of adipose Tissues, Hormonal control of Reproductive behavior, Endocrine basis of communication in reproduction and aggression Pheromones, Vitamin D as a Hormone

Unit-IV: General Toxicology and Toxicity Testing:

General principles and terminology; Types of toxicity; Factors affecting toxicity; Acute and Chronic toxicity; LD₅₀, LC₅₀, IC₅₀, EC₅₀; Route of administration; Dose response relationship and its evaluation, Risk assessment Introduction and Principle of Free radical toxicity testing methods, Cytotoxicity testing methods and Genotoxicity testing methods.

ELECTIVE PAPER - II
ENDOCRINOLOGY AND REPRODUCTIVE TECHNOLOGY

BMT-504-EB: ENDOCRINOLOGY AND REPRODUCTIVE TECHNOLOGY - II

UNIT – I: Gonadal Development

Development of Gonads, Accessory sex organ and external genitalia, Factors affecting sex determination, Genetic Control of sex determination, Disorders of gonadal differentiation, Endocrinology of the foetal gonads, Prenatal diagnostic techniques

UNIT – II: Female Reproductive Organs

Structure and functions of Female reproductive organs. Folliculogenesis, Ovulation, Corpus luteum, atrecia, Implantation, Placenta, Pregnancy and its control Foetoplacental unit as an endocrine entity. Menopause and hormone replacement therapy, reproductive cycles, non-steroidal regulators of ovarian function. Gamete and zygote transport. Mammary glands, Lactation and its hormonal control

UNIT – III: Male Reproductive Organs

Structure and function of the Male Reproductive Organs. Spermatogenesis and its hormonal control. Ultrastructure functions of the Sertoli cells and Leydig Cells. Semen formation and its biochemistry. Sperm structure function and sperm function tests. Testis Anomalies, Senescence, Puberty

UNIT – IV: IVF and General Techniques.

Principles of Fertility Regulation in males and females, *In-Vitro* Fertilization, ET and AR technologies, PGS and PGD, Mitochondrial Replacement therapy, Collection and preservation of Gametes, Cryopreservation assay, Research methodologies; RIA, PCR, EIA, IRMA, Radioreceptors, Sequencing methods, Chemiluminescence, ECL, Polyclonal and Monoclonal antibodies, Hybridoma technology.

ELECTIVE PAPER - III
ENTOMOLOGY

BMT-503EC: General entomology, taxonomy and ecology

Unit-I: General entomology

Insect morphology

Insect anatomy, excretion, circulation, reproduction and life cycle

Insect digestion and nutrition

Insect nervous system and sense organs

Insect behavior

Pheromones and toxins

Insect genetics

Unit-II: Taxonomy and types

Evolutionary, parataxonomy, numerical, phylogenetic taxonomy

Classification of insects up to orders and their characters

Biodiversity, threats and conservation

Unit-III: Insect ecology

Ground dwelling insects

Aquatic insects

Social insects

Aerial and plant inhabiting insects

Unit-IV: General Toxicology and Toxicity Testing:

General principles and terminology; Types of toxicity; Factors affecting toxicity; Acute and Chronic toxicity; LD₅₀, LC₅₀, IC₅₀, EC₅₀; Route of administration; Dose response relationship and its evaluation, Risk assessment Introduction and Principle of Free radical toxicity testing methods, Cytotoxicity testing methods and Genotoxicity testing methods.

ELECTIVE PAPER - III
ENTOMOLOGY

BMT-504EC: APPLIED ENTOMOLOGY AND TECHNIQUES

Unit-I: Commercial and applied entomology

Economically important insects
Insects and plants
Insect as a crop pest
Biotechnology in control of insect crop pests
Predators and parasitoids for insect pests
Sericulture
Apiculture

Unit-II: Medical and Veterinary entomology

Insect associated pathology of humans and animals
Insect vectors
House pests and their control
Animal parasites

Unit-III: Forensic entomology

Application of Forensic Entomology to Wildlife Crimes
Arthropods Commonly Encountered
Diptera
Coleoptera
Sampling

Unit-IV: Techniques for entomology

Insect collection
Insect identification
Preservation and dry mount
Liquid preservation
Storage and handling
Insect repositories
Indian national biodiversity guidelines

ELECTIVE PAPER - IV GENETIC COUNSELING

BMT-503ED: Genetic Counseling – I

Unit-I: Practice of Genetic counseling & Pedigrees

Concept and purpose, Historical overview of genetic counseling, goals, Philosophy and ethos of genetic services and counseling, Providers of genetic counseling, Practice based competencies for genetic counselors, Indications and purpose, Past medical, social & family history, construction of pedigrees & Patterns of inheritance, Incidental detection of other genetic disorders on pedigree evaluation, establishing carriers.

Unit-II: Interviewing, Case preparation & Management

Basic communication skills, interviewing techniques, verbal & non-verbal communication, inter cultural communication, case preparation & management, Psychotherapeutic counseling & decision-making concepts, Medical Genetic evaluation, Physical examination, Documentation.

Unit-III: Risk assessment

Risk assessment and counseling in: common Variants, Mendelian and multifactorial Disorders, genetic case pathway and preventive management guidelines, bioinformatics resources and their use in informing genetic testing methodologies and reporting.

Unit-IV: Principles of Genetic Toxicology & Toxicity Testing

General principles and terminology; Types of toxicity; Factors affecting toxicity; Acute and Chronic toxicity; LD₅₀, LC₅₀, IC₅₀, EC₅₀; Route of administration; Dose response relationship and its evaluation, Risk assessment Introduction and Principle of Free radical toxicity testing methods, Cytotoxicity testing methods and Genotoxicity testing methods.

ELECTIVE PAPER - IV GENETIC COUNSELING

BMT-504ED: Genetic Counseling – II

Unit-I: Prenatal diagnosis & Newborn screening

Ethical and legal issues in Prenatal diagnosis, Indications of prenatal diagnosis, prenatal diagnosis in late onset disorders, Techniques: invasive, non-invasive methods – Amniocentesis, Chorion Villus sampling, NIPT, ultrasound, maternal blood screening, PGD, Screening of genetic disorders in newborn.

Unit-II: Genetic testing & interpretation

understanding genetic testing: Interpretation of new genome testing techniques, DNA testing – Direct testing (Known and unknown mutations) and Indirect testing (gene tracking), DNA profiling: establishing identity and relationships Population screening - ethics, organization and advantages. Pre-symptomatic testing for late onset diseases.

Unit-III: Contexts of Genetic counseling

Reproductive issues: Technologies in reproductive assistance, pre-conceptional counseling, Medico-legal Issues: Surrogacy, Paternity testing. Congenital anomalies and rare medical disorders: risk factors, Rare disorders – why not treatable? pre-pregnancy evaluation and intervention strategies, Social and cultural issues, support groups for rare medical disorders. Impact of disorders of sexual development (DSDs) and genetic counselling. Genetic counseling for late onset diseases (example neuro-genetic disorders, Myotonic dystrophy and Inherited cancers, breast and ovarian cancer): Predictive counseling & Principles, management in follow-up sessions. Testing of vulnerable populations, ethical issues in testing of minors & incapacitated individuals.

Unit-IV: Ethical, legal and social issues in Human genetics

Influences on Genetic counseling, Bioethics in research & experimentation, Implications of New Technologies: embryonic stem cells, animal cloning, genetic engineering, gene therapy & clinical trials, Supervision and strategies for providing support & guidance to new counselor, Dilemmas faced by counselors, Medical ethics in India, Informed consent and confidentiality, Right of choice, Impact of genetic disease on patients and families, social practices and health cost issues. Case studies, interaction with parents & families to increase empathy.

ELECTIVE PAPER - V
TOXICOLOGY

BMT-503EE - TOXICOLOGY-I

Unit-I: Animal House and Maintenance:

Design and construction of animal housing facilities; Caging and housing system; Important factors in animal housing: Illumination, Noise, Ventilation, Temperature, Humidity, Bedding, Water, Food; Health monitoring; Sanitation; Waste disposal; IAC and CPCSEA

Unit-II: Target Organ Toxicity:

Toxic responses of Blood, Liver, Kidney, Skin, Immune system, Respiratory system, Nervous system, Ocular and visual system, Heart and vascular system, Reproductive system, *Endocrine* system

Unit-III: Toxic Agents and Toxicokinetics:

Classification of toxicants; Metals; Pesticides; Xenobiotics; Teratogens; Food additives and contaminants; Toxins of animal and plant origin; Radiation types, detection and effects. Absorption; Digestion; Metabolism; Excretion; Mutagenicity; Carcinogenicity; Teratogenicity; Biotransformation; Bioactivation; Mechanism of Toxicity

Unit-IV: Guidelines, Quality Standards and Applications of Toxicology:

General principles and terminology; Types of toxicity; Factors affecting toxicity; Acute and Chronic toxicity; LD₅₀, LC₅₀, IC₅₀, EC₅₀; Route of administration; Dose response relationship and its evaluation, Risk assessment, Introduction and Principle of Free radical toxicity, Cytotoxicity and Genotoxicity testing methods

ELECTIVE PAPER - V
TOXICOLOGY

BMT-504EE- TOXICOLOGY-II

Unit-I: Cytotoxicity, Genotoxicity and Free Radical Toxicity Testing:

Cell viability and cytotoxicity: Trypan blue dye exclusion assay, MTT assay, LDH and Neutral red uptake assay, WST assay, SRB assay; Genotoxicity: Ames test, TK, HPRT and XPRT mutation test, SCE, Chromosomal aberration assay, Comet assay, Micronucleus assay; Free radical toxicity: Total ROS, LPO, SOD, Catalase, GSH, GPx, Grd, GST; Carcinogenicity testing; Teratogenicity testing, (OECD 473 and 490) Cell lines for toxicity testing: L5178Y, CHO, AS52, V79, TK6, CACO II

Unit-II: Ecotoxicology:

Principle of ecotoxicology; Terrestrial model and ecotoxicity testing: Earthworm, Honey bee, Birds, Plants; Aquatic models and ecotoxicity testing: Algae, Daphnia, Brine shrimp, Fish. Route of exposure: Water, Soil, Food; Ecotoxicogenomics: Estrogen receptor, Aryl hydrocarbon receptor, Protein damage, DNA damage

Unit-III: Environmental Toxicology:

Environmental risk assessment; Environmental health and hazards; Air pollutants: Past disasters and current condition, Outdoor pollutants, Photochemical oxidants, Indoor air pollutants; Water and soil pollutants: Synthetic persistent chemicals, Inorganic ions, Cyanotoxins

Unit-IV: Guidelines, Quality Standards and Applications of Toxicology:

National regulatory guidelines: DCGI / CDSCO, FSSAI, GOTS, CPCB / GPCB; International regulatory guidelines: US FDA, OECD, US EPA, ICH, Food safety, TTC; National and international quality standards: NABL, OECD, GLP, ISO; Application of Toxicology: Food toxicology and food residues; Analytic/Forensic toxicology; Clinical toxicology; Occupational toxicology

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BMT – 505 PR:

Practicals based on the theory papers BMT-501 and BMT-502. Field/Industrial/ Laboratory visits.

BMT – 506 PR:

Practicals based on the theory papers BMT-503 and BMT-504. Field/Industrial/ Laboratory visits.

Reference Books

1. David W. Mount (2001). Bioinformatics: Sequence and Genome Analysis (1st edition). Cold Spring Harbor Laboratory Press, USA.
2. Hooman H. Rashidi; Lukas K. Buehler (1999). Bioinformatics Basics: Applications in Biological Science and Medicine. CRC press
3. S. C. Rastogi, Namita Mendiratta, Parag Rastogi (2006). Bioinformatics, Concepts Skills and Applications. CBS Publishers & Distributors.
4. Arthur M. Lesk (2019). Introduction to Bioinformatics (5th edition). OUP Oxford
5. Misner & Krawetz (2000). Bioinformatics. Methods and protocols. Humana press
6. Khan & Kanum (2001). Recent Advances in Bioinformatics. Ukraaz Publication
7. Jeremy Ramsden (2016). Bioinformatics: An Introduction. Springer
8. David Edward; Jason Stajich; David Hansen (2014). Bioinformatics: Tools and Applications. Springer
9. Vaclav Insler; Bruno Lunenfeld (1993). Infertility: Male and Female. Churchill Livingstone
10. Louis Lichtenstein (1970). Diseases of Bone and Joints. Mosby
11. Joel E Goldthwait (2018). Diseases of the Bones and Joints: Clinical Studies. Forgotten Books
12. Akmal El-mazny (2016). Female Reproductive System: Clinical Anatomy and Physiology. Createspace Independent Pub
13. Björn Glantz; Klas Edquist (2010). Male & Female Infertility: Genetic Causes, Hormonal Treatments & Health Effects (Human Reproductive System - Anatomy, Roles and Disorders). Nova Science Publishers Inc
14. Berwick, S.H. and Saharia, V.B. 1995. *Wildlife Research and Management*. OUP, New Delhi.481pp.
15. A handbook of research methodology by Mishra and Alok, Educreation Publication
16. Research Methodology for life Sciences by Arumugam, Saras publication
17. Graduate research - A guide for students in Life Sciences. 2nd edition. Robert V. Smith
18. Research methods for Biosciences. 3rd edition. Debbie Holmes, Peter Moody, Diana Dine, Laurence Trueman
19. Experimental designs for Life Sciences. 4th edition. Graeme D., Ruxton and Nick Colegrave
20. Research methodology - Step by Step Guide for Beginners. 3rd edition. Ranjit Kumar
21. Research methodology - Tools and techniques, Bridge Centre 2015
22. Thesis and Dissertation Writing in a Second Language a handbook for supervisors - Brian Paltridge and Sue Starfield, Routledge Publishers
23. The process of research writing - Steven Krause – Eastern Michigan University
24. Animal - Use Research IAEC Project Proposal & animal imports Guidelines – NCBS Animal Care and Resource Center
25. Jens, K. & Cy Aaron, S. (2016). An Introduction to Molecular Medicine. Germany, Wiley-VCH.
26. Dennis, W. R. (2013). Introduction to molecular medicine. Germany, Springer Science and Business Media.
27. William, B. C. & Gregory, J. T. (2016). Diagnostic Molecular Pathology. United States.
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30. Lauren Pecorino (2008). Molecular Biology of Cancer. Oxford Uni. Press
31. Yao-Shan Fan (2003). Molecular Cytogenetics - Protocols and Applications. Methods in Molecular Biology (MIMB-204); Humana Press
32. Lauren Pecorino (2008). Molecular Biology of Cancer: Mechanisms, Targets and Therapeutics. Oxford University Press
33. Paul B. Fisher (2007). Cancer Genomics and Proteomics: Methods and Protocols (Methods in Molecular Biology, Vol. 383); Humana Press
34. Brian C.-S. Liu; Joshua R. Ehrlich (2008). Tissue Proteomics: Pathways, Biomarkers, and Drug Discovery (Methods in Molecular Biology, Vol. 441); Humana Press
35. Lawrence S.B. Goldstein; Meg Schneider (2010). Stem Cells For Dummies (1st Edition). For Dummies
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42. Firdos Alam Khan (2021). Advances in Application of Stem Cells: From Bench to Clinics. Springer Nature Switzerland AG
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44. Lu's Basic Toxicology Fundamentals, Target Organs, and Risk Assessment. Frank C. Lu and Sam Kacew. Informa Healthcare USA.
45. Principles and Methods of Toxicology by A. Wallace Hayes. Taylor and Francis.
46. Griffith et al. An introduction to Genetic analysis. Published by Freeman
47. Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick. Lewin's GENES XII. Published by Jones and Bartlett learning.
48. D. Peter Snustad, Michael J. Simmons. Principles of Genetics.
49. W S Klug & M R Cummings. Concepts of Genetics.
50. R E Pyeritz, B R Korf, W W Grody (Ed.). Emery & Rimoin's Principles & practice of medical genetics & Genomics. Academic Press.
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76. D L Rimoin, J M Connor & R S Pyeritz (eds). Principles & practice of medical genetics. Published by Churchill Livingstone
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81. Principles and Methods of Toxicology by A. Wallace Hayes. Taylor and Francis.
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84. Principles and Methods of Toxicology by A. Wallace Hayes. Taylor and Francis.
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88. Reproductive and developmental Toxicology. Korach.
89. Medical Toxicology. Schonwald.
90. Toxicology and Pathology. Haschek R.
91. Experimental Toxicology. Aldridge et al.
92. A guide to practical toxicology. Evaluation, Prediction & Risk. Adam Woolley.
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96. Environmental Toxicology. Sigmund F. Zakrzewski
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103. A-Z Guide to Drug-Herb-Vitamin Interactions. Gaby, Batz, Chester and Constantine, eds. Three Rivers Press.
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M.Sc. Biomedical Technology Semester – IV

SR. No.	Course Code	Name of the Course	Hours per Week	Internal Marks	External Marks	Total Marks	Credits
1	BMT – 507PT	Dissertation and Viva-voce	20	120	280	400	16
2	BMT – 508S	Assignments / group discussions.	4	30	70	100	04
3	BMT – 509M	Seminars and Industrial Visits during the Semester.	4	30	70	100	04
		Total	28	180	420	600	24

BIOMEDICAL TECHNOLOGY SEMESTER – IV

BMT-507PT : Dissertation and Viva-voce

BMT-508S : Seminars and Industrial Visits during the Semester.

BMT-509M : Assignments / Group Discussions.