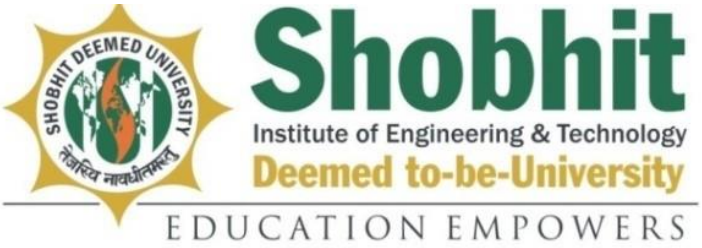
B.Sc.
Biomedical

SYLLABUS



SHOBHIT INSTITUTE OF ENGINEERING AND TECHNOLOGY, MEERUT
(A NAAC Accredited Deemed to-be-University)

Department of Biomedical and Bioinformatics Engineering
School of Biological Engineering and Life Sciences

Approved and adopted in year 2018 (Board of Studies, August 3, 2018)
by 22nd Academic council (Agenda no-3.2 b)

B.Sc. Biomedical

Overview: B.Sc. Hons. Biomedical Sciences concerns with the topics to understand the biological principles that govern the functioning of the human body, to discover the mechanisms of any disease and to find new and distinct ways to cure a disease by developing advanced diagnostic tools or new therapeutic strategies. The B.Sc. (Hons) Biomedical Science started as an interdisciplinary course at Shobhit University, Meerut. It is the applied domain of life and natural sciences, used for diagnosis, prevention and treatment of human diseases. This course is suited for those students who are desirous of teaching at the college level. Students should have skills like identifying blood groups, interpreting results and liaising with medical staff, maintaining records and writing medical reports to seek admission to B.Sc. Hons. (Biomedical Sciences).

Program Outcome: Bachelor of Science (B.Sc.) offers theoretical as well as practical knowledge about different subject areas. These subject areas include Physics, Chemistry, Mathematics and Biology and other fields depending on the specialization a student opts. This programme course is most beneficial for students who have a strong interest and background in Science and Mathematics. The course is also beneficial for students who wish to pursue multi and inter-disciplinary science careers in future. Following are the various programme outcomes:

PO1. This course forms the basis of science and comprises of the subjects like physics, chemistry, biology, zoology and mathematics.

PO2. It helps to develop scientific temper and thus can prove to be more beneficial for the society as the scientific developments can make a nation or society to grow at a rapid pace.

PO3. After the completion of this course students have the option to go for higher studies i.e. M. Sc and then do some research for the welfare of mankind.

PO4. After higher studies students can join as scientist and can even look for professional job oriented courses.

PO5. This course also offers opportunities for serving in Indian Army, Indian Navy, Indian Air Force as officers.

PO6. Students after this course have the the option to join Indian Civil Services as IAS, IFS etc.

PO7. Science graduates can go to serve in industries or may opt for establishing their own industrial unit.

PO8. After the completion of the B.Sc degree there are various other options available for the science students. Often, in some reputed universities or colleges in India and abroad the students are recruited directly by big MNC's after their completion of the course.

PO9. Apart from the research jobs, students can also work or get jobs in Marketing, Business & Other technical fields. Science graduates also recruited in the bank sector to work as customer service executives. Students can also find employment in government sectors.

Program Specific Outcome:

Objective of this program is to offers exciting career opportunities in specialist laboratory work, consultant work, research, education and management while serving the human society. The findings of the biomedical scientists are instrumental in making the advancements of modern medicine. However, the subject should not be considered as a substitute for Medicine. Biomedical scientists usually work in the laboratory. They handle biological samples (blood, urine, cells and tissues) and use a wide range of laboratory equipments ranging from test tubes, beakers and pipettes to computers and hi-tech equipments.

Some of the common job roles and responsibilities of a biomedical scientist are:

PSO1. testing and screening for lifestyle diseases like diabetes, cancer or cardiovascular disease; and screening for infectious ones such as rubella, hepatitis or Ebola

PSO2. investigating and understanding the disease mechanisms, profile and progression

PSO3. finding new, effective and innovative ways to detect diseases as early as possible (e.g. discovery of new biomarkers or a new method of detecting a biomarker)

PSO4. working towards discovery and development of treatments, which could be preventive (vaccines) and/or therapeutic (drugs and medicines)

PSO5. In order to become a biomedical scientist a Bachelors degree is a must.

Eligibility Criteria:

B.Sc. Hons. Biomedical Sciences is a highest demanding program nowadays and as per experts it's been said that it is a job-oriented Bachelor's degree program which is of 3-years duration. Students who have passed Class 12 examination with Physics, Chemistry and Biology/ Mathematics or Both as compulsory subjects can pursue this program.

Credit Distribution:

S.No.	Criteria	I	II	III	IV	V	VI	Total
1.	**Core Biomedical (BBM)**	12	12	18	18	12	12	84
2.	**Generic Elective (GBT/GBM)**	6	6	6	6			24
3.	**Ability Enhancement (AEC)**	2	2					4
4.	**Skill Enhancement (SBM)**			2	2			4
5.	**Discipline Specific Elective (BMD)**					12	12	24
	Total	**20**	**20**	**26**	**26**	**24**	**24**	**140**

SHOBHIT INSTITUTE OF ENGINEERING AND TECHNOLOGY, MEERUT

Department of Biomedical Engineering
School of Biological Engineering and Life Sciences

CHOICE BASED CREDIT SYSTEM
TEACHING AND EVALUATION SCHEME
B.Sc. Biomedical Science
Total Program Credit- 140

Semester: I					
Course Code	**Course / Title**	**L**	**T**	**P**	**Credit**
BBM-101	Human Anatomy and Physiology	4	0	0	4
BBM-102	Organic Chemistry	4	0	0	4
AEC- 101	Professional Communication	2	0	0	2
GBT-101	Basic Cell Biology	4	0	0	4
BBM-151	Anatomy and Physiology Lab.	0	0	3	2
BBM-152	Organic Chemistry Lab.	0	0	3	2
GBT-151	Cell Biology Lab.	0	0	3	2
Total					**20**

Semester: II					
Course Code	**Course / Title**	**L**	**T**	**P**	**Credit**
BBM-201	Diagnostic and Therapeutic Instrumentation	4	0	0	4
BBM-202	Immunology	4	0	0	4
AEC-202	Environment Studies	2	0	0	2
GBT-201	Principles of Genetics	4	0	0	4
BBM-251	Diagnostic and Therapeutic Instrumentation Lab.	0	0	3	2
BBM-252	Immunology Lab.	0	0	3	2
GBT-251	Genetics Lab.	0	0	3	2
Total					**20**

Semester: III					
Course Code	**Course / Title**	**L**	**T**	**P**	**Credit**

BBM-301	Analytical Instrumentation and its Application	4	0	0	4
BBM-302	Medical Physics	4	0	0	4
BBM-303	Molecular Biology	4	0	0	4
GBT-301	Microbiology	4	0	0	4
SBM-301	Biocomputation	2	0	0	2
BBM-351	Analytical Instrumentation Lab.	0	0	3	2
BBM-352	Medical Physics Lab.	0	0	3	2
BBM-353	Molecular Biology Lab.	0	0	3	2
GBT-351	Microbiology Lab.	0	0	3	2
Total					**26**

Semester: IV					
Course Code	**Course / Title**	**L**	**T**	**P**	**Credit**
BBM-401	Pathology	4	0	0	4
BBM-402	Techniques for Forensic Science	4	0	0	4
BBM-403	Biochemistry	4	0	0	4
GBT-401	Toxicology	4	0	0	4
SBM-401	Biostatistics	2	0	0	2
BBM-451	Pathology Lab.	0	0	3	2
BBM-452	Forensic Science Lab.	0	0	3	2
BBM-453	Biochemistry Lab.	0	0	3	2
GBT-451	Toxicology Lab	0	0	3	2
Total					**26**

Semester: V					
Course Code	**Course / Title**	**L**	**T**	**P**	**Credit**
BBM-501	Medicinal Chemistry	4	0	0	4
BBM-502	Medical Biotechnology	4	0	0	4
BMD -501	Pharmacology	4	0	0	4
BMD -502	Radiation Biology	4	0	0	4
BBM-551	Medicinal Chemistry Lab.	0	0	3	2
BBM-552	Medical Biotechnology Lab.	0	0	3	2

BMD -551	Pharmacology Lab.	0	0	3	2
BMD -552	Radiation Biology Lab.	0	0	3	2
Total					24

Semester: VI					
Course Code	**Course / Title**	**L**	**T**	**P**	**Credit**
BBM-601	Hospital Management	4	0	0	4
BBM-671	Project Work	**0**	**0**	**12**	**6**
BMD -601	Medical Ethics	4	0	0	4
BMD -602	IPR	4	0	0	4
BBM-651	Hospital Management Case Studies Lab.	0	0	3	2
BMD-651	Medical Ethics Case Studies Lab.	0	0	3	2
BMD -652	IPR Case Studies Lab.	0	0	3	2
Total					**24**

BBM: Core Courses; GBM: Generic Elective; AEC: Ability Enhancement Compulsory Course; SBM: Skill Enhancement Courses; DBM: Discipline Specific Elective

Generic Elective for others (GBM):

Code	**Subject Name**	**L**	**T**	**P**	**Cr.**	**Preferred Semester**
GBM-101	Human Anatomy and Physiology	4	0	0	4	
GBM-102	Organic Chemistry	4	0	0	4	

GBM-152	Anatomy and Physiology Lab	0	0	3	2	**I**
GBM-152	Organic Chemistry Lab	0	0	3	2	
GBM-201	Diagnostic and Therapeutic Instrumentation	4	0	0	4	
GBM-251	Diagnostic and Therapeutic Instrumentation Lab.	0	0	3	2	**II**
GBM-301	Analytical Instrumentation and its Application	4	0	0	4	
GBM-302	Medical Physics	4	0	0	4	**III**
GBM-351	Analytical Instrumentation Lab.	0	0	3	2	
GBM-352	Medical Physics Lab.	0	0	3	2	
GBM-401	IPR	4	0	0	4	
GBM-402	Medical Ethics	4	0	0	4	**IV**
GBM-451	IPR Case Studies	0	0	3	2	
GBM-452	Medical Ethics Case studies	0	0	3	2	

Ability Enhancement Courses (AEC)

Code	Subject Name	L	T	P	Cr.	Preferred Semester
AEC- 101	Professional Communication	2	0	0	2	I
AEC-102	Technical Communication	2	0	0	2	I
AEC-201	Personality Development	2	0	0	2	II
AEC-202	Environment Studies	2	0	0	2	II

Skill Enhancement Courses (SBM)

Code	Subject Name	L	T	P	Cr.	Preferred Semester
SBM-301	Biocomputation	2	0	0	2	**III**
SBM-401	Biostatistics	2	0	0	2	**IV**

Department Specific Elective (DBM)

Code	Subject Name	L	T	P	Cr.	Preferred Semester
BMD -501	Pharmacology	4	0	0	4	
BMD -502	Radiation Biology	4	0	0	4	**V**
BMD -503	Biomaterial	4	0	0	4	
BMD -504	Computational Biology and Drug Discovery	4	0	0	4	
BMD -505	Introduction to Genomics	4	0	0	4	
BMD -551	Pharmacology Lab.	0	0	3	2	
BMD -552	Radiation Biology Lab.	0	0	3	2	
BMD -553	Biomaterial Testing Lab.	0	0	3	2	
BMD -554	Computational Biology Lab.	0	0	3	2	
BMD -555	Genetics Lab.	0	0	3	2	
BMD-601	Medical Ethics	4	0	0	4	**VI**
BMD -602	IPR	4	0	0	4	
BMD -603	Medical Safety and waste management	4	0	0	4	
BMD -651	Medical Ethics Case Studies Lab.	0	0	3	2	
BMD -652	IPR Case Studies Lab.	0	0	3	2	
BMD -653	Waste Management Tutorial	0	0	3	2	

Course code	**BBM-101**				
Category	Core Biomedical				
Course title	**Human Anatomy and Physiology**				
Scheme and Credits	**Credit**	**L**	**T**	**P**	
	4	4	0	0	
Pre-requisites (if any)	Basic Knowledge of Biology				
Objectives	The prime concern of this syllabus is to integrate the individual functions of all the cells and tissues and organs into functional whole, the human body. Since function is dependent on a structure, the curriculum lays stress on functional anatomy of the organs. It attempts to highlight the necessary bodily balances and internal bodily control so called homeostasis as well as present their abnormal function in disease. It provides a link between basic sciences and Medicine.				
Outcomes	Upon successful completion of the course, the student will be able to: Label the functions of the human anatomy and physiology from a regional perspective for the following regions and systems: a. Head and neck, thoracic, abdominopelvic, and upper and lower extremities. 1. Major skeletal muscles, their actions, origins, insertions, and peripheral nerves. c. Central nervous system and plexuses d. Respiratory system e. Cardiovascular/hematologic system 2. Identify the major structures of the human anatomy for the following: a. Head and neck, thoracic, abdominopelvic, and upper and lower extremities. b. Major skeletal muscles, their actions, origins, insertions, and peripheral nerves. c. Central nervous system and plexuses d. Respiratory system e. Cardiovascular/hematologic system 3. Identify the major bones and their processes as they relate to each region of the body. 4. Tell briefly the basic components and functions of the gastrointestinal, renal/urinary, endocrine/metabolic, hepatic/biliary, genital/reproductive and immunologic, systems. 5. Identify the findings from a simulated healthcare record such as electrocardiogram data and pulmonary ventilation outcomes.				
Unit I	**Body organization**: General Anatomy of the body, Introduction to various kinds of body planes, cavities their membranes, Tissues level of organization (Types, origin, function & repair). Body homeostasis. Composition and Function of blood and its components: WBC, RBC, platelets. Hematopoiesis, Hemostasis and blood coagulation mechanism.				**08**
Unit II	**Nervous System** Structure and function of neuron. Action potential, Synapse and Synaptic Transmission, Neurotransmitters; types and function. Organization of nervous system - Structure and function of Central nervous system, Peripheral nervous system and Autonomic nervous system (spinal and cranial nerves).				**08**
Unit III	**Musculoskeletal system**: Functional anatomy of muscular system, types of muscles, mechanism of skeletal muscle excitation and contraction, Cartilage: structure, function and types. Bones: structure, function, location and types. Joints: structure, function and types.				**08**
Unit IV	**Cardiovascular and Respiratory system** Structure and function of heart, Properties of cardiac muscle, Functional Anatomy of the respiratory system. Mechanisms of pulmonary ventilation, alveolar ventilation, gaseous exchange, transport of gases.				**08**
Unit V	**Renal Physiology and Endocrine System**: Functional Anatomy of kidney, function and histology of nephron, Urine formation (glomerular filtration and tubular reabsorption), General mechanism of hormone action, Structure, function and regulation of the following glands and their secretions: Pituitary, Hypothalamus, Pineal, Thyroid, Parathyroid, Adrenal,Thymus and Pancreas.				**08**

Course Title	Anatomy and Physiology Lab.	**CR**
Course code	**BBM-151**	**2.0**

PRACTICALS : (Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. To study different human organs and their sections through permanent histological slides.
2. Estimation of hemoglobin (Sahli's method) and determination of blood group.
3. Determination of bleeding time and clotting time of blood.
4. Determination of total sugar in blood.
5. To study the structure and function of human body.
6. Evaluation of electrophysiological parameters.
7. To analyze the Human body composition using Bioelectrical Impedance Analyzer.

References

1. Guyton and Hall Textbook of Medical Physiology, 11th edition (2006), J. E. Hall; W B Saunders and Company, ISBN-13: 978-1416045748.

2. Human Physiology, 9th edition (2006), Stuart I. Fox; Tata McGraw Hill, ISBN-13: 978-0077350062.

3. Lab Manual on Blood Analysis and Medical Diagnostics, 1st edition (2012), Dr. Gayatri Prakash; S. Chand, ISBN: 81-219-3967.

4. Manual of Practical Physiology, 4th edition (2012), A. K. Jain; Arya Publication, ISBN: 8178553155.

5. Principles of Anatomy and Physiology, 13th edition (2011), Gerard J. Tortora and Bryan H. Derrickson; Wiley and Sons, ISBN-13: 978-0470565100.

6. Ganong's Review of Medical physiology, 24th edition (2012), K. E. Barett, S. M. Barman, S. Boitano and H. Brooks; Tata McGraw Hill, ISBN-13: 978-0071780032.

7. Textbook of Practical Physiology, 7th edition (2007), CL Ghai; Jaypee Publication, ISBN-13: 978-8184481419.

Course code	**BBM-102**					
Category	Core Biomedical					
Course title	**Organic Chemistry**					
Scheme and Credits	**Credit**	L	T	P		
	4	4	0	0		
Pre-requisites (if any)	Basic knowledge of Chemistry					
Objectives	Organic Chemistry is a discipline that integrates organic chemistry and biochemistry. It aims at understanding the relevance of biological processes using the fundamental concepts of organic chemistry. This course includes basic principles of organic chemistry like concepts of acids and bases, molecular forces responsible for the activities of biomolecules, principles of stereochemistry and their importance in understanding various biomolecular reactions along with introduction to biomolecules.					
Outcomes	Upon successful completion of the course, the student will be able to: 1. Know and recall the fundamental principles of organic chemistry that include chemical bonding, nomenclature, structural isomerism, stereochemistry, chemical reactions and mechanism. 2. Name the functional groups and different class of organic compounds. Recognize the basic practical skills for the synthesis and analysis of organic compounds. 3. Predict the reactivity of an organic compound from its structure; Develop basic skills for the multi-step synthesis of organic compounds; Justify a reasonable mechanism for a chemical reaction. 4. Demonstrate ability to work independently as well as within a team. 5. Manage resources and time and get along well with other members of the group.					
Unit I	**Solutions, Acids and Bases:** Water, pH and buffers, concept of pKa (titration curves of amino acids), Henderson-Hasselbach equation, buffering zone, buffer index, concept of pI and zwitter ion, Arrhenius concept, Bronsted Lowry concept, Lewis concept, the levelling effect.					**08**
Unit II	**Chemical Bonding and Molecular Forces** Introduction to ionic interactions and covalent bond, inter-molecular and intra-molecular forces, types of intermolecular forces and their characteristics: ion-dipole, dipole-dipole, dipole-induced dipole and dispersion (London) forces, hydrogen bond (intra-molecular and inter-molecular), effect of inter/intra-molecular forces on structure of different biomolecules.					**08**
Unit III	**Carbohydrates** Monosaccharides- cyclization of aldoses and ketoses, conformations, concept of mutarotation, anomers, epimers, derivatives-sugar phosphate, sugar alcohol, sugar acids, deoxy and amino sugars, ascorbic acid (examples from biomolecules). Disaccharides- structure, reducing and non-reducing sugars. Polysaccharides- Starch, glycogen and cellulose.					**08**
Unit IV	**Lipids** Fatty acids, triacylglycerols, glycerophospholipids, sphingolipids, steroids (cholesterol and its derivatives). **Amino Acids** Structure and classification of amino acids, ionization, chemistry of peptide bond, non-ribosomal peptide bond formation, essential and non-essential amino acids, amino acids as precursors of other bioactive compounds, zwitterion, isoelectric point, optical properties of amino acids, Lambert-Beer Law.					**08**
Unit V	**Nucleotides** Sugars and Bases, conformation of sugar phosphate backbone, hydrogen bonding by bases, Types of DNA (A, B and Z DNA), tautomers of bases, nucleotide derivatives, nucleotides as regulating molecules, concept of anti-sense molecules.					**08**
Course Title	**Organic Chemistry Lab**					**CR**
Course code	**BBM-152**					**2.0**

PRACTICALS (Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Preparation of solutions based on molarity, normality, percentage, dilutions etc.
2. Preparation of buffers.
3. Qualitative tests for carbohydrates to identify the given unknown carbohydrate solution: Mohlisch, Barfoed, Fehling/ Tollen/ Benedict, Selvinoff, Osazone, Bial‟stests.
4. To determine the Iodine number of the given oil/ fat.
5. To find pKa value of given acetic acid/ amino acid.
6. Qualitative test for the protein
7. Isolation of the casein from the milk sample
8. Qualitative test for the amino acids.

References

1. Concise Inorganic Chemistry, 5th edition (1999), J. D. Lee; Wiley-Blackwell, ISBN-13: 9780632052936.

2. Organic Chemistry, 6th edition (1996), I L Finar; ELBS, Longman Higher Education. ISBN-13: 978-0582305601.

3. Lehninger: Principles of Biochemistry, 5th edition (2008), David L. Nelson and Michael M. Cox; Prentice Hall Publishers, ISBN-13: 978-0321707338

4. Biochemistry, 4th edition (2003), Campbell, M. K. and Farrel, S. O.;Brooks/Cole, Cengage Learning (Boston), ISBN: 0030348498.

5. An Introduction to Practical Biochemistry, 3rd edition (1987), Plummer, McGraw-Hill College; ISBN-13: 978-0070841659

6. Organic Chemistry, 6th edition (1992), R. T. Morrison and R. N. Boyd; Pearson Education. ISBN-13: 9780136436690.

7. Biochemistry, J. M. Berg, J. L. Tymoczko and L. Stryer, 6th edition (2006), W. H. Freeman and Co.,ISBN-13: 978-0716787242

8. Bioorganic Chemistry, 3rd edition (1999), Hermann Dugas; Springer Verlag. ISBN-13: 978-0387989105

Course code	**GBT-101**				
Category	Generic Elective				
Course title	**Basic Cell Biology**				
Scheme and Credits	**Credit**	L	T	P	
	4	4	0	0	
Pre-requisites (if any)	None				
Objectives	Cells are the 'basic unit of life', the study of cells can be considered one of the most important areas of biological research. This course will provide information about cells, including their composition, their function and cell-cycle checkpoints. The module on radiation biology will help to explore and gain insight into radiation-induced biological responses at molecular, cellular and tissue levels.				
Outcomes	1. Students will understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles 2. Students will understand how these cellular components are used to generate and utilize energy in cells 3. Students will understand the cellular components underlying mitotic cell division. 4. Students will apply their knowledge of cell biology to selected examples of changes orlosses in cell function. These can include responses to environmental or physiological changes, or alterations of cell function brought about by mutation.				
Unit I	**The Cell:** Historical background, significant landmarks, cell theory, structure of prokaryotic and eukaryotic cells, mycoplasma, viruses, viroids, prions. Cell Fractionation - Centrifugation: types of centrifuges, principle and different types of centrifugation- differential, density gradient and equilibrium.				**08**
Unit II	**Cell Membrane and Transport:** Functions, different models of membrane structure, types of membrane lipids, membrane proteins: types, methods to study membrane proteins (detergents, RBC ghosts), RBC membrane as a model, membrane carbohydrates, membrane asymmetry and fluidity. *Transport of small molecules*: Passive transport (simple diffusion and facilitated diffusion) and active transport and their types (P, V, F and ABC transporter) with example of Na+/K+ pump. *Transport of macromolecules*: Endocytosis (pinocytosis, phagocytosis), exocytosis.				**08**
Unit III	**Cell Organelles :** Structure and functions of various organelles: *Nucleus*: Different components, nuclear envelope- its structure, pore complex, nucleo-cytoplasmic interaction (NLS and NES), nucleolus- structure and functions. *Chromosome*: Structure- centromere and telomere, types of chromosomes based on centromere. Diversity in structure and significance of polytene and lampbrush chromosomes. *Endoplasmic Reticulum*: RER- biosynthesis and processing of proteins, co-translational and post-translational transport of proteins, signal hypothesis, protein sorting. SER- detoxification, biosynthesis of membrane, carbohydrate metabolism, steroid synthesis. *Golgi Apparatus*: Golgi stack (cis, trans and medial cisternae), flow of proteins through GB. Glycosylation and protein sorting. *Lysosomes*: Development of different forms of lysosomes, role in cellular digestion. *Peroxisomes*: Assembly, functions- H2O2 metabolism, oxidation of fatty acids. Glyoxysomes. *Mitochondria and Chloroplast*: Detailed structure, endosymbiotic theory, its genome, and functions in brief.				**08**
Unit IV	**Cell Junctions and Cytoskeletal Elements:** Basics concepts of anchoring junctions, tight junctions, communication junctions (gap junction and plasmodesmata).Structure, assembly and functions of: *Microtubules*: Axonemal and cytoplasmic microtubules (cilia, flagella, centrioles, basal bodies). *Microfilaments*: Globular and filamentous actin. General idea about myosin. *Intermediate Filaments:* Different classes				**08**

Unit V	**Cell Division and Cell Cycle** *Mitosis and Meiosis:* Different phases and their significance. Different phases of cell cycle and their significance. Checkpoints and regulation of cell cycle.	**08**
Course Title	**Cell Biology Lab**	**CR**
Course code	**GBT-151**	**2.0**

PRACTICALS : (Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Microscopy- Theoretical knowledge of Light and Electron microscope.
2. To study the following techniques through electron/ photomicrographs: fluorescence microscopy, autoradiography, positive staining, negative staining, freeze fracture, freeze etching shadow casting, endocytosis and phagocytosis.
3. To explain mitosis and meiosis using permanent slides.
4. To cytochemically demonstrate presence of proteins in cheek cells or onion peel using mercuric bromophenol blue or fast green.
5. To cytochemically demonstrate presence of carbohydrates in cheek cells or onion peel using periodic acid Schiff's reagent.
6. To cytochemically demonstrate presence of DNA in cheek cells or onion peel using Feulgen reagent.
7. To study the effect of isotonic, hypotonic and hypertonic solutions on cells. 8. To prepare polytene chromosomes.

References	**1.** The Cell: A Molecular Approach, 5th edition (2009), Cooper and Hausman. Sinauer Associates, Inc. ISBN-13: 978-0878933976. **2.** Cell and Molecular Biology: Concepts and Experiments, 6th edition (2009), Gerald Karp, Wiley. ISBN-978-0470483374. **3.** Physical Biochemistry: Applications to Biochemistry and Molecular Biology, David Freifelder, 2nd edition (1983), W. H. Freeman and Company. ISBN: 0716714442 / 0-7167-1444-2. **4.** An Introduction to Radiobiology, 2nd edition (1998), A. H. W. Nias, Wiley Blackwell, ISBN-13: 978-0471975908. **5.** The World of the Cell, 7th edition (2008), Becker, Kleinsmith, Hardin and Bertoni. Benjamin Cummings, ISBN-13: 978-0805393934. **6.** The Cell: A Molecular Approach, 6th edition (2013), Cooper and Hausman; Sinauer Associates, Inc. ISBN-13:978-1605351551. **7.** Essential Cell Biology, 7th edition (2009), Alberts, Bray, Hopkin, Johnson, Lewis, Raff, Roberts and Walter. Garland Science. ISBN-13:978-0815341291. Molecular Cell Biology, 7th edition (2012), Lodish, Berk, Kaiser, Krieger, Bretscher, Ploegh, Amon

Course code	**BBM-201**					
Category	Core Biomedical					
Course title	Diagnostic and Therapeutic Instrumentation					
Scheme and Credits	**Credit**	**L**	**T**	**P**		
	4	4	0	0		
Pre-requisites (if any)	Basic knowledge of Human Anatomy and Physiology					
Objectives	Objective of this course is to acquaint the students with the recording methodology (placement of electrode or sensor, equipment, analysis and safety procedures) for electrical and non-electrical signals. It will also be helpful for them to understand the mechanism of signal origination and specified amplifier used for signal recording.					
Outcomes	After studying this course, students will able to: 1. Explain basic electrophysiology mechanism involve in bio-potential generation. 2. explain the working of patient monitoring system, diagnostic and therapeutic equipments 3. Examine the bioelectrical and non-bioelectrical activities. 4. Calibrate and handle the equipments related to the patient care and monitoring. 5. Students will know the definitions, basic principles and the applications of the available diagnostic and therapeutic devices.					
Unit I	**Biopotential Recorders:** Resting and action potentials, propagation of action potential, Bioelectric signals (ECG, EMG, ECG, EOG & ERG) and their characteristics, effects of high contact Impedance, types of electrodes, electrodes for ECG, EEG and EMG.					**08**
Unit II	**Patient Monitoring System:** System concepts, Heart rate Meter & Alarm. Respiration rate meter, Blood pressure meter, temperature indicator. Foetal Mentoring System: Cardiotacography Method Foetal heart Rate (FHR) measurement.					**08**
Unit III	**Diagnostic Equipments:** Blood gas analyzer, Blood pH measurements, Measurement of Blood PCO2 & PO2. Blood cell counters: Method of cell counting coulter counters, Differential counting cell. Impedance Plethysmography & Pulmonary Function Measurement, Spirometry, Pulmonary Function Analyzer, Respiratory Gas Analyzer					**08**
Unit IV	**Therapeutic Equipments:** Short ware diathermy machine microwave diathermy machine Ultrasonic therapy Unit. Pain relief through electrical stimulation. Pacemaker, Defibrillator and Incubator. Life Supporting Equipments: Life support systems: Heart Lung machine, Haemodialysers, Ventilators. .					**08**
Unit V	**Safety and Precautions:** Gross current, Micro Current shock, safety standards rays and considerations, safety testing instruments, biological effects of X-rays and precaution.					**08**
Course code	**BBM-251**					**CR**
Course title	Diagnostic and Therapeutic Instrumentation Lab.					**2.0**

PRACTICALS : (Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Diagnosis of Electrical Activity of Heart
2. Diagnosis of Electrical Activity of Brain/ Muscles
3. Testing, Calibration, Maintenance and Working Principle of TENS
4. Testing, Calibration, Maintenance and Working Principle of Ultrasound

5. Testing, Calibration, Maintenance and Working Principle of Muscle Stimulator 6. Testing, Calibration, Maintenance and Working Principle of IFT	
References	1. Waugh, A., & Grant, A. (2001). Ross and Wilson anatomy and physiology in health and illness. Churchill Livingstone. 2. Webster, J. (2010). Medical instrumentation: application and design, Fourth edition. In John Wiley and Sons, Inc. USA. 3. Khandpur, R. S. (1987). Handbook of biomedical instrumentation. McGraw-Hill Education. 4. Joseph, J. Carr, & Brown, J. M. (2001). Introduction to biomedical equipment technology. Prentice hall. 5. Clark, J. W., Neuman, M. R., Olson, W. H., Peura, R. A., Primiano, F. P., Siedband, M. P., & Wheeler, L. A. (1998). Medical instrumentation: application and design. Wiley.

Course code	**BBM-202**					
Category	Core Biomedical					
Course title	Immunology					
Scheme and Credits	**Credit**	**L**	**T**	**P**		
	4	4	0	0		
Pre-requisites (if any)	Basic knowledge of cell and Biology.					
Objectives	The immune system distinguishes between self and foreign molecules and thus alerts and mediates protection against attack by potentially infectious organisms. Malfunctioning of the immune system leads to a number of disorders and diseases. Immunobiology is a comprehensive study of the organization and functioning of the immune system with its network of cells and molecules. Understanding the biology of the immune system is, therefore, key to developing strategies towards prevention and cure to a number of disorders and diseases that result due to interference in the functioning and regulation of the immune system. This paper covers the structure, organization, function and regulation of and by the immune system keeping the above aspects in mind.					
Outcomes	After going through this unit student shall be able to: 1. Trace the history and development of immunology. 2. Describe surface membrane barriers and their protective functions. 3. Explain the importance of phagocytosis and natural killer cells in innate body defense. 4. Describe the roles of different types of T cells, B cells and APCs. Compare and contrast the origin, maturation process, and general function of B and T lymphocytes.					
Unit I	**Introduction to Immunology:** History and terminology, innate and acquired immunity, active and passive immunity, immune responses, cells (T-cells, B-cells) and organs of immune system, cell mediated and humoral immunity, cytokines, toll-like receptors.					**08**
Unit II	**Antibody:** Classification, isotypes, fine structure**,** biosynthesis of immunoglobulin, complement system. **Antigen:** Nature of antigens, haptens, adjuvants, vaccines.					**08**
Unit III	**MHC complex:** Function, structure and MHC restriction.					**08**
Unit IV	Principles of virulence and pathogenicity: Host-parasite interactions. Transplantation and tumor immunology: Tumor cell immunity, transplantation of tissues and organs, relationship between donor and recipient, role of MHC molecules in allograft rejection, bone marrow and haematopoietic stem cell transplantation, tumor antigen, tumor immunoprophylaxis.Autoimmune diseases: Autoimmune hemolytic anemia, systemic lupus erythematosus, multiple sclerosis, rheumatoid arthritis, AIDS, diabetes mellitus. Inflammation and hypersensitivity: Hypersensitivity reactions, inflammasome.					**08**
Unit V	Applied immunology: Antigen-antibody interaction, affinity and avidity, agglutination and precipitation reactions, immunoflourescence, fluorescence activated cell sorting analysis. Antibody engineering: Hybridoma and monoclonal antibody (Mab), recombinant antibody molecules, human and humanized antibodies, uses of Mab. Antigen engineering: ELISA, RIA, immunodiffusion, immunoelectrophoresis, immunoblotting, antibody for diagnosis, antibody for therapy, cytokine therapy					**08**
Course code	**BBM-252**					**CR.**
Course title	**Immunology Lab.**					**2.0**

PRACTICALS : (Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Estimation of hemoglobin (Sahli‟s method) and determination of blood group.
2. Determination of bleeding time and clotting time of blood.
3. Determination of total erythrocyte count.
4. Determination of total leukocyte count.
5. Preparation of blood smears and identifying various WBC
6. To perform differential leukocyte count of blood.
7. Determination of specific gravity of blood.
8. Determination of osmotic fragility

References	1. Immunology, 6th edition, (2006), J. Kuby et al, W.H. Freeman and Company, New York. ISBN-13: 978-1429202114. 2. Microbiology, 7th edition, (2008), Prescott, L., John Ii Harley, Donald A. Klein, McGraw Hill. ISBN-13: 978-0071102315. 3. Roitt‟s Essential Immunology, 12th edition, (2011), Wiley-Blackwell Science. ISBN-13: 978-1405196833. 4. Immunology, 8th edition, (2012), Male, D., Brostoff, J., Roth, D.B. and Roitt, I., Elseivier-Sauders. ISBN-13: 978-0323080583. 5. An Introduction to Immunology, Immunochemistry and Immunobiology, 5th edition, (1988), Barrett, James T., Mosby Company, St. Louis. ISBN-13: 978-0801605307. 6. Immunology: An Introduction, 4th edition, (1994), Tizard, I.R., Saunders College Publishing, Philadelphia. ISBN-13: 978-0030041983.

Course code	**GBT-201**				
Category	Generic Elective				
Course title	Principles of Genetics				
Scheme and Credits	**Credit**	**L**	**T**	**P**	
	4	4	0	0	
Pre-requisites (if any)	Basic knowledge of Biology				
Objectives	Genetics having its roots in mathematics thanks to Mendel, appeals to students as one of the analytical branches of biology even in senior school. Basic concepts that are essential to understand inheritance will be taught, starting from the abstract factors to physical basis of inheritance. The course aims to communicate the pivotal role of Mendelian concepts in the development of the science of genetics and also the fact that nature is full of examples that deviate from Mendelian laws starting from linkage groups. Introduction of models and the way they have contributed to our understanding of genetics will provide a perception of how forward genetics has been used to understand the basis of continuity of information transfer that is applicable to not only to the simple life forms but also to humans. Most of the topics will be at the introductory level, which would motivate the students to understand the molecular basis of genotype to phenotype correlation.				
Outcomes	The student will demonstrate knowledge of the basics principles of Mendelian genetics by: 1. Discussing the progression of discovery from Classical to Modern Genetics. 2. Defining basic concepts of Classical Genetics. 3. Describing Mendel's experimental design. 4. Utilizing conventional Mendelian genetic terminology. 5. Explaining Mendel's principles ofsegregation, and independent assortment. 6. Solving monohybridcross genetic outcomes utilizing branch diagrams and/or Punnett squares. 7. Using testcrosses to identify parental genotype and confirm the principle ofsegregation. 8. Solving dihybrid cross genetic outcomes utilizing branch diagrams and/or Punnett squares. 9. Analyzing the results of multihybrid crosses to confirm the principle of Independent Assortment. 10. Using the laws of probability to statistically analyze the outcomes of genetic crosses.				
Unit I	**Mendelian genetics:** Mendel's law of inheritance, Mendelian ratio, linkage, crossing over, chromosomal theory of inheritance. **Chromosome mapping:** linkage analysis, two point test cross, three point test cross, interference, coefficient of coincidence, chi-square analysis.				**08**
Unit II	**Structural and numerical changes in chromosomes:** Chromosomal aberration (deletion, duplication, translocation and inversion), euploidy and aneuploidy, aneuploidy in human. **Mutations:** Natural and induced mutations, physical and chemical mutagens, Ames test, uses of mutations in genetic studies, human health and crop improvement. **Biochemical and microbial genetics:***Neurospora* as model system, one gene one enzyme hypothesis.				**08**
Unit III	**Sex determination:** Sex linked inheritance, determination of sex and dosages compensation. **Chloroplast and mitochondrial genetics:** Cytoplasmic inheritance, chloroplast inheritance in plants, mitochondrial genes in yeast.				**08**
Unit IV	**Human genetics:** Inborn errors of metabolism, Genetic diseases in human-Phenyl ketonuria, Alkaptonuria, Albinism, Lesch-Nyhan syndrome, Tay-Sachs disease, Cystic fibrisis, genetic counseling.				**08**
Unit V	**Population and evolutionary genetics:** Gene pool and gene frequencies, Hardy-Weinberg law, inbreeding, genetic equilibrium, genetic basis of evolution and speciation, molecular evolution, evolution of multigene families.				**08**
Course code	**GBT-251**				**CR.**

Course title	Genetics Lab.	2.0
PRACTICALS : (Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.) 1. Verification of Mendelian laws through dominant, recessive, test and back cross. 2. Verification of sex-linked characteristics, linkage and crossing over mechanism. 3. Verification of population genetics 4. Pedigree charts of some common characters like blood group, color blindness and PTC testing		
References	1. Principles of Genetics, 6th edition (2011), Snustad DP and Simmons MJ, John Wiley and Sons, Inc; ISBN-13: 978-0470903599 2. Human Molecular Genetics, 3rd edition (2003) by Tom Strachan and Andrew Read; Garland Science Publishers, ISBN -13: 978-0815341826. 3. Concepts of Genetics, 10th edition, (2011). William S. Klug, Michael R. Cummings, Charlotte A. Spencer, Michael A. Palladino; Pearson Education, ISBN-13: 978-0321724120. 4. Principles of Genetics, 8th edition (2005), Gardner EJ, Simmons MJ, Snustad DP. John Wiley and Sons, Inc. ; ISBN-13: 978-9971513467. 5. An introduction to Genetic Analysis, 10th edition (2010), Griffith AJF, Miller JH, Suzuki DT, Lewontin RC, Gelbert WM., W. H. Freeman and Co. New York. ISBN-13: 978-429229432. 6. Principles of Genetics, 6th edition (1998), Robert H. Tamarin Publisher: William C Brown Pub; ISBN-13: 978-0697354624.	

Course code	**BBM-301**				
Category	Core Biomedical				
Course title	Analytical Instrumentation and its Applications				
Scheme and Credits	**Credit**	**L**	**T**	**P**	
	4	4	0	0	
Pre-requisites (if any)	None				
Objectives	Biological phenomena cannot be understood fully without physical insight. Biophysics is an interdisciplinary frontier of science in which the principles and techniques of physics are applied to understand biological problems at every level, from atoms and molecules to cells, organisms and environment. The work always aims to find out how biological systems work. This paper covers various spectroscopic techniques, hydrodynamic methods, molecular biophysics and introduction to various physical principles responsible for maintaining the basic cellular function and integrity of biological membranes including transport across them.				
Outcomes	Students would be able to: 1. Strategically plan analytical campaigns to apply to different types of samples and research objectives, including selection of the most appropriate technique/instrumentation for the students' research project. 2. Undertake the correct sample preparation and characterization prior to analysis by the chosen techniques or instruments. 3. Design an analytical work-flow to acquire data and achieve the research objectives of their project. 4. Process data from the chosen instruments and demonstrate understanding of the limitations and quality of the data. Justify the approach taken to data processing. 5. Write a clear and concise justification and description of the analytical techniques employed, suitable for publication in a scientific journal.				
Unit I	Principle, Instrumentation and analytical applications of following techniques Atomic Absorption spectroscopy , Flame photometry, Inductively coupled plasma-Atomic Emission spectroscopy , Scanning Electron Microscopy				**08**
Unit II	Chromatography : Gas solid Chromatography , Gas liquid Chromatography, High performance liquid chromatography, ion exchange chromatography, paper chromatography, thin layer chromatography, column chromatography, gel permeation chromatography				**08**
Unit III	Radioanalytical methods : Neutron activation analysis, isotope dilution analysis, Radiometric titrations, particle induced X-ray Emission, Use of radioisotopes - in industry, agriculture and physicochemical studies .				**08**
Unit IV	Spectroscopic Techniques U V Introduction to spectroscopy, Lambert Beer's law, Deviation from Lambert Beer s law, instrumentation and applications IR Introduction, basic principles, factors affecting IR group frequencies , Instrumentation and Applications				**08**
Unit V	NMR Basic principles, elementary ideas and instrumentation chemical shifts, spin-spin coupling, instrumentation and applications Mass Spectroscopy: Introduction, basic principles, applications and uses ESR: Principle, instrumentation and applications X-ray Spectroscopy: X-ray absorption, methods, diffraction methods Raman Spectroscopy : Principle instrumentation and applications				**08**
Course code	BBM-351				**CR.**
Course title	Analytical Instrumentation Lab.				**2.0**

PRACTICALS (Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Effect of different solvents on UV absorption spectra of proteins.
2. Study of structural changes of proteins at different pH using UV spectrophotometry.
3. Study of structural changes of proteins at different temperature using UV spectrophotometry. 4. Determination of melting temperature of DNA.
4. Study the effect of temperature on the viscosity of a macromolecule (Protein/DNA).
5. Use of viscometry in the study of ligand binding to DNA/protein.
6. Crystallization of enzyme lysozyme using hanging drop method.
7. Analysis, identification and comparison of various spectra (UV, NMR, MS, IR) of simple organic compounds
8. Determination of molar composition of complex
9. Determination of indicator constant of an indicator.
10. Determination of physico-chemical parameters of water
11. Estimation of free fatty acid in oil
12. Determination of serum cholesterol
13. Estimation of reducing sugar
14. Estimation of amino acid by Ninhydrin method
15. Estimation of protein by Lowry met

References

1. Physical Biochemistry: Principles and Applications, 2nd edition (2009), David Sheehan, John Wiley. ISBN-13: 978-0470856031.
2. Physical Biochemistry: Applications to Biochemistry and Molecular Biology, 2nd edition (1982), David Freifelder, W.H. Freeman and Company. ISBN-13: 978-0716714446.
3. Physical Chemistry: Principles and Applications in Biological Sciences, 4th edition (2001), I. Tinoco, K. Sauer, J.C. Wang and J.D. Puglisi, Prentice Hall, ISBN-13: 978-0130959430.
4. Molecular Biology of the Gene, 7th edition (2007), Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R, Benjamin Cummings Publishers, ISBN-13: 978-0805395921.
5. Biophysics, 1st edition (1983), W. Hoppe, W. Lohmann, H. Markl and H. Ziegler, SpringerVerlag, ISBN-13: 978-3540120834.
6. The Physics of Proteins: An introduction to Biological Physics and Molecular Biophysics, 1st edition (2010), H. Frauenfelder, S.S. Chan and W.S. Chan, Springer, ISBN-13: 978- 1441910431.
7. Principles of Instrumental Analysis, 6th edition (2006), D.A. Skooget. al., Saunders College Publishing. ISBN-13: 978-0495012016.
8. Principles of Physical Biochemistry, 2nd edition (2005), K.E. Van Holde, W.C. Jhonson and P. Shing Ho, Prentice Hall Inc. ISBN-13: 978-0130464279.
9. Biophysical Chemistry, 1st edition (1980), C.R. Cantor, P.R. Schimmel, W.H. Freeman andCompany. ISBN-13: 9780716711889.
10. Crystallography Made Crystal Clear: Guide for Users of Macromolecular Models, 3rd edition (2010), Gale Rhodes, Academic Press. ISBN: 9780080455549.

Course code	**BBM-302**					
Category	Core Biomedical					
Course title	Medical Physics					
Scheme and Credits	**Credit**	**L**	**T**	**P**		
	4	4	0	0		
Pre-requisites (if any)	None					
Objectives	This course will introduce the student to basic principles of medical imaging and involves equipment design and function. The production of x-rays, their characteristics and their role in the imaging process will be discussed and demonstrated. The role of exposure factors and the effects on image quality will be discussed and demonstrated. Special Imaging Modalities will be introduced.					
Outcomes	Students would be able to: 1. Describe the construction and function of the x-ray system. 2. Describe the image formation process on radiographic film and digital imaging plates. 3. Describe the conversion of a latent x-ray image into a radiologic image. 4. Compare and contrast x-ray images with different quality characteristics. 5. Describe how x-ray images are developed in a rapid film processor. 6. Compare and contrast the basic radiation interactions that occur in matter exposed to x-rays. 7. Explain how scattered radiation can affect the film and how its effects can be minimized. 8. Recommend methods of improving an x-ray image with deficits. 9. Describe the operating characteristics of conventional tomography 10. Explain how fluoroscopy differs from conventional overhead radiography					
Unit I	**Bioelectromagnetics:** Non-ionizing electromagnetic field, introduction to extremely low frequency, radio & microwave frequency, environmental and man made sources of extremely low frequency, natural electric and magnetic field, biophysical mechanism, established interactions, biological effect of power frequency, biohazard and effects of electromagnetic field.					**08**
Unit II	Chromatography : Gas solid Chromatography , Gas liquid Chromatography, High performance liquid chromatography, ion exchange chromatography, paper chromatography, thin layer chromatography, column chromatography, gel permeation chromatography					**08**
Unit III	Radioanalytical methods : Neutron activation analysis, isotope dilution analysis, Radiometric titrations, particle induced X-ray Emission, Use of radioisotopes - in industry, agriculture and physicochemical studies .					**08**
Unit IV	Spectroscopic Techniques U V Introduction to spectroscopy, Lambert Beer's law, Deviation from Lambert Beer s law, instrumentation and applications IR Introduction, basic principles, factors affecting IR group frequencies , Instrumentation and Applications					**08**
Unit V	NMR Basic principles, elementary ideas and instrumentation chemical shifts, spin-spin coupling, instrumentation and applications Mass Spectroscopy: Introduction, basic principles, applications and uses ESR: Principle, instrumentation and applications X-ray Spectroscopy: X-ray absorption, methods, diffraction methods Raman Spectroscopy : Principle instrumentation and applications					**08**
Course Code	BBM-352					**CR.**
Course title	Medical Physics					**2.0**

PRACTICALS (Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Testing, calibration, Maintenance, working of MRI Instrument
2. Testing, calibration, Maintenance, working of Ultrasound
3. Testing, calibration, Maintenance, working of X-Ray
4. Testing, calibration, Maintenance, working of Computed Tomography

References

1. 1 Waugh, A., & Grant, A. (2001). Ross and Wilson anatomy and physiology in health and illness. Churchill Livingstone.
2. Webster, J. (2010). Medical instrumentation: application and design, Fourth edition. In John Wiley and Sons, Inc. USA.
3. Khandpur, R. S. (1987). Handbook of biomedical instrumentation. McGraw-Hill Education.
4. Joseph, J. Carr, & Brown, J. M. (2001). Introduction to biomedical equipment technology. Prentice hall
5. Clark, J. W., Neuman, M. R., Olson, W. H., Peura, R. A., Primiano, F. P., Siedband, M. P., & Wheeler, L. A. (1998). Medical instrumentation: application and design. Wiley.

Course code	**BBM-303**				
Category	Core Biomedical				
Course title	Molecular Biology				
Scheme and Credits	**Credit**	**L**	**T**	**P**	
	4	4	0	0	
Pre-requisites (if any)	Basic knowledge of genetics				
Objectives	Molecular Biology encompasses the basic study and understanding of the execution of central dogma. The paper starts with the basic organization of the genome in prokaryotes and eukaryotes along with their discerning features. This is followed by chapters on prokaryotic and eukaryotic replication, transcription and translation processes.				
Outcomes	Students would be able to 1. Exhibit a knowledge base in genetics, cell and molecular biology, and anatomy and physiology 2. Demonstrate the knowledge of common and advanced laboratory practices in cell and molecular biology 3. Exhibit clear and concise communication of scientific data 4. Engage in review of scientific literature in the areas of biomedical sciences 5. Critique and professionally present primary literature articles in the general biomedical sciences field				
Unit I	**The replication of DNA in Prokaryotes and Eukaryotes** Chemistry of DNA synthesis, General principles - bidirectional replication, Semi-conservative, discontinuous. RNA priming, Various models of DNA replication including D-loop(mitochondrial), Theta mode of replication, rolling circle model, Replication of linear ds-DNA, Replicating the 5‟ end of linear chromosome, Enzyme involved in DNA replication – DNA polymerases, DNA ligase, primase, telomerase and other accessory proteins. Denaturation and renaturation of DNA, Cot curves.				**08**
Unit II	**The mutability and Repair of DNA** Replication Errors (Transitions, transversion and thymine dimer), DNA Damage (deamination, depurination and dimerization) and their repair: mismatch repair, SOS response (recombination), Excision Repair, Photoreactivation.				**08**
Unit III	**Information Transfer –I: Mechanism of Transcription** Basic transcription apparatus, Initiation, elongation and termination of transcription, Eukaryotic transcription of mRNA, tRNA and rRNA, types of RNA polymerases, transcription factors, Inhibitors of transcription- rifampicin and α-amanitin.				**08**
Unit IV	**Post-Transcriptional Modifications** Split Genes, Concept of introns and exons, RNA splicing, Spliceosomes and Self splicing introns, alternative splicing and exon shuffling, mRNA transport.				**08**
Unit V	**Information Transfer-II: Mechanism of Translation** Features of genetic code and exceptions in some systems, Ribosome structure- rRNA and proteins, Charging of tRNA, aminoacyl tRNA synthetases, Proteins involved in initiation (both in prokaryotes and eukaryotes), elongation and termination of polypeptides, Fidelity of translation, Inhibitors of protein synthesis – tetracyclins, aminoglycosides, chloramphenicol and aminoglycosides.				**08**
Course Code	**BBM-353**				**CR.**
Course title	Molecular Biology Lab.				**2.0**
PRACTICALS (Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.) 1. Preparation of various stock solutions required for Molecular Biology Laboratory.					

2. Preparation of culture medium (LB) for E. coli (both solid and liquid) and raise culture of E. coli. 3. Isolation of chromosomal DNA from bacterial cultures and visualization on Agarose Gel Electrophoresis. 4. Quantitative estimation of DNA using colorimeter (Diphenylamine reagent) and Spectrophotometer (A260 measurement). 5. Isolation of genomic DNA from blood/ tissue. 6. Demonstration of Polymerase Chain Reaction (PCR) technique	
References	1. Molecular Biology of the Gene, 6th edition (2007), Watson, J. D., Baker T. A., Bell, S. P., Gann, A., Levine, M., and Losick, R; Benjamin Cummings Publishers, ISBN-13: 978-0805395921. 2. Cell and Molecular Biology: Concepts and Experiments, 7th edition (2013), Gerald Karp. ; Wiley Publishers ISBN-13: 978-1118206737. 3. Molecular Cloning: A Laboratory Manual, 4th edition (2012), Michael R. Green and Joseph Sambrook; Cold Spring Harbor Laboratory Press, ISBN-13: 978-1936113422. 4. The World of the Cell, 7th edition (2008), Becker, Kleinsmith, Hardin and Bertoni. Benjamin Cummings, ISBN-13: 978-0805393934. 5. The Cell: A Molecular Approach, 6th edition (2013), Cooper and Hausman; Sinauer Associates, Inc. ISBN-13: 978-1605351551. 6. DNA Replication, 2nd edition (2005), Arthur Kornberg; University Science Books ISBN-13: 978-1891389443.

Course code	**GBT-301**				
Category	Generic Elective				
Course title	Microbiology				
Scheme and Credits	**Credit**	**L**	**T**	**P**	
	4	4	0	0	
Pre-requisites (if any)	Basic knowledge of Biology				
Objectives	Microbiology course has been formulated to impart basic and medically relevant information on the microbes. The microbial structure, growth and development, methods and role of sterilization in the context of study of microbes are included. The pathogenic microbes and the diseases caused by them are included to broaden the perspective of the subject. This course will also focus on mechanisms of microbial pathogenesis and the host response, and the scientific approaches that are used to investigate these processes. Lastly the course deals with the problem of emerging antimicrobial resistance with reference to known pathogens.				
Outcomes	1. Students will be able to acquire, articulate, retain and apply specialized language and knowledge relevant to microbiology. 2. Students will acquire and demonstrate competency in laboratory safety and in routine and specialized microbiological laboratory skills applicable to microbiological research or clinical methods, including accurately reporting observations and analysis. 3. Students will communicate scientific concepts, experimental results and analytical arguments clearly and concisely, both verbally and in writing. 4. Students will demonstrate engagement in the Microbiology discipline through involvement in research or internship activities, the Microbiology Student Association club (MSA) and outreach or mentoring activities specific to microbiology				
Unit I	**Fundamental Concepts** a) History of microbiology, Discovery of microorganisms, Contributions of Louis Pasteur and Robert Koch in Medical Microbiology. b) Molecular methods of assessing microbial phylogeny- molecular chronometer, phylogenetic trees, rRNA, DNA and proteins as indicator of phylogeny. Major Divisions of life- Domains, Kingdoms. c) Requirements for microbial growth, growth factors, culture media- synthetic and complex, types of media. Obtaining Pure Cultures, Preserving Bacterial Cultures, Growth Curves and generation time, Control of microbial growth, general concept of effect of environmental factors on growth of microbes.				**08**
Unit II	**Bacterial Cells - fine structure and function** Size, shape and arrangement of bacterial cells. Cell membrane, cytoplasmic matrix, inclusion bodies, nucleoid, Ultrastructure of Gram +ve and Gram –ve bacterial cell wall, Pili, Capsule, Flagella and motility.				**08**
Unit III	**Microbial Genetics** Mutations, Bacterial recombination: general and site specific and replicative, bacterial plasmids fertility factor, col plasmid, bacterial conjugation (Hfr, F′, F+, F-), transformation, transduction- generalized and specialized.				**08**
Unit IV	**Viruses, viroids, prions** General characteristics of viruses, structure, isolation, cultivation and identification of viruses, viral multiplication, one step multiplication curve, lytic and lysogenic phages (lambda phage), concept of early and late proteins, clinical virology with reference to HIV virus and hepatitis virus (Life cycle and clinical symptoms), viroids and prions.				**08**
Unit V	**Medically important disease** Bacterial Diseases: Diphtheria and Tuberculosis, Staphylococcal food poisoning and E. coli gastroenteritis, Gonorrhea and syphilis. Medical Mycology: Aspergillus and Candida albicans. Common protozoan disease: Malaria, Infections caused by Taeniasolium / Taeniasaginata, Fasciola hepatica and Ascarislumbricoides. Spectrum of antimicrobial activity, action of antimicrobial drugs, inhibitors of cell wall				**08**

	synthesis, anti-mycobacterial antibiotics, inhibitors of protein synthesis and nucleic acid synthesis, competitive inhibitors of essential metabolites, antifungal, antiviral, anti-protozoan drugs; effectiveness of chemotherapeutic agents, concepts of antimicrobial resistance, novel methods to combat increasing antimicrobial resistance.	
Course code	**GBT-351**	**CR.**
Course title	Microbiology Lab.	**2.0**

PRACTICALS : (Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Preparation of different media: synthetic media, Complex media-nutrient agar, Luria Agar.

2. Staining methods: Gram‟s staining, Acid fast staining (permanent slide only), Capsule staining and spore staining.

3. Study and plot the growth curve of E coli using turbidometric method and to calculate specific growth rate and generation time.

4. To perform antibacterial testing by Kirby-Bauer method.

5. Staining and morphological characterization of Aspergillus sp., Pencillium sp. and Saccharomyces sp.

6. Demonstration of PCR based method of detection.

7. Isolation of bacteriophages (any with a non-pathogenic host) and calculation of the plaque forming units (pfu)

References

1. Microbiology: An Introduction, 9th edition (2008), Gerard J. Tortora, Berdell R. Funke, Christine L. Case; Benjamin Cummings. ISBN-13: 978-0321733603.

2. Prescott, Harley, and Klein's Microbiology, 8th edition, (2011), Joanne M. Willey, Linda M. Sherwood, Christopher J. Woolverton, McGraw Hill International. ISBN-13:9780071313674.

3. Bailey and Scott‟s Diagnostic Microbiology, 12th edition (2007), Betty A. Forbes, Daniel F. Sahm and Alice S. Weissfeld; Mosby Elsevier Publishers, ISBN-13: 978-0808923640.

4. Microbiology, 6th edition (1993), Pelczar, Chan and Krieg; McGraw Hill International, ISBN-13: 978-0070492585.

5. Brock Biology of Microorganisms, 13th edition (2010), Michael T. Madigan, John M. Martinko, David Stahl and David P. Clark, Pearsons, Benjamin Cummings, ISBN-13: 9780321649638.

6. Microbiology: A Laboratory Manual, 10th edition, (2013), James Cappuccino and Natalie Sherman, Benjamin Cummings. ISBN-13: 978-0321840226.

Course code	**SBM-301**					
Category	Skill Enhancement					
Course title	Biocomputation					
Scheme and Credits	**Credit**	**L**	**T**	**P**		
	2	2	0	0		
Pre-requisites (if any)	Basic knowledge of Molecular Biology and Genetics					
Objectives	This course will introduce the discipline of computational biology and drug design. It has been designed to explain the different aspects of nucleotide and protein sequence analyses, sequence alignments and their applications in understanding biology. The course will also emphasize on the strategic issues in drug discovery and development, principles of computational methods involved in lead generation virtual screening, quantitative structureactivity relationship and molecular docking.					
Outcomes	Students would be able in Sequence alignment and visualization and Phylogenetic and microarray analysis					
Unit I	**Introduction to computational biology** Computational biology and bioinformatics, internet and bioinformatics, chemoinformatics.					**08**
Unit II	**Biological databases and genome browsers** Introduction to various databases and their classification (primary and secondary databases) e.g. NCBI, DDBJ, EMBL, ENSEMBL, UCSC and their use in laboratories: literature, sequence, structure, medical, enzymes and metabolic pathways databases.					**08**
Unit III	**Sequence alignment and visualization** Local and global sequence alignments (Needleman-Wunsch and Smith-Waterman algorithms), pair-wise (BLAST and FASTA algorithms) and multiple sequence alignment (Clustal W) and its importance.					**08**
Unit IV	Theory behind BLAST- how Hidden Markov Model (HMM) can be used to model a family of unaligned sequences or a common motif within a set of unaligned sequences and further be used for discrimination and multiple alignment, BLAST score, amino acid substitution matrices, s-value and e-value, calculating the alignment score and significance of e and p value.					**08**
Unit V	**Phylogenetic and microarray analysis** Basics and tools for phylogenetic analysis, cladistics, tree-building methods (character and distance based methods), construction of phylogenetic trees (PHYLIP) and identifying homologs. Microarray analysis - Introduction and use of DNA microarray to assay gene expression, designing of the experiment, analysis and biological interpretation, principle and applications of protein microarray.					**08**
References	1. Bioinformatics: Sequence and Genome analysis, 2nd edition (2004), David W. Mount, Cold Spring Harbour Laboratory Press. ISBN-13: 978-0879697129. 2. Bioinformatics: A practical guide to the analysis of genes and proteins, 3rd edition (2004), Andreas D. Baxevanis and B.F. Francis Ouellette, John Wiley and Sons. ISBN-13: 978-0471478782. 3. Introduction to Medicinal Chemistry, 4th edition (2009), Graham l. Patrick, Oxford University Press. ISBN-13: 978-0199234479. 4. The Process of New Drug Discovery and Development, 2nd edition (2006), C.G. Smith and J.T. O'Donnell, Informa Healthcare, ISBN-13: 978-0849327797. 5. Cheminformatics (2003), J. Gasteiger, Thomas Engel; Wiley-VCH. ISBN: 9783527618279. 6. Molecular modeling - Principles and Applications, 2nd edition (2003), A. R. Leach, Pearson Education Limited, UK. ISBN 13: 9780582382107. 7. Cheminformatics in Drug Discovery (2006), edited by. T.I. Opera; Wiley Publishers, ISBN: 9783527604203. 8. Molecular dynamics simulation: elementary methods (1992), J. M. Haile, WileyInterscience, New York. ISBN-13: 978-0471184393.					

Course code	**BBM-401**					
Category	Core Biomedical					
Course title	Pathology					
Scheme and Credits	**Credit**	**L**	**T**	**P**		
	2	2	0	0		
Pre-requisites (if any)	Basic knowledge of medical terminologies					
Objectives	The curriculum of pathology aims at preparing the students in basic understanding of diseases and their pathogenesis. The topics are of introductory nature and build the concepts of how human system work in altered and diseased stage under the influence of various internal and external stimuli Thus the syllabi of pathology compliments and supplements the necessary knowledge students have gained in Physiology. Consequently it incorporates topics like cellular adaptations, inflammation, neoplasia, cellular ageing and other infectious diseases. Laboratory exercises have been designed to substantiate and clarify the theoretical concepts.					
Outcomes	Upon successful completion of this course unit, the student should comprehend the general principles of disease and of biological and genetic processes involved in cancer development. The student should also be able to describe the most important diseases of selected organs.					
Unit I	**Introduction:** History of pathology, Basic definitions and common terms used in pathology, Survival mechanism and disease, microscopic and cellular pathology, scope and techniques used, An overview of cellular adaptation: Hyperplasia, Hypertrophy, Atrophy, Metaplasia; Causes and mechanisms of cell injury, reversible and irreversible injury, Necrosis, Apoptosis, Types of apoptosis, Intracellular accumulations, Cellular ageing					**08**
Unit II	**Inflammation in disease, Tissue repair Healing and Fibrosis(with suitable examples**) General features of acute and chronic inflammation: Vascular Changes, cellular events, important chemical mediators of inflammation, Morphological effects inflammation response, Granulomatus Inflammation. Basic mechanism of tissue regeneration, and repair by healing, scar formation and fibrosis					**08**
Unit III	**Hemodynamic Disorders and Cancer (with suitable examples)** Definitions, Nomenclature, characteristics of benign and malignant neoplasms, grading and staging of cancer, biology of tumor growth, invasion and metastasis, carcinogens and cancer, concept of oncogenes, tumor suppressor genes,					**08**
Unit IV	DNA repair genes and cancer stem cells. An overview of Edema, hyperemia, congestion, hemorrhage, hemostasis and thrombosis, Embolism, Infarction and shock with suitable examples					**08**
Unit V	**Nutritional and Infectious diseases** Protein energy malnutrition, deficiency diseases of vitamins, minerals, nutritional excess and imbalances. Role and effect of metals. Modes of infections with suitable examples. Overview of cause, extent, prevention, treatment and control of the diseases: Respiratory infections, Intestinal infections, Arthropod-borne infections, Zoonosis and Surface infections					**08**
Course code	**BBM-451**					**CR.**
Course title	Pathology Lab.					**2.0**

PRACTICALS (Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.) 1. Urine Analysis: Gross examination of urine for colour, odour etc. Abnormal constituents like protein, ketone bodies, glucose, blood, urea (any three) 2. Tissue Processing, embedding, sectioning. Staining and preparation of permanent histological slide. 3. Study of histological slides showing hypertrophy, hyperplasia, dysplasia, leukemia, cirrhosis and any common cancer. 4. Diagnostic tests for detection of various Diseases – CRP, VDRL, RA, Pregnancy, Dengue and HIV (any four) 5. Physiological data acquisition like Temperature EEG 6. PCR based diagnostics (for any one disease) 7. Measurement of Erythrocyte Sedimentation Rate	
References	1. Robbins and Cotran Pathologic Basis of Disease, 8th edition (2009), Vinay Kumar, Abul K.Abbas, Jon C. Aster, Nelson Fausto; Saunders Publishers, ISBN-13: 978-1416031215. 2. General and Systematic Pathology, 2nd edition (1996), J., Ed. Underwood and J. C. E. Underwood; Churchill Livingstone, ISBN-13: 978-0443052828. 3. Robbins Basic Pathology, 9th edition (2012), Kumar, Abbas, Fausto and Mitchell; Saunders Publication, ISBN-13: 978-1437717815. 4. Medical Laboratory Technology Methods and Interpretations Volume 1 and 2, 6th edition (2009), Ramnik Sood; Jaypee Brothers Medical Publishers, ISBN-13: 978-8184484496. 5. Pathophysiology, 3rd edition (2012), Lee-Ellen C. Copstead-Kirkhorn and Publisher Saunders, ISBN-13: 978-1455726509.

Course code	**BBM-402**				
Category	Core Biomedical				
Course title	**Techniques for Forensic Science**				
Scheme and Credits	**Credit**	**L**	**T**	**P**	
	4	4	0	0	
Pre-requisites (if any)	None				
Objectives	Forensic science is the application of scientific knowledge to questions of civil and criminal law. Interest in forensic science has grown considerably in recent years. Keeping this in view, the present forensic science course is designed for students to explore how forensic scientist's work, the tools and techniques they use and how they reach the conclusions they present in court. This engage students in using a creative, problem solving and inquiry based approach to investigate the crime scene. It also explains the characteristics of a fingerprint collect, process, and analyze fingerprint evidence and explain DNA analysis.				
Outcomes	At the completion of the Forensic Science Technology student will be able to: 1. Demonstrate competency in the collection, processing, analyses, and evaluation of evidence. 2. Demonstrate competency in the principles of crime scene investigation, including the recognition, collection, identification, preservation, and documentation of physical evidence. 3. Demonstrate an understanding of the scientific method and the use of problem-solving within the field of forensic science. 4. Identify the role of the forensic scientist and physical evidence within the criminal justice system. 5. Demonstrate the ability to document and orally describe crime scenes, physical evidence, and scientific processes. 6. Identify and examine current and emerging concepts and practices within the forensic science field.				
Unit I	**Crime Scene Investigation :** Introduction and principles of forensic science, Forensic science laboratory and its organization and service, tools and techniques in forensic science, branches of forensic science, causes of crime, role of modus operandi in criminal investigation				**08**
Unit II	**Types of injuries and death :** Classification of injuries and their medico-legal aspects, method of assessing various types of deaths, Case studies to depict different types of injuries and death.				**08**
Unit III	**Forensic chemistry and Ballistics:** Classification of fire arms and explosives, introduction to internal, external and terminal ballistics. Chemical evidence for explosives.				**08**
Unit IV	**Forensic Graphology:** General and individual characteristics of handwriting, examination and comparison of handwritings and analysis of ink various samples. Forensic Toxicology Role of the toxicologist, significance of toxicological findings				**08**
Unit V	**Fingerprint analysis:** Fundamental principles of fingerprinting, classification of fingerprints, development of finger print as science for personal identification, Principle of DNA fingerprinting, application of DNA profiling in forensic medicine. Cyber Forensic Investigation				**08**
Course Code	**BBM-452**				**CR.**
Course title	**Forensic Science Lab**				**2.0**

PRACTICALS : (Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Crime scene documentation
2. Crime scene investigation
3. Fingerprint Analysis
4. Injury and Death Analysis
5. Chemical investigation
6. Biomatric Analysis
7. Gender Identification
8. Odontology

References	1. Forensic Science – An introduction to Scientific and Investigative Techniques, 3rd edition (2009), James SH, Nordby JJ and Bell S; CRC Press, ISBN-13: 978-1420064933. 2. Practical Forensic Microscopy: A laboratory manual, 1st edition (2008), Barbara Wheeler and Lori J Wilson; Bios Scientific Publisher, ISBN-13: 978-0470031766. 3. Forensic Handwriting Identification: Fundamentals, Concepts and Principals 1st edition (2000) Ronald N. Morris, Academic press ISBN-13: 978-0125076401 4. Handbook of Firearms and Ballistics: Examining Interpreting Forensic Science by Brian J Heard 2nd edition (2008), John Wiley and Sons ISBN-13: 978-0470694602. 5. Principles of Forensic Medicine and Toxicology, 1st edition (2011) Rajesh Bardale; Jaypee Brothers Medical Pub, ISBN-13: 978-9350254936. 6. Practical Crime Scene Processing and Investigation, 2nd edition (2011), Ross M Gardner, CRC press ISBN-13: 978-1439853023. 7. Forensic Medicine and Toxicology: Oral, Practical And Mcq, 3rd edition (2006), Karmakar,Jaypee Brothers, ISBN-13:978-8171797350. 8. Fundamentals of Forensic Science, 2nd edition (2010), Houck, M.M. and Siegel, JA; Academic Press, ISBN-13: 978-0123749895. **9.** Criminalistics- An Introduction of Forensic Science, 10th edition (2010), Prentice Hall Inc; ISBN-13: 978-0135045206.

Course code	**BBM-403**				
Category	Core Biomedical				
Course title	**Biochemistry**				
Scheme and Credits	**Credit**	**L**	**T**	**P**	
	4	4	0	0	
Pre-requisites (if any)	Basic knowledge of Biology and the Chemistry				
Objectives	Biochemistry is a discipline, which aims at understanding the chemical properties of the biomolecules, their structural architecture and how they fold to their native, functional forms. This course includes metabolic pathways and their regulation, protein stability, folding and mis-folding, various analytical techniques used in characterization of the proteins and a detailed account of how enzymes function: their kinetics, regulation and inhibition.				
Outcomes	Students would be able to: • Demonstrate a broad knowledge of the fundamental introductory concepts of Chemistry, Biology and Physics. • Demonstrate a thorough knowledge of the intersection between the disciplines of Biology and Chemistry. • Demonstrate a proficiency in developing relevant biochemical questions, carrying out laboratory investigations to answer those questions, and critically analyzing, interpreting, and presenting in oral and written form the results of their experiments. • Locate, critically analyze, interpret and discuss data, hypotheses, results, theories, and explanations found in the primary literature, applying knowledge from Chemistry and Biology. • Appreciate the way in which practitioners in the disciplines of Biology and Chemistry intersect and bring their expertise to bear in solving complex problems involving living systems. • Understand the societal impacts, both positive and negative, of science and technology and the limitations of science.				
Unit I	**The foundations of biochemistry:** Cellular and chemical foundations of life, Water, Unique properties, weak interactions in aqueous systems, ionization of water, buffers, water as a reactant and fitness of the aqueous environment.				**08**
Unit II	**Carbohydrates and glycobiology Monosaccharides** - structure of aldoses and ketoses, ring structure of sugars, conformations of sugars, mutarotation, anomers, epimers and enantiomers, structure of biologically important sugar derivatives, oxidation of sugars. Formation of disaccharides, reducing and nonreducing disaccharides. Polysaccharides – homo- and heteropolysaccharides, structural and storage polysaccharides. Structure and role of proteoglycans, glycoproteins and glycolipids (gangliosides and lipopolysaccharides). Carbohydrates as informational molecules, working with carbohydrates				**08**
Unit III	**Lipids Building blocks of lipids** - fatty acids, glycerol and ceramide. Storage lipids - triacyl glycerol and waxes. Structural lipids in membranes – glycerophospholipids, galactolipids and sulpholipids, sphingolipids and sterols, structure, distribution and role of membrane lipids. Plant steroids. Lipids as signals, cofactors and pigments.				**08**
Unit IV	**Amino acids and Nucleotides** - Structure and classification, physical, chemical and optical properties of amino acids Nucleotides - structure and properties. Nucleic acid structure – Watson - Crick Model of DNA. Structure of major species of RNA - mRNA, tRNA and rRNA. Nucleic acid chemistry - UV absorption, effect of acid and alkali on DNA. Other functions of nucleotides - source of energy, component of coenzymes, second messengers.				**08**
Unit V	**Vitamins** Structure and active forms of water soluble and fat soluble vitamins, deficiency diseases and symptoms, hypervitaminosis				**08**

Course Code	BBM-453	CR.
Course title	Biochemistry Lab.	2.0

PRACTICALS (Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. To perform dialysis
2. Protein estimation by any one: Lowry's/Bradford method.
3. Separation of sugars/amino acids by thin layer chromatography.
4. To perform SDS-PAGE 5. Calculation of void volume of Sephadex G -2
5 column, using blue dextran
6. Assay of any one enzyme under optimal conditions.
7. To study the effect of temperature on the activity of enzyme. 8. To study the effect pH on the activity of enzyme.

References

. Lehninger Principles of Biochemistry, 5thedition (2012), David L. Nelson and Michael M. Cox; W. H. Freeman, ISBN-13: 978-0716771081.

2. An Introduction to Practical Biochemistry, 3rd edition (1987), Plummer, McGraw-Hill College; ISBN-13: 978-0070841659.

3. Introduction to Protein Structure, 2nd edition (1999), Carl Branden and John Tooze; Garland Science, ISBN-13: 978-0815323051.

4. Principles and Techniques of Practical Biochemistry, 5thedition (2000), Keith Wilson and John Walker; Cambridge University Press, ISBN -13: 978-0521799652.

5. Protein Folding, 1st edition (1992), Thomas E. Creighton; W. H. Freeman Company, ISBN13: 978-0716770275.

6. Structure and Function of Intrinsically Disordered Proteins, 1st edition (2010), Peter Tompa; CRC Press, ISBN-13: 978-1420078923.

Course code	**GBT-401**				
Category	Core Biomedical				
Course title	**Toxicology**				
Scheme and Credits	**Credit**	**L**	**T**	**P**	
	4	4	0	0	
Pre-requisites (if any)	None				
Objectives	Different types of poisons have been known to humans since ages. Even in early times when science was in its infancy, curious people such as "Paracelsus" could predict "Every substance is a poison and, it is the right dose of the substance which differentiates remedy from poisons". This thought is fundamental even to modern toxicology and pharmacology. There is an increasing use of chemicals in the modern society and hence, toxicology is becoming a more important subject to study with the passage of time. Modern toxicology is a vast, multidisciplinary subject encompassing various other basic fields of science. The present course content is designed to provide the basics of toxicology. Relevant importance has been given to those topics which can build a strong foundation in the subject, based on which, facts can be assimilated during subsequent higher studies.				
Outcomes	**Student would be able to:** 1. Critically evaluate different advanced exposure assessment methods 2. Design strategies for exposure assessment 3. Analyse and interpret exposure measurements applying different modelling tools (stochastic and deterministic) 4. Characterize measurement error and its consequences **5.** Appreciate the advantages and disadvantages of toxicological and epidemiological studies for deriving dose-response relationships				
Unit I	**Introduction** Brief history, Different areas of modern toxicology, classification of toxic substances, various definitions of toxicological significance. Effect of duration, frequency, route and site of exposure of xenobiotics on its toxicity. Characteristic and types of toxic response. Types of interactions between two and more xenobiotics exposure in humans. Tolerance and addiction.				**08**
Unit II	**Evaluation and mechanism of toxicity** : Various types of dose response relationships, assumptions in deriving dose response, LD50, LC50, TD50 and therapeutic index. Delivery of the toxicant, mechanisms involved in formation of ultimate toxicant, detoxification of ultimate toxicant.				**08**
Unit III	**Xenobiotics and toxic agents** Absorption, Distribution, Excretion and Metabolism of xenobiotics (biotransformation, Phase- I reactions including oxidations, hydrolysis,				**08**
Unit IV	Reductions and phase II conjugation reactions).Toxic insult to liver, its susceptibility to toxicants with reference to any two hepatotoxicants.Human exposure, mechanism of action and resultant toxicities of the following xenobiotics: Metals: lead, arsenic, Pesticides: organophosphates, carbamates, organochlorine, bipyridyl compounds and anticoagulant pesticides.				**08**
Unit V	**co-toxicology and Clinical toxicology** Brief introduction to avian and aquatic toxicology, movement and effect of toxic compounds in food chain (DDT, mercury), bioaccumulation, biomagnification, acid rain and its effect on ecosystems, concept of BOD and COD. Management of poisoned patients, clinical methods to decrease absorption and enhance excretion of toxicants from the body use of antidotes.				**08**
Course code	**GBT-451**				**CR.**
Course title	**Toxicology Lab.**				**2.0**

PRACTICALS (Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Separation of a mixture of benzoic acid, beta- napthol and napthelene by solvent extraction and identification of their functional Groups.
2. Determination of Dissolved oxygen (DO) using Winkler's method.
3. Determination of Biological oxygen demand (BOD) of water.
4. To perform quantitative estimation of residual chlorine in water samples.
5. To determine the total hardness of water by complexo-metric method using EDTA.
6. To determine acid value of the given oil sample.
7. To estimate formaldehyde content of given sample.
8. Calculation of LD50 value of an insecticide from the data provided.
9. Determination of COD (chemical oxygen demand) of the given water sample.

References

.

1. Cassarett and Doull's Toxicology "The Basic Science of The Poisons" 7th edition (2008), Curtis D. Klaassen Editor, McGrawHill Medical. ISBN: 9780071470513.
2. Cassarett and Doull's "Essentials of Toxicology" 2nd edition (2010), Klaassen and Whatkins, McGraw Hill Publisher. ISBN-13: 978-0071622400.
3. Introduction to Toxicology, 3rd edition (2001), John Timbrell, Taylor and Francis Publishers. ISBN 13: 9780415247627.
4. Principles of Toxicology, 2nd edition (2006), Stine Karen and Thomas M Brown, CRC press. ISBN-13: 978-0849328565.
5. Lu's basic toxicology: Fundamentals target organ and risk assessment, 5th edition (2009), Frank C Lu and Sam Kacow, Informa Health care. ISBN: 9781420093117.

Course code	**SBM-401**				
Category	Skill Enhancement				
Course title	**Biostatistics**				
Scheme and Credits	**Credit**	**L**	**T**	**P**	
	4	4	0	0	
Pre-requisites (if any)	None				
Objectives	In public health work, one may be concerned with planning of experiments and the analysis of their results. Therefore, one has to deal with statistical data analyses that come from no deliberate experiment but that arise because of the data collected from the population in the course of public health study and survey. This course therefore provides training to the students on how to conduct epidemiological surveys, design questionnaire and analyze the data. The students will get hands-on-training on 'R', a free software environment for statistical computing and graphics.				
Outcomes	After the completion of this course students would be able to: 1. use and interpret results of, descriptive statistical methods effectively. 2. Explain the principal methods of statistical inference and design. **3.** Read and learn new statistical procedures independently.				
Unit I	**Descriptive Statistics** Data in Biology: Development in biostatistics, samples and populations, techniques of sampling (random and stratified), sampling and non-sampling errors, variables in biology, accuracy, precision, univariate and bivariate frequency distributions and their graphical representations. Measures of Central Tendency: Arithmetic means, mode, median and partition values.				**08**
Unit II	**Measures of Dispersion**: Range, standard deviation, coefficient of variance and covariance. Moments: Raw and central moments and their relationships. Measures of Skewness: Pearson‟s and Bowley‟s coefficients of skewness, Measures of Kurtosis.				**08**
Unit III	**Correlation Analysis:** Pearson‟s and Spearman‟s coefficients of correlation, coefficient of determination, standard and probable errors.				**08**
Unit IV	**Regression Analysis:** Method of least squares, equations of lines of regression and their applications in biostatistics.				**08**
Unit V	**Probability and Probability Distributions** Probability: Basic concepts, addition and multiplication rules of probability, conditional probability, Bayes‟ theorem and its applications in biostatistics.				**08**
References	. Cassarett and Doull‟s Toxicology "The Basic Science of The Poisons" 7th edition (2008), Curtis D. Klaassen Editor, McGrawHill Medical. ISBN: 9780071470513. 2. Cassarett and Doull‟s "Essentials of Toxicology" 2nd edition (2010), Klaassen and Whatkins, McGraw Hill Publisher. ISBN-13: 978-0071622400. 3. Introduction to Toxicology, 3rd edition (2001), John Timbrell, Taylor and Francis Publishers. ISBN 13: 9780415247627. 1. Principles of Toxicology, 2nd edition (2006), Stine Karen and Thomas M Brown, CRC press. ISBN-13: 978-0849328565. 2. Lu‟s basic toxicology: Fundamentals target organ and risk assessment, 5th edition (2009), Frank C Lu and Sam Kacow, Informa Health care. ISBN: 9781420093117.				

Course code	**BBM-501**				
Category	Core Course				
Course title	**Medicinal Chemistry**				
Scheme and Credits	**Credit**	**L**	**T**	**P**	
	4	4	0	0	
Pre-requisites (if any)	None				
Objectives	The course highlights the importance of Medicinal Chemistry in all our lives and the fascination of working in a field that overlaps the disciples of chemistry, biology, biochemistry, pharmacology etc. It gives brief understanding about drug-receptor interactions, lead discovery, drug design and molecular mechanism by which drug act in the body. The course emphasizes on various drug targets in the body and drug development strategies with mechanism of action of antibacterial agents and concept of drug resistance.				
Outcomes	**completion of this course will be helpful in** 1. Correlating between pharmacology of a disease and its mitigation or cure. 2. Understanding the drug metabolic pathways, adverse effect and therapeutic value of drugs 3. Knowing the structural activity relationship of different class of drugs. 4. Well acquainted with the synthesis of some important class of drugs. **5.** Knowledge about the mechanism pathways of different class of medicinal compounds. 6. To understand the chemistry of drugs with respect to their pharmacological activity.				
Unit I	**Drug discovery and drug development** Introduction to drug discovery and development; Identification of disease, drug target, bioassay; methods of screening of lead compounds; isolation and purification; structure determination; structure-activity relationships; pharmacophore identification; target oriented drug design; pharmacokinetic drug design; drug metabolism; toxicity testing; clinical trials; patents.				**08**
Unit II	**Drug targets and action/Pharmacodynamics** Drug targets and actions on lipids and carbohydrates; drug actions on proteins – Structure of proteins, drug action at proteins, peptides and proteins as drugs; drug actions on enzymes- Enzymes as catalysts, types of drug binding at active site, enzyme kinetics of drugs interaction, medicinal uses of enzyme inhibitors; drug action at receptors- Role of receptors, conformational changes in receptors, design of agonists and antagonists, partial agonists, inverse agonists, desensitization and sensitization; drug actions on nucleic acids- Nucleic acids structure, drugs acting on DNA and RNA.				**08**
Unit III	**Drug targets and action/Pharmacokinetics** Drug distribution and survival; pharmacokinetic issues in drug design; drug dose levels; solubility, membrane permeability, hydrolysis and metabolism in drug design; Prodrugs and its importance in drug design; Routes of drug administration; Synergism in drug design.				**08**
Unit IV	**Molecular Modelling** Quantitative structure activity relationships – Graphs and equations, physicochemical properties, Hansch equation, Craig plot, Topliss Scheme, Bioisosteres, 3D QSAR; Combinatorial synthesis – drug optimization and drug discovery, Methods of combinatorial synthesis – Solid phase techniques, parallel synthesis techniques, mixed combinatorial synthesis techniques, deconvolution, methods of structure determination of active compounds, planning and designing a combinatorial synthesis, activity testing, limitations.				**08**
Unit V	**Computing in drug design** Molecular and quantum mechanics; drawing and viewing chemical structures; 3D structures; Energy minimization; Molecular dimensions and properties; Conformational analysis; Structure comparisons and identification of active conformations; Pharmacophore identification; Docking techniques; Databases screening and handling for lead compounds; Receptor mapping; *De Novo* designing; Case study..				**08**

Course Title	**BBM-551**	**CR.**
Course title	**Medicinal Chemistry Lab.**	**2.0**

PRACTICALS (Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Preparation of Benzocaine.
2. Preparation of Benzoquinone.
3. Preparation of Aspirin and determination of partition coefficient in octanol-water system.
4. Preparation of Paracetamol.
5. Preparation of Phenacetin.
6. Preparation of Hippuric acid.
7. Preparation of s-benzyl thiouronium salt.
8. Extraction of caffeine from tea leaves and study its absorption properties.
9. Phytochemical screening and qualitative chemical examination of various plant constituents by Solvent extraction. (Detection of alkaloids, carbohydrates, glycosides, phytosterols, oils and fats, tannins, proteins, gums and mucilages).

References	1. Introduction to Medicinal Chemistry, 4th edition (2009), Graham l. Patrick, Oxford University Press. ISBN-13: 978-0199234479. 2. The Organic Chemistry of Drug Design and Drug Action, 2nd edition (2004), Richard B. Silvermann, Elsevier, Academic Press. ISBN-13: 978-0126437324. 3. Medicinal Chemistry: A Molecular and Biochemical Approach, 3rd edition (2005), Thomas Nogrady and Donal F. Weaver, Oxford University Press. ISBN-13: 978-0195104561.

Course code	**BBM-502**				
Category	Core Courses				
Course title	**Medical Biotechnology**				
Scheme and Credits	**Credit**	**L**	**T**	**P**	
	4	4	0	0	
Pre-requisites (if any)	None				
Objectives	The unique preposition of this paper is that the students learn the basic techniques and methods used in the diagnosis and therapy of various human diseases and in the production of biopharmaceuticals. The concepts of cloning and expression of the desired gene is explored. This paper aims to train students to understand how biological systems are applied in the advancement of medical biotechnology				
Outcomes	By the end of the course the student will be able to: 1. Develop an understanding of the Cytoskeleton and Cell Membrane. 2. Discuss the structure of Microtubules, microfilaments. **3.** Understand infections caused by different bacteria and viruses.				
Unit I	**Introduction to Medical Biotechnology** Brief history and Importance, Agarose gel electrophoresis, Southern and Western blotting and hybridization, use of enzymatic and chemiluminiscent methods for detection of proteins, preparation of labeled probes.				**08**
Unit II	**Manipulation of DNA and Cloning Vectors** Isolation and purification of genomic and plasmid DNA, Restriction and modification systems, type I-IV restriction endonucleases, nomenclature and sequence recognition, restriction mapping. Joining of DNA molecules: role of DNA ligase, adaptors, linkers, homopolymer tailing , Basic biology of plasmids, Plasmid vectors (pBR322 and pUC vectors, T-vectors) and phage vectors (Bacteriophage vectors- replacement and insertion vectors), cosmids, in vitro packaging, expression vectors, example of prokaryotic and eukaryotic expression vectors, inducible and constitutive expression vectors with one example each.				**08**
Unit III	**Cloning and expression of cloned genes in prokaryotic and eukaryotic Cells** Challenges in expression of foreign proteins in heterologous host, factors affecting the expression host cell physiology, promoters, codon choice, plasmid copy no. etc., expression in eukaryotic cells (yeast), Shuttle vectors, Bacterial transformation and selection and screening of transformants (blue/white and antibiotic selection methods). Principle and applications, primer-design, detailed understanding of PCR and RT- (Reverse transcription) PCR.				**08**
Unit IV	**Construction of genomic and cDNA libraries, screening and selection of recombinants** Immunochemical methods of screening, nucleic acid hybridization (Colony and Plaque hybridization), different methods of preparation of gene probe. Hybrid Release Translation and Hybrid Arrest Translation. Methods in Random mutagenesis: any two, methods in Site-directed mutagenesis: oilgonucleotide-directed mutagenesis, PCR-based method, screening and identification of mutants. Protein engineering concept and examples of Subtilisin, and alpha-Antitrypsin (AAT)				**08**
Unit V	**Application of Medical Biotechnology** (a) Production of recombinant biomolecules: Insulin, somatostatin, Factor VIII and interferons. (b) DNA Profiling: Introduction, DNA profiling based on STRs, minisatellites, RFLP, AFLP, VNTRs, SNPs and their applications. (c) Gene Therapy: Strategies and limitations, somatic and germline gene therapy, different vectors (viral and non viral) and their comparison, treatment for genetic and infectious diseases.				**08**
Course code	**BBM-552**				

Course title	Medical Biotechnology	
PRACTICALS (Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.) 1. To understand the method of digesting DNA with different restriction enzymes. 2. To maintain and store the E.coli DH5 alpha cells. . Preparation of Competent Cell (Calcium Chloride Treatment). 4. To prepare insert and vector for ligation. 5. To perform ligation reaction using T4 DNA ligase. 6. Transform competent bacterial cells with foreign DNA. 7. To identify recombinants by blue-white screening and PCR.		
References	1. Gene cloning and DNA analysis, 6th edition (2010), T.A. Brown. Wiley-Blackwell ISBN-13: 978-1405181730. 2. Principles of Gene Manipulation and Genomics, 7th edition (2006), S.B. Primrose and R.M. Twyman. Blackwell Scientific ISBN: 978-1405135443. 3. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th edition (2009),Bernard R. Glick, Jack J. Paternack, Cheryl I. Patten. ASM press, ISBN13:9781555814984. 4. DNA Replication, 2nd edition (1992), Arthur Kornberg; University Science Books, ISBN -13:978- 0716720034. 5. Genomics: The Science and Technology behind the Human Genome Project, 1st edition (1999), Cantor and Smith; John Wiley and Sons, ISBN-13:978-0471599081. 6. Molecular Cloning: A Laboratory Manual, 4th edition (2012), Three-volume set by Michael R. Green, Joseph Sambrook; Cold Spring Harbor Laboratory Press, ISBN-13: 978-1936113422.	

Course code	**BMD-501**					
Category	**Department Specific Elective**					
Course title	**Pharmacology**					
Scheme and Credits	**Credit**	**L**	**T**	**P**		
	4	4	0	0		
Pre-requisites (if any)	Medicinal Chemistry and Medical Biotechnology					
Objectives	Pharmacology is the science concerned with the study of drugs and how they can best be used in the treatment of disease in both humans and animals. The course starts with the general considerations and lead to understanding of various drugs acting on different body systems. It is a very important biomedical discipline, with roots both in basic biology and chemistry, and plays a vital role in helping to safeguard our health and welfare.					
Outcomes	By the end of this course, each student should be able to: 1. Identify the fundamental principles of pharmacokinetics and pharmacodynamics. 2. Apply the pharmacodynamic and pharmacokinetic principles that describe drug actions in humans. 3. Compare and contrast the specific pharmacology of the major classes of drugs, important distinctions among members of each class, the risks and benefits, in relation to the organ systems they affect, and the diseases for which they are used therapeutically. 4. Identify the role of molecular genetics and genomic principles in pharmacotherapeutics and drug development.					
Unit I	**General Pharmacology** Nature and Source of drugs, Routes of drug administration and their advantages, receptor and receptor subtypes.					**08**
Unit II	**Pharmacokinetics and Pharmacodynamics** Drug absorption, distribution, metabolism, and excretion, bioavailability, First Pass metabolism, excretion and kinetics of elimination, Bioavailability, Biological half life of drug and its significance, Drug-drug interactions. Principles and mechanism of drug action,Factors affecting drug action. General considerations, pharmacological classification, mechanism of action and uses of following classes of drugs acting on various systems.					**08**
Unit III	**Drugs acting on CNS** (a) Mechanism of General anaesthesia, Stages of anaesthesia, General anaesthetics (Nitric oxide, halothane), (b) Principles of hypnosis and sedatives: sedative and hypnotics drugs (Phenobarbitone, diazepam), (c) Opioid analgesics (Morphine) (d) CNS stimulants (strychnine, amphetamine).					**08**
Unit IV	**Autocoids and anti-microbial agents** Drug therapy of inflammation, NSAID and other drugs (aspirin, celecoxib). Antibacterial (sulfonamides), antifungal (amphotericin B).					**08**
Unit V	**Hormones and hormone antagonists** Insulin and oral hypoglycaemic agent (tolbutamide, rosiglitazone), thyroid and anti-thyroid drugs (eltroxin, carbimazole), estrogen and progestins (progesterone, hydroxyprogesteronecaproate).					**08**
Course Code	**BMD-551**					**CR.**
Course title	**Pharmacology**					**2.0**
	PRACTICALS (Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.) 1. Handling of laboratory animals. 2. Routes of drug administration (Oral, I.M.)					

	3. To study the presence of acetaminophen in given sample. 4. To study the stages of general anesthesia. 5. To determine partition coefficient of general anesthetics. 6. Effect of analgesic (Tail-flick test). 7. Anti-anxiety effect of valium (Plus maze test). 8. Fixing of organ bath and kymograph. 9. To record CRC of acetylcholine using guinea pig ileum / rat intestine. 10. Determination of dose ratio. 11. Study of competitive antagonism using acetylcholine and atropine.	
References	1. Essentials of Medical Pharmacology, 7th edition (2010), K.D. Tripathi, Jaypee Brothers, ISBN: 9788184480856. 2. Pharmacology, 7th edition (2011), H.P. Rang, M.M. Dale, J.M. Ritter and P.K. Moore, Churchill Livingstone. ISBN: 9780702045042. 3. Hand book of Experimental Pharmacology, 4th edition (2012), S.K. Kulkarni, Vallabh Prakashan, 2012. ISBN 13: 9788185731124. .	

Course code	**BMD-502**				
Category	**Department Specific Elective**				
Course title	Radiation Biology				
Scheme and Credits	**Credit**	**L**	**T**	**P**	
	4	4	0	0	
Pre-requisites (if any)	Cell Biology				
Objectives	Biology is essentially the study of life in all of its varied forms. Because cells are the 'basic unit of life', the study of cells can be considered one of the most important areas of biological research. This course will provide information about cells, including their composition, their function and cell-cycle checkpoints. The module on radiation biology will help to explore and gain insight into radiation-induced biological responses at molecular, cellular and tissue levels.				
Outcomes	**End of this course students would be able to:** 1. Describe direct and indirect interactions between radiation and cells. 2. Describe the molecular basis of cellular radiosensitivity. 3. Explain the influence of cell cycle, repair, repopulation and reoxygenation on tissue radiosensitivity. 4. Describe the components of a cell survival curve. 5. Given clinical data, draw a cell survival curve. 6. Differentiate between cell survival curves of varying LET radiations, hypoxic and aerated cells as well as cell cycle phases. 7. Identify the acute and late effects of radiation on living tissue. 8. Describe the effects of whole body radiation. 9. Describe the long term effects of radiation. 10. Explain the effects of radiation on the developing embryo and fetus at each stage. 11. Explain the effects of time, dose and fractionation on long term side effects and treatment effectiveness. **12.** Describe the relationship between LET, RBE and OER.				
Unit I	**Basic principles of electromagnetic radiation :** Energy, wavelength, wave numbers and frequency, review of electronic structure of molecules.				**08**
Unit II	**Introduction of radiation biology :** Basic concept of radioisotopes, types of radioactive decay (gamma and beta emitter), half-life, detection and measurement of radioactivity methods based upon ionization (GM counter), methods based upon excitation (scintillation counter). Use of radioisotopes in cell biology in understanding of DNA replication (bidirectional and theta replication), transcription (labeling of RNA) and labeling of protein using labeled amino acid. Use of radioisotopes in biology: Autoradiography, radioisotopes in diagnosis (thyroid disorders, cancer) and therapy (radiotherapy). Effect of radiations (ionizing and non-ionizing) on living systems, radiation induced damage to cell (chromosome and DNA damage), precautions and safety measures in handling radioisotopes.				**08**
Unit III	**Techniques in Radiation Biology** UV-visible spectrophotometry: Beer Lambert law, light absorption and its transmittance, factors affecting absorption properties of a chromophore, structural analyses of DNA/ protein using absorption of UV light.**,** Fluorescence spectroscopy: Theory of fluorescence, static and dynamic quenching, resonance energy transfer, fluorescent probes in the study of protein and nucleic acids.				**08**
Unit IV	Optical rotatory dispersion and Circular dichroism: Principle of ORD and CD, analysis of secondary structure of proteins (denatured and native form) and nucleic acids using CD. Infra-red spectroscopy: Theory of IR, identification of				**08**

	exchangeable hydrogen, number of hydrogen bonds, tautomeric forms.	
Unit V	**Magnetic resonance spectroscopy and X-ray crystallography** Basic theory of NMR, chemical shift, medical applications of NMR. Mass spectrometry (MALDI-TOF): Physical basis and uses of MS in the analysis of proteins/ nucleic acids.: Diffraction,Bragg‟s law and electron density maps (concept of R-factor and B-factor), growing of crystals (Hanging drop method).	**08**
Course Code	**BMD-502**	**CR.**
Course title	Radiation Biology Lab.	**2.0**

PRACTICALS (Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Microscopy- Theoretical knowledge of Light and Electron microscope.
2. To study the following techniques through electron/ photomicrographs: fluorescence microscopy, autoradiography, positive staining, negative staining, freeze fracture, freeze etching shadow casting, endocytosis and phagocytosis.
3. To explain mitosis and meiosis using permanent slides.
4. To cytochemically demonstrate presence of proteins in cheek cells or onion peel using mercuric bromophenol blue or fast green.
5. To cytochemically demonstrate presence of carbohydrates in cheek cells or onion peel using periodic acid Schiff's reagent.
6. To cytochemically demonstrate presence of DNA in cheek cells or onion peel using Feulgen reagent.
7. To study the effect of isotonic, hypotonic and hypertonic solutions on cells.
8. To prepare polytene chromosomes.

References

1. The Cell: A Molecular Approach, 5th edition (2009), Cooper and Hausman. Sinauer Associates, Inc. ISBN-13: 978-0878933976.
2. Cell and Molecular Biology: Concepts and Experiments, 6th edition (2009), Gerald Karp, Wiley. ISBN-978-0470483374.
3. Physical Biochemistry: Applications to Biochemistry and Molecular Biology, David Freifelder, 2nd edition (1983), W. H. Freeman and Company. ISBN: 0716714442 / 0-7167-1444-2.
4. An Introduction to Radiobiology, 2nd edition (1998), A. H. W. Nias, Wiley Blackwell, ISBN13: 978-0471975908.
5. The World of the Cell, 7th edition (2008), Becker, Kleinsmith, Hardin and Bertoni. Benjamin Cummings, ISBN-13: 978-0805393934.
6. The Cell: A Molecular Approach, 6th edition (2013), Cooper and Hausman; Sinauer Associates, Inc. ISBN-13:978-1605351551.
7. Essential Cell Biology, 7th edition (2009), Alberts, Bray, Hopkin, Johnson, Lewis, Raff, Roberts and Walter. Garland Science. ISBN-13:978-0815341291. 8. Molecular Cell Biology, 7th edition (2012), Lodish, Berk, Kaiser, Krieger, Bretscher, Ploegh, Amon and Scott. W. H. Freeman. ISBN-13: 978-1429234139.
.

Course code	**BBM-601**				
Category	Core Biomedical				
Course title	Hospital Management				
Scheme and Credits	**Credit**	**L**	**T**	**P**	
	4	4	0	0	
Pre-requisites (if any)	None				
Objectives	The main focus of this programme is to promote professional management practices that are necessary for effective healthcare ensuring continuous quality improvement, labour relations, financial sustainability, awareness creation, demand generation, optimum utilization of limited available resources and strategic approach towards inflation, rapid advancement in medical technology, increased expectations of staff and patients.				
Outcomes	In the end of this course students would be able to: 1. Understand the need and importance of cost effective sustainable healthcare through demand generation and enhanced quality care 2. Develop and apply various employee friendly systems for effective functioning of different administrative activities and support services of hospital 3. Promote patient centred care with a continuous quality improvement orientation ensure smooth functioning of core process by forecasting, streamlining patient flow, staff scheduling, planning space/ facilities/ supplies, maintenance, etc. 4. Ensure optimum tilization of available limited resources. 5. Sharpen managerial skills. **6.** Have an appreciation on the use of information technology in the hospital				
Unit I	**Organization Of the Hospital:** Organizational structure, governance, duties and responsibility of governing board, management structure, Management process and functions, nature of management process and managerial functions planning, organizing, staffing, directing, coordinating and controlling, Application of managerial functions to health care organizations.				**08**
Unit II	**Planning Administrative services:** Financial management, Hospital information system, Human resources department, Public relations department, nursing service administration.				**08**
Unit III	**Planning medical services:** Outpatient Services, Emergency Services, Clinical laboratory, radiological services, Diagnostic services, Radio therapy department, Nuclear medicine, surgical department, labour and delivery suites, Physical medicine and rehabilitation, speech and hearing.				**08**
Unit IV	**Training And Management Of Technical Staff In Hospital** : Difference between hospital and industrial organization, levels of training, steps of training, developing training program, evaluation of training, wages and salary, employee appraisal method.				**08**
Unit V	**Standard Codes and Uses of Computer in patient care:** Necessity for standardization, FDA, Joint Commission of Accreditation of hospitals, ICRP and other standard organization, methods to monitor the standards.Computer application in Different departments like X-Ray department, laboratory administration, ICU, patient data, medical records, communication, and simulation				**08**
Course Code	**BBM-651**				**CR.**
Course title	Hospital Management Case Studies				**2.0**

PRACTICALS : (Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.) 1. Operational Improvement and Increased Patient Satisfaction at An Urgent Care Center 2. Organizational Transformation at A Pediatric Emergency Department 3. Integrated Acute Care Lays the Groundwork for Sepsis Bundle Compliance 4. Inpatient Throughput Improvements 5. Hospitalist Impact on Patient Throughput 6. Improving ED Patient Throughput and Achieving Sustainable Outcomes 7. Practice Reduces Door-to-Provider Time, Increases Patient Satisfaction **8.** Implementing the "Comfort Zone" Leads to 97th Percentile Patient Satisfaction	
References	Webster J.C. and Albert M.Cook, "*Clinical Engineering Principle and practice*", Prentice Hall Inc., Englewood Cliffs, New Jersey, 1979. Goyal R.C., **"*Handbook of hospital personal management*"**, Prentice Hall of India, 1996. Kunders GD, Gopinath S and Katakam Asoka ," ***Hospitals Planning , Design and Management****"* Tata McGraw Hill Publishing Company Limited New Delhi. .

Course code	**BMD-601**				
Category	Department Specific Elective				
Course title	Medical Ethics				
Scheme and Credits	**Credit**	**L**	**T**	**P**	
	4	4	0	0	
Pre-requisites (if any)	None				
Objectives	The recent advances in the field of biotechnology have brought into focus several safety and ethical issues. The inventions in the field of genetic engineering and related fields of molecular biology not only affect us but also the plants, microorganisms, animals and the entire environment and the way we practice agriculture, medicine and food processing. An increase in our ability to change life forms in recent years has given rise to the new science of bioethics. The present course focus on the biosafety and bioethical issues the modern society confronts. Topics such as biosafety levels, GM food debate, impact of biotechnology on biosafety, biotech products and ethical issues, governance of biosafety, environmentally responsible use of biotechnology, clinical ethics will be discussed in the curriculum.				
Outcomes	This course will 1. provide students with the research competencies required to work as professional scholars in bioethics 2. train students in examining and analyzing the salient topics of contemporary healthcare ethics, especially regarding their normative, global and religious dimensions 3. provide students with clinical experience through rotations in various clinical settings **4.** assist student in writing a practical project that qualifies for the professional doctorate				
Unit I	Technology, Engineering, and Economics, Engineering Competence, Engineering, Integrated and Specialized, Systematics, Incorporating Ethics into the Design Process, Major Bioethical Areas				**08**
Unit II	Human Enhancement, Organ Transplantation, Responsible Conduct of Human Research, Animal Testing, Genetically Modified Organisms, Environmental Health				**08**

Unit III	The Ethics of Scale and the Scale of Ethics Temporal Aspects of Bioethical Decisions. opinion and thought of Engineers,	**08**
Unit IV	Improvement *versus* Enhancement, Moral Coherence, Creativity and Bioethics, The Ethical Quandary of Enhancement, Scientific Dissent, Codes of Ethics,	**08**
Unit V	Bioethical Research and Technological Development, Bioethical Success and Failure, Justice and Fairness as Biomedical and Bio-system Engineering Concepts, Sustainable Bioethics, Engineering Wisdom, Practical Bioethics.	**08**
Course code	**BMD-651**	**CR.**
Course title	Medical Ethics Case Studies	**2.0**

PRACTICALS (Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. A case study based on genetic modified organism (Bt-Cotton).
2. A case study based on genetic modified organism (Bt-Brinjal).
3. A case study based on terminator seeds.
4. A case study based on removal of selective marker in a DNA vaccine.
5. A case study on clinical trials of drugs in India with emphasis on ethical issues.
6. A case study on women health ethics.
7. A case study on medical errors and negligence.
8. A case study on critical care ethics.
9. A case study on ethical issues in clinical practice of AIDS.
10. A case study on handling and disposal of radioactive waste.

References

.1. Bioethics and Biosafety, 1st edition (2008), M. K Sateesh, I K International Pvt Ltd, ISBN13: 978-8190675703.

2. The Cambridge Textbook of Bioethics, 1st edition (2008), Peter A. Singer and A. M. Viens; Cambridge University Press, ISBN-13: 978-0511545566.

3. Foundation of Bioethics, 2nd edition (1996), E. H Tristram; Oxford University Press, ISBN13: 9780195057362.

4. Social science: An introduction to the study of society, 14th edition (2010), Hunt, E. F.,and Colander, D. C. ; Peason/Allyn and Bacon, Boston, ISBN-13: 978-020570271.

5. Principles of Biomedical Ethics, 6th edition (2011), Beauchamp Tl, Childress JF; Oxford University Press, 2001. ISBN-13: 978-0195143317.

6. A Companion to Bioethics, 2nd edition (2012), Helga Kuhse, Peter Singer; John Wiley and Sons, ISBN-13: 978-1444350845.

7. Bioethics: An Introduction to the History, Methods, and Practice, 1st edition (1997), Nancy Ann Silbergeld Jecker, Albert R. Jonsen, Robert A. Pearlman; Jones and Bartlett Learning, ISBN-13: 978-0763702281.

8. Genetically Modified Organisms and biosafety, 1st edition (2004), Tomme Young. ISBN13: 978-2831707983.

9. Environmental Safety of Genetically Engineered Crops, 1st edition (2011), Rebecca Grumet, James F. Hancock, Karim M. Maredia, CholaniWeebadde, Michigan State University Press ISBN-13: 978-1611860085.

10. Biosafety and Bioethics, 1st edition (2006), Rajmohan Joshi; Isha Books ISBN-13: 978-8182053779.

11. Bioethics and biosafety in biotechnology, 1st edition (2007), V. Sreekrishna; New Age International (P) Ltd., ISBN-13: 978-8122420852.

Course code	**BMD-602**				
Category	Department Specific Elective				
Course title	IPR				
Scheme and Credits	**Credit**	**L**	**T**	**P**	
	4	4	0	0	
Pre-requisites (if any)	None				
Objectives	Developments in the recent years has increased the knowledge acquisition process which is considered to have commercial value as well. The knowledge pool so generated can be considered as intellectual property which has grown tremendously in academic community and society at large. The pace with which our modern science is progressing today, various new and useful inventions take place. Through this paper, students are made aware to understand the need for creation, protection, and commercialization of intellectual property in the area. Various forms of Intellectual Property Rights are also explained. Paper also deals with the entire process of patent filling, taking some case studies.				
Outcomes	The students once they complete their academic projects, they get awareness of acquiring the patent and copyright for their innovative works. They also get the knowledge of plagiarism in their innovations which can be questioned legally.				
Unit I	Introduction: meaning of property, origin, nature, meaning of intellectual property rights, provision of ipr under trips and wto. Kinds of intellectual property rights— copy right, patent, trade mark, trade secret and trade dress, design, layout design, geographical indication, plant varieties and traditional knowledge				**08**
Unit II	Patent rights and copy rights— origin, meaning of patent, types, inventions which are not patentable, registration procedure, rights and duties of patentee, assignment and licence , restoration of lapsed patents, surrender and revocation of patents, infringement, remedies & penalties. Copy right—origin, definition &types of copy right, registration procedure, assignment & licence, terms of copy right, infringement, remedies, copy rights with special reference to software.				**08**
Unit III	Trade marks — origin, meaning & nature of trade marks, types, registration of trade marks, infringement & remedies, offences relating to trade marks, passing off, penalties.				**08**
Unit IV	Intellectual property commercialization and technology transfer: licensing, biomedical business models and ip management strategies international convention related to intellectual property, establishment of wipo, mission and activities,				**08**
Unit V	Indian position vs wto and strategies, indian ipr legislations, commitments to wto-patent ordinance and the bill, draft of a national intellectual property policy. Basic tenents of information technology act-2000- cyber crimes, digital signature and e-commerce.				**08**
Course Code	BMD-652				**CR.**
Course title	IPR Case Studies				**2.0**

PRACTICALS (Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Basmati Rice Patent Case
2. Turmeric patent case
3. What Makes An Invention Patentable?
4. And other useful recent patent case studies..

References	.1. Prabuddha Ganguli – Intellectual property rights : unleashing the knowledge economy, Tata McGraw Hill Publishing. 2. Wadhera, Intellectual property Rights. 3. Patent law / by P Narayanan (Highly Recommended) 4. Selected Reading from Landis 5. The Patents Act (1970), with latest Amendments. 6. Manual of patent practice and procedure: Indian patent office website.