



D. Y. Patil University

D.Y. PATIL EDUCATION SOCIETY KOLHAPUR DEEMED UNIVERSITY

(Declared under section 3 of the UGC act 1956)

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POST-GRADUATE PROGRAM IN MEDICAL BIOTECHNOLOGY

COURSE CURRICULUM

M.Sc. MEDICAL BIOTECHNOLOGY (Choice based Credit System)



BL-MB-01: Introduction

Centre for Interdisciplinary Research is initiating a new course on M.Sc. Medical Biotechnology since 2017. This course focuses on the Scientific and Industrial application of biotechnology in support of medicine. The course concentrates on various aspects of basic science such as cell and molecular biology, immunology, genetics, microbiology etc. with a special focus on applied/industrial and medical biotechnology coupled with biological processes, technologies and skills used in the research and development of pharmaceutical products, vaccines and devices for the application in medical industry

BL-MB-02: Vision, Mission and Goal

VISION

M. Sc. Medical Biotechnology is a post graduate biotechnology course in medical field. The vision of the course is to provide the students with knowledge within areas such as medical biotechnology, applied and Industrial biotechnology, Nanotechnology, Cell Physiology, Enzymology, Research Methodology and Entrepreneurship.

MISSION

- To provide a stepping stone for aspiring students willing to pursue research and employment opportunities in Academic or Industrial Sector.
- To impart hands-on- training in the field of medical biotechnology
- To help students in gaining higher education to fulfill the purpose of research and employment.

GOAL

- To introduce a host of scientific development, legal and ethical issues that shape the public view of the medical biotechnology and its applications.
- To provide students with basic concepts and understanding of how the various drivers of medical biotechnology interact with one another and shape this industry and impact the growth of medical biotechnology companies.



OUTCOMES

- Student will have extensive theoretical and practical knowledge on Medical Biotechnology
- Understanding the use of relevant analytical techniques within the field of medical biotechnology.
- Increasing awareness of professional, ethical and social responsibilities with relationship to medical biotechnology.
- Increasing the opportunities to pursue higher studies in foreign countries.

BL-MB-03: Syllabus

SEMESTER-I

Theory Papers	Theory marks	Internal marks	Total marks
(Paper I) MB.1.1.1 Molecular Cell Biology	80	20	100
(Paper II) MB.1.1.2 Immunology	80	20	100
(Paper III) MB.1.1.3 Biochemistry	80	20	100
(Paper IV) MB.1.1.4 Developmental Biology, Anatomy and Histology	80	20	100
Practical	Marks		
(Practical I) MB.1.1.P.1 Molecular Cell Biology and Developmental Biology	80	-	80
(Practical II) MB.1.1.P.2 Biochemistry, Anatomy and Histology	80	-	80
(Practical III) MB.1.1.P.3 Industry visit and report	40	-	40
Total	520	80	600



SEMESTER-II

Theory Papers	Theory paper marks	Internal marks	Total marks
(Paper V) MB.1.2.1 Cell Physiology & Metabolism	80	20	100
(Paper VI) MB.1.2.2 Biomedical Instrumentation	80	20	100
(Paper VII) MB.1.2.3 Biomaterials, Medical Nanobiotechnology & Tissue Engineering	80	20	100
(Paper VIII) MB.1.2.4 Animal Models Biostatistics & Bioinformatics	80	20	100
Practical	Marks		
(Practical IV) MB.1.2.P.4 Cell Physiology, Metabolism and Biomedical Instrumentation	80	-	80
(Practical V) MB.1.2.P.5 Biomaterials, Medical Nanobiotechnology & Tissue Engineering, Animal Models, Biostatistics & Bioinformatics	80	-	80
(Practical VI) MB.1.2.P.6 Industry visit and report	40		40
Total	520	80	600

SEMESTER-III

Theory Papers	Theory paper marks	Internal marks	Total marks
(Paper IX) MB.2.3.1 Enzymology and Enzyme Technology	80	20	100
(Paper X) MB.2.3.2 Applied and Industrial Biotechnology	80	20	100
(Paper XI) MB.2.3.3 Molecular Diagnostics and Therapeutics	80	20	100
(Paper XIIA) MB.2.3.3 Stem Cell Biology			
(Paper XIIB) MB.2.3.4 Medical Microbiology and Human Genetics	80	20	100
Practical	Marks		
(Practical VII) MB.2.3.P.7 Enzymology and Industrial Biotechnology	80	-	80
(Practical VIII) MB.2.3.P.8 Medical Microbiology and Genetics	80	-	80
(Practical IX) MB.2.3.P.9 Industry visit and report	40	-	40
Total	520	80	600



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SEMESTER-IV

Theory Papers	Theory paper marks	Internal marks	Total marks
(Paper XIII) MB.2.4.1 Research Methodology	80	20	100
(Paper XIV) MB.2.4.2 Entrepreneurship & Management	80	20	100
Project and Practical			
(Practical X) MB.2.4.P.10 Major Project	350	-	350
(Practical XI) MB.2.4.P.11 Industrial visit and report	50	-	50
Total	560	40	600



COURSE CURRICULUM

SEMESTER-I

(Paper I) MB.1.1.1– Molecular Cell Biology (60h)

1. Cell structure and Membrane Transport (15 h)

Evolution, Prokaryotes, Eukaryotes & their organelles, Cytoskeleton, the self assembly and dynamic structure of cytoskeletal filaments, regulation of cytoskeletal filaments, molecular motors. Cell Polarity & Membrane Transport, Introduction to cell polarity, Cell-cell adhesion, Cell junction proteins, Cell-matrix adhesion, and Extracellular matrix. Membrane composition and structure, Membrane fluidity (Fluid mosaic mode) ,Active and passive transport, mediated and non-mediated transport, Carrier proteins Na⁺ driven pumps, Na⁺-K⁺ ATPase pump, Ca²⁺,H⁺ pumps, Membrane potential and action potential (propagation of an impulse, salutatory conduction, chemical synapse, long term potentiation).

2. Cell Signaling and cell cycle regulators (15 h)

Cell Signaling, feedback & crosstalk, signaling molecules & their receptors, functions of cell surface receptors: G Proteins – coupled receptors, tyrosine kinase, enzyme linked receptors, pathways of Intracellular signal transduction: C-AMP pathway, Cyclic GMP, PI3-Kinase Phospholipids & Calcium homeostasis, RAS/ RAF & MAP kinase, JAK /STAT & TGF – β/Smad pathways, NF- κB signaling ,Wnt pathway, signaling based on pro-cleavage pathway (Hedgehog, Notch & SHP-2- ER signaling). An overview of the cell cycle, mitosis and meiosis, components of the cell cycle, control system, intracellular control of cell-cycle events. Programmed cell death (Apoptosis)

3. Central dogma theory (15 h)

DNA replication: Initiation, elongation and termination in prokaryotes and eukaryotes, Gene stability and DNA repair, DNA repair enzymes, photoreactivation, nucleotide excision repair, mismatch correction, SOS repair. Recombination: homologous and non-homologous recombination, site specific recombination.



Prokaryotic Transcription & Regulation, promoters, operators, Initiation, Termination, operon concept; Regulation of transcription of lactose and tryptophan, Processing of t-RNA and r-RNA, types of RNA polymerase, 5'-Cap formation, 3'-end processing and polyadenylation in Eukaryotic, RNA Splicing.

Translation: Ribosomes composition and assembly, Universal genetic code, degeneracy of codons, termination codons, wobble hypothesis. Mechanism of initiation, elongation and termination, Transport of proteins and molecular chaperones, protein stability, protein turnover and degradation.

4. **Molecular biology of cancer**

(15 h)

Molecular biology of Cancer – Activation of oncogenes, Inactivation of tumor suppressor genes, Inappropriate expression of micro RNAs in cancer, Chromosomal rearrangements and cancer, Viruses and cancer, Chemical carcinogenesis.

Text/Reference Books:-

1. Bruce Alberts, Alexander Johnson, Julian Lewis, Keith Roberts, Peter Walter - Molecular Biology of the Cell, 5th edition (2007), Garland science, New York.
2. Harvey Lodish- Molecular Cell biology, 5th edition (2003), Freeman W. H. and company
3. Gerald Karp - Cell Biology, 7th edition (2013), Wiley publications.
4. E. D. P. De Robertis and E. M. F. De Robertis Jr.- Cell and Molecular Biology, Eight edition (2010), Lippincott Williams & Wilkins publication.
5. James Watson, Tania Baker, Stefan Bell, Alexander Gann, Michelle Lewin, Richard Losick - Molecular biology of the gene, 7th edition (2013), Pearson publications.



(Paper II) MB.1.1.2 Immunology (60 h)

1. Basics of Immunology and humoral immune response (15 h)

Adaptive and Innate immunity, Humoral Immunity, Mucosal Immunity, Cellular Immunity, Cells of immune system, Memory responses, Inflammation, Vaccination, Primary and secondary lymphoid organs, Lymphocyte trafficking

Immunoglobulin structure, Different classes of immunoglobulins, Functions of Ig, Immunoglobulin variability, Regulation of Ig production, Antibody specificity and affinity maturation

2. Development of the immune system and Antigen presentation (15 h)

Lymphocyte development, Immune tolerance, B cell development and signaling events involved in B cell differentiation, T-cell development and signaling events involved in T-cell development. Structure of antigens, Antigen recognition, Antigen presenting cells, Antigen processing, Role of MHC and accessory molecule, Cells involved in immune effector responses, Cytokines, neuro-endocrine modulation, Genetic factors affecting immune responsiveness.

3. The complement pathways and cell mediated immunity (15 h)

Complement components, complement receptors, classical pathway and alternate pathways of complement activation. T cell regulation, T cell subsets, Activation of T and B cells, Cell mediated cytotoxicity, Antibody dependent cell mediated cytotoxicity (ADCC), NK cells, LAK cells, Macrophages, activation of macrophages, Immune- adhesion molecules.

4. Cytokine, Chemokines and Autoimmunity (15 h)

Lymphokines, Chemokine families, Cytokine signaling, role of chemokines in homing and inflammation, transplant immunology and immunological tolerance, acute & chronic graft rejection, natural, experimental, auto immunity, Hypersensitivity type I, II, III and IV reactions. Autoimmune disorders, Tumor immunology, Immunological techniques



Texts/Reference Books:-

1. Jenni Punt, Judy Owen, and Sharon Stranford - Kuby Immunology- 7th edition (2013), Macmillan publications
2. Abul K. Abbas, Andrew H. H. Lichtman, and Shiv Pillai- Cellular and Molecular Immunology, 8th edition (2014), Elsevier publications
3. Hood, Wood and Wilson - Immunology , 2nd edition (1984)
4. Ivan M. Roitt- Essential Immunology, 8th edition (1994), Blackwell Sci., Oxford.

(Paper III) MB.1.1.3- BIOCHEMISTRY

(60 h)

1. Chemistry of carbohydrates

(15 h)

Classification, properties and biological functions, Monosaccharide's- classification, properties, functions, isomerism, D & L forms, Disaccharides -Glycosidic bond, classification, composition and biological importance. Polysaccharides: Classification, properties and functions. Salic acid and blood group substances Identification tests for sugars. Characterization/identification test used for sugars, Disorders of carbohydrate metabolism, Diabetes mellitus, Glycohemoglobins, Hypoglycemia, Ketone bodies, Glucose tolerance test.

2. Chemistry of proteins

(15 h)

Classification, properties and biological functions, Amino acid: Classification, structure and properties, amphoteric nature, isoelectric point, peptide bond formation, Protein Structure: primary, secondary, tertiary and quaternary, Oxygen transporting proteins- myoglobin, hemoglobin, collagen structure and functions.

3. Chemistry of lipids and nucleic acids

(15h)

Classification, properties and functions of lipids. fatty acids-composition, classification, characteristics and functions, Simple lipids-Triglycerides Conjugated lipids: phospholipids-types and functions, glycolipids lipoproteins. Cholesterol-structure,



properties, occurrence and functions. Liposomes, lipids, lipoproteins and apolipoproteins-role in diseases. Experimental evidence for nucleic acids as genetic material. Components of nucleic acids. Structure of nucleosides and nucleotides. Watson and Crick model of DNA A, B and Z forms of DNA. RNA-structure and type. Inborn errors of nucleic acid metabolism.

4. Nutrition and organ function tests (15 h)

Classification of nutrition. Composition of nutrition. Caloric contents of food. Daily caloric requirement-BMR, specific dynamic action and physical activity- factors affecting and significance. Formulation of diet in health and disease. Balanced diet and nutritional diseases. Urine profile. Liver function tests. Kidney function tests. Chemical analysis of CSF. Electrolyte and fluid balance and its disorders. Electrolyte, blood gases and acid base balance.

Text/Reference books:

1. Jeremy M. Berg, Lubert Stryer, John L. Tymoczko, Gregory J. Gatto- Biochemistry, 8th edition (2015), WH Freeman publications.
2. A. L. Lehninger, D.L. Nelson and M.M. Cox- Principles of Biochemistry –2nd edition. Worth Publishers, U.S.A.1993
3. Biochemistry by Voet Donald, Voet, Judith G. (2004) 3rd edition (J Wiley and Sons.)

(Paper IV) MB.1.1.4 -Developmental Biology and Histology (60 h)

1. Developmental Biology and clinical embryology (15 h)

Introduction of animal development, Scope of development biology, stages of animal Development, Evolution of development, Techniques used to study mechanisms of development.

Differentiation of germ cells and gametogenesis, Fertilization and implantation. Stages of human embryonic development, Congenital malformations and teratogenesis. Reproductive failure and infertility and assisted reproduction.



2. Fate mapping And regeneration: (15 h)

Fate Mapping, Autonomous cell specification by cytoplasmic determinants, Specification of cell fate by progressive cell-cell interactions Establishment of body axis in mammals. Regeneration, aging and metamorphosis.

3. Organogenesis and extra embryonic membranes (15 h)

Formation of germ layers (gastrulation and neurulation up to formation of notochord) Placenta, amnion and amniotic fluid, yolk sac and allantois. The development of the heart, vessels, bones, teeth, mammary gland, digestive tract & its derivative and nervous system, Parturition & multiple pregnancies.

4. Anatomy and Histology (15 h)

Human Systems- Alimentary system, Cardiovascular System, Respiratory system, Digestive system, Urinary systems, Central Nervous system, Musculoskeletal System, Endocrine system, Reproductive system

Human Histology: Cytoplasm – Cytoplasmic matrix, cell membrane, cell organelles, cytoskeleton, cell inclusions, cilia and flagella. Nucleus – nuclear envelope, nuclear matrix, DNA and other components of chromatin, protein synthesis, nucleolus, nuclear changes indicating cell death. Cell cycle, mitosis, meiosis, cell renewal. Cellular differentiation and proliferation. Tissues of Body: Light and electron microscopic details and structural basis of function, regeneration and degeneration. The systems/organs of body – Cellular organization, light and electron microscopic features, structure function correlation, and cellular organization. Histology– microscopy, basic tissues, blood vessels, lymphoid tissue and histology of organs

References

1. Scott F Gilbert and J. F. Beressi- Developmental biology, 11th edition (2016), Sinauer publishers
2. John Hall Arthur Guyton- Text Book of Medical Physiology, 11th edition. (2005), Elsevier.



3. Tortora and Derrickson : Principles of Anatomy and Physiology, 11th edition . (2005)
Wiley
4. Inderbir Singh: Text Book of Human Histology with Colour Atlas, 6th edition. (2011)
Jaypee
5. Richard Drake A. Wayne Vogl Adam Mitchell- Gray's Anatomy for students, 3rd
edition (2014), Elsevier.
6. Moore and Persaud - The developing human, clinically oriented embryology.
6th edition (1998). Saunders press.

SEMESTER-I

(Practical I) MB.1.1.P.1 Molecular cell Biology and Developmental Biology (30 h)

- 1) Preparation of temporary slides of Mitosis from Onion root tips
- 2) Preparation of temporary slides of meiosis from *Tradescantiabuds/Datura/Testis*.
- 3) Cell counting and viability
- 4) Blood smear preparation
- 5) Karyotyping analysis.
- 6) Preparation of slides of polytene chromosomes.
- 7) Microscopy techniques
- 8) Isolation of genomic DNA.
- 9) Isolation of RNA.
- 10) Estimation of DNA and RNA.
- 11) Gel electrophoresis
- 12) ABO blood grouping
- 13) Cell toxicity assay (Trypan blue indicator and MTT);
- 14) apoptosis of cells
- 15) Culture and mounting of Chick embryo.
- 16) News ring method
- 17) Shell less culture
- 18) Demonstration of Chick embryo fibroblast.

(Practical II) MB.1.1.P.2 Biochemistry Anatomy, Histology and Immunology (30 h)

- 1) Separation of amino acids by paper chromatography.
- 2) Separation of phospholipids by TLC technique.
- 3) Colorimetric estimation of glucose.
- 4) Colorimetric estimation of proteins.
- 5) Determination of isoelectric pH of Proteins.
- 6) Demonstration of various organ systems of mice/rat.
- 7) Spotting of bones.
- 8) Spotting and discussion of histological slides of animal tissues.



- 9) Microtome and hematoxylin and eosin staining
- 10) ABO blood grouping
- 11) Immunodiagnosics using commercial kits
- 12) Immunohistochemistry
- 13) Mixed lymphocyte reaction.

(Practical-III) MB.1.1.P.3 Industrial visit and report

SEMESTER-II

(Paper V) MB.1.2.1 CELL PHYSIOLOGY& METABOLISM (60 h)

1. Carbohydrate Metabolism: (15 h)

Introduction of metabolism and overview. Digestion and absorption of carbohydrates. Glycolysis - aerobic and anaerobic, regulation of glycolysis. Krebs cycle and its regulation Alternate pathways of carbohydrate metabolism- Hexose Monophosphate shunt, Glyoxylate pathway. Interco versions and metabolism of other sugars (Fructose, Galactose & Mannose) Gluconeogenesis, Glycogenesis and glycogenolysis and their regulation. Regulation of blood glucose and homeostasis. Disorders associated with carbohydrate metabolism-glycogen storage diseases, galactosemia.

2. Lipid and Protein Metabolism: (15 h)

Digestion and absorption of lipids. β -oxidation of fatty acid and regulation. Energy yields from fatty acid oxidation. Synthesis of fatty acid and regulation. Synthesis of triacylglycerides. Role of acylcarnitine. Ketone bodies - formation and utilization. Disorders of lipid metabolism (Ketosis, Niemann Pick disease, Gaucher's disease, hypercholesterolemia, hyper and hypolipoproteinemia, fatty liver, obesity and therosclerosis Classification and biological importance of proteins. Digestion and absorption of Protein Amino acid metabolism (Transamination, Deamination, urea cycle) and its signifigance, Disorders associated with Protein metabolism – phenylketonuria, albinism, alkaptonuria



3. Enzymes:

(15 h)

Biochemical nature of Enzyme, Characteristics of enzymes. Enzyme substrate complex. Concept of active centre, binding sites, and ES complex formation. Enzyme activity, international units, specific activity, turnover number. Activation energy. Transition state theory. Mechanism of Enzyme Catalysis. Enzyme kinetics: Michaelis-Menten Equation Significance of V_{max} and K_m . Factors affecting enzyme activity. Enzyme inhibition - types of inhibitors -competitive, non-competitive and uncompetitive, Allosteric enzymes. Diagnostic importance of Enzyme & Enzyme pattern in diseases. Structure function relations: Lysozyme, ribonuclease, trypsin, Immobilized enzyme

4. Hormones, Vitamins and Minerals:

(15 h)

General classification of hormones - synthesis, structure, secretion, metabolism and mechanism of action of pancreatic, thyroid, parathyroid, pituitary, adrenal. Hormonal control of spermatogenesis, menstrual cycle, pregnancy and lactation. Prostaglandins and functions of Prostaglandins. Cell membrane and intracellular receptors for hormones. Secondary messengers. General nature, classification, sources, active forms and metabolic role, deficiency manifestations, daily requirement and hyper vitaminosis of water soluble and fat soluble vitamins. Study of macro elements (Calcium, phosphorous, Magnesium, Sodium, Potassium) and microelements (Iron, copper, manganese, Cobalt, Iodine, Zinc, Fluorine and their physiological importance.

TEXT/ REFERENCE BOOKS:-

1. Jeremy M. Berg, John L. Tymoczko and Lubert Stryer - Biochemistry, 5th edition (2002), W.H. Freeman and Company, New York.
2. A. L. Lehninger, D.L. Nelson and M.M. Cox- Principles of Biochemistry – 2nd edition (1993) Worth Publishers, U.S.A
3. Voet Donald Voet, Judith G. – Biochemistry, (2004) 3rd edition J Wiley and Sons.
4. C. Guyton, John E. Hall - Human physiology and mechanisms of disease, 6th edition (1997), Saunders publication.



(Paper VI) MB.1.2.2 Bio -Medical Instrumentation (60 h)

1. Instruments for Basic tissue Culture &Ultrasound Technique: (15 h)

Carbon dioxide incubators – types & functions, Laminar Air flows- Types & functions, “FACS” technique for Evaluation of Markers of Stem Cell, Instruments for Ultrasound Technique-Principles, Applications, Machines, Probes, Frequencies, Diagnostic & Interventional indications.

2. Instruments for Cryopreservation: (15 h)

Mechanical and Thermal Properties of engineering materials at low temperatures; Components of Cryogenic refrigerators and liquefiers; Compressors: types, construction and characteristics; Expansion machines: characteristics of reciprocating and turbine expanders, design of J-T expander; Heat exchangers: theory, types, design approaches and selection criteria, Irreversibility in cryogenic Heat exchangers; Safety in cryogenic systems: Design of cryogenic storage vessels, transfer devices, insulation system, valves; Characteristics of cryogenic pumps, Safety of cryogenic systems.

3. Chromatography Techniques: (15 h)

Partition and adsorption Chromatography- paper, TLC, GLC, gel filtration, ion exchange chromatography, HPLC, HPTLC, affinity chromatography, hydrophobic interaction chromatography, metal chelate chromatography, covalent chromatography, DNA cellulose chromatography and MAK hydroxyl-apatite chromatography.

4. Electrophoresis, Spectroscopy and other Analytical Instruments: (15 h)

Types of electrophoresis: moving boundary electrophoresis and zone electrophoresis (paper, cellulose -acetate electrophoresis, gel Electrophoresis (starch gel, native PAGE, disc PAGE, gradient PAGE, SDS-PAGE, agarose gel electrophoresis, Isoelectric focusing, 2D gel electrophoresis). UV and visible, NMR, ESR, IR, Mass Spectrometry. Filters: Nitrocellulose, fiber glass, Polycarbonate filters, Hollow membrane fiber (Ultrafiltration), dialysis, reverse dialysis, freeze drying and lyophilisation. Sedimentation: Preparatory and analytical ultracentrifuges, Zonal centrifugation. (Proteins, enzymes & other biomolecules). PCR, RT-PCR, Flow cytometer.



Text/Reference Books :-

1. M.Arumugam- Bio-Medical Instrumentation, 1st edition (2003)Anuradha Agencies.
2. L.A. Geddes and L.E.Baker- 'Principles of Applied Bio-Medical Instrumentation', 1st edition (1975) John Wiley & Sons.
3. J. Webster- 'Medical Instrumentation, 1st edition (1995)John Wiley & Sons.
4. C. Rajarao and S.K. Guha- Principles of Medical Electronics and Bio-medical Instrumentation, 1st edition (2000) Universities press (India) Ltd.

(Paper VII) MB.1.2.3-Biomaterials, Medical Nanobiotechnology and Tissue Engineering (60 h)

1. BIOMATERIALS

(15 h)

Properties of Materials, Classes of materials used in medicine:

Metals, Polymers, Hydrogels, Bioresorbable and Biodegradable Materials, Ceramics, Natural materials, Composites, Thin films, grafts, Coatings, Medical fibers and Biological functional materials.

Host reactions to biomaterial: Inflammation, Wound healing and the Foreign body response. Systemic toxicity and Hyper sensitivity. Blood coagulation and Blood-materials Interactions Tumorigenesis.

Testing biomaterials: In Vitro and In Vivo assessment of tissue compatibility. Testing of blood- material interactions. Animal model.

2. MEDICAL NANOBIO TECHNOLOGY

(15 h)

Diagnosis: BiomemsNanochips-Gene chip and Protein chip., Ultrasensitivebiobarcode., Nano chip for HIV detection(targeting Cd4)., Quantum dots

Treatment: Nanorobotics, Cancer (pebble brain cancer) Nanoparticles A platforms for cancer therapy, Bucky balls, Textiles and wound care products, Implantable material for vascular interventions, Active implantable devices and bionics, Dendrimer, Implantable materials for orthopedics and dentistry. Nanotechnology based chemotherapy (smart bomb)



3. NANOTECHNOLOGY IN TISSUE ENGINEERING

(15 h)

Introduction of tissue engineering and implants Impact of nanotechnology on tissue engineering and implants: Cell transplantation (liver) Nano structuring/Nano coating Titanized synthetics Nanoneuro knitting Development of synthetic polymer Nano- scale patterns for induction of stem cell differentiation Smart scaffolds. Nano scale tissue engineering & growth of new organs.

Preparation and use of biological scaffold.

4. TISSUE ENGINEERING AND ITS CLINICAL APPLICATION

(15 h)

Reconstruction of the skeleton, bone, cartilage, teeth,

Reconstruction of skeletal and cardiac muscle, urinary bladder, liver, cornea.

Tracheal tissue engineering transplant, Bladder tissue engineering transplant

Vein & arteries tissue engineering transplant.

Texts/Reference Books:-

1. Harry F. Tibbals- Medical Nanotechnology and Nanomedicine, 1st edition (2010) CRC Press
2. Viola Vogel- Nanotechnology, volume 5 (2009), Wiley-ICH publications
3. Buddy D. Ratener, Allan S. Hoffman- Biomaterial Science: An Introduction to Material in Medicine, 3rd edition (2012), Elsevier.
4. J.J. Mao, G. Vunjak-Novakovic- Translational Approaches In Tissue Engineering & Regenerative Medicine, 1st edition (2008), Artech House, INC Publications.

(Paper VIII) MB.1.2.4 Animal Models, Biostatistics & Bioinformatics

(60 h)

1. Animal models for human diseases

(15 h)

The animal model Concept, Classification of animal models, Classification of disease models Model body size and scaling, Methods for creating transgenic animals (SCID & Knock Out) Selection of biomedical animal models: History of animal use in research. Definition of animal model. Types of animal models Legislative and legal requirements



for using animals in Research choosing the right model. improved models for animal research: Animal Models of Diabetes, Acute & chronic liver disease, Animal Model System for Studies of the efficiency of Anticancer therapies Ethical basis for animal use in research

2. Basic concepts in biostatistics and sampling techniques (15 h)

Definition – Biostatistics, Variable Quantitative Variable, Qualitative Variable, Random Variable, Discrete random Variable, Continuous Random Variable, Examples of applications of statistics in Biology.

Sampling:

Definitions: Population Sample, Advantages of Sample Studies. Types of Samples - Convenience Sample, Random Sample. Methods of Sampling- Simple random sampling, stratified random sampling, systematic sampling, cluster sampling, multistage sampling, multiphase sampling (Definitions, merits, demerits and applications only) Sampling error.

Descriptive statistics: Types of data - Qualitative, Quantitative, Categorical, Raw and grouped data. Averages - Arithmetic mean, Geometric mean, Median, Mode (Calculations, merits, demerits and uses). Measures of dispersion - Range, Mean deviation, Variable standard deviation, Coefficient of Variation (Computation, merits, demerits and application)

Graphical Presentation of data - Pie chart, Bar diagram, Line graph, Histogram, Frequency polygon, Frequency Curve

3. Probability distributions, correlation and regression (15 h)

Sample space, Events, Definition of probability - Classical relative frequency, axiomatic properties of probability (only statements). Conditional probability. Addition theorem, Multiplication theorem and Baye's theorem (only statements)

Discrete probability distributions-Binomial and Poisson (concept and list of applications.)

Continuous probability distribution-Normal distribution concept, properties and applications.



Tests of significance: Null hypothesis, Alternate hypothesis, Type I error, Type II error, Level of significance, p-value, Power of the test, Concept of test of significance. Chi-square test, Normal test, Student's t-test (paired and unpaired). Confidence interval for arithmetic mean and proportion. One-way analysis of variance (only introduction)

Correlation and Regression: Dependent Variable, Independent variable, Definition and properties of simple Pearson's correlation coefficient, Test of significance of correlation coefficient, concept of simple linear regression, scatter graph with regression line.

4. Bioinformatics

(15 h)

Protein and DNA database, Sequence alignment programs, FASTA and BLAST Searches, Gene expression analysis using microarray, MiRNA sequencing, Sequence analysis using BIOPERL, Biochemical pathway database, Finding useful resources on the www.

Text/Reference Books:-

1. Wayne W. Daniel, Chad L. Cross- Biostatistics: A foundation for analysis in the health science, 10th edition (2013), John Wiley & sons
2. J. Richard, Sundar P. S. S. Rao- Introduction to Biostatistics and Research Methods, 4th edition (2006), Prentice-Hall of India Pvt. Ltd. publication
3. Armitage P and Berry G - Statistical methods in medical Research, 4th edition (2008), Oxford Blackwell scientific publication
4. Sokal P R and Rohlf F. R. - Biometry: The principles and practice of statistics in Biological, 3rd edition (1981), Freeman and company Sanfrancisco

(Practical- IV) MB.1.2.P.4 Biomaterials, Medical Nanobiotechnology and Tissue Engineering, Animal Models of Human diseases and Bioinformatics

1. Preparation of tissue engineered Alginate Capsules.
2. To study metal and polymer as Biomaterials
3. Tissue engineered composites Hydrogel.
4. Preparation of Cytodex beads.
5. Synthesis of silver NPs from different plant extracts.
6. Synthesis of gold NPs from different Plant extracts.



7. Antimicrobial activity of silver NPs.
8. Preparation decellularize porcine/ bovine tracheal scaffold.
9. Preparation decellularize porcine/ bovine arteries and vein scaffold
10. Estimation of blood glucose in Alloxan induced diabetic mice/rats by Glucometer.
11. Estimation of glucose in urine of Alloxan induced diabetic mice/rats by Urostrips method.
12. Getting an amino acid sequence, nucleotide sequence and blasting.
13. Structure analysis: secondary, tertiary and quaternary structure, bond angle, bond length, different interactions.

(Practical- V) MB.1.2.P.5. Cell Physiology, Metabolism and Bio-Medical Instrumentation

1. Cell fractionation and centrifugation.
2. Identification and quantitation of activity of enzymes
3. Determination of enzyme activity in presence of activators.
4. Determination of enzyme activity in presence of inhibitors.
5. Determination of optimum pH of enzyme
6. Determination of optimum temperature of enzyme
7. Determination of K_m of enzyme
8. Column Chromatography of proteins.
9. Isolation of Starch and characterization.
10. Estimation of Cholesterol.
11. Determination on alpha amino nitrogen of amino acid.
12. UV-spectrophotometer estimation of Protein.
13. Cell cycle analysis
14. Live cell imaging by microscopic technique

Demonstration experiments

- A. FISH
- B. Cell tracing technique
- C. Real time PCR
- D. Microarray
- E. 2D PAGE
- F. Mass spectrophotometry
- G. Zeta analysis.
- H. DLS

(Practical- VI) MB.1.2.P.6 Industrial visit and report



SEMESTER-III

(Paper- IX) MB.2.3.1 Enzymology and Enzyme Technology (60 h)

1. Introduction To Enzymes & Enzyme Kinetics: (15h)

The Enzyme, Introduction, nomenclature and classification, applications in Industrial, Medical, Analytical, Chemical, Pharmaceutical and Food Sectors, specific activity, turnover number, Enzyme kinetics, Michaelis - Menten equation, Brigg's-Haldane equation & estimation of constants using graphical technique, Kinetics for reversible reactions, basics of enzymatic reaction, collision theory and transition state theory and role of entropy in catalysis, Enzyme inhibition kinetics, substrate product and toxic substance inhibition.

2. Pre-Steady-State Enzyme Kinetics: (15 h)

Determination of rate constants, rapid mixing, stopped flow, determination of the number of active sites of enzyme and relaxation technique. Enzyme kinetics at limiting condition, enzyme kinetics at interface and kinetics of multi substrate reactions.

3. Effect Of Physical Factors & Enzyme Kinetics In Biphasic Reaction: (15 h)

Temperature dependence of rate constants of enzymatic reaction, thermal deactivation, pH effect on rate constants and protein structure. pH dependence: ionization of Acids and Bases. Enzyme kinetics in biphasic liquid systems, stabilization of biphasic aqueous-organic systems, equilibria in biphasic aqueous- organic systems.

4. Enzyme Immobilization & Kinetics Of Immobilization: (15 h)

Immobilization of Biocatalysts an Introduction, Electrostatic Effect, effect of charged and uncharged support, Effect of external and internal mass transfer, Damkohler number, effectiveness factor, Interparticles diffusion kinetics, Biot number.



TEXT BOOKS:

1. C. Walsh - Enzymatic reaction mechanisms, (1979) WH Freeman, San Francisco.
2. I. Segel- Enzyme Kinetics, (1993) Wiley Interscience, New York.
3. An introduction to enzyme and coenzyme chemistry by T. Bugg 2nd edition (2004), Blackwell Publishers, Oxford.
4. A. Cornish-Bowden - Fundamentals of Enzyme Kinetics, 3rd Edition (2004), Portland Press, London.

(Paper – X) Paper MB.2.3.2 Applied and Industrial Biotechnology (60 h)

1. Bioreactor and Fertilizers (15 h)

Design, parts and their functions. Types of reactor. Upscaling of the fermentation process. Regulation of fermentation process. Quorum sensing in Bioprocess. Genetic modification of industrial microorganism. Metabolites from micro-organisms- amino acids and antibiotics, microbial polysaccharides, Azospirillum, Azolla, Rhizobium, Frankia, VAM. Petrocrops, Single cell proteins (SCP), aquaculture. Improvement of nutritional value of seed storage proteins. Genetic engineering of plant for virus, pest and herbicide resistance, Biopesticide and Biofertilizers.

2. Medical application of r-DNA technology (15 h)

Human disorders associated with defects in protein/enzyme biosynthesis. DNA probes and their application in diagnostics of genetic and other disorders. Detection of HIV, hepatitis virus in human. Quantitative assay of viral DNA by branched DNA and PCR methods. Introduction to basic concepts of Nanobiotechnology.

3. Environmental Pollution– (15 h)

types of pollution methods for management of the pollution, Environmental management, waste water treatment, degradation of xenobiotics in Environment, Bioremediation of xenobiotics and heavy metals, Ozone depletion, greenhouse effect and acid rains and their impact and biotechnological approaches of management. Use of microbes: Mineral beneficiation and oil recovery



4. Basic Concepts of Intellectual Property: (15 h)

Introduction to intellectual property rights; Intellectual property laws; Trade Related Aspects of Intellectual Property Rights. Forms of IPR like patent, design and copyright trademark, IPR Laws. Bioethics: Necessity of bioethics, different paradigms of bioethics-national and international, Ethical issues against molecular technologies

Textbooks

1. Campbell, M.A and Heyer L.J.,- Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition (2007), CSHL Press, Pearson/Benzamin Cummings San Francisco, USA.
2. James W Goding- Monoclonal antibodies: Principles and Practice, 3rd Edition (1996), Academic Press.
3. Old R.N. and Primerose S.B.- Principles of Gene manipulation : an introduction to genetic engineering , 5th edition (1994), Blackwell scientific.

(Paper –XI) Paper MB.2.3.3 Molecular Diagnostics and Therapeutics (60 h)

1. Host pathogen interactions in disease process (15 h)

Protective immune response in Bacterial, Viral and Parasitic diseases; Cancer; Inappropriate Immune response; Disease pathology and clinical spectrum; Clinical diagnosis of diseases; Molecular Genetics of the host and the pathogen, Biochemical disorders; Immune, Genetic and Neurological disorders; Molecular techniques for analysis of these disorders; Assays for the Diagnosis of inherited diseases; Bioinformatic tools for molecular diagnosis Antibody based diagnosis; Monoclonal antibodies as diagnostic reagents; Production of monoclonal antibodies with potential for diagnosis; Diagnosis of bacterial, viral and parasitic diseases by using; ELISA and Western blot.

2. DNA sequencing and diagnosis (15 h)

Isolation of DNA; purification and analysis; DNA sequencing and diagnosis; PCR and Array based techniques in diagnosis; Single nucleotide polymorphism and disease association; Two dimensional gene scanning Isolation of proteins and other molecules



associated with disease; Process and their profiling for diagnosis; 2D analysis of such proteins by sequencing individual spots by Mass Spectrometry; Protein Micro array; Present methods for diagnosis of Specific diseases like Tuberculosis, Malaria and AIDS; Ethics in Molecular Diagnosis

3. Gene therapy (15 h)

Intracellular barriers to gene delivery; Overview of inherited and acquired diseases for gene therapy; Retro and adeno virus mediated gene transfer; Liposome and nanoparticles mediated gene delivery Cellular therapy; Stem cells: definition, properties and potency of stem cells; Sources: embryonic and adult stem cells; Concept of tissue engineering; Role of scaffolds; Role of growth factors; Role of adult and embryonic stem cells; Clinical applications; Ethical issues

4. DNA technology and Gene Silencing (15 h)

Clinical applications of recombinant technology; Erythropoietin; Insulin analogs and its role in diabetes; Recombinant human growth hormone; Streptokinase and urokinase in thrombosis; Recombinant coagulation factors Immunotherapy; Monoclonal antibodies and their role in cancer; Role of recombinant interferons; Immunostimulants; Immuno suppressors in organ transplants; Role of cytokine therapy in cancers; Vaccines: types, recombinant vaccines and clinical applications, Antisense therapy; siRNA; miRNA and silencing, transfection techniques, Tissue and organ transplantation; Transgenics and their uses; Cloning; Ethical issues

Texts/References

1. Campbell, M.A and Heyer L.J.- Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition (2007), CSHL Press, Pearson/Benzamin Cummings San Francisco, USA.
2. Andrew Read and Dian Donnai- New Clinical Genetics, 3rd edition (2007) Scion Publishing Ltd, Oxford shire, UK.
3. James W Goding- Monoclonal antibodies: Principles and Practice, 3rd Edition (1996), Academic Press



4. George Patrinos and Wilhelm Ansoarge, Molecular Diagnostics, 1st Edition (2005), Academic Press.
5. Lela Buchingham and Maribeth L Flawsm, Molecular Diagnostics: Fundamentals, Methods and Clinical Applications, 1st Edition (2007), F A Davis Company, Philadelphia, USA.

(Paper XII A) MB.2.3.3 Stem cell Biology (60 h)

1. Introduction and basic biology of stem cells (15 h)

Stem cell evolution, Historical perspective - with model systems, Stemness basic, Type of stem cells, Embryonal carcinoma cells: Teratomas and Teratocarcinoma, Stem cell markers, Stem cell niches, Trans-differentiation, Growth Factors and Paracrine mechanism and action of stem cells,

Cell stage to blastocyst formation, Implantation, gastrulation, properties and characterization of embryonic stem cells, Types of adult stem cells: Bone marrow, adipose tissue, cord blood, placenta etc, Differentiation and trans-differentiation of stem cells, regulation of stem cell niche in different adult tissues.

2. Isolation of Pluripotent stem cell and molecular mechanism of Self renewal and differentiation (15h)

Isolation and maintenance of embryonic stem cell isolated from: Mouse, Human, Primate, Avian, Xenopus, Serum and feeder free culture of embryonic stem cells Alternate method of isolation of embryonic stem cell lines, Isolation and maintenance of Trophoblast, characterization of embryonic stem cells, Extracellular signaling involved in embryonic vs adult stem cells, Genetic regulation of stem cell fate, Telomerase and its regulation, cell cycle and their regulators: embryonic vs adult cells, Symmetric and asymmetric division.

3. Hematopoietic and non-hematopoietic stem cells and their differentiation (15h)

Bone marrow microenvironment, Hematopoietic stem cell mobilization, mesenchymal stem cells and their properties, Hematopoietic Vs mesenchymal stem cells, Isolation of Hematopoietic and mesenchymal stem cells, Ex vivo expansion, Characterization of



Hematopoietic and mesenchymal stem cells, Transcriptional regulation of Hematopoietic and mesenchymal stem cells, Side population phenotypes, endothelial progenitor cells, Multipotent adult progenitor cells, Differentiation of stem cells in-vivo and ex-vivo, Differentiation of hematopoietic stem cell lineages, Differentiation of mesenchymal stem cells in to osteoblast adipocyte, chondrocyte lineages, Transdifferentiation of mesenchymal stem cell into various lineages, differentiation into endothelial cells and stem cell mediated angiogenesis.

4. Cancer stem cells and their regulation (15h)

Introduction to cancer, Oncogenes, Tumor suppressive gene, Metastasis, Stem cell origin of cancer, Cancer stem cells, Pathways involved in cancer stem cells and their tumor progression, cancer stem cells, pericytes and tumor angiogenesis.

Text/Reference Books

1. K. D. Deb and S. M. Totey - Stem cell basics and application, 2nd edition (2011) Tata McGraw Hill Pvt. Ltd.
2. Robert Lanza -Hand book of Stem Cells, 1st edition (2004) Elsevier Academic Press.
3. Stewart Sell -Stem Cells Handbook, 2nd edition (2013) Humana Press.
4. Arlene Y. Chiu, MahendraRao - Human embryonic stem cells, 2nd edition (2003) Humana Press.
5. Press.
6. S. Indumathi- Stem cell therapy for organ failures, 1st edition (2015), Springer Verlag.



(Paper XII B) MB.2.3.4 Medical Microbiology and Human Genetics (60 h)

1. Infections of the Gastrointestinal Tract, Respiratory system and Nervous system (15 h)

Amoebiasis; Giardiasis and cryptosporidiosis; Intestinal infection by nematodes; Intestinal infection by cestodes (taeniasis and H.nana infection); Trematodes; Bacterial food poisoning(toxic and infective); E.coli Diarrhoea; Cholera; Bacillary dysentery; Hepatitis , Streptococcal infections; Viral infections; Diphtheria; Whooping cough; Bacterial pneumonias (Haemophilus and GNB, Pneumococcus/Legionella/ etc); Tuberculosis, Viral encephalitis and Aseptic meningitis; Rabies; Cysticercosis and other CNS parasitic infections; Tetanus

2. Bacterial and Viral Diseases (15 h)

Malaria; Kala-azar; Leishmaniasis; Filaria; Enteric fever; Brucellosis; Rickettsial diseases; Leptospirosis and relapsing fever; Viral Hemorrhagic fever, Herpes Simplex virus infections; HIV infection and AIDS; Chlamydial infection; Syphilis; Mycoplasma and Ureaplasma infection; Gonorrhoea and other bacterial STD; Congenital viral infections; Toxoplasmosis

3. Mendelian and non-Mendelian Genetics and Gene Mapping (15 h)

Introduction to human genetics; Background and history; Types of genetic diseases; Role of genetics in medicine; Human pedigrees; Patterns of single gene inheritance - autosomal recessive; autosomal dominant; X linked inheritance; Complicating factors - incomplete penetrance; variable expression; Multiple alleles; Co dominance; Sex influenced expression; Hemoglobinopathies - Genetic disorders of hemoglobin and their diseases. Non Mendelian inheritance patterns Mitochondrial inheritance; genomic imprinting; Lyon hypothesis; isodisomy. Complex inheritance - genetic and environmental variation; Heritability; Twin studies; Behavioral traits; Analysis of quantitative and qualitative traits, Physical mapping; linkage and association Population genetics and evolution Phenotype; genotype; gene frequency; Hardy-Weinberg law;



Factors distinguishing Hardy-Weinberg equilibrium; Mutation selection; Migration; Gene flow; Genetic drift. Human genetic diversity; Origin of major human groups.

4. Cytogenetics, Developmental Genetics and Immunogenetics (15 h)

Cell division and errors in cell division; Non disjunction; Structural and numerical chromosomal abnormalities – deletion; duplication; translocation; Sex determination; Role of Y chromosome; Genetic recombination; Disorders of sex chromosomes and autosomes; Molecular cytogenetics–Fluorescence In Situ Hybridization (FISH); Comparative Genomic Hybridization (CGH), Genes in early development; Maternal effect genes; Pattern formation genes; Homeotic genes; and Signaling and adhesion molecules, Major histocompatibility complex; Immunoglobulin genes - tissue antigen and organ transplantation; Single gene disorders of immune system. Mutations; kinds of mutation; agents of mutation; genome polymorphism; uses of polymorphism.

Textbooks/ References:

1. S.R. Maloy, J.E. Cronan, D. Friefelder- Microbial Genetics, 2nd Edition (1994), Jones and Bartlett Publishers.
2. N. Trun and J. Trempy- Fundamental Bacterial Genetics (2004), Blackwell publishing.
3. Strachan T and Read A P- Human molecular genetics, 3rd Edition (2006) Wiley Bios.
4. Mange E J and Mange A. P.- Human genetics, 2nd Edition (1999), Sinauer Associates publications.
5. Hartl L D and Jones B- Analysis of genes and genomes, 3rd Edition (1994), Jones and Bartlett Publishers.

Practical - VII (MB.2.3.P.7) Enzymology and Industrial Biotechnology (30 h)

1. Measuring time course of an enzyme
2. Effect of varying enzyme concentration
3. Estimation of K_m and V_{max} for an enzyme
4. Effect of temperature on enzyme activity
5. Effect of pH on enzyme activity
6. Effect of metal ions on enzyme activity
7. Enzyme inhibition
8. Temperature stability of enzymes
9. pH stability of enzymes
10. Bacteriological analysis of food products.



11. Determining the quality of milk by MBRT.
12. Agglutination reactions – blood group, Widal, VDRL.
13. Enzyme Linked Immunosorbent Assay.
14. Antibiotic sensitivity test by well and disc methods.
15. DLC, TLC.
16. Preservation methods.
17. Isolation and identification of major bacterial pathogens such as Staphylococcus, Streptococcus etc.

Practical – VIII (MB.2.3.P.8) Medical Microbiology and Genetics

(30 h)

1. Pure culture techniques: Isolation and characterization of pure cultures from soil, water or patients samples
2. Preparation of liquid media for growth of microorganisms & determination of growth curve,
3. Total cell count
4. Isolation and maintenance of organisms by plating, streaking and serial dilution
5. Determination of Antibiotic resistance
6. Determination of MIC
7. Preparation of competent cells & transfer of selected genetic marker by transformation,
8. Demonstration of episome transfer using “F” plasmid, Demonstration of plaque assay of bacteriophages
9. Behavior of mutants on indicator plates; Isolation of mutants using UV light
10. Reversion test (Ames Test)
11. Detection of restriction and modification enzyme activity
12. Gene complementation using gene transfer technique
13. Measurement of gene expression using reporter assay

Practical IX (MB.2.3.P.9) Industrial visit and report



D. Y. Patil University

SEMESTER-IV

(Paper –XIII) MB.2.4.1. RESEARCH METHODOLOGY (60 h)

1. Research

(15 h)

Need and importance of Research in General and with special reference to scientific research. Criteria of selecting a Research problem-Limitations and Delimitations. Reasons for surveying related literature. Allied and critical Literature.

2. Hypothesis

(15h)

Significance of Hypothesis. Types of Hypothesis. Meaning and Nature of Experimental Research. Sources of Experimental Invalidity.

3. Experimental Designs:

(15h)

Introduction, Types of Experimental Design, Pre, True and Quasi Experimental designs. Research Report, Identifying research problem, funding agencies

4. Computer Applications

(15h)

Introduction to spreadsheet application, features and functions, Using formulas and functions, Data storing, Features for Statistical data analysis, Generating charts/ graph and other features. Tools used may be Microsoft Excel, Open office or similar tool. Introduction to presentation tool, features and functions, Creating presentation, Customizing presentation, Showing presentation. Tools used may be Microsoft Power Point, Open Office or similar tool.

Introduction to Internet, Use of Internet and WWW, Using search engine like Google, Yahoo etc, and Using advanced search techniques.

References:

1. Panneerselvam, R.- Research methodology, Prentice hall of India, New Delhi, 2004.
2. Kothari CR- Research methodology-methods and techniques, 2nd edition (2009) New Wiley Eastern Ltd., Delhi, 2009.



3. Ranjit Kumar-Research methodology-step by step guide for beginners 1st edition (1999), Sage publications.
4. Norman K. Denzin- The SAGE handbook of qualitative research, 1st edition (2005, SAGE publications).

(Paper- XIV) MB.2.4.2. ENTREPRENEURSHIP AND MANAGEMENT (60 h)

1. Introduction (15 h)

Meaning – nature and characteristics of Management, Scope and Functional areas of management. Management V/s Administration – Roles of Management, Levels of Management. Evolution of management thought: early, contemporary and modern.

2. Nature and purpose of planning and Organization (15 h)

Types of plans .Decision making. Importance of planning – steps in planning & planning premises.Hierarchy of plans.Components of planning.Principles of organization, Types of organization.DepartmentationCommittees.CentralizationVs Decentralization of authority and responsibility. Nature and importance of staffing–Process of Recruitment and Selection.

5. Meaning and nature of directing (15 h)

Understanding, Supervision, motivation and leadership. Leadership styles, Motivation Theories (Abraham Maslo, Herzberg and Victor Hvrom’s). Communication – Meaning and importance. Meaning and steps in controlling – Essentials of a sound control system – Methods of establishing control (in brief).

6. Structure of a Biotechnology Company (15 h)

Start-up of Biotechnology Company, New Product Development. Market Research. Sales &Marketing Principles. Intellectual Property Principles in Biotechnology. Health Care Overview and Role of Government in Biotechnology. Ethical and Other Legal Issues in Biotechnology



D. Y. Patil University

Reference Books:-

1. P.C.Tripathi, P. N. Reddy - Principles of Management, 5th edition (2012), Tata McGraw Hill,
2. Vasant Desai – Dynamics of Entrepreneurial Development & Management, 4th edition (2001), Himalaya Publishing House.
3. Poornima M.Charantimath- Entrepreneurship Development Small Business Enterprises, 2nd edition (2006), Pearson Education..
4. Stephen Robbins- Management, 17th Edition (2003), Pearson Education.

(Practical-X) MB.2.4.P.10 Major Project

(Practical –XI) MB.2.4.P.11 Industrial visit and report

BL-MB-04: Course structure and distribution of credits

M.Sc. Medical Biotechnology is on choice based credit system and consists of total 14 theory courses, 6 practical lab courses and 4 Industrial visits and 1 major project spread over 4 semesters. First three semesters consists of 12 theory courses (4 theory papers in each semester), 6 practical lab courses with 3 Industrial visit. Fourth semester consists of 2 theory papers, one Industrial visit and a research project. For third semester, student can select one theory paper from groups of elective papers [(Paper XIA) MB. 2.3.3 Stem Cell Biology or (Paper XIIB) MB.2.3.4 Medical Microbiology and Human Genetics)]. Each theory course will be of 4 (four) credits, a practical lab course will be of 4 (four) credits, Industrial visit is of 3 credits and project will be of 8 (eight) credits. A student earns 27 (twenty seven) credits per semester for first 3 semesters and 19 credits in semester 4. Total of 100 credits overall in 4 semesters.



D. Y. Patil University

BL-MB-05: Scheme of Examination and Standard of passing:

Scheme of examination

1. This course will have 20 % Internal Assessment (IA) and 80% external (University written examination of 3 hours duration for each course paper and practical examination of 3 hours duration for each practical). All external examinations will be held at the end of each semester and will be conducted by the University as per the existing norms.
2. Internal assessment- IA (20%) and University examination (80%) - shall have separate heads of passing (i.e. 8 Marks for passing in IA and 32 Marks for passing in University examination)
3. To pass, a student has to obtain minimum grade point E.
4. The University (external) examination for Theory and Practical shall be conducted at the end of each Semester.
5. The candidate shall prepare and submit for the practical examination a certified journal based on the practical course carried out under the guidance of a faculty member with experiments as specified in the syllabus for each group.
6. The candidate shall prepare the dissertation based on the Research Project for the fulfillment of Master's Degree.



Standard of Passing

As per ordinances and regulations prescribed by the University for semester based credit and grading system.

Standard point scale for grading:

Grade	Marks	Grade Points
O	70 & above	7
A	60-69.99	6
B	55-59.99	5
C	50-54.99	4
D	45-49.99	3
E	40-44.99	2
F(Fail)	39.99 & below	1

Grade Point Average (GPA) calculation:

- GPA is calculated at the end of each semester after grades have been processed and after any grade have been updated or changed. Individual assignments/quizzes/surprise test/unit/tests/tutorials/practicals/project/seminars etc. as prescribed by University are all based on the same criteria as given above.

The teacher should convert his marking into the Quality-Points and Letter-Grade.

- Performance of a student in a semester is indicated by a number called Semester Grade Point Average (SGPA). It is the weighted average of the grade points obtained in all the

$$SGPA = \frac{\sum_{i=1} C_i p_i}{\sum_{i=1} C_i}$$

C_i = The number of credits earned in the i^{th} course of a semester.
 p_i = Grade point earned in the i^{th} course
 $i = 1, 2, \dots, n$ represents number of courses for which the student is registered.



D. Y. Patil University

subjects registered by the students during the semester.

3. The Final remark will be decided on the basis of Cumulative Grade Point Average (CGPA) which is weighted average of the grade point obtained in all the semesters registered by the 1 earner.

$\sum_{j=1} C_j p_j$	C_j = The number of credits earned in the j^{th} course upto the semester for which the CGPA is calculated
$\text{CGPA} = \frac{\sum_{j=1} C_j p_j}{\sum_{j=1} C_j}$	p_j = Grade point earned in the j^{th} course*
	$j = 1, 2, \dots, n$ represents number of courses for which the student is registered upto the semester for which the CGPA is calculated.
	* : A letter Grade lower than E in a subject shall not be taken into consideration for the calculation of CGPA
	The CGPA is rounded upto the two decimal places.