

DELHI TECHNOLOGICAL UNIVERSITY
SCHEME OF TEACHING AND EVALUATION
MASTER OF TECHNOLOGY IN BIOMEDICAL ENGINEERING (BME)

The following alphanumeric coding scheme has been adopted

Core Courses XXXYMN

Elective Courses XXXYCMN

XXX abbreviates a particular M. Tech. program, Y – (5 for M. Tech. 1 st year, 6 for M. Tech. 2 nd year),

C – credit of the course (4/3/2),

MN – Subject code (Odd number for odd semester and even number for even semester courses)

Semester-I														
	S. No.	Course Code	Course Name	Type/ Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE	Total Credits
Group A	1	BME501	Human Anatomy and Physiology	Core	4	3	0	2	15	25	20	40	-	17
	2	BME503	Biomaterials and Clinical Devices	Core	4	3	0	2	15	25	20	40	-	
Group B	3	BME5401/5403/..... ...	Elective 1	Elective	4	3/4	0	2/0	15/ 20	25 /-	20/30	40/50	-	
	4	BME5301/5303/..... ...	Elective 2	Elective	3	3	0	0	20	0	30	50	-	
	5	BME5201/5203/..... ... /UEC5201/5203/..... ...	Elective 3/ University Elective I	Elective	2	2	0	0	20	-	30	50	-	
Semester-II														

Commented [SR1]: Accordingly syllabi of practicals to be checked

	S. No.	Course Code	Course Name	Type/ Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE	Total Credits	
Group C	1	BME502	Tissue Engineering and Artificial Organs	Core	4	3	0	2	15	25	20	40	-	17	
	2	BME504	Immuno-diagnostics and Therapeutics	Core	4	3	0	2	15	25	20	40	-		
Group D	3	BME5402/5404/..... ...	Elective 4	Elective	4	3/4	0	2/0	15/ 20	25 /-	20/30	40/50	-		
	4	BME5302/5304/..... ...	Elective 5	Elective	3	3	0	0	20	-	30	50	-		
	5	BME5202/5204/..... .../ UEC5202/5204/..... ...	Elective 6/ University Elective II	Elective	2	2	0	0	20	-	30	50	-		
Semester-III															
	S.N o.	Course Code	Course Name	Type/ Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE	Total Credits	
Track 1														12	
Group E	1	BME651	Research Project	Core	12	0	0	1 2	0	-	0	100	0		
	Track 2														
	1	BME601	Major Project I	Core	3							40	60		12

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	2	BME6401/6403/..... ...	Elective 7	Elective	4	3/4	0	2/0	15/ 20	25 /0	20/30	40/50	-	
	3	BME6301/6303/..... ...	Elective 8	Elective	3	3	0/1	2/0	15/ 20	25 /-	20/30	40/50	-	
	4	BME6201/6203/..... ...	Elective 9	Elective	2	2	0	0	20	-	30	50	-	
Semester-IV														
	S.N o.	Course Code	Course Name	Type/ Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE	Total Credits
Group F	Track 1													
	1	BME652	Research Project	Core	12	0	0	2 ¹	0	-	0	100	0	12
	Track 2													
	1	BME602	Major Project II	Core	12	0	0	2 ¹	0	-	0	100	0	12

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LIST OF ELECTIVES :														
	S.No.	Course Code	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE	
Elective 1	1	BME5401	Medical Physics and Biochemistry	Elective	4	3	0	2	15	25	20	40	-	
	2	BME5403	Instrumentation in Biomedical Engineering		4	4	0	0	20	-	30	50	-	
	3	BME5405	Rehabilitation Engineering		4	4	0	0	20	-	30	50	-	
	4	BME5407	Biopolymer Technology		4	4	0	0	20	-	30	50	-	

	S.No.	Course Code	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE
Elective 2	1	BME5301	Nanobiotechnology & Nanomedicine	Elective	3	3	0	0	20	-	30	50	-
	2	BME5303	Infection and Disease		3	3	0	0	20	-	30	50	-
	3	BME5305	Molecular Basis of Metabolic Disorders		3	3	0	0	20	-	30	50	-
	4	BME5307	Pharmacology and Toxicology		3	3	0	0	20	-	30	50	-
	S.No.	Course Code	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE
	1	BME5201	Open Area Seminar I		2	2	0	0		-	100		-
Elective 3	2	BME5203	Advanced Human Genetics	Elective	2	2	0	0	20	-	30	50	-
	3	BME5205	Protein Engineering		2	2	0	0	20	-	30	50	-
	4	BME5207	Biosensors		2	2	0	0	20	-	30	50	
	S.No.	Course Code	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE
Elective 4	1	BME5402	Biophysical Signal and System Simulations	Elective	4	3	0	2	15	25	20	40	-
	2	BME5404	OMICS in Medicine		4	4	0	0	20	-	30	50	-
	3	BME5406	Image Processing in Medicine		4	4	0	0	20	-	30	50	-
	4	BME5408	Industrial Biotechnology		4	4	0	0	20	-	30	50	-

	S.No.	Course Code	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE
Elective 5	1	BME5302	Minor Project-1	Elective	3					-	40	60	-
	2	BME5304	Neurobiology		3	3	0	0	20	-	30	50	-
	3	BME5306	Oncology		3	3	0	0	20	-	30	50	-
	4	BME5308	Drug Design and Development		3	3	0	0	20		30	50	
	S.No.	Course Code	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE
Elective 6	1	BME5202	Microarray Technology	Elective	2	2	0	0	20	-	30	50	-
	2	BME5204	Genetic Manipulation in Medicine		2	2	0	0	20	-	30	50	-
	3	BME5206	Hospital Management		2	2	0	0	20	-	30	50	-
	4	BME5208	Open Area Seminar II		2	2	0	0			100		-
	S.No.	Course Code	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE
Elective 7	1	BME6401	Bioinformatics	Elective	4	3	0	2	15	25	20	40	-
	2	BME6403	Biopharmaceuticals		4	4	0	0	20	-	30	50	-

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	3	BME6405	Biostatistics		4	4	0	0	20	-	30	50	-
	4	BME6407	Molecular and Cellular Biophysics		4	4	0	0	20	-	30	50	-
	S.No.	Course Code	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE
Elective 8	1	BME6301	Bioethics and IPR	Elective	3	3	0	0	20	-	30	50	-
	2	BME6303	Population Genetics		3	3	0	0	20	-	30	50	-
	3	BME6305	Artificial Intelligence		3	3	0	0	20	-	30	50	-
	4	BME6307	Research Methodology		3	3	0	0	20	-	30	50	-
		S.No.	Course Code	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE
Elective 9	1	BME6201	Gene Therapy	Elective	2	2	0	0	20	-	30	50	-
	2	BME6203	Entrepreneurship		2	2	0	0	20	-	30	50	-
	3	BME6205	Biomechanics		2	2	0	0	20	-	30	50	-
	4	BME6207	Alternative Medicine		2	2	0	0	20	-	30	50	-

SEMESTER I	
Courses	
BME501	Human Anatomy and Physiology
<p>Introduction of Structure and function of cell and cellular components; Membrane Potential; Overview of Immune system. Anatomy of physiological systems(I): Cardiovascular system; Nervous System; Nervous control of Heart. Anatomy of physiological systems(II): Musculo Skeletal System; Respiratory system; Regulation of Respiration; Artificial respiration. Overview of physiological systems:Gastro Urinal system, Urine Reflex; Skin and Sweat Gland – Temperature regulation. Physiological functions: Optics of Eye; Photochemistry of Vision; Accommodation Neurophysiology of Vision – EOG; Structure and functions Internal Ear - Mechanism of Hearing – Auditory pathway</p> <p>Practicals:</p> <ol style="list-style-type: none"> 1. Study of the human skull, forelimb and hind limb, pectoral and pelvic girdle, ribs 2. Study of the kidney, liver, brain with microscopic analysis 3. Microscopic staining techniques of various organs <p>Suggested Books:</p> <ol style="list-style-type: none"> 1. A. C. Guyton, Textbook of Medical Physiology, Prism Book (p) Ltd. 1996. 2. C. L. Ghai, A textbook of Practical Physiology, 5th Edition. Jaypee Medical Publishers, 2003 3. S. Subramanyam, K. MadhavanKutty and H. D. Singh, Text book of Human Physiology. S. Chand & Company, 1996 	
BME503	Biomaterials and Clinical Devices
<p>Introduction: Definition of biomaterial, history of biomaterial, requirements of biomaterials, classification of biomaterials, Comparison of properties of some common biomaterials. Classic examples of clinical use of biomaterial, Biological host responses to material. Metallic implant materials: Stainless steel, Co-based alloys, Ti and Ti-based alloys. Host tissue reaction with metal, corrosion behavior and the importance of passive films. Hard tissue replacement implant: Orthopedic implants, Dental implants, Percutaneous implants, Soft tissue implant: vascular, facial and heart valve implants. Polymeric implant materials: Classification according to thermosets, thermoplastics and elastomers. Physiochemical characteristics of biopolymers. Ceramic and composite implant materials: Definition of bioceramics. Common types of bioceramics: Aluminium oxides, Glass ceramics, Carbons. Bioresorbable and bioactive</p>	

ceramics. Toxicological screening and mechanical testing of biomaterials: Toxicity tests: acute and chronic toxicity studies (in situ implantation, tissue culture, haemolysis, thrombogenic potential test, systemic toxicity, intracutaneous irritation test), sensitization, carcinogenicity, mutagenicity tests.

Suggested Books:

1. J. D. Bronzino, The Biomedical Engineering Hand Book. Second Edition, CRC Press LLC. 2000
2. J.Y. Wong and J.D. Bronzino, Biomaterials, CRC Press, Taylor and Francis group. 2007.
3. B.D. Ratner, Biomaterials Science-An Introduction to Materials in Medicine, Third Edition. Elsevier press. 2013
4. J. Black, Biological Performance of Materials: Fundamentals of Biocompatibility, Fourth edition. CRC Press, Taylor and Francis group. 2005

BME5401 Medical Physics and Biochemistry

Functions of various cellular constituents: Action potential and its measurements, Hodgkin – Huxley model; Functioning of skeletal muscles; Blood and lymph circulation; Radioisotopes in biology and medicine; Safety handling of radioisotopes. Physics of the lungs and breathing: Physics of breathing mechanism, Surface tension and Laplace law; Airway resistance and determination; Measurement of lung Volumes, spirometer; Physics of some common lung diseases. Physics of the cardiovascular system: Major Components of the Cardiovascular System and its functioning; Physics of fluid movement, Bernoulli's Principle applied to cardiovascular system; Laminar and Turbulent Blood Flow. Biochemistry (I): Biomolecules; Carbohydrates, Structure and properties of mono, di, oligo and polysaccharides; Classification of lipids, phospholipids, steroids, essential fatty acids, prostaglandin. Biochemistry (II): Structure and properties of amino acids, titration curve, proteins, Ramachandran plot; Structure and properties of nucleic acids, denaturation and renaturation kinetics; Vitamins and minerals and associated disorders; Biochemical diagnostic tests and applications.

Practicals:

1. Qualitative estimation of carbohydrates by Molish test
2. Qualitative estimation of reducing sugars by Fehling solutions.
3. To determine presence of starch by Iodine test.
4. Qualitative estimation of aromatic amino acids by Xanthoproteic test
5. To detect the presence of Tyrosine by Millon's test
6. Detection of glycerol by Acrolein test for detection of
7. Estimation of total protein content by Lowry's method
8. To study Spirometer for lung volume measurement and its calculations
9. To study Electrocardiogram (ECG) and its analysis
10. To study Blood pressure measurement

Suggested Books:

1. J.R. Cameron and J.G. Skofronide, Medical Physics, Wiley publication; 1st edition (1978).
2. B.H. Brown, Medical Physics and Biomedical Engineering, IOP Publishing Ltd. (1999).
3. K. Elena, Basics of Medical Physics and Biophysics for electronic education of health professionals, Asklepios, Bratislava (2013).
4. D. L. Nelson and M. M. Cox, Lehninger's Principles of Biochemistry, Third Edition, Macmillan worth Publishers (2008).
5. D. Voet and J.G. Voet, Biochemistry, 4th ed. John Wiley & Sons(2010).

BME5403 Instrumentation in Biomedical Engineering

Clinical instrumentation: Centrifugation techniques, Analytical and Preparative centrifuges, Ultracentrifugation, pH: pH measurement, Microscope: Principle, parts, types and functioning of Microscope, Spectroscopy: UV, Visible, NIR, Spectrofluorometry, Atomic absorption spectrophotometry, Mass Spectrometry, Infrared and Raman Spectroscopy, Nuclear Magnetic Resonance and Electron Spin Resonance spectroscopy techniques. Electrophoretic and chromatographic techniques: Paper electrophoresis, Gel electrophoresis, Immunoelectrophoresis, Isoelectric focussing, Two-dimensional electrophoresis, Capillary electrophoresis; Paper chromatography, TLC, Gas chromatography, Gel filtration chromatography, Ion exchange chromatography, Affinity chromatography, HPLC and FPLC. Basic concept of biomedical instrumentation: Electrodes, transducers, biosensors and their characteristics. Biopotential amplifiers. Biotelemetry. Recording of ECG, EEG, EMG, ERG. Cardiovascular measurements. Measurement of the respiratory system. Analytical instruments in biomedical engineering; oximeter, blood gas analyzer, blood cell counter. Therapeutic & assist devices for cardiovascular system and respiratory system. Physiotherapy devices. Electrosurgical units. Specialized therapeutic and diagnostic equipment: Cardiac pacemakers, heart lung machines, Haemodialysis - design, clinical laboratory instrumentation, Audiometer, Phonocardiogram.

Suggested Books:

1. K. Wilson and J. Walker, Principles and Techniques of Practical Biochemistry, Cambridge University Press, 2010
2. C.R. Cantor and P.R. Schimmel, Biophysical Chemistry: The conformation of Biological Macromolecules. Publisher: W.H. Freeman, 1980.
3. J. G. Webster, "Medical Instrumentation Application and Design", John Wiley and sons, New York, 2009
4. P. Narayanan, Essentials of Biophysics, Publishers: New Age International Publishers, 2000.
5. D.L. Pavia, G.M. Lampman and G. S. Kriz, Introduction to Spectroscopy. Publisher: Brooks Cole, 2009.
6. C. Tanford, Physical Chemistry of Macromolecules. Publisher: John Wiley and Sons Inc, 1961.
7. M. Kutz, Standard Handbook of Biomedical Engineering & Design, McGrawHill Publisher, UK, 2003

BME5405 Rehabilitation Engineering

Introduction to rehabilitation: Rehabilitation acts and legislations, Key entities of Rehabilitation Engineering, Ergonomics: Work related disorders and their solutions, Assistive technologies devices, rehabilitation technology issues, Principles involved in the Assistive technology assessment, Misconceptions in field of assistive technology. Rehabilitation engineering concepts: Rehabilitation Engineering project design, Categories of assistive devices, Engineering concepts in sensory rehabilitation, Engineering concepts in motor rehabilitation, Rehabilitation in communication disorders. Orthopedic prosthetics and orthotics in rehabilitation technology: Upper limb prosthesis, lower limb prosthesis, Intelligent limb prosthesis, Problems in limb prosthesis, Functional Electrical Stimulation system. Sensory augmentation and substitution: Visual System: Visual augmentation, Tactual-Vision substitution, Auditory-Vision substitution; Auditory system: Auditory augmentation, Visual-Auditory substitution, Tactual-Auditory substitution; Tactual system: Tactual augmentation and substitution. Principles of application in rehabilitation engineering technology: Conceptual frameworks; The Provision Process; Education and quality assurance; Future development

Suggested Books:

1. J. D. Bronzino, The Biomedical Engineering Hand Book, Second Edition. CRC Press LLC. 2000.
2. T.Y. Kheng, Rehabilitation Engineering. InTech, Chapters. 2009
3. R.A Cooper, An Introduction to Rehabilitation Engineering, First Edition. CRC Press. 2006
4. R.A Cooper, Rehabilitation Engineering Applied to Mobility and Manipulation, First Edition. CRC Press. 1995

BME5407 Biopolymer Technology

Introduction: Biopolymers produced from various renewable resources, characteristics, merits and demerits over conventional polymers. Biopolymer Technology and Applications: Biopolymers and Artificial Biopolymers in Biomedical Applications, an Overview. Biosynthesis and Modifications: Synthesis and modification of different Biopolymers like xanthum gum. Bioplastic: Different types of bioplastics; Applications of Bioplastics. Material Testing and Analytical Methods: An Overview of Available Testing Methods, Comparison of Test Systems for the examination of the Fermentability of Biodegradable Materials, Structure-Biodegradability Relationship of biopolymers.

Suggested Books:

1. E. Chiellini and H. Gil, Biorelated Polymers: Sustainable Polymer Science and Technology, Springer 2001.
2. R.M. Johnson, L.Y. Mwaikambo and N. Tucker, Biopolymers, Rapra Technology, 2003.

3. N. Kosaric (Ed), Biosurfactants. Marcell Dekker Inc, 1993

BME5301 Nanobiotechnology

Introduction to MEMS: Historical Background; Smart materials and structures- Microsystems and their advantages; General applications in aerospace, automotive industry and health care. Market size and world scenario. Micro machining technology: Lithography- etching- Ion implantation- wafer bonding- Integrated processing- Bulk micro machining- surface micro machining- coating technology and CVD-LIGA process. Principles of microsystems: General principles- Microsensors – Pressure sensors- Actuators- Electrostatic forces- Piezoelectric crystals – Intelligent materials and structures MEMS application in medicine (BioMEMS): Special features / requirements for medical applications. Current scenario of MEMS for health care. Drug delivery systems and MEMS. Application models – Blood pressure sensors – Biochip – Micro needles- Microelectrodes- Neural prosthesis and catheter end sensors. Biomedical nanotechnology: Nanotechnology and biomedicine- Medical applications of Nanotechnology- Drug synthesis and delivery- Nanobiomedicine and diagnostic – Nanofabrication methods – Nanomaterials in human body- Toxicity in nanomaterials.

Suggested Books:

1. M. Madau, Fundamentals of Microfabrication, CRC Press, 2002.
2. M. Gad-el-Hak, The MEMS Handbook, CRC Press, 2002.
3. T. R. Hsu, MEMS & Microsystem, Design and manufacture, McGraw Hill, 2002.
4. N. Malsch, Biomedical Nanotechnology, CRC Press, 2005.

BME5303 Infection and Disease

Immune pathogenic interactions: Host parasite interactions; Innate and acquired immunity, Toll like receptors; first line of defence; T cell and B cell mediated immune response. Parasitology: Virulence factors in parasites; basis for pathogenesis and molecular mechanisms in parasites. Drug resistance: Mechanism of drug resistance in different parasites. Diagnostics: Immunological diagnostic techniques - Immunodiffusion, Immuno-electrophoresis, ELISA, RIA, fluorescence activated cell sorter. Therapeutics: Vaccines; Hybridoma technology; Antibody engineering, synthetic antibodies; Immunity to parasites and therapeutics.

Suggested Books:

1. C. Janeway, P. Travers, M. Walport and M.J. Shlomchik, Immunobiology, Garland Science, New York. (2001)
2. R. A. Goldsby, T. J. Kindt, B.A. Osborne and J. Kuby; Immunology , 5th edition; W.H. Freeman & Company, Pages 19-

BME5201 Open Area Seminar I**BME5203 Advanced Human Genetics**

Induction: Basic concepts in genetics, history genetic diseases, inheritance of single and polygenic disorders in human; autosomal, sex linked, sex limited and sex influenced traits. Molecular basis genetic disorders: common and rare genetic disorders, chromosomal aberrations and mutations. Approaches to identify genetic disorders: Identification and detection of genetic loci causing common and rare genetic disease, linkage and linkage disequilibrium mapping, genomewide association studies, genome sequencing. Epigenetics in genetic disorders: Role of epigenetics in human genetic disorders: mechanism, changes in phenotypes and inheritance. Risk assessments/ predictions: Calculation/predictions of risk of inheritance of genetic diseases, treatment of genetic diseases and ethical considerations

Suggested Books:

1. K. Ikehara, Advances in the study of Genetic Disorders, IntechOpen Limited, The Sharad, 25th Floor, 32 London Bridge Street, London, SE19SG-United Kingdom, 2011
2. M. Levitan, Text book of Human Genetics, Third edition, Oxford University Press, Oxford, U.K. 1988
3. A. Gardner and T. Davies, Human Genetics, Scion Pub., 2009
4. A. Lewish, Human Genetics: Concepts and Applications, 4th Edition, McGraw-Hill, 2001
5. A. Al-Chalabi and L. Almasy, Genetics of Complex Human Diseases: A Laboratory Manual Cold Spring Harbor Laboratory Press, U.S, 2009

BME5205 Protein Engineering

Bonds and Energies in protein: Covalent, Ionic, Hydrogen, Coordinate, hydrophobic and Vander walls interactions in protein structure. Amino acids and their characteristics: Amino acids- structure with three and single letter codes, molecular properties, Chemical reactivity. Protein architecture: Primary structure, Secondary structure, Tertiary structure, peptide sequencing. Structure-function relationship: DNA binding proteins- Prokaryotic transcription factors, Eukaryotic transcription factors, Membrane proteins. Identification and analysis of proteins: Identification and analysis of proteins by 2D analysis, Mass spectrometry.

Suggested Books:

1. P.C.E. Moody and A.J. Wilkinson, Protein Engineering, IRL Press, Oxford, UK. 1990
2. C Branden and J Tooze, Introduction to Protein Structured, Second Edition, Garland Publishing, NY, USA. 1999
3. T.E. Creighton, Proteins, Freeman WH, Second Edition. 1993

4. J. P Sheldon and R.C Jennifer, Protein Engineering and Design, CRC Press. 2009
5. S Lutz and U. T. Bornscheuer, Protein Engineering Handbook, Volume 1 & Volume 2, Wiley publication, 2011

BME5207 Biosensors

Introduction: Biosensors–definition, types and components, biologically active material and analytes as bioreceptors, Types of membranes used in biosensor constructions, Immobilization of bioreceptors, transducers in biosensors and their types, applications and uses of Biosensors, advantages and limitations. Functions of biological sensors: Sensors/receptors in the human body, chemoreceptors: hot and cold receptors, baroreceptors, sensors for smell, sound, vision, osmolarity and taste. Transducers: Electrochemical Transducers, three-electrode system, Reference electrodes, redox systems and mediators for biosensors, electrochemical techniques for biosensing, optical transducers. Types of biosensors: Enzyme electrode, glucose sensors, immunosensors, DNA-based biosensors, optical biosensors, optical fiber sensors, and indicator mediated transducers, surface plasmon resonance, Biosensors based on Evanescent Waves. Applications: Nanomaterials based biosensors, Microfabricated Sensors and the Commercial Development of the I-Stat-Point-of-Care system, Biosensors for personal diabetes management, Non-invasive Biosensors in Clinical Analysis, Biosensors in environmental monitoring, Introduction to Biochips and their application in modern sciences, Bimolecular electronics.

Suggested Books:

1. B.D. Malhotra and C.M. Pandey, “Biosensors: Fundamentals and Application,” Smithers Rapra, UK, 2017.
2. B.D. Malhotra and Md. A. Ali, “Nanomaterials for Biosensors: Fundamentals and Applications,” Elsevier Inc, 2017.
3. J. Wang, “Analytical Electrochemistry,” Wiley-VCH, 1994.
4. A.V.S. De Renck, “Touch Heat & Pain”, Churchill Ltd. London.
5. D. L. Wise, “Applied Biosensors”, Butterworth, London, 1989.
6. J.G. Webster, Encyclopedia of Medical Devices and Instrumentation Vol I,II,III,IV (PHPub), 2006.

SEMESTER II

BME502 Tissue Engineering and Artificial Organs

Historical perspective and introduction: Historical perspective of tissue engineering industry and products; Cell and Tissue Biology: Introduction to basic biology concepts; Stem cells and its applications. Scaffolds for tissue engineering: Classification of scaffold materials, criteria for ideal scaffold, control of architecture; Design and Clinical Implementation. Design of artificial organs: Substitutive medicine, Biomaterial Concentration, Outlook for Organ Replacement, Design Consideration, Evaluation of Artificial Organs. Artificial Heart and Circulatory Assist Devices. Artificial organ studies: Artificial lungs; Artificial kidney;

Artificial pancreas; Artificial blood; Artificial liver. Case studies: Comparison of Artificial Lungs and Natural Lungs, Insulin therapy.

Practicals:

1. Recording of blood pressure using sphygmomanometer and stethoscope
2. Cardiac Efficiency Test
3. Mechanical Stimulation of the eye, Near point and Near response
4. Tuning Fork tests for Hearing
5. To sterilize the materials required for various cell culture practices.
6. To prepare desired growth medium for the given Animal cell culture.
7. Primary Cell Culture To perform primary cell culture technique using chick embryo under aseptic condition.
8. To develop secondary growth or established cells line (Balb3T3).
9. Subculturing of established cells line (Balb3T3).
10. To ensure the population of cells required for the culture works by cell counting method and its viability by vital staining methods
11. To preserve the cells in viable condition for future works by using proper preservative
12. To check cell viability and cell proliferation by MTT assay

Suggested Books:

1. L. L. Hench and J R Jones, Biomaterials, artificial organs and Tissue engineering, Wood head Publishing Ltd, 2005.
2. R P. Lanza, R L William and L. Chick Principle of Tissue Engineering, Academic Press, 2004.
3. Palsson and Bhatia, Tissue Engineering, Pearson Prentice Hall, 2004.
4. J.D. Bronzino, Tissue Engineering and Artificial Organs, CRC Taylor and Francis, 2007.
5. S.M. HollenBerg, Cardiogenic Shock, 2001.
6. G.E. Miller, Artificial Organs Morgan & Claypool Publishers, 2006.

BME504 Immuno- Diagnostics and Therapeutics

Introduction: Innate and acquired immunity, clonal nature of immune response, Concepts in Immunology: Antigens, Antibodies, Antigen-Antibody Reactions.Regulation of immune response: Antigen processing and presentation, generation of humoral immune responses, Cell mediated immune response; cytokines and their role in immune regulation. Cell-mediated toxicity: Mechanism of T-cell and NK-cell mediated lysis, antibody dependent cell mediated toxicity, cytotoxicity and macrophage mediated cytotoxicity, complement activation. Immune disorders: Mechanisms and failures in self-tolerance; complexity of immune disorders, Common autoimmune disease models. Immunology

diagnostics and therapeutics: Immunological diagnostic techniques - Immuno diffusion, immunoelectrophoresis, ELISA, RIA, fluorescence activated cell sorter; Vaccines; Hybridoma technology; Antibody engineering, synthetic antibodies; Immunity to tumors

Practicals:

1. To study antigen antibody interaction by single immunodiffusion
2. To study antigen antibody interaction by double immunodiffusion
3. To study agglutination reactions
4. To perform dot blot techniques
5. Learn ELISA technique by direct and sandwich ELISA
6. Flowcytometry and its various applications
7. Differential count of white blood cells
8. Therapeutic applications in drug design and biomedical application

Suggested Books:

1. C. Janeway, P. Travers, M. Walport and M. J. Shlomchik, Immunobiology, Publisher: Garland Science, New York. (2001)
2. R.A. Goldsby, T.J. Kindt, B. A. Osborne and J Kuby; Immunology; W.H. Freeman & Company, 5th edition, Pages 19-504, 2003.
3. I. M. Roitt and P. J. Delves, Roitt's Essential Immunology; Blackwell Science Ltd., 10th Edition, 2001.
4. T.J. Kindt, B.A. Osborne and R.A. Goldsby, Kuby Immunology. Publisher: W.H. Freeman. (2006)

BME5402

Biophysical System and Signal Simulations

Introduction to continuous and discrete time signal and system: Signal energy and power, Transformation of independent variable, Types of signals. System Properties. Fourieranalysis: For continuous and discrete time process,Fourier transform analysis, C.T.F.Tand D.T.F.T.System .Time frequency and Wavelet analysis. Signal to noise analysis: Need for time frequency analysis for biomedical signal analysis, Introduction to tools: i) S.T.F.T ii) Wavelet. Introduction to Biomedical Signals - Event related potentials- Biomedical Signal Analysis- Estimationof Noise in Signals: Noise bandwidth, Noise factor, Noise factor in an amplifier and cascade amplifier. Feedback system: Basic Feedback concept, Positive and Negative Feedback, Sensitivity analysis, Effect of Feedback on disturbance or Noise, Distortion analysis by FeedBack, Control system-Open loop Control System-Control

system With Feed Back. Modeling of physiological system block diagram: Modeling of Nerve action potential: Hodgkin-Huxley model, Modeling of Skeletal Muscle Contraction: Modeling of Myo electric activity. Modeling of cardiovascular system.

Practicals:

1. Demonstration of different signals and their properties.
2. To identify a given system as linear or non-linear, casual – Non causal.
3. Noise removal from the raw signal using Filters (High pas, low pass and Band Pass)
4. To visualize the relationship between the continuous-time Fourier series and Fourier transform of a signal.
5. To transform time domain signals to frequency domain signals
6. Wavelet analysis of different signals -1D wavelet.

Suggested Books:

1. Oppenheim, A Wilskey and S Nawab- “Signal & System”, Prentice Hall India, 1983.
2. Hayken & VanVeen- “Signal & System”, Willey, 2007.
3. A. Anand Kumar, “*Signals and systems*”, PHI learning Pvt. Ltd., 3rd edition, 2015.
4. Taub & Schilling-“Principles of Communication System”, Tata McGraw Hill, 1970.
5. Kennedy & Devis-“Electronic Communication System”, Tata McGraw Hill, 1970.
6. Gayakward-“Opamps and Linear Integrated Circuits”, Prentice Hall India, 1993.

BME5404

OMICS in Medicine

Introduction: Omics concepts and applications, sequencing of Human and other organisms. Metagenomics of infectious diseases: Role of Genomics in identification of microbes causing infectious diseases (microbiomes study), molecular epidemiology, host resistance to infection, pathogenicity, combating infectious diseases. Detection of genetic disorders: Genomics in detection of genetic disorders and treatment, pharmacogenomics. Epigenomics and non-coding RNAs: Role of Epigenomics and non-coding RNAs in disease development, inheritance and control. Translational and clinical trials: Genomics in translational and clinical trials, and risk assessments/prediction of genetic diseases with few successful case studies.

Suggested Books:

1. T. Strachan and A.P. Read, Garland Human Molecular Genetics, Third Edition, Science Publication, (2003).
2. H. Lodish, A. Berk, and C.A. Kaiser, Molecular Cell Biology, Sixth Edition, W. H. Freeman & Co Ltd, (2007).

3. V. J. Dzau and C. Chin Liew, Cardiovascular Genetics and Genomics for the Cardiologist, Blackwell Publishing, (2007).
4. C. R. Cantor and C. L. Smith, Genomics: The Science of Technology Behind the Human Genome Project, John Wiley & Sons, Inc, (1999).
5. M. Keynes, A.W.F. Edwards and R. Peel, A Century of Mendelism in Human Genetics, CRC Press, (2005).
6. T. Strachan , J. Goodship, P. Chinnery, Genetics and Genomics in Medicine, Garland Science, first edition, Garland Science, New York, U.S.A, (2014) .
7. S. T. Sonis, Genomics, personalized medicine and oral disease(2015) First edition, Springer publisher, 2015.

BME5406

Image Processing in Medicine

Photography and film image: Principle of photography and radiographic film image, image quality factors (resolution, contrast, noise), Visual perception, structure and image formation in the eye, Introduction to digital image processing: Image acquisition and processing, uniform and Non-Uniform Sampling, Quantization, Image formats. Image enhancement: Spatial Domain-Point processing techniques, histogram processing, Frequency Domain techniques-Basics of Fourier transform, 2D-DFT, Low pass and high pass filters, Noise removal, Homomorphic filters. Image Compression. Basic principles of image segmentation and its transforms: Representation and description in image processing, special imaging techniques: Cineradiography, stereoscopic radiography, magnification radiography, microradiography, neutron radiography. Introduction to computed tomography: Principle and configurations/generations, detectors, data acquisition system, spiral CT, scanner parameters, CT Number Reconstruction techniques, Radon Transform, Filtered Backprojection, Radiation therapy: Radiotherapy principles, dosage data for clinical applications (ISODOSE charts), radiation therapy planning, collimators and beam direction devices, dose measurement and treatment planning, teleisotope units, safety protocols & protection.

Suggested Books:

1. R. Gonzalez and E. Woods, Digital Image Processing, Pearson Education, 2009.
2. A.K. Jain, Fundamentals of Digital Image Processing, P.H.I., 1989.
3. C. Majumder, Digital Image Processing and Analysis, Printice Hall India, 2011.
4. Sonka, Hlavac and Boyle, Digital Image Processing and Computer Vision, Cenage learning.
5. W. Pratt, Digital Image Processing, John Wiley & Sons, 2007.

6. Dowsett, Kenny & Johnston, "The Physics of Diagnostic Imaging", Chapman & Hall Medical, 2006.
7. Massey & Meredith, "Fundamental Physics of Radiology", John Wright & Sons, 1977.
8. S. Webb, "The Physics of Medical Imaging", Adam Hilger, Bristol.
9. S.M. Stockley, "A Manual of Radiographic Equipments", Churchill Livingstones, 1986.
10. T. S. Curry, J. E. Dowdey and R. C. murry, Chistrmis, "Physics of Diagnostic Radiology", Lippincott Williams & Wilkins, 1990.

BME5408 Industrial Biotechnology

Introduction to industrial bioprocess: Fermentation, Basic concepts of Upstream and Downstream processes. Production of primary metabolites: Organic acids, Amino acids and alcohols. Production of secondary metabolites: Antibiotics, Vitamins and Steroids. Production of enzymes and other bioproducts: Production of Industrial Enzymes, Biopesticides, Biofertilizers, SCP & Mushroom cultivation. Bioseparation technologies: Solid liquid separation and other DSP steps.

Suggested Books:

1. Casida, Industrial Microbiology. Publisher: New Age International (2003).
2. W. Crueger and A. Crueger, Biotechnology. A Textbook of Industrial Microbiology (1990).
3. M.L. Shuler and F. Kargi, Bioprocess Engineering Basic Concepts, Publisher: Prentice Hall (1987).
4. J.E. Baily and D.F. Ollis, Biochemical Engineering Fundamentals. Publisher: McGraw Hill 2nd edition (1986).
5. R.O. Jenkins, Product Recovery in Bioprocess Technology, BIOTOL Series. Publisher: Butterworth Heinmann (1992).

BME5302 Minor Project-1

BME5304 Neurobiology

Introduction: Fine structure of the brain and its function, synapses, receptors and neurotransmitters. Basic neuroscience: molecular and cellular neurobiology and basic knowledge of general neurobiology. Neurodegenerative disorders: General description, Alzheimer's disease, Huntington's disease, Poly Q disorders, Amyotrophic Lateral Sclerosis (ALS). Cross talk between neurons and muscles: Parkinson's disease, Inclusion body myositis (IBM), Polymyositis (PM). Neurotherapeutics and neuroinformatics: Action of bio molecules in neuroprotection, neuroprosthetics.

Suggested Books:

1. B. F. Mark, B.W. Connors, and M.A. Paradiso, Neuroscience: Exploring the Brain, 3rd ed. Baltimore, MD: Lippincott Williams & Wilkins, 2006. ISBN: 9780781760034
2. D. E. Haines PhD FAAAS FAAA (Author) and G. A. Mihailoff PhD Fundamental Neuroscience for Basic and Clinical Applications, Elsevier, 1998.
3. B F. Mark., Neuroscience , Publisher: Lippincott Williams and Wilkins, ISBN: 9780781778176, 0781778174, Pages: 1008, 2015.

BME5306 Oncology

Gene expression and DNA repair in eukaryotes: Mechanisms of DNA replication, transcription and translation, Telomerase, DNA repair mechanisms. Cell communication and signaling: Cell-cell interactions, Cell junctions, Communicating junctions, Adhesion junctions, Occluding junctions, Cell adhesion molecules, Extracellular matrix, Cell to cell signaling. Cell cycle and apoptosis: Processes and regulation of cell cycle, apoptosis, mitosis and meiosis. Molecular genetics of cancer: General concepts, Normal vs cancer cells, Tumor viruses, Metastasis, Angiogenesis, Genetic pathways in cancer, Roles of oncogenes and tumor suppressor genes in cancer, Regulation by p53 and pRb. Cancer therapy: Diagnosis, Molecularly targeted therapies of cancer, Cancer stem cells.

Suggested Books:

1. B. Alberts, Molecular Biology of the Cell. 6th ed. Garland Science, 2015
2. G. Karp, Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons, Inc., 2002
3. H. Lodish, Molecular Cell Biology. 7th ed. W.H. Freeman and Company, 2012
4. B. Alberts, Essential Cell Biology. Garland Publishing, 2009
5. R.A. Weinberg, The Biology of Cancer, 2nd ed. Garland Science, 2013
6. R. Lanza, Essentials of Stem Cell Biology. 2nd ed. Elsevier Academic Press, 2009

BME5308 Drug Design and Development

Drug discovery: Organized Drug discovery and development; drug delivery systems and high throughput screening systems. Approaches to new drug discovery: Alternative strategies in Lead identification, Lead optimization. Preclinical development. drug metabolism. Enzymes as targets of drug design: Enzyme kinetics, Enzyme inhibition and activation, Approaches to the Rational Design of Enzyme Inhibitors Structures of enzyme, Enzyme inhibition and activation, Approaches to the Rational Design of Enzyme Inhibitors. Receptors as targets of drug design: Receptor Theory, Lead Compound Discovery of Receptor agonists and antagonists Receptor Complexes and Allosteric

Modulators, Pharmacophore-based Ligand Libraries, QSAR; peptido-mimetics; Molecular Mechanics, Protein Folding, Docking, Pharmacophore Models, Quantum Mechanics in Drug Design. Drug design regulations: Clinical trials, Patenting; New age drugs-synthetic vaccine design; personalized medicine.

Suggested Books:

1. C. Hansch (Ed.); Comprehensive Medicinal Chemistry, (Vols. I-VI) Academic Press, 1990.
2. M. Sandler and H.J. Smith; Design of Enzyme Inhibitors as Drugs, Oxford Univ. Press, 1989.
3. J. Matsoukas and T. Mavromoustakos, Drug Discovery and Design: Medical Aspects, IOS Press, 2002.
4. D.R. Flower, Drug Design: Cutting Edge Approaches, The Royal Society of Chemistry, Cambridge, 2002.
5. R.A. Broglia and L. Serrano, Protein Folding and Drug Design, IOS Press, 2007.

BME5202 Microarray Technology

Introduction:Types of microarray, cDNA microarray, oligonucleotide microarray, spotted microarray, *In situ* synthesized microarray, Hybridization process, DNA microarray database. *In situ* synthesized microarray: Method of manufacturing, Phosphoramidite method. Spotted microarray: Method of manufacturing, Photolithography. Data acquisition and chip image analysis:Image segmentation, Intensity measurement, Normalization of data, Clustering analysis, Coexpression analysis. Applications of microarray technology: Differential gene expression analysis, Expression profiling, Genome sequencing, Copy number variation, Alternative splicing detection, Mutation analysis.

Suggested Books:

1. H. Causton, J. Quackenbush and A. Brazma, Microarray Data Analysis: Gene Expression Data Analysis. A Beginner's Guide. Publisher: Blackwell, 2003
2. D.P. Berrar, W. Dubitzky and M. Granzow, A Practical Approach to Microarray Data Analysis. Publisher: Springer, 2003
3. S. Drăghici, Data Analysis Tools for DNA Microarrays. Publisher: Chapman and Hall/CRC, 2003
4. F. E. Streib and M. Dehmer, Analysis of Microarray Data: A Network-Based Approach. Publisher: Wiley-VCH Verlag GmbH & Co., 2008

BME5204 Genetic Manipulation in Medicine

Transgenic technology:Vectors, Methods of transformation, Gene silencing, Co-suppression, Antisense RNA, RNAi, dsRNA-mediated DNA methylation, dsRNA mediated RNA degradation. Cell nuclear replacement: Stem cells, Somatic cell nuclear transfer, Embryo transfer technique, Embryo splitting, Therapeutic cloning, Reproductive cloning. Gene and genome editing:Site-specific integration, Random integration, Knock outs, Knock downs, Recombinases, Zinc Finger Nucleases, CRISPR/Cas 9, Transcription activator-like effector nuclease. Applications in medical and health sectors: Applications of transgenic microbes, plants and animals in medicine, Recent advancements.

Regulations: Biosafety guidelines, National regulatory mechanism, Public perception

Suggested Books:

1. T.A. Brown, Gene Cloning & DNA Analysis: An Introduction. Blackwell Publisher, 2001
2. Primrose & Twyman, Principles of Gene Manipulation & Genomics. Seventh edition, 2006
3. J. Sambrook and D.W. Russel, Molecular Cloning: A Laboratory Manual. Third edition Publisher: Cold Spring Harbor Laboratory Press, 2001
4. B.R. Glick and J.J. Pasternak, Molecular Biotechnology: Principles and Applications of Recombinant DNA. Publisher: ASM Press, 2003
5. S. Rastogi and N. Pathak, Genetic Engineering. Publisher: Oxford University Press, 2009

BME5206 Hospital Management

Organisation and planning of the hospital: Organisational structure: Governance, Duties and responsibilities of the governing board, Management structure: Duties, responsibilities and functions of the CEO, Hospital information System: Benefits, Organisation, Layout, Survey, Financial planning, Equipment planning. Medical and auxiliary services: Emergency services, Clinical laboratories, Radiological services, Diagnostic radiology, Radiation therapy department, Nuclear Medicine, Surgical Department, Physical Medicine and Rehabilitation, CATH lab, OT: Design and related equipments. Nursing services: General nursing unit, Central Nurse Station, Paediatric nursing unit, Isolation rooms, Intensive Care Unit(ICU), Coronary Care Unit(CCU), Newborn nurseries. Hospital services: Electrical system, Air conditioning services, Centralised gas system, Communication systems, Transportation, Biomedical Engineering department: Functions, Designs, Space facilities, Utilities. Safety and security in the hospital: Hospital safety rules, Security and loss prevention, Fire safety, Bomb threat, Alarm systems, Disaster and Disaster preparedness plan, Safety codes for electrical and medical equipments, Medical standards for hospitals and equipments.

Suggested Books:

1. G.B. Kunder and Gopinath, "Hospital Planning, Design and Management", Tata McGraw Hill, 2000.
2. S.L. Goel and R. Kumar, "Principles of Hospital Administration and Planning", Deep and Deep Publications, 2007.
3. B. Feinberg, "Applied Clinical Engineering", Prentice Hall, 1986.
4. J. Webster and A. Cook, "Clinical Engineering Principles and Practices", Prentice Hall, 1979.
5. H.D. Banta and B. Luce, "Health Care Technology and its Assessment", Oxford Medical Publications, 1993.
6. B.M. Sakarkar, "Principles of Hospital Administration and Planning", Jaypee Publications, 2004.

SEMESTER III

BME6401 Bioinformatics

Biological databases: Types, Overview of Biological Databases and Retrieve; Nucleic acid databases: NCBI; Protein Databases- Primary, Functional, Composite, Secondary, Ensembl; Sequence Formats & storage, Sequence submission to sequence database. Computational genomics: Structure of DNA, Polymorphisms in DNA Sequence, Human Genome Project, Complete Genome Sequences, Functional Annotation. Database searching: Local alignment, Global alignment, Scoring matrices- PAM, BLOSUM, Gaps, Dot Plots. Dynamic programming Approach: Needleman and Wunsch Algorithm, Smith and waterman Algorithm, Heuristic Approach: BLAST, FASTA. Multiple sequence alignment: global and local alignments, scoring matrices and gap penalties, filtering, position specific scoring matrices, internet resources, uses of multiple. Sequence alignment, programs and methods for multiple sequence alignment, representation, structural inference. Soft computation: Machine learning, support vector machines, Neural Networks, Fuzzy logic, genetic algorithms - applications to bioinformatics.

Practicals:

1. Inter-conversion different sequence file format
2. Database Searching using Entrez and SRS
3. Study of Databases and Data retrieval
4. Dot Matrix Alignments
5. Needleman Wunsch Alignments.
6. Smith Waterman Alignments
7. Multiple Sequence Alignment & Phylogenetic Tree
8. Understanding machine learning using weka

Suggested Books:

1. A.M. Lesk; Introduction to Bioinformatics; Oxford University Press, 2003
2. D.W. Mount, Sequence and Genome Analysis, Cold Spring Harbor Laboratory, 1st edition; 2004.
3. A.D. Baxevanis and B.F.F Ouellette, Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Wiley-Interscience, 3rd Edition, 2004

BME6403 Biopharmaceuticals

Introduction to pharmaceuticals: History, sources of drugs, Routes of drug administration, Drug metabolism, Prodrug and soft

drugs; Physico-chemical parameters in drug design; QSAR; Active site determination of enzymes; Design of enzyme inhibitors. Pharmacokinetics and pharmacodynamics: Biotransformation of drugs, mechanism of drug action, drug receptors, Preclinical Pharmacokinetics; Assay systems and models (e.g., Knock-out Mice). Pharmaceutical dosage forms: Dosage Forms and Basic Preparations, Clinical Trials, packaging techniques – quality control. Pharmaceutical products and products of DNA technology: Microbial products - Antibiotics, vitamins, probiotics; Plant secondary metabolites; Pharmaceutical products of DNA technology. Drug safety evaluation and patenting process in drug manufacturing process: Regulation of Human Pharmaceutical Safety, Toxicity Testing in Drug Safety Evaluation, Immunotoxicology in Pharmaceutical Development, Pharmaceutical Quality Assurance, Patenting- Patent types, The patent application, Patenting in biotechnology, The role of regulatory authorities.

Suggested Books:

1. H. Klefenz, Industrial pharmaceutical biotechnology, John Wiley sons, 2002.
2. S. Wu-Pong, Y. Rojanasakul, and J. Robinson, Biopharmaceutical drug and design and development, Humana Press, 2007.
3. G. Walsh, Biopharmaceuticals: Biochemistry and Biotechnology (2e), John Wiley & Sons, 2003.
4. H.A. Kirst, W.K. Yeh and J. Milton, Enzyme Technologies for pharmaceutical and biotechnological applications, WILEY-VCH Verlag, 2003

BME6405 Biostatistics

Descriptive Statistics & Probability: Measure of central tendency and dispersion, Axiomatic concepts; Conditional probability. Multiplication rule of probability. Baye's rule. Random variable and expectation: Random variable and distribution function. Mathematical expectation. Statistical parameters. Chebyshev's inequality. Probability distributions: Binomial, Multinomial, Poisson and Exponential distribution. Correlation, regression and sampling distributions: Method of least square and curve fitting, Probable error, Regression, Statistics and sampling distributions, Tests of significance. Exact sampling distributions and small sample test: The Chi-square distribution. Student's t-distribution. Snedecor's F-distribution.

Suggested Books:

1. M. Pagano and K. Gaureau, Principles of Biostatistics, 7th ed., Publisher: Thomson Learning, (2007).
2. S.M. Ross, Probability and Statistics for Engineers and Scientists, 3rd ed. Publisher: Academic Press, (2005).
3. R.E. Walpole, R.H. Myers, S.L. Myers and K Ye, Probability and Statistics for Engineers and Scientists. Publisher: Prentice Hall, Inc. (2002)
4. H.C. Taneja, Statistical Method for Engineering and Sciences Publisher: IK International, (2009).

BME6407 Molecular and Cellular Biophysics

Basic concepts: atomic and molecular structure, molecular orbital theories, Secondary bonding: weak interactions, hydrogen bonding; dipole-dipole & dipole-induced dipole interactions, Molecular structures: conformation parameters of nucleic acids, nucleic acid geometrics, glycosidic bond rotational isomers, DNA polymorphism and supercoiling, base pairing and stacking, Types & structure of RNA, m RNA, tRNA, rRNA & modified nucleotides, tertiary structure of nucleic acids. Proteins: properties of amino acids , equilibria in proteins, structural levels of proteins & stabilizing forces, conformational properties of polypeptides, Ramchandran plot, Helical parameters & conformation, conformational structures of alpha keratin, collagen, actin, conformation of globular proteins, hemoglobin , myoglobin, etc., β bends & bulges, super secondary structures, Domain & motifs, Cell Membranes and Ion channels: Components of cell membrane, electrical properties of cell membrane, membrane organization & stability; Molecular motion in membrane & membrane fluidity, Protein lipid interactions. Electrostatic interaction between membrane surfaces, simple diffusion & facilitated diffusion, diffusion of nonelectrolytes across the membrane, Molecular basis of aqueous channels, osmotic pressure and equilibrium, Ion channel structure and gating function, Ion channel types and characterization, Role of carriers in ion transport, cellular thermodynamics.

Suggested Books:

1. A.E.A. Ellis, L.E.E. & L.E. Williams, Biophysical Science, Prentice-Hall Inc (1979).
2. C. Barrow, Physical Chemistry For Life Sciences, McGraw-Hill(1974).
3. V.A. Bloomfield and R.E. Harrington, Biophysical chemistry, W.A. Freeman and CO(1975).
4. A.V. Bulterl And D. Noble, Progress in Biophysics and Molecular Biology (all volumes) pergamon, Oxford(1976).

Elective 8

BME6301 Bioethics and IPR

Introduction to ethics and bioethics: Ethical theories; Biotechnology and ethics;ethical aspects relating to use of genetic information, genetic engineering and bio-warfare. Ethical implications of cloning: Reproductive cloning, therapeutic cloning; Ethical, legal and socio-economic aspects of gene therapy, stem cell research; ELSI of human genome project. Introduction to biosafety and containment: Biosafety issues in biotechnology; safety protocols, biosafety levels, biosafety guidelines and regulations; types of biosafety containment. Introduction to intellectual property rights: Types of IPR: patents, copy rights, trade marks; importance of IPR, special application of Indian patent laws; IPR in research.

Ethics related to clinical trials: Stages of Clinical trials, protection of rights of subjects in clinical trial cohorts, challenges for the Pharmaceutical and Biotechnological industries and marketing of drugs; Case studies for discussing legal and socioeconomic impacts of biotechnology.

Suggested Books:

1. M.W. Martin and R. Schinzing, Ethics in Engineering, III Edition, Tata McGraw- Hill, New Delhi. 2003.
2. P. J. Atkins, Biotechnologies and Development, UNESCO Publications, 1988
3. A Biotechnologies in developing countries present and future, UNESCO Publishers, 1993
4. K. Singh, Intellectual property rights on Biotechnology, BCIL, New Delhi, 2014.
5. V. Krishna, Bioethics and biosafety in Biotechnology, New Age International Publishers, 2007

BME6303 Population Genetics

Introduction: Population Genetics, Genetic and Phenotypic Variation, mutations and their effect. Population structure: The Hardy-Weinberg Equilibrium, random and non random mating population, effective population size, factors affecting HW equilibrium. Molecular basis of genetic and phenotypic variations: Measuring genetic variation in natural population, understanding the molecular basis of within and between population diversity, population structure, linkage disequilibrium Selection and Mutations. Genetics of evolution: Molecular basis of phenotypic evolution in populations, rate of molecular evolution, synonymous and non synonymous substitutions, mapping and understating of evolution of quantitative traits variations in natural populations. Population genomic and proteomics: Human Population Genetics, Analysis of complex diseases using Genome-Wide Association studies, population structure and demographic history. Epigenetics in populations: role of epialleles and epigenetic mechanism in variation and inheritance in phenotypic traits in populations.

Suggested Books:

1. S Freeman and J C. Hendon, Evolutionary Analysis, Fourth Edition, Pearson Education. Molecular Genetic Analysis of Populations and Hoelzel, 2nd Edition, Oxford University, 1998.
2. Hartl and Jones, Genetics -Principles and Analysis 5th edition Jones and Barlet, 2001.
3. P.W. Hedrick, Genetics of Populations, 2nd Edition, Jones & Bartlett 2000
4. Hartl& Clark, Principles of Population Genetics, 3rd Edition, Sinauer Associates Inc. 1997

BME6305 Artificial Intelligence

Artificial intelligence: Definition, Motivation for computer assisted decision making, Knowledge representation- Production rules, Frames, Predicate calculus and Semantic nets, Knowledge acquisition, reasoning methodologies- Problem representation,

Search, Dempster-shafer theory, Evaluation. Expert systems: Basic concepts of Expert system, Structure of Expert system, Working, Types, Benefits, Problems and limitations of Expert system. Alternative approaches: Genetic algorithm- Genetic operators, Evolution strategies, Probabilistic systems- Bayesian approaches, parameter estimation, Discriminant analysis, regression analyser, Hybrid systems- Hybrid system approaches, components of hybrid system, design methodologies, Pattern recognition- Statistical and Syntactic recognition. Advanced intelligent systems: Objectives of neural network, Early models, Basic concepts, Classes of neural network, Learning – Supervised and unsupervised learning methods, Design, Validation and Evaluation. Fuzzy systems in medicine: Fuzzy machine and signal processing – Unsupervised brain tumor segmentation using fuzzy techniques, Neuro-fuzzy knowledge processing, Neuro- fuzzy control and hardware in medical application.

Suggested Books:

1. D. L. Hudson and M. E. Cohen, Neural Networks and Artificial Intelligence for Biomedical Engineering, IEEE press, 2000.
2. A.M. Base and Elsevier, Pattern Recognition for Medical Imaging, Academic Press, 2004.
3. H.N. Teodorescu, A. Kandel and L.C. Jain, Fuzzy and Neuro- Fuzzy systems in medicine, CRC Press, 1999.
4. E. Turban and J E. Aronson, Decision Support Systems and Intelligent Systems, 6th edition, Prentice-Hall, 2001.

BME6307 Research Methodology

Phenomena, Scientific proofs and conjunctions Research concept, Basis and nature of inquiry and research, types, scientific research, falsification and critical thinking. Introduction to research, need, ethics, research plan, literature review, citation, plagiarism, report structure and writing. Hypothesis, modeling, data collection, test of hypothesis, validation. Literature review- longitudinal and thematic. Nature of data-primary, secondary, techniques of measurement and scaling, sampling methods, sample result. Collection of data-research questionnaire-types of questions, questionnaire design, survey methods. Research design- Exploratory, experimental, causal, analytical, empirical, case research.

Suggested Books:

1. W.J. Goode and P.K. Hatt: Methods in social research. McGraw-Hill New York, (1982).
2. C.R. Kothari, Research methodology: Methods & Techniques, New Age International. New Delhi(2006).
3. M. Roig, Avoiding plagiarism, self-plagiarism, and other questionable writing practices: A guide to ethical writing, (2006)
4. L. Vaughan, Statistical methods for the information professional: A practical, painless approach to understanding, using and interpreting statistics (Ed. 2), Information Today, Medord(2004).
5. I. Willeme, Statistical methods and calculation skills (Ed. 3), Juta. Cape Town(2009).

BME6201 Gene Therapy

Introduction: Somatic and germline gene therapy, Gene replacement and gene addition, *ex vivo* and *in vivo* gene therapy, Applications, Genetic disorders. Gene silencing and transgenics: Vector based gene therapy, siRNA technology, Micro RNA, Transgenics, Gene and genome editing. Gene knockouts: Creation of knockout mice, Disease model, Gene tagging, T-DNA and transposon tagging, Homologous recombination. Gene analysis: cDNA arrays, Intragenic arrays, Differential gene expression analysis, Protein array. Gene therapy and diseases: Case studies, Drug designing, Clinical trials of gene therapeutics, Regulation.

Suggested Books:

1. J. Niewöhner and C. Tannert , Gene Therapy: Prospective Technology Assessment in its Societal Context. Publisher: Elsevier B.V., 2006
2. M. Giacca, Gene Therapy. Publisher: Springer Science, 2010
3. S. Rastogi and N. Pathak, Genetic Engineering. Publisher: Oxford University Press, 2009
4. S.S. Stober and D. Yarri, God, Science, and Designer Genes: An Exploration of Emerging Genetic Technologies. Publisher: Praeger, 2009
5. R.W. Herzog and S.Zolotukhin, Guide to Human Gene Therapy. Publisher: World Scientific Publishing Company, 2010

BME6203 Entrepreneurship

Introduction: Definition. growth of small-scale industries; role of small scale industries in the national economy; characteristics and types of small scale industries; Government policy for small scale industry; stages in starting a small scale industry. Project identification: Assessment of viability, formulation, evaluation, financing, field-study and collection of information, preparation of project report, demand analysis, material balance and output methods, benefit cost analysis. Accountancy: Preparation of balance sheets and assessment of economic viability, decision making, expected costs, planning and production control, quality control, marketing, industrial relations, sales and purchases. Project planning and control: The financial functions, cost of capital approach in project planning and control. Economic evaluation, risk analysis, capital expenditures, policies and practices in public enterprises. capital expenditure and operations. control of financial flows, control and communication. Laws concerning entrepreneur: Partnership laws, business ownership, sales and income taxes and workman compensation acts.

Suggested Books:

1. Forbat, John, "Entrepreneurship" New Age International, 2008.
2. Havinal, Veerbhadrappa, "Management and Entrepreneurship" New Age International, 2009.
3. J. L. Massie, "Essential of Management", Prentice Hall of India, 1971.

BME6205 Biomechanics

Introduction: Fundamentals of mechanics, torsion, bending, stress transformation, thermodynamics. Mechanics in Physiology: Applications of mechanics in physiology. Mechanical properties of biomaterials: Mechanical properties of bones, cartilage. Physiological application of Mechanics: Muscle movements, forces and mechanics, Current Research topics; IPR and patents.

Reference Books:

1. R. Hibbeler, Mechanics of Materials, 10th edition, ISBN 9780134321240, 1985.
2. D. Knudson, Fundamentals of Biomechanics, Springer Publication; ISBN 978-0-387-49312-1, 2003.
3. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007

BME6207 Alternative Medicine

AYUSH: medical systems practiced in India such as Ayurveda, Yoga & Naturopathy, Unani, Siddha and Homeopathy, The basic approach of all these systems on health, disease and treatment. Mental Health Disorder and Psychotherapy: different types of mental health disorders and treatment, including hospitalization, inpatient, outpatient, and psychotherapy. Physiotherapy and Supportive care: Physiotherapy in palliative care, supportive care in treatment of disease, and psychological, social, and spiritual problems related to a disease or its treatment. Naturopathy and Nutrition: Yoga, types of Yoga and its relevance, Meditation, Diet and Nutrition. Health awareness and Public Health Systems.

Suggested Books:

1. L. Emmerton, J. Fejzic, & S.E. Tett, Consumers' experiences and values in conventional and alternative medicine paradigms: A problem detection study (PDS). BMC Complementary and Alternative Medicine, 12(1), 39. doi:<http://dx.doi.org/10.1186/1472-6882-12-39>, (2012).
2. W. Jonas, Advising patients on the use of complementary and alternative medicine. Applied Psychophysiological Biofeedback, 26(3), 205-214., (2001).

